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THE

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THE

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## NOTES.

**Faraday Society.**—We regret that in the report of this society's proceedings, which appeared in our last issue, the name of Mr. L. Gaster should have been inadvertently rendered as "Mr. L. Gasta."

**Municipal and County Club.**—At the next house dinner on the 27th inst., Sir William J. Collins, M.D., D.L., J.P., chairman of the Education Committee, London County Council, will be the guest of the club.

**New Publications.**—"Catalogo da Biblioteca du Marina," two vols. (Rio de Janeiro Government Printer). The library of the navy department of Brazil is a highly technical one, and is arranged on the decimal system of Melvil Devoy by Captain-Lieutenant J. A. dos Santos Porto. There is a subject index and an author's index, the former containing 928 pages.

**Personal.**—We are pleased to hear that Mr. Gisbert Kapp has recently been made an honorary member of the Physical Society of Frankfort. This honour shows that Mr. Kapp's work is as highly appreciated on the Continent as in this country, and it will afford him a pleasant reminder of his friends across the Channel when he returns to England to take up his appointment at Birmingham University.

**Electric Lighting Provisional Orders.**—Elsewhere in this issue will be found an official list of applications for electric lighting provisional orders for the next session of Parliament. The total number is 62, which is 14 less than in the last session. Looking through the list, we see that this year 32 municipal authorities are seeking electric lighting powers in the districts they control or in adjoining areas, and that there are 30 companies asking for powers. Last year 35 local authorities and 41 companies sought powers. The reduction in the number of applications is largely due to the fact that electric light and power services have already been organised in the most remunerative areas within the United Kingdom. Quite a large number of applications, both last year and this, come from power distribution companies who wish to supply small areas in bulk.

**Manufacturers and Contractors.**—The agreement between the Electrical Manufacturers' Association and the Electrical Contractors' Association has been terminated, the primary cause being the question of preferential discount. Formal notice was given by the first-named organisation in order that terms might be reconsidered, whereupon the contractors put forward counterclaims for amendment, they having for a long time alleged grievances against the manner in which manufacturers interpreted the clauses referring to preferential discount. The grievance of the contractors appears to be that discounts have been given to parties outside the legitimate trade, and the official organ of the contractors considers that the question of contractors being accorded the "favoured nations" clause should be a secondary consideration as compared with the exclusion of outsiders from participation in the preferential discount. We observe that negotiations are about to be opened with a view to a fresh compact, and we trust that an equitable solution will be arrived at, as it is eminently desirable that there should be concord between the two interests. To attain this end, it will be well if the parties first come to a distinct understanding as to who is entitled to trade discount.

**Personal.**—Mr. E. Kilburn Scott, A.M.I.C.E., M.I.E.E., has been appointed chief of the electrical engineering department at Sydney University. We understand that this is a new department, which he will have to organise and work. Mr. Kilburn Scott has for the past four years been a lecturer to the senior electrical engineering students at the Northampton Institute, Clerkenwell. In addition to his lecturing duties at Sydney, we understand that he will engage in consulting practice. His experience with Messrs. Johnson and Phillips and other firms included a considerable amount of power transmission work. It will be remembered that Mr. Kilburn Scott is the author of a treatise on "The Local Transmission of Power for Workshops," which we published some years ago. We wish him every success in Australia.

**Commercial Education in Japan.**—The perusal of an interesting little article on this subject in the *Journal* of the Society of Arts impresses one with the systematic manner in which the Island Empire of the East has, as in other fields, set to work to frame a curriculum of commercial education. There are practically three stages, culminating in the high schools at Tokyo and Kobé, which may be regarded as commercial universities. One of the leading features of the system is the excellent way in which the grades are consolidated, a student on completing one course being ripe for the next. The substance of the training consists of internal and external economics, technology, practical physics, general law, mathematics, and composition, with such foreign languages as English, German, French, Chinese, and Korean. Dai Nippon is certainly not lacking in culture, yet our allies do not consider it necessary to instil the classics into the youth intended for a commercial career, though it will be noticed that considerable attention is paid to the languages of countries with which he is likely to have dealings. For linguistic instruction the foundations at Tokyo and Kobé have several foreign professors, who in course of time will be replaced by natives, as was done in regard to electrical tuition, organised by Profs. Ayrton and Perry. In fact, this has been the Japanese policy in practically all spheres, including the public services. Japan does not disdain to borrow from the West. On the contrary, where she excels is in selecting her instructors from the most capable, and in adopting the best features of their civilisation, while rejecting the bad or the indifferent.

**Inventors' Rights.**—An important judgment was delivered by Mr. Justice Buckley the other day concerning the relations between employer and employé in reference to patents. The litigation arose out of a machine to gin cotton without injuring the fibre, but the legal aspect of

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the case is of general application. A patent was obtained by the plaintiff, and while the machine was under construction certain variations were made, for which the defendant, who had just before been engaged by plaintiff as an engineering draughtsman, appears to have contributed a few trifling suggestions. These alterations were made the subject of a supplementary patent. Shortly afterwards the plaintiff summarily ended his association with the defendant. A day or two later the defendant filed an application on his own behalf, the specification for which was almost a facsimile copy of that lodged by the plaintiff in connection with his supplementary patent. His Lordship, in revoking the patent which had been granted to defendant through the oversight of the plaintiff's agents in not depositing an objection within the allotted time, cited the following words from the judgment of Mr. Justice Earle in Allen *v.* Rawson: "I take the law to be that if a person has discovered an improved principle, and employs engineers, agents, or other persons to assist him in carrying out that principle, and they in the course of experiments arising from that employment make valuable discoveries accessory to the main principle and tending to carry that out in a better manner, such improvements are the property of the inventor of the original improved principle, and may be embodied in his patent; and if so embodied the patent is not avoided by evidence that the agent or servant made the suggestion of the subordinate improvement of the primary and improved principle." It is reassuring to see that on this point law accords with equity.

**Electrolytic Formation of Carbon.**—In the *Zeitschrift anorg. Chemie*, Messrs. F. Haber and S. Tolloczko contribute an article upon the reduction to carbon of chemically-combined carbonic acid, of which an abstract appears in the *Journal* of the Chemical Society. Solid sodium hydroxide was fused in an iron dish; it was then cooled, and as soon as it solidified was electrolysed by a current of 0·15 ampere and 11 volts, and finally at 200deg. with one ampere and five volts. The yield of sodium was 39 to 46 per cent. Barium chloride was electrolysed at a temperature 400deg. below its melting point. When barium carbonate is added to barium chloride, carbon is formed at the cathode in quantitative amount. By aid of sodium, barium carbonate is readily converted into oxide, whilst carbon separates. Barium chloride and barium carbonate were fused together in a nickel crucible, allowed to cool, and then electrolysed at 550deg. to 600deg., the cathode consisting of iron, platinum, or graphite. Carbon separated in a dendritic form. The E.M.F. between 550deg. and 580deg. varied from 6 to 10·4 volts, whilst the current strength varied from 22 to $45 \times 10^{-3}$ amperes. In the experiments with graphite electrodes, the latter were not attacked. During the electrolysis of barium chloride in a Hempel furnace, carbon was formed at the cathode, owing probably to the action of carbon dioxide and oxygen present in the heating gases on barium chloride, a reaction which proceeds thus: $BaCl_2 + CO_2 + O = BaCO_3 + Cl_2 - 11{,}850$ cal. The analogous reaction with calcium chloride, proceeding according to the equation $CaCl_2 + CO_2 + O = CaCO_3 + Cl_2 + 1{,}550$ cal, was studied. Chlorine is also produced in an analogous manner by the action of carbon dioxide and oxygen on sodium chloride. No carbon was obtained when barium chloride was electrolysed in an electric furnace at about 600deg. in an atmosphere of nitrogen. For the formation of barium and nickel chlorides as products of the electrolysis of solid barium chloride with nickel anodes, a polarisation of 2·65 volts would be expected according to the equation $Ba + NiCl_2 = BaCl_2 + Ni + 122{,}400$ cal. The value of 1·9 volts was found corresponding with the free energy of formation of solid barium chloride and nickel from the reaction $2BaCl + NiCl_2 = 2BaCl_2 + Ni$; the reaction $Ba + BaCl_2 = 2BaCl + 34{,}600$ cal. corresponds with 0·7 volt. Determinations of the E.M.F. of two solid Daniell cells, $PbCl_2/AgCl$, agreed with the calculated value 0·519 volt.

**Cape Town.**—The report of this Corporation for the year ending Sept. 22, from which we gave some extracts as to electric lighting last week, contains a number of interesting items. In the new station in Dock-road there are two 750-kw. dynamos, driven by Ferranti engines of 1,000 h.p., the largest of their kind in Africa. The number of consumers of electric light has been multiplied by 37 since the opening of the system in 1895. Up till 1900 very few people took energy for power purposes, but on a special reduction for day current being introduced the number promptly rose, and up to February of last year the motors connected represented 1,375 b.h.p., the result of a steady increase from 200 b.h.p. since the reduction in charge. The plant is called upon to provide energy at night for street and private lighting equal to about 50,000 8-c.p. lamps, leaving a margin of some 20 per cent. on the peak load. The charges have undergone material reduction since 1897, and from 1900 energy has been supplied in the day at 4d. per unit, as against 8d. at night. Mr. W. F. Long, the city electrical engineer, anticipates that within the next few months the economy lately effected in operating costs will enable the Corporation to again reduce their tariff, at any rate for lighting, and also the maximum charge for power; but he does not think they will be able to get below 4d. for energy in the daytime just yet. A new type of lamp has been installed in the side streets, and the overhead wires for street-lighting have been superseded by cables from England of double the size, enabling arc lamps to be placed in all the principal streets. In the year ending September, 1903, the Council paid interest and sinking fund charges to the amount of £9,244, a sum of £5,921 was placed to depreciation, £5,362 was allotted for small extensions, whilst £3,404 went in relief of the general rate. We also observe that during the year the Corporation sanctioned extensions of the tramway lines owned by the Camps Bay and other companies. Altogether the pioneer municipal electric light undertakers of Africa well merit congratulation upon their progress.

**Municipal Wiring.**—The opposition of the National Electrical Contractors' Association to the clause in the London County Council's Bill seeking power for local authorities to execute wiring was referred to in our issue of June 10, when we felt constrained to concur with the arguments of the objectors. One invidious circumstance to which the clause is calculated to give rise is that it would devolve upon the municipal engineer to pass the work of his private competitors. At a recent meeting of the Law and Parliamentary Committee of the County Council a deputation was received from the Hampstead Borough Council in reference to this subject. At this meeting it was suggested on behalf of the Electrical Contractors' Association that what is now known as the "Ealing Clause" should be adopted. For the sake of reference we reproduce this: "(73) It shall be lawful for the council of any metropolitan borough being authorised to supply and supplying electrical energy to expend money through a contractor, but not otherwise, upon the wiring and fitting and supplying with wires, fittings, and apparatus, the premises of their consumers or prospective consumers, and to enter into and carry into effect agreements and arrangements with respect thereto, and to make such charges therefor, whether directly or otherwise, as they may think fit. Provided that nothing

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in this section shall authorise the council of any borough themselves to fix upon any consumer's premises electric light fittings or electric wiring other than may be required to complete the service line between the corporation's supply mains and their own apparatus upon such consumer's premises. (74) Any such council of a metropolitan borough may borrow, in the same manner and subject to the same conditions as if such expenditure were for the purposes of the Electric Lighting Acts, 1882 and 1888, as amended by the London Government Act, 1899, such sums of money as may be required by such council for the purposes of this part of this Act." One of the Hampstead representatives, Mr. Alderman Pritchard, who is also barrister to the metropolitan borough councils, assented to this clause, subject to slight modification, but a few days later the County Council intimated that, after careful consideration, they were not prepared to alter their original clause. It therefore seems inevitable that the struggle of 1903, when the contractors' opposition prevailed, will be renewed, and with increased vigour. The *Electrical Contractor*, which is the official organ of the association, contains a rallying call to the industry, enumerating several large towns which the efforts of the organisation have preserved to the private contractor.

**Electricity from Tides.**—The vast amount of energy in the tides, which is at present unutilised, has attracted the attention of a large number of engineers. Unfortunately, the cost of the civil engineering works required to make this energy available for industrial purposes is, as a rule, prohibitive. Coupled with this high cost there are the variable high and low tide levels, and frequently the position in which the civil engineering works have to be constructed is such that their permanence is doubtful owing to the action of the waves. What is required to make tidal power available in large quantities can only be obtained economically under certain configurations of coast-line, The requisites are a large inlet which can be used to store water at high tide, and another large inlet which can be drained regularly at low tide, and from which the incoming tide can always be excluded. According to Mr. W. S. Cleveland, writing in the *Scientific American*, these conditions can be obtained in one or two localities in the United States and Canada. He describes these, and mentions as one of the best opportunities for applying this method of using tidal water power the harbour of the city of St. John, N.B. Kennebecasis and Courtney bays are large arms of the harbour, but both, under present conditions, are of little service to shipping. The entrance to the former bay is located above the famous Reversible Falls, but subject to the action of the tides at high water, and the latter is studded with dangerous reefs and rocky flats, which render it worthless to shipping, except at high water. The entrance to Kennebecasis Bay is very narrow, and the embankment making it serviceable as a high-water basin could be cheaply constructed; but the mouth of Courtney Bay is much wider, although not imposing any serious engineering difficulties in the work of converting it into a discharge basin. In applying the 30ft. head of water thus obtained, the narrow neck of land separating the bays could be crossed by power and tail-race channels, and the turbines located at the most convenient point thereon. Should previously suggested improvements, embodying the maintenance of continuous high water in this harbour, be carried out, a slight modification of the original plans would facilitate the application of this great water power, and make St. John City one of the leading industrial centres of the continent. As the author does not give any particulars of cost or area one cannot tell the horse-power available, or the capital charge per horse-power year, which is usually the prohibitive factor in these schemes. When, however, the indirect advantages from the large civil engineering works are such as are described above, there may be a chance of a remunerative undertaking being established.

**Californian Power Plant.**—A plant has recently been installed at Monterey, California, designed by the National Electric Company, of Milwaukee, which attracted a good deal of attention at the annual convention of the Pacific Coast Electric Transmission Association, and of which a description appears in the *Street Railway Review*. It consists of a 200-kw. generator and motor-generator set, comprising a synchronous revolving-field motor of 162 kw. capacity, which drives by direct coupling a National 550-volt direct-current railway generator with a rating of 150 kw. The 200-kw. alternating-current generator follows closely the structural design that has become well established in American types of revolving-field generators, and its inherent regulation is well within 6 per cent. at unity power factor. It is run at a speed of 600 revolutions per minute, and consequently, to deliver a current at 60 cycles, it is provided with 12 poles on its revolving field. The usual temperature guarantee, that with an atmospheric temperature of 25deg. C., the temperature of the machine will not rise more than 35deg. under a continuous 24-hour run at full normal load, was well above the limit reached in operation, the rise being but 22deg. above the temperature of the surrounding air. The efficiencies of the generator are as follows: 93 per cent. at 25 per cent. overload, 92·5 per cent. at full load, 91·25 at three-quarter load, and 88 per cent. at half load. The exciter runs at a speed of 1,450 revolutions per minute, is normally rated at 12 kw. at 110 volts, and is belt-driven from a pulley placed on the end of the generator shaft. The motor-generator set runs at a speed of 720 revolutions per minute, and in operation it has been found that the temperature of the synchronous motor does not exceed 25deg. C. above the temperature of the surrounding air, and the direct-current generator does not show a rise of more than 25deg. in any part when both machines are working under full-load conditions. An interesting feature in connection with the motor-generator set is that a 22in. pulley with a 16in. face has been placed on the shaft between the motor and generator, and belted to the flywheel of a 200-h.p. high-speed Buckeye engine. This gives absolute flexibility to the plant, in that during the hours of light load both the units of the motor-generator set may be run as generators, and in that the motor-generator set affords the link by means of which the railway load may be coupled in with the two-phase load, or *vice versâ*. Obviously, this enables a day alternating-current service to be maintained in conjunction with the railway load as minimum efficiency in operation, and though the installation of the motor-generator set may appear anomalous in view of the fact that the current for its operation is taken from generators located within the same premises, it is considered the rational solution of the problems presented by the local conditions.

**Insulation of Motor Field Coils.**—The *Street Railway Journal* contains an article upon some experiments carried out by the Deltabeston Fuse Company, of Providence, R.I., relative to the insulation and winding of their magnet wire for railway motor field coils. The experiments were conducted by the company with a view to the production of a field-coil insulation capable of withstanding unusual temperatures and practically impervious to water. The process involves the employment only of material which will not be affected by any ordinary motor temperature, and the material must be so treated as to render it waterproof. The portion of the coil upon which the terminals

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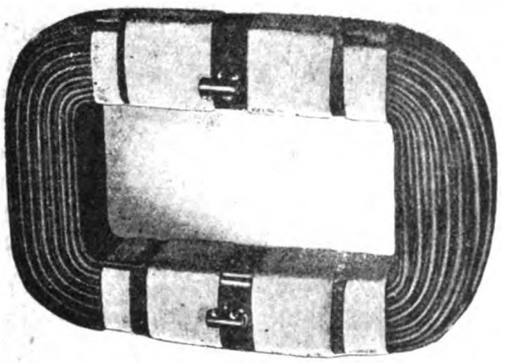
are fixed is carefully insulated by covering with a single layer of a special asbestos paper. Over this and under the terminal a thin sheet of micanite is placed, upon which the terminal, after being soldered to the twine, is securely bound by asbestos twine, as shown in the accompanying illustration. The asbestos paper is then formed about the coil by damping it with a thin solution of good paste. It has been found desirable to cut the paper into various shapes in order to harmonise with the irregular form of the coil. Two layers are used in covering the body of the coil, the paper employed being about ·01in. thick, and it must be thoroughly impregnated with the paste. Before applying the second layer, the coil should be left overnight, and then placed in an oven for two or three hours, raising the temperature to about 300deg. F. Taking the coil out while hot, it should be immersed in a fairly thin solution of a paraffin insulating compound, allowing the coil to remain in same until thoroughly cooled down. The second jacket is similarly applied, and the coil having been air-dried, it is ready for a tight outer wrapping of ·03in. asbestos tape, preferably of about ¾in. width. Having been rapidly dried in an oven at 300deg. F., the coil is ready for its final dipping, which is performed by saturating it in a bath of good baking japan. The coil is



then allowed to drain, after which it is baked until quite hard, a period of three to four hours being required as a rule. To render the saturation perfect, the coil may be replaced in the japan bath, and having been again drained and baked the process is complete. The company's experience has shown that the repetition of this process twice a year, giving the motor one dipping and baking, is ample. To determine the value of this insulation, comparative tests were conducted under service conditions of coils as above and those wound on ordinary asbestos paper and cotton insulation, the exterior insulation in the latter being of the type commonly used throughout the States. At the end of a 97-hour practically continuous run the cotton-covered coil was reduced to charcoal, while the Deltabeston coil appeared to be quite uninjured. On the application of water the insulation of the cotton-covered coil receded practically to zero, the Deltabeston coil, on the other hand, exceeding the capacity of the instruments, some 400 megohms.

**Electrical Equipment of Canals.**—The report of Mr. S. E. Fedden, the general manager of Sheffield's electric supply department, upon his recent tour in America contains some interesting notes upon the electrical equipment of canals, which is largely the vogue on these waterways in Canada. Electricity is employed for illumination and for operating the various devices at the locks and the swing-bridges. Mr. Fedden gives a concise description of the Soulanges Canal—14 miles long—joining the St. Francis and St. Louis Lakes, which is typical of the system generally adopted. The canal banks are illuminated by 2,000-c.p. alternating arc lamps of the enclosed type, which are placed 480ft. apart on one side, and when nearing locks or bridges they are erected considerably nearer and on both banks, enabling navigation to be carried on with ease and safety during the night. Altogether, 219 arc lamps are used along the canal. The supply of energy is obtained from their own power-house, situated five miles from the Lake St. Francis entrance of the canal. At this point the Grease River crosses underneath the canal in a 10ft. culvert, and empties into the St. Lawrence. The water for the turbines is taken from the canal, the Grease River forming the tail race. The head of water obtained is about 20ft. The canal is crossed by seven bridges, which weigh about 100 tons each. The electrical apparatus for operating these bridges consists of a gear and friction mechanism driven by a 2-h.p. 220-volt three-phase induction motor, placed in a cabin at the centre of the bridge. By a simple movement of a lever in one direction the bridge can be started, or it can be stopped or retarded by a motion of the same lever in the opposite direction. A 3 h.p. induction motor is geared to a friction mechanism for operating the locks and sluice gates, which involves the same principle as that described for operating the bridges. The gates are closed or opened by means of a strut or drawbar hinged to the gate under the gate platform, at the end of which is a rack and pinion mechanism worked by the friction apparatus. The whole machinery is placed in a watertight cast-iron box, which projects about 15in. above the coping of the lock. At each lock there is a switch cabin, which contains two sets of transformers for stepping down from 2,200 to 220 volts, which is the motor voltage. One main switch controls all the motors at each lock. The electrical equipment of this canal, which has been in operation for over two years, has given entire satisfaction, and in concluding his observations Mr. Fedden pays this notable tribute to the system: "I think this is one of the best applications of electrical energy I have ever seen, the change to this system increasing the working capacity of the canals very greatly, besides effecting a large saving in manual labour."

**German Tramway Practice.**—*Kuhlow's Review* has an article upon the changes in German electric tramway practice during the past year. Few new lines have been installed, as experience has shown that with towns of less than 50,000 population a service cannot be conducted profitably, so attention has been mainly concentrated upon improvements in detail. A greater number of car miles are now run without increasing the track mileage, but how far the receipts have benefited is not stated. In most cases this increase in car mileage has been between 3 and 4 per cent., but on some of the large city lines it has reached 10 to 11 per cent. The type of car now favoured is of the single-truck order, with two motors and a short-circuiting brake, without an upper deck, but with movable windows, so as to have open cars in summer. Double-truck cars are not likely to be built frequently, because they are too large for German street conditions, and single-truck cars with trailers are cheaper and more flexible. Many trailers are being fitted with magnetic brakes to save extra brakesmen, and roller bearings have been found to effect a large saving in tractive effort. The G.E. 800 motor is being gradually displaced by motors of somewhat larger capacity. When replacing motor gearing a great deal of attention is now given to seeing that the motor pinion will have as long a life as the gear, which is generally made of ordinary cast iron, hardened steel being used for the pinion. A life of 24,000 miles for the pinion is considered satisfactory, though a few large companies have obtained 66,000 miles. A number of lines have placed wattmeters on their cars. These have been found to work accurately within 4 per cent. during four to six months' service, and have had an excellent influence on the current used by the motorman.

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The single-tongue switch has gained a decided victory, maintenance cost being negligible compared with the double-tongue type. Contrary to American practice, the results with very large generating sets have not been of the best. Units of 1,000 h.p. to 1,500 h.p. have proved the most suitable for large stations, on account of economic conditions. Practically all the power stations are now equipped with storage batteries, which has resulted in substantial fuel economy, especially in small stations Feed-water heaters and purifiers have become almost universal, and the use of inferior fuels such as ashbin refuse with automatic firing has increased with good results. Liquid lubricants are displacing grease. Concrete is now recognised as the most desirable base for the track if the rails rest on an intervening layer of asphalt concrete 1in. thick, which must be allowed ample time to harden. The rails now coming into general use are much harder than the earlier ones. The Goldschmidt "thermit" process of welding has been applied successfully on some of the large systems, and the new Melaun method is well spoken of, though it is too early to pronounce definitely with regard to the latter. The fender is unpopular, and in some cities the authorities have prohibited it as more likely to increase than to diminish accidents. The tendency to reduce fares has undergone a reversal, especially on municipal lines. Transfer traffic has been encouraged, but more attention is being given to the control of transfers. There is also a tendency to sub-divide the management of operation by appointing inspectors of stopping places, switches, track-cleaning, etc. A valuable innovation has been the compilation of uniform statistics for all German street and light railways. The traction companies are making efforts with a view to the modification of the oppressive laws regulating liability for accidents. The executive offices of the Street Railway and Light Railway Association have been removed from Hamburg to Berlin, which is expected to facilitate management. Destructive competition between lines in the same area has given place to co-operation. There has been less controversy upon the question of municipal ownership. Some of the corporations have done well, but "quite a number" show deficits. It is gratifying to observe, however, that the officials of the two classes are working in harmony on all technical matters.

**Cooper Hewitt Converter.**—Patents have been granted in the United States to Mr. P. H. Thomas for three forms of the Cooper Hewitt converter or current rectifier. A description of these, with the accompanying diagrams, appears in the *Electrical World* of New York. It will be remembered that the converter is based upon the "electric valve" principle; a current passes through the converter in only one direction, an electrode resistance so great being opposed to flow in the opposite direction as practically to prohibit the passing of current of opposite character. The object of the new forms of rectifier is to provide means for conducting a large amount of current into and from the converter with relatively small resistance, to provide means for keeping the converter cool, and to withdraw from the chamber any excess vapour so as to maintain the vapour in proper condition. The enclosing chamber shown at the top of Fig. 1 is provided with two side tubular extensions containing columns of mercury, which constitute respectively the positive and negative terminals of the device. The lower ends of the tubes are open and are submerged in vessels containing mercury. The chamber is provided with a third tube in the middle, which terminates in a vessel also containing mercury. This vessel is connected by a pipe with a pump, the outlet of which is connected by a pipe with the bottom of one of the electrode vessels. In operation current is led into, say, the left-hand electrode vessel, then passes up the mercury column in the tube leading therefrom, then through the vapour in the upper chamber, and thence down through the right-hand column and to line by way of the circuit conductor. As more or less heat will be developed in the passage of the current, a more or less continuous flow of mercury is kept up through the left-hand tube into the chamber, whence it flows downward through the centre tube, carrying with it more or less of the gas or vapour contained within the chamber. This continuous flow of mercury will not only result in providing cool mercury for the positive terminal of the device,

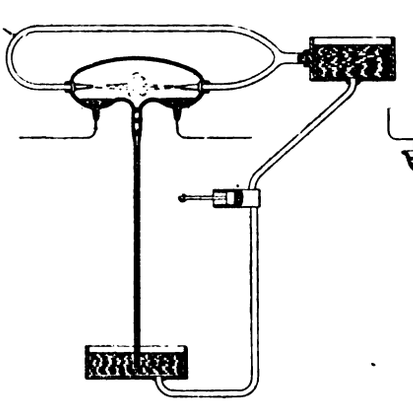

FIG. 1.

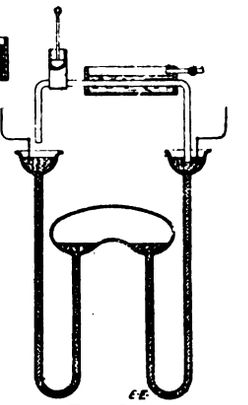

FIG. 2

but will continually act as a pump for maintaining the requisite purity with respect to the vapour in the chamber. The receptacle beneath the centre tube may be constructed to afford a considerable heat radiating surface, and there may be added a cooling pipe, as shown, for circulating water or other cooling fluid. It is generally found unnecessary to cool the negative terminal, as in some instances the device operates better while this terminal is hot. There will always be more or less condensation of the mercury vapour upon the walls of the vapour chamber, and the presence of the cold body of mercury contributes to this action, which results in keeping the vapour at its proper density. The second diagram

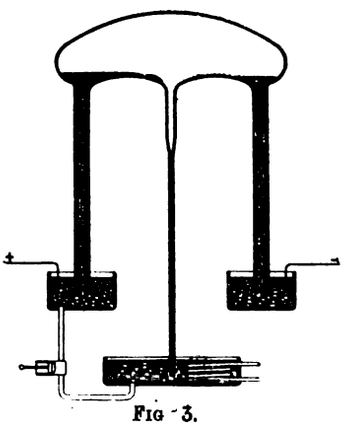


FIG. 3.

illustrates another arrangement, in which the lead wires are connected directly with the positive and negative terminals, and mercury from a receiver is forced through pipes into the chamber in the form of a finely-divided spray. By this means both the terminals and the conducting vapour within the chamber are cooled. Fig. 3 represents an arrangement for use when it is desired to maintain the conducting gas or vapour in the container at a high pressure, in which case atmospheric pressure might be insufficient for the purpose. The pressure within the container corresponds to the height above the level therein of the mercury in the tubes shown. In this case a water-jacket for cooling the mercury is shown around the pipe connected with the pumping arrangement.

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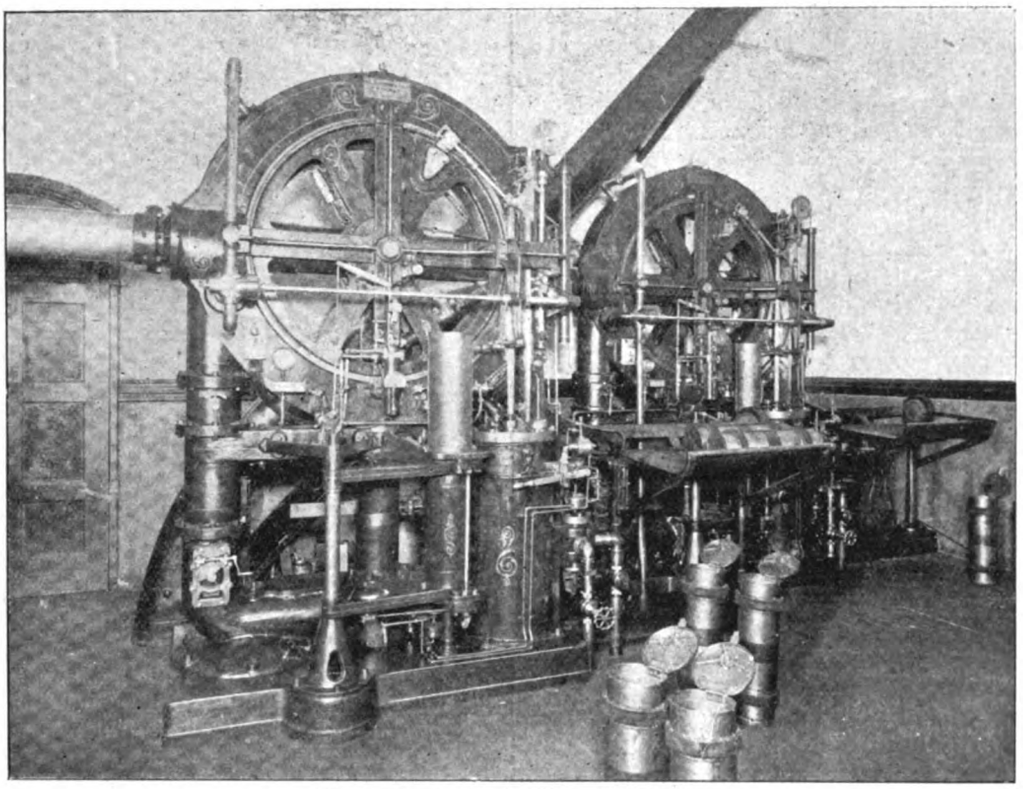
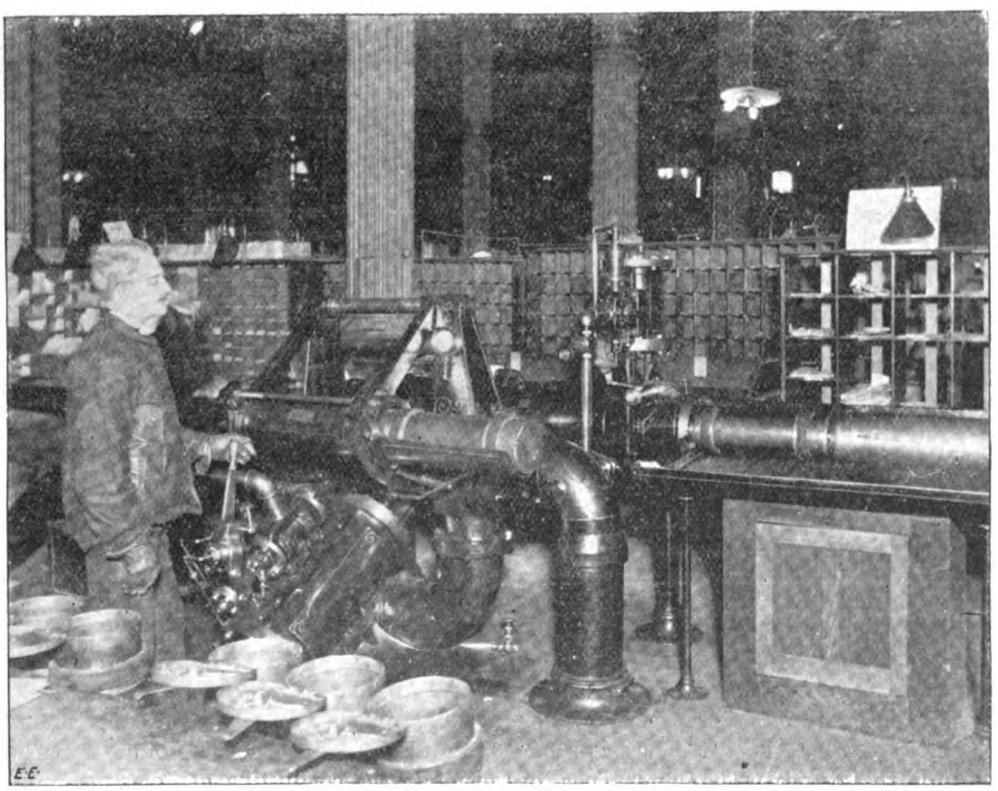
## THE PNEUMATIC-TUBE SYSTEM OF DISPATCH.

At a recent meeting of the Municipal and County Club, Sir John Wolfe Barry, his associate (Mr. C. A. Brereton), Colonel Crompton, C.B., and Mr. K. E. Stuart (engineer to the Batcheller Pneumatic Tube Company) gave a description to a number of metropolitan borough engineers and surveyors of the scheme for dispatch of letters and parcels in London on the pneumatic-tube principle which will be laid before Parliament next session. On each route it is proposed to lay a pair of 12in. tubes at a depth of about 6ft., with electric mains alongside, and between the tubes a telephone line for use in connection with the system. It is calculated that these tubes will permit of nearly 90 per cent. of London's parcel traffic being thus transmitted. Receiving and dispatching offices to the number of 172 will, according to the scheme, be located over the Metropolis at short intervals, and pedestrian messengers will perform the bulk of the delivery. By this means it is considered that the greater part of the vans for delivering mails and parcels (which represent over 20 per cent. of London's traffic) will be obviated, so contributing to the solution of the traffic problem. Large establishments like Harrod's would have an installation on their premises.



Selective Receivers as installed in Philadelphia.



Tube Terminals at Boston (U.S.A.) Post Office.

Another important consideration is the question of saving

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time, and upon this one or two examples may be given. A letter from Charing Cross to Liverpool street occupies by post three hours; by tube transit it would occupy 20 to 40 minutes, or by an express system of tube transit 10 to 15 minutes. This express service would, it is claimed, be not only more expeditious but cheaper than the existing Post Office system. Other advantages are that deliveries would be more frequent, and letters could be posted up till a later hour; in fact, one of the fundamental ideas of the scheme is smaller consignments and quicker deliveries as compared with the existing system.

The essential features of the Batcheller pneumatic tube system are: (1) a suitable conduit or tube; (2) a receptacle or carrier for passing through it; (3) a device for dispatching the carrier, called a transmitter; and (4) a device for arresting the carrier and delivering it from the line, called a receiver. The carriers are operated by a uniform current of air at low pressure created by electric motors, which would be much more economical than the system used on the old Euston tube. These carriers consist of a light steel cylindrical cartridge, and it has been found in practice abroad that there is no danger of entanglement. The cylindrical steel vessel travels upon a pair of bearing rings placed near each end of the carrier. The rings are of specially-prepared composition, and the carrier travels 10,000 miles upon them before they are worn out, when they can be replaced at moderate expense. The object of the transmitter is to introduce the carrier into the air current without interrupting the flow. The receivers are of four types, each adapted for some special condition. The simplest, which is also the newest, has no moving mechanism whatever. In each of the other three types the carrier is brought to rest by the air cushion formed ahead of it in entering the closed section of tube. When placed where the pressure of the line is atmospheric, the carrier is automatically discharged by the opening of the gate that normally closes this section. Where the pressure of the line is above that of the atmosphere a special form of receiver is provided, which delivers the carrier without escape of air. Colonel Crompton spoke enthusiastically of the ease with which the receiver brings the carrier to rest. Such articles as eggs, pigeons, and kittens have been transmitted with perfect safety, although travelling at from 30 to 40 miles per hour.

One of the most ingenious features of the apparatus is the arrangement by which letters and parcels are delivered at the desired station. Stations other than terminal offices are provided with a piece of mechanism called the intermediate receiver. By means of metallic discs of graduated diameter, carried on the front end of the carrier, this machine selects the carriers intended for delivery at that station, and passes all carriers for stations beyond. The operation is performed by two slender metallic pencils or needles in the head of the machine. These are placed at such a distance apart as corresponds with the diameter of the metallic disc on the end of the carrier. If the disc is large enough to span the distance between these needles, the electric circuit is formed which operates the mechanism that discharges the carrier from the tube. The operator has merely to attach a disc of the size corresponding to the station to which he is dispatching, and the carrier goes there automatically and is discharged from the tube without further attention. We reproduce an illustration of this selective apparatus as installed in Philadelphia, U.S.A., and also a view of the tube terminals at the Boston, U.S.A., Post Office. In America, by the way, 8in. tubes are employed, but the promoters have increased the diameter, as mentioned above, for the present scheme so as to render it more comprehensive.

Regarding the opening of the streets, the promoters and their eminent technical advisers consider that traffic disturbance can be reduced to a minimum by employing the "cut-and-cover" method, and in a large number of cases side streets can be utilised. Colonel Crompton and Mr. Brereton, who have seen the system at work in America, as well as Mr. Stuart, who has had experience of its working, testified to the facility of its operation, and quoted the expressions of unqualified admiration which it evoked from the New York postmaster.

An experimental installation has been laid down at Fulham, where the promoters will welcome visits from anybody interested in the scheme.

## WIRELESS TELEGRAMS TO SHIPS AT SEA.

The first day of the New Year marked the inauguration of a commercial scheme which will be highly appreciated by those who spend part of the time each year in crossing the Atlantic. In official terms this new arrangement for transmitting wireless telegrams from any telegraph office within the United Kingdom is announced as follows: "The Postmaster-General has made provisional arrangements with the Marconi International Marine Communication Company for the acceptance and prepayment at telegraph offices in the United Kingdom of telegrams for transmission from wireless stations on the coast to ships at sea. The arrangement will come into operation on New Year's Day. The charge will be 6½d. a word, with a minimum of 6s. 6d. for each telegram." Of this charge 6d. goes to the Marconi Company, which is a moderate sum for the convenience of receiving definite private information at sea. The arrangement is one of considerable significance both for the Marconi Companies and for the general public. Hitherto, wireless messages have freely passed from ships at sea to the Marconi Companies' shore stations, and thence over the postal telegraph system to their destination. The whole rate for the transmission of the telegrams—viz., the wireless rate from ship to shore and the postal telegraph rate over the inland system—has been collected on the ships by the Marconi operators in charge of the stations there. The Marconi operator at the shore station has, on receipt of a wireless message from a ship, handed it in at the nearest postal telegraph office, paying, of course, the Post Office charges. When, however, messages had to be transmitted from the shore to the ship, the matter was not so simple. In the first place, the general public had no information of the movements of ships carrying the wireless apparatus, or of the locality of the shore stations through which messages might be sent at certain times. Further, any Marconi telegraph station on a ship was not recognised by the postal telegraph officials as an address. Anyone desiring to send a message, for example, from London to a passenger on the "Lucania" could only telegraph the message to one of the Marconi Companies' shore stations, paying only the inland telegraph rate at the telegraph office from which the message was dispatched, and leaving the wireless rate from the shore to the ship to be collected on the ship from the addressee. Apart from the objection to compelling the addressee to pay the wireless rate on receipt of the message, a good deal of knowledge as to the movements of the ships and as to the locality of the Marconi Companies' shore stations, not obtainable at the telegraph offices, was necessary. So crude were the facilities available that the wireless traffic from shore to ship has been practically nil.

All this will now be changed. Anyone desirous of sending a message to a ship at sea by wireless telegraphy will be able to obtain at any telegraph office information as to the ships fitted with the Marconi apparatus, the shore stations with which the ship comes into communication, and the hours during which the ship is within range of such shore stations. The whole rate of the transmission—the land charges to the point where the message passes to the Marconi system, and the rate for transmission over the Marconi system—that is, from the Marconi shore station to the wireless apparatus on the ship—will be collected by the Post Office authorities, the land charges being, of course, retained and the wireless rates handed to the Marconi Companies.

For some years the companies have been endeavouring to secure these facilities, but they have only recently achieved success. The difficulty has been two-fold—partly a disinclination on the part of the Post Office to exchange traffic with companies carrying on such a novel business as the transmission of messages by wireless telegraphy to a moving object (ship at sea), and partly failure in certain quarters to recognise the necessity to the companies of such facilities as these for which they asked.

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The present agreement is thus welcome, as showing that the Marconi system is now open commercially for the dispatch of messages to steamers at sea.

For use, we presume, of the telegraph offices throughout the United Kingdom, the Marconi Company have issued a list of the proposed sailings of all ships carrying Marconi telegraphs during the present month. In this list there are no less than 29 sailings from European ports and 27 from either New York or Boston. The following extracts from this list will show the general character of the information given. Thus the "Campania" leaves Liverpool on Jan. 14. It can be communicated with from the Rosslare station of the Marconi Company at midnight of Jan. 14, and from Crookhaven station at noon on Jan. 15.

The "Vaderland" leaves Antwerp on Jan. 14. It can be communicated with from the North Foreland station at 3 p.m. on Jan. 14, from the Niton station at midnight the same day, and from the Lizard at 11 a.m. on Jan. 15.

In the same way the times given for the ships leaving America show that telegrams can be dispatched to the same a day or so before they are due to arrive at their European ports. The scheme now inaugurated does not include transmission of messages to ships in mid ocean. Such intercommunication is regularly maintained with many of the best liners, and we are given to understand that a service of private messages will be arranged in the near future. The charge for transmission will, however, be greater than the rates given above. At present the long-distance messages provide the news for the daily papers published on these liners and the weather reports sent to the *Daily Telegraph*.

## THE GLOVER ALMANAC.

The third annual tear-off sheet almanac issued by Messrs. W. T. Glover and Co. is as interesting as either of its two predecessors. This year a vast improvement has been made in the binding of the sheets, which prevents one tearing off a half-year in looking through the almanac for the first time to see what it contains. The feature this year is the inclusion of the photographs of a large number of central-station engineers. One would not suppose from looking at these that the engineer-in-charge of electric lighting works had a happy time, but it must be remembered that the photographer was without doubt the disturbing element when the portrait was made, and thus it would not be fair to put some of the expressions down to the running of the plant in the towns in which the engineers in question are engaged. Another new feature is the insertion of a number of original contributions of an interesting and humorous nature, which tends to lighten the publication. As last year, we think it only fair to the firm to reprint one or two of the daily sheets in order to show the humour which can be extracted even from an engineering profession. Thus, for Jan. 1 we have some remarks on New Year's resolutions (with apologies to Mr. Dooley):

"Well, sir," said Mr. Dooley, "we are in th' nixt year again, an' th' pavin' season has opened down below. Th' surveyor there is layin' out new r-roads f'r th' flagstones made be folks whin they wint home la-ast night. There's nawthin' like a New Year's Eve f'r repinting your wickidniss iv th' past whin ye're singin' God save Oireland, or f'r makin' resolooshuns f'r th' future whin ye're tryin' to pit your key into th' wrong dure. Take th' mannyfacturers now, full iv punch an' mince pies in th' bussum iv their families; an' feelin' so peaceful wid all th' wurruld that they raysolved to divide th' profits iv this year with th' staff. An' every mimber iv th' staff, who are all wishin' to marry this year, tellin' his sweetheart in th' parlor that onless he gits a roise befure th' nixt month he'll leave to onct. Contractors comin' home fr'm St. Paul's raysolve not to send another pennyworth iv ordhers to th' Blankety Blank Company, an' Insultin' Ingineers wake up, whin they hear th' Church Bells an' swear they'll never ask f'r discounts again.

"Perfessors, burnin' th' midnight oil, as Hogan says, an' absorbed in the pa-apers iv last year, pause whin they hear th' whistles an' raysolve to become Insultin' Ingineers. Th' Sicrety iv th' Institooshun was raysolvin' to dhrop th' tripper biz'niss an' make a bee-line f'r foundayshun stones an' portraits iv past-prisidints. I dunnaw where th' Station Ingineers was last night, but if ye asked me I might be right; but they was all raysolvin' f'r to scrap their mains an' ordher Glovers' Cables. Here, Jawn, raise your glass an' may everybody keep to their good resolooshuns."

On Jan. 8 an extract is given from Mr. D. H. Morton's remarks before the Institution of Electrical Engineers. This extract is headed "The Engineers' Creed."

"If one is to be esteemed an advanced engineer to-day, one must believe in the electrical transmission of power and in the internal-combustion engine. I believe in the electrical transmission of power and in the internal-combustion engine, but I am not lost in adoration, nor do I believe that there is but one method of generating and but one method of transmitting and distributing power. Rather, I believe that, with equal skill and zeal exercised in each case, the difference between one system and another is never so great as the retained advocates of each would have us believe. Each system has its physical limitations; those of electrical transmission are the widest, therefore electrical transmission is likely to be the most used and universally employed"

The following extract from Mr. John F. C. Snell's contribution to a discussion before the Municipal Electrical Association appears on May 1. We can quite conceive of the resident engineers of smaller towns reserving this extract for the attention of the chairman of their committee. In those places where salaries are increased in January we are afraid that the leaflet for May 1 will not rest in Glover's almanac until the appointed day for its removal.

"I think it wise that a municipality should engage an independent expert engineer to launch the undertaking and to assist in the selection of a capable chief officer. This officer being appointed, will then seriously consider local conditions, and if he is worth anything at all, will devote his energy to the proper and careful development of the work entrusted to him. But being young and ambitious he will be naturally allured to another town offering a wider field and a bigger salary, and I have known men who have been allowed to leave because their councils have been niggardly, and have declined to increase salaries which were entirely disproportionate to their serious responsibilities. One does not hear of the like changes on the staffs of the larger companies. A change of management in such a case must affect temporarily the progress and development of the system, for it takes time for a new man—however capable—to acquire a thorough knowledge of local conditions, and even a slight change of policy may cost the municipality a great deal of money. Councils, I think, want to form an idea of the depreciation of the engineers, the wear and tear on whom is a really serious factor, for the responsibility of electrical supply undertakings is a very heavy strain. I think more encouragement is required to be given to officials of proved efficiency."

The almanac will have a hearty reception.

## ELECTRIC LIGHTING PROVISIONAL ORDERS (SESSION 1905).

The following is the complete list of applications for provisional orders deposited with the Board of Trade, under the provisions of the Electric Lighting Acts, 1882 to 1890, for consideration in the 1905 session of Parliament:

| Title of Order and Description of Area. | Name of Promoters. |
|---|---|
| Airdrie Burgh Electric Lighting Order (Transfer of Powers and Amendment). | The Scottish House-to-House Electricity Company, Limited. |
| Andover Electric Lighting Order.—The Borough of Andover. | The Corporation. |
| Ballaghaderreen Electric Lighting Order.—The Town and Townland of Ballaghaderreen, and the Townlands of Lung, Friarshill, Knockanaconny and Kilcolman, all in the Rural District of Castlerea. | The Rural District Council. |
| Barnet Electric Lighting Order.—The Urban District of Barnet. | The North Metropolitan Electrical Power Distribution Company, Limited. |

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| Title of Order and Description of Area. | Name of Promoters. |
|---|---|
| Barton-upon-Irwell Electric Lighting Order.—The Rural District of Barton-upon-Irwell. | The Lancashire Electric Power Company. |
| Bishop's Stortford Electric Lighting Order. — The Urban District of Bishop's Stortford. | The Urban District Council. |
| Brentford Electric Lighting Order.—The Urban District of Brentford. | The Brentford Electric Supply Company, Limited. |
| Brentford Electric Lighting Order.—The Urban District of Brentford. | The Metropolitan Electric Supply Company, Limited. |
| Brockenhurst and Milton Electric Lighting Order.—The Parishes of Brockenhurst and Milton, in the Rural District of Lymington. | Messrs. Christy Bros. and Middleton. |
| Burslem Electric Lighting (Extension) Order. — The Urban District of Tunstall. | The Corporation of Burslem. |
| Bury Rural District Electric Lighting Order.—The Rural District of Bury. | The Rural District Council. |
| Clewer and Old Windsor Electric Lighting Order.—The Parishes of Clewer Without and Old Windsor, in the Rural District of Windsor. | The Windsor Electrical Installation Company, Limited. |
| Coatbridge Electric Lighting Order (Transfer of Powers and Amendment). | The Scottish House-to-House Electricity Company, Limited. |
| Conway Corporation Electric Lighting Order.—The Borough of Conway. | The Corporation. |
| Croydon Rural District Electric Lighting Order.—The Rural District of Croydon. | The County of London Electric Supply Company, Limited. |
| Cults and District Electric Lighting Order.—Portion of the Parish of Peterculter, in the County of Aberdeen. | Messrs. Lowdon Bros. and Co. |
| Denny and Dunipace Electric Lighting Order.—The Burgh of Denny and Dunipace. | The Corporation. |
| Dorchester Electric Lighting Order.—The Borough of Dorchester. | The Dorchester and District Electric Supply Company, Limited. |
| Dover Electric Lighting (Extension) Order.—The Parishes of Hougham, Poulton, River, Alkham, Ewell, Whitfield, West Langdon, East Langdon, St. Margarets-at-Cliffe, West Cliffe, and Guston, in the Rural District of Dover. | The Corporation of Dover. |
| Durham Districts Electric Lighting Order. — The Rural District of Durham and portion of the Rural District of Chester-le-Street. | The County of Durham Electrical Power Distribution Company, Limited. |
| Eastbourne Corporation Electric Lighting (Willingdon Extension) Order.—The Parish of Willingdon in the Rural District of Eastbourne. | The Corporation of Eastbourne. |
| Farnham Electric Lighting Order.—The Urban District of Farnham. | The Farnham and District Electric Supply Company, Limited. |
| Golborne Electric Lighting Order.—The Urban District of Golborne. | The Urban District Council. |
| Gosport Electric Lighting Order.—Portion of the Urban District of Gosport and Alverstoke. | The Gosport and Alverstoke Electric Lighting Company, Limited. |
| Grangemouth Electric Lighting Order. The Burgh of Grangemouth. | The Corporation. |
| Gravesend Electric Lighting (Extension to Northfleet) Order.—The Urban District of Northfleet. | The Corporation of Gravesend. |
| Haydock Electric Lighting Order.—The Urban District of Haydock. | The Urban District Council. |
| Hemsworth and District Electric Lighting Order.—Portion of the Rural District of Hemsworth. | The Hemsworth Electricity Supply Company, Limited. |
| Hessle Electric Lighting Order.—The Urban District of Hessle and the Parish of Anlaby in the Rural District of Soulcoates. | The Urban District Council of Hessle. |
| Hipperholme Electric Lighting Order.—The Urban District of Hipperholme. | The Urban District Council. |
| Houghton-le-Spring and District Electric Lighting Order (Transfer of Powers). | Harry James Almond, Esq., and the Sunderland District Electric Tramways, Limited. |
| Inverness Electric Lighting Order.—The Royal Burgh of Inverness. | The North of Scotland Electric Light and Power Company, Limited. |
| Kingsbury Electric Lighting Order.—The Urban District of Kingsbury. | The Urban District Council. |
| Lichfield Electric Lighting Order.—The City of Lichfield. | Messrs. Foote and Milne, Limited. |
| Litherland Electric Lighting Order.—The Urban District of Litherland. | The Urban District Council. |
| Little Hulton Electric Lighting Order. The Urban District of Little Hulton. | The Urban District Council. |
| Little Lever Electric Lighting Order.—The Urban District of Little Lever. | The Urban District Council. |
| London : Woolwich Electric Lighting Order.—The Metropolitan Borough of Woolwich. | The Borough Council. |
| Ludlow Electric Lighting Order.—The Borough of Ludlow. | William Norton, Esq. |
| Lytham Electric Lighting Order.—The Urban District of Lytham. | Messrs. Foote and Milne, Limited. |
| Macclesfield Electric Lighting Order.—The Borough of Macclesfield. | Messrs. Foote and Milne, Limited. |
| Marlborough Electric Lighting Order. The Borough and Urban District of Marlborough. | The Marlborough Electric Supply Company, Limited. |
| Penmaenmawr Electric Lighting Order. The Urban District of Penmaenmawr. | The Urban District Council. |
| Pollokshaws (Burgh of) Electric Supply Order.—The Burgh of Pollokshaws. | The Corporation. |
| Ravensthorpe Electric Lighting Order. The Urban District of Ravensthorpe. | The Urban District Council. |
| Renfrew Burgh and District Electric Lighting Order.—The Royal Burgh of Renfrew and portions of the Parishes of Renfrew and Govan. | The Corporation of Renfrew. |
| Rushden, Higham Ferrers, Irthlingborough, and Thrapston (Rural) Electric Lighting Order.—The Urban District of Rushden, the Borough of Higham Ferrers, the Urban District of Irthlingborough and portion of the Rural District of Thrapston. | Edwin Percy Harvey, Esq. |
| Rutherglen Electric Supply Order.—The Royal Burgh of Rutherglen. | The Corporation. |
| St. Albans Rural Electric Lighting Order.—The Rural District of St. Albans. | The St. Albans and District Electric Supply Company, Limited. |
| Southall-Norwood Electric Lighting Order.—The Urban District of Southall-Norwood. | The Urban District Council. |
| Southall-Norwood Electric Lighting Order.—The Urban District of Southall-Norwood. | The Metropolitan Electric Supply Company, Limited. |
| Spalding Electric Lighting Order.—The Urban District of Spalding. | The Urban District Council. |
| Stratford-upon-Avon Electric Lighting (Amendment) Order. | The Corporation. |
| Surbiton Electric Lighting Order.—Portions of the Urban District of Surbiton. | The Urban District Council. |
| Tewkesbury Electric Lighting Order.—The Borough of Tewkesbury. | The Corporation. |
| Tottington Electric Lighting Order.—The Urban District of Tottington. | The Lancashire Electric Power Company. |
| Uphall Electric Lighting Order.—The Uphall Special Lighting District in the County of Linlithgow. | The Linlithgow County Council. |
| Ware Electric Lighting Order.—The Urban District of Ware. | The North Metropolitan Electrical Power Distribution Company, Limited. |
| Whitwood Electric Lighting Order.—The Urban District of Whitwood. | The Urban District Council. |
| Whitworth Electric Lighting Order.—The Urban District of Whitworth. | The Urban District Council. |
| Wimborne and District Electric Lighting Order.—The Urban District of Wimborne, the Parishes of Canford Magna and Kinson in the Rural District of Poole, and the Parishes of Colehill, Hampreston, Pamphill, and West Parley, in the Rural District of Wimborne and Cranborne. | The Bournemouth and Poole Electricity Supply Company, Limited. |
| Woking (Chertsey Extension) Electric Supply Company Electric Lighting Order.—Portion of the Parish and Urban District of Chertsey, the Parishes of Byfleet, Pyrford, Chobham, and Bisley in the Rural District of Chertsey. | The Woking Electric Supply Company, Limited. |

## TRADE NOTICES AND NOVELTIES.

### Calendars, Diaries, etc., Received.

ARMORDUCT MANUFACTURING COMPANY, LIMITED.—A very serviceable desk calendar, rather novel in design, of the tear-off-a-leaf variety. Notes can be made on any leaf ahead, and all notes taken during the year are preserved.

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THE
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### TO CORRESPONDENTS.

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## MONEY.

"'Tis money makes the mare to go"—an old and well-known adage; though perhaps a direct meaning it has none, still it forms a very nice and convenient text upon which to sermonise. A well-known engineer discussing prospects before Christmas said, as has many another, that money was tight, and far too dear. What! with a bank rate at 3 per cent. for so many months? Oh, the bank rate is no criterion as to what we have to pay in order to obtain money necessary to carry out new authorised schemes. "Here," said the speaker, "are drawings showing proposed works. The schemes are acknowledged to be good, have every prospect of success, are necessary to fully develop other works in successful operation, and need not be expensive." The question of carrying out such work, of course, depends upon funds being forthcoming, and unless these be obtained *through the usual channels*, there seems little prospect of obtaining them. The usual channel is by the aid of professed financiers, and there seems to be a very general impression that the better the proposed scheme the dearer it is to get money. This seems difficult to understand; but the way it is explained makes it clear. The estimated income is so much, that income means 5 or 10 per cent. upon so many thousands of capital; therefore the capital is made to depend upon the estimated income instead of upon the actual cost of construction. Hence the capital as put forth in a prospectus may be double what is actually required and the payments to the financial fraternity are large, bringing about a large sum sooner or later planted upon the public for which there is and never has been a corresponding asset, and for the issue of which there is no reason except inflated estimates. The labourer is worthy of his hire. True, no one disputes that, nor grudges him his due, but what we are suggesting now is that in many of the schemes carried out by the aid of City financiers the question of due and true hire is never considered. All that governs action is plunder; plunder — the more the merrier. Thus it has come to pass; money is unobtainable for new enterprises except at high rates. A direct appeal to the public for money is almost useless. Honesty of proposers is scouted. The purse holder is led to invest only by a promise of high dividends. He discounts to a certain extent the promise, but bites, on the off-chance that it is one of the few cases where performance is better than the promise. Again our engineer, "What chance should I have of getting the money required direct from the public without the intervention of the financier?" Our reply was diplomatic, with might, may, if, and but looming largely; but in sober earnest, what real chance is there to obtain money in such a way? If, then, the inference we draw is correct, and our present methods of floating companies are as indicated, most of our industrial concerns are over-capitalised, and their balance-sheets must mention assets of doubtful value if they could be read aright. One of the arguments of the anti-municipalist is that the local authorities can obtain money at a less cost than can companies. From this point of view that undoubtedly is so, and will be so long as the financier is paramount. On the other hand, no feasible scheme has yet been suggested whereby the cost of obtaining money can be reduced. The financiers say, "On the whole we do not obtain too great an income," but that is simply because the best things have to pay for the failures, and hence, again, a reason for over-capitalisation when the concern is first rate. The average to the financier comes out all right, but the financier looks at the matter quite differently to the engineer or the parties whose interest is more in the future working than in promotion. Is there a solution?

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## THE AMSTERDAM-HAARLEM ELECTRIC RAILWAY.

In our issue for Dec. 2 last we referred briefly to the successful completion of the above undertaking. Through the courtesy of Messrs. J. G. White and Co., Limited, the engineers and contractors, we are now able to give a full illustrated description of this interesting line.

### Historical.

About five years ago a system of electric tramways was constructed in Haarlem by a local Dutch company. This system—the first of its kind in Holland—included a circular route round the city, with two branches, one running north to Bloemendal, a thriving residential suburb, and the other about five miles west to Zandvoort, an important seaside resort. Haarlem contains some 65,000 inhabitants, and is popular among the business men of Amsterdam as a place of residence. The distance between the boundaries of the two cities is 10 miles, and it appeared to a number of people that an electric line connecting them should be a paying enterprise. A concession for such a line was granted several years ago; but the proposed route was rather roundabout, and finally the Holland Steam Railway Company secured control and prevented the fruition of the scheme. In 1901, however, Messrs. Anderhagen and Neumeyer, of Amsterdam, took the preliminary steps towards obtaining a new concession for the construction of a line by way of the direct Government high road, which runs parallel with the steam railroad. It was proposed to construct a line on each side of this high road, thus forming a double track, and in due course the necessary concession was granted. Its principal terms were: (1) That the concessioniare was required to sheet pile the sides of the road (which is bordered by a canal on one side and a ditch on the other) in order to secure the necessary width and stability, and to carry out the whole of the works with the least possible interference with the regular use of the road. (2) The period of the concession was for 50 years from Dec. 31, 1902. (3) All construction plans of every nature were required to be submitted for the Government approval. (4) The period allowed for the construction was two years. (5) The speed allowed for the cars was to be regulated by the Secretary of State, and the speed actually permitted was 22 miles per hour. The Secretary of State was also empowered to fix the maximum fares, but it was generally understood that the maximum fares allowed should be equal to those of the steam road.

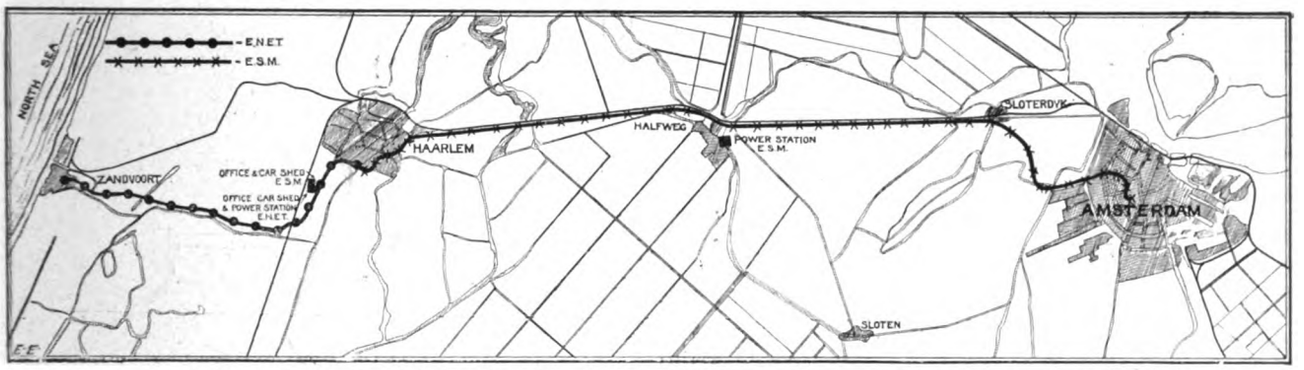


FIG. 1.—Map of Route. Key: E.N.E.T., First Netherlands Electric Tramways; E.S.M., Amsterdam-Haarlem Light Railway.

At the expiration of the concession the Government takes over, without compensation, all the property of the company located on Government lands. There are a large number of minor provisions regarding protection of workingmen, as to hours of labour, accident insurance, pensions, and so forth, and as to the protection of the various water boards, drainage boards, telegraph companies, railways, etc.

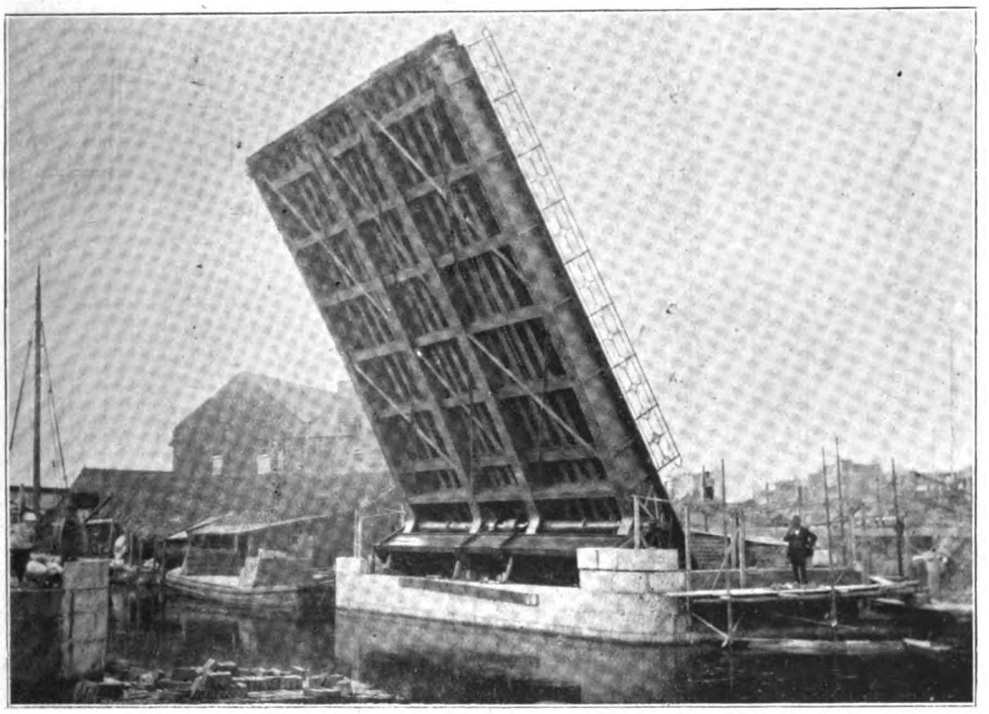

FIG. 2.—Kostverloren Vaart Bridge, Amsterdam-Haarlem Light Railway.

In addition to this concession for the use of the Government high road, it was necessary to obtain an entrance into Amsterdam, and to do this satifactorily the concessionaires obtained options on a private right-of-way for about two miles from the Government road to the Amsterdam city boundary, at a point near the terminus of one of the Corporation tramway lines. In obtaining this private right-of-way, the option was made to include a strip of land for the whole distance, wide enough to permit of a row of building sites on each side of the road being laid out and sold. On this section the tramway is built in a purely private right-

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of-way in the centre of the road, with a paved carriageway on each side, and outside of this carriageway the usual footpath and building sites are arranged.

Running powers were then secured over the tramways of Amsterdam, then in process of electrification, for a distance of about one mile from the city boundary to the corner of the Spui and the Kalverstraat, the centre of the office and retail business quarters. The gauge of the Amsterdam lines being standard and that called for by the new concession 1m., it was necessary to lay a third rail for the greater part of this distance, where the lines are common, to permit through running of the company's cars over the Corporation route, and this work was carried out by the Corporation at an agreed percentage over cost. A large swingbridge had also to be constructed to permit the through running of the cars. In addition to paying for this bridge and third-rail construction, the concessionaires agreed to pay 40 per cent. of the fares which the town would have charged within the city boundary on the basis of its own rates, and also to refund the actual cost plus 10 per cent. expended by the Corporation for repairs and maintenance of the tracks used by the concessionaires, and, further, to pay for power within the city and taken from the Corporation's trolley wire, at a rate of not less than 0·9d. per car mile. The period of this contract is the same as that of the concession on the Government road. It will be noted that the conditions are most stringent, and that a net profit on the running in the city of Amsterdam could not be looked for; but, on the other hand, the distance within the city was a very short one (1·4 mile in a total run of 12), and to secure the satisfactory terminal facilities these concessions were necessary. Messrs. Anderhagen and Neumeyer then secured an agreement with the Corporation of Haarlem permitting the construction of about 1½ miles of lines within that city, to give the company a satisfactory terminus at its eastern end. The Haarlem concession is also for a period of 50 years, and is without unusual features, except that the concessionaires are required to pay large amounts for the renewal of bridges and similar works along the route.

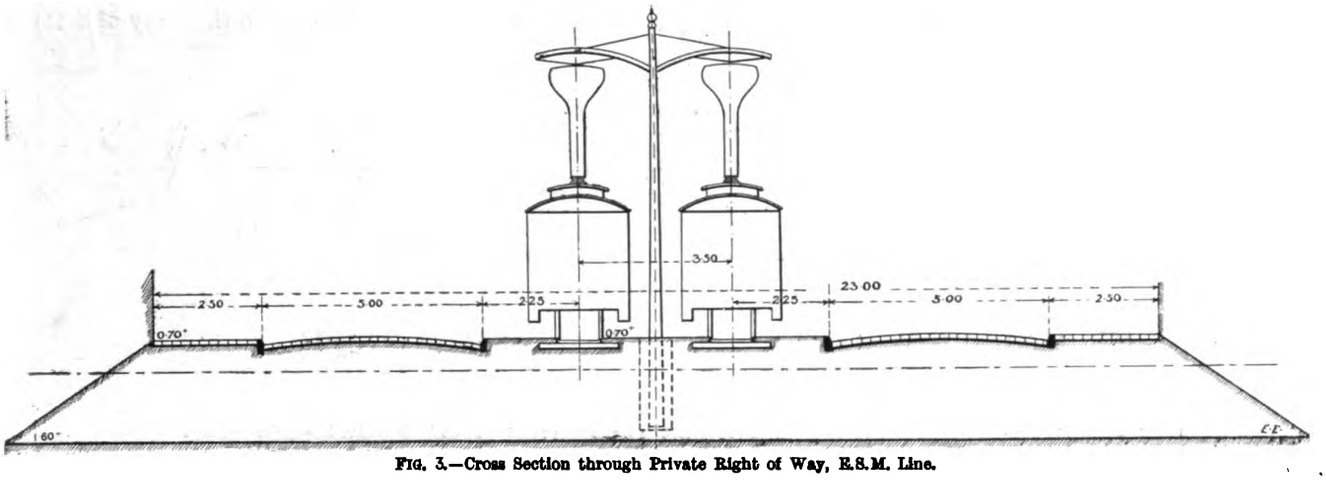


FIG. 3.—Cross Section through Private Right of Way, E.S.M. Line.

When all the concession arrangements above outlined were completed and the local permits obtained, the scheme was submitted to an American syndicate headed by Mr. H. J. Pierce, of Buffalo, who, after full investigation, decided to take the matter up and build and operate the proposed line. The Electric Railway Company of Amsterdam—a Dutch corporation—was formed for the purpose. All the shares of this company were subscribed and fully paid for in cash by the Netherlands Tramways Company of New Jersey, the American syndicate above mentioned. The debentures of an amount equal to the amount of shares—viz, 3,000,000 guilders (about £300,000)—were purchased outright by the well-known Amsterdam banking firm of H. Oyens and Sons. The Netherlands Tramway Company decided that in order to secure more satisfactory terminal facilities in Haarlem and through running arrangements between Amsterdam and Zandvoort, the seaside resort referred to in the foregoing, the local Haarlem tramway company, which had been in operation then for two years, and which is known as the First Netherlands Electric

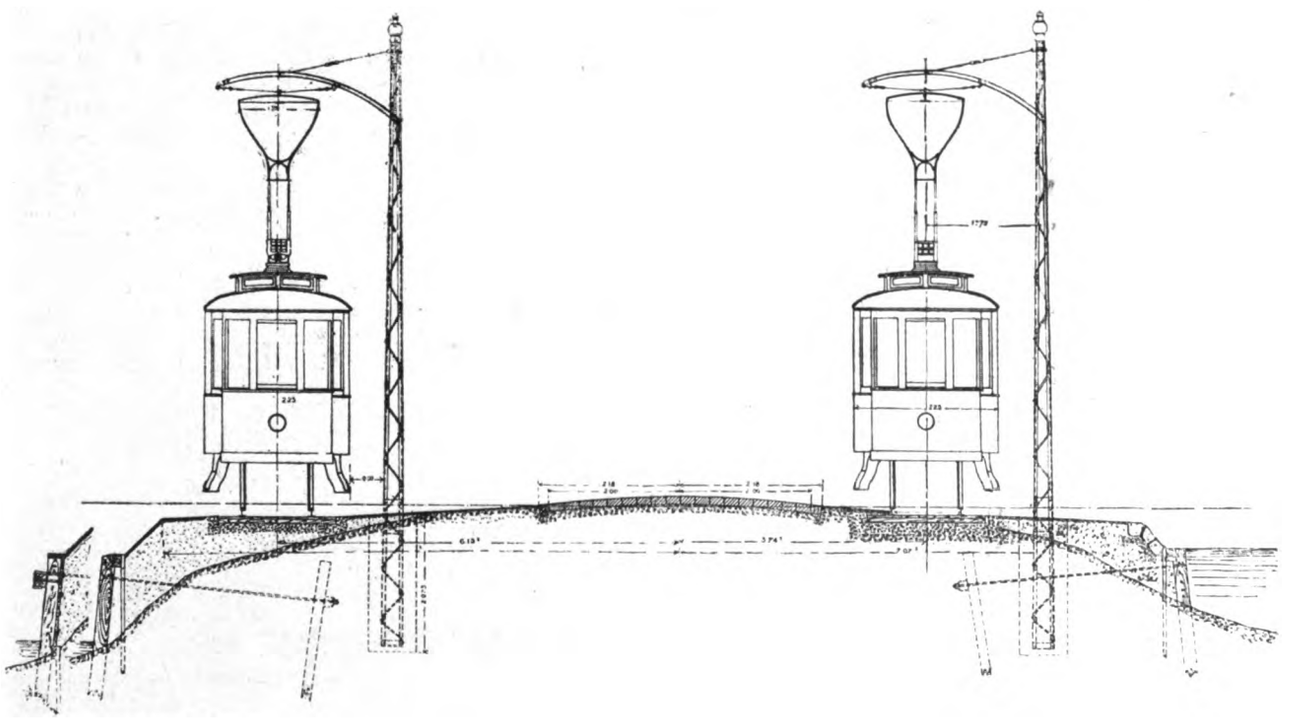

FIG. 4.—Cross Section through Government High Road, showing arrangement of Tracks and Sheet-Piling, E.S.M. Line.

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Tramways, generally abbreviated to E N.E.T., should be purchased outright. This was carried out, and practically all of the shares of the E.N.E.T. passed into the hands of the Netherlands Tramways Company of New Jersey. The two undertakings are thus consolidated, and for practical working the lines will be operated as a single system.

A contract was then entered into with Messrs. J. G. White and Co., Limited, of London, for the complete design and construction of all the works required, including the permanent way, overhead equipment, power station, car shed, shops, office buildings, bridges, etc., for the

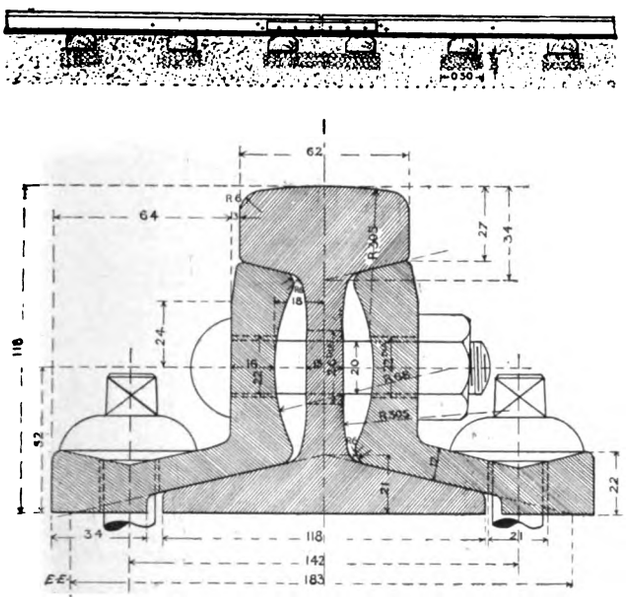

FIG. 5.—Details of Rail and Joint used on Government High Road and Private Right of Way.

Amsterdam-Haarlem inter-urban system, and the reconstruction and additions required by the E N.E T., including the double tracking of the line running to Zandvoort, increase of office and car-shed accommodation, and extension plant in the power station serving this section. The contract was signed on Jan. 1, 1903, and the operation of the completed system commenced in October, 1904. It was intended to inaugurate a service of cars in the spring of 1904, but the works were delayed, due to the failure of the Corporation of Amsterdam to complete bridges, and the delay in getting the approval of the Municipality of Haarlem.

## The Route.

Referring to the accompanying map (Fig. 1), the almost direct route taken by the lines from the centre of Amsterdam to the Zandvoort terminus will be at once appreciated. It will be noted that the designations E S.M. and E.N.E T. distinguish respectively the Amsterdam-Haarlem inter-urban line from that of the First Netherlands Electric Tramways. The bridge (Fig. 2) at the point of junction between the Amsterdam Corporation's and E.S.M. lines is known as Kostverloren Vaart. This bridge was designed and constructed for the Amsterdam Municipality by the Haarlem Machine Company at the cost, as before mentioned, of the Electric Railway Company. It is what is generally known as the bascule type of swing-bridge, and not being easily adaptable for an overhead construction the cars run across it by momentum. There has been found to be no difficulty in this, notwithstanding the fact that there is a considerable ascending grade and a sharp curve on the Amsterdam approach. It should be mentioned that the bridge is operated electrically. The current for working the tramcars to this bridge, and also for working the bridge itself, is furnished by the Municipality, though there is a cable connection made under the canal to enable current to be supplied from the company's mains in case of failure on the west side. For the further information of the reader it may be stated that the bridge in question has a span of 39ft. 6in., and is 39ft. 6in. wide, while some 876 piles and 230 cubic yards of other timber were used in connection with the foundations. It also contains 1,620 cubic yards of brickwork, 130 cubic yards of granite, and 220 tons of steel. Bearing in mind the above quantities, it is almost unnecessary to add that loose sand, that characteristic of Holland, had to be contended with during the construction.

From this point for a distance of about two miles the line runs over what is known as the private right-of-way. The cross-section of the road (Fig. 3) over the greater portion of this part of the route measures 72ft. from building line to building line, a strip 26ft. 6in. wide being left in the middle for tramway tracks with centre-pole construction. The average level of the ground was 5ft. 3in. below the Amsterdam datum, and the height of the finished road was 2ft. 3in. above, so that 7ft. 6in. of material had to be added. The total filling in corresponding to these figures works out at 200,000 cubic yards, but the actual amount of sand brought on to the work was 350,000 cubic yards. There was therefore used on the work 150,000 cubic yards more than shown on the embankment. This is accounted for by the bad soil, the additional amount sinking into the ground. The sand was conveyed in scows to the works from a distance of 12½ miles. It was unloaded from the canal, by means of elevators, into trucks, and hauled by engines on to the road. On this private right-of-way two steel bridges and one of wood had to be built. The first mentioned have a span of 16ft. 4in. and a width of 39ft. 6in. Some 440 piles, with 93 cubic yards of additional timber, 400 cubic yards of brickwork, 26 cubic yards of granite, and 20 tons of steel, enter into their composition. There was also used for the approaches 500 piles and 130 cubic yards of other timber.

At the village of Sloterdyk (see the accompanying map, Fig. 1) the line joins the Government high road, between Amsterdam and Haarlem. On the north side of this road is a canal running the whole length, except through the village of Halfweg, while on the south side there is a ditch. The ground over this distance is what is known in Holland as "polder land." The land itself is below the canal level. It is divided by ditches, generally running in a north-easterly and south-westerly direction. These ditches lead to various points, where windmills are placed to pump the water from the low level up into the canals. The land is of a boggy, peaty nature, and is used wholly for grazing purposes. One of the conditions of the concession, it will be remembered, was that the sides of this road should be sheet piled, and this piling constitutes perhaps the most interesting feature of the whole scheme. It is shown in the cross-section (Fig. 4). On the north or canal side of the road the distance from centre to centre of the piles

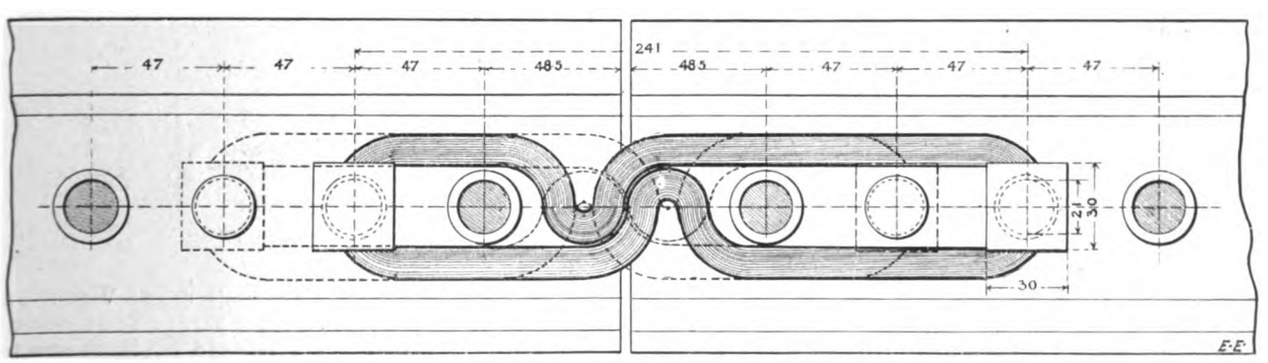

FIG. 6.—Double Concealed Rail Bond.

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is 1·25m. They are of heavy kolders or hellens, measuring about 22cm. at the top and 18cm. diameter at the point. Their length is 5m. A purlin 13cm. by 20cm. of squared pine is carried along this piling, being bolted to the piles. The bolts are made with square heads countersunk into the wood. Behind this purlin a row of planks, 6cm. thick and 2·50m. long, are driven in, each plank being 28cm. by 30cm. wide. These planks are fish-mouth jointed, and each is fixed on the purlin with three spikes. They are driven in perfectly vertical, and the joints are of good workmanlike fit. At the back of every other pile two anchor piles are driven in. Behind these

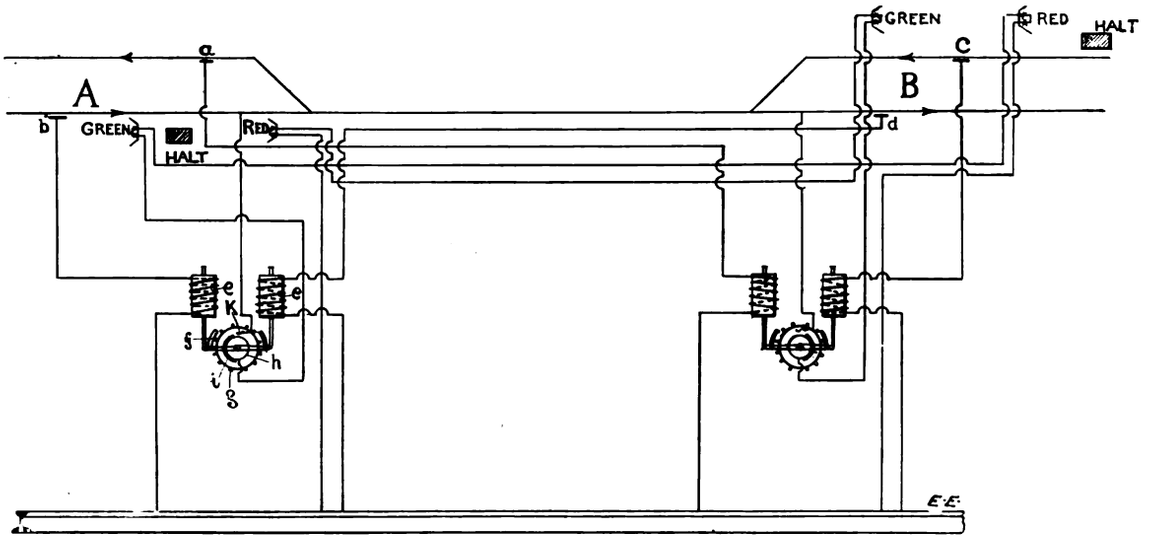


FIG. 7.—Diagram of Connections to the Siemens-Schuckert Automatic Signalling Apparatus installed at Halfweg.

again there is an anchor plate of wood. These plates are tied to the sheet piles with 25mm. round iron rods.

On the south side of the road the piles are of roughly-dressed creosoted pine, 6m. long, 22cm. diameter at the head, and 18cm. diameter at the point, the distance between the piles from centre to centre being 1·10m. The back of this piling is shuttered with boards 5cm. thick of creosoted pine, the joints being covered with strips of timber. This shuttering reaches to a depth of 10cm. below the summer level of the water in the ditch, a purlin 8cm. by 18cm. being fixed to the piles underneath it. Behind the purlin a row of pine planks 6cm. thick are driven to a depth of 3m. For anchoring every alternate pile two anchor piles 3·50m. long are driven in, and to these are attached anchor plates, which in turn are tied with the purlin by means of 25mm. diameter iron rods 4m. long. The space between these retaining walls has been filled in as shown in the cross-section (Fig. 4). Before commencing the sand filling the turf was carefully taken up and stacked, the subsoil and other material being also removed. Pure sand was then deposited in level layers and well rammed down, a coarse gravelly variety being used under the railway sleepers to a depth of 15cm.

At the south side of the road, where the height of the slopes is more than 60cm. above the top of the sheet piling, the slopes are built up with sods in graduated layers. The remaining slopes and the surface of the filling, as far as the sleepers, are covered with either sods or turf 10cm. thick. Where the latter is used grass seed has been planted. The slopes on the canal side above the sheet piling are covered with basalt, which gives them an exceedingly neat and durable appearance. A layer of broken bricks is placed between the sand filling and basalt, the finished pitching having a slope of 1 in 1. The paving of the high road was practically relaid the entire length, to the stipulated datum level of Amsterdam. Some idea of the immense amount of work involved on this section of the route may be gathered from the following quantities of materials used: 20,500 uncreosoted and 23,000 creosoted piles; 3,500 cubic yards uncreosoted and 2,450 cubic yards creosoted timber; 160 tons of iron for tie-rods; 5,000 tons of basalt for projecting slopes; 100,000 cubic yards sand filling; 37,500 square yards of brick paving; 5,700 cubic yards of dredging; 1,850 yards of fencing; and 74 gateways and approaches to farms and houses on the south side. When the work was in full swing on the entire line there were employed 2,360 labourers, two steam locomotives, one electric locomotive, 31 steam pile drivers, three steam spouters, one steam crane, 60 hand pile drivers, one steam bucket rigger, and 165 flat boats and scows.

## Permanent Way.

The permanent way along the Government high road, and also along the private right-of-way, is practically a steam railway construction. The rails are of Vignoles or T section (Fig. 5), weighing 70lb. per yard. The section is the standard of the American Society of Civil Engineers for that weight. The rails rest directly on the sleepers, spaced 2ft. 6in. from centre to centre, except at the joints, where the distance between the centres is 1ft. 7in. The joints are staggered. The sleepers are of creosoted Norway pine, 23cm. by 11·5cm., the upper edges being bevelled. The rails are fastened to the sleepers by screw bolts. Double concealed bonds (Fig. 6) are placed at each joint. The length of route along the canal is 8½ miles. At the village of Halfweg, which, as the name indicates, is situated approximately half-way between Amsterdam and Haarlem, the line crosses two canals. Over these bridges were built

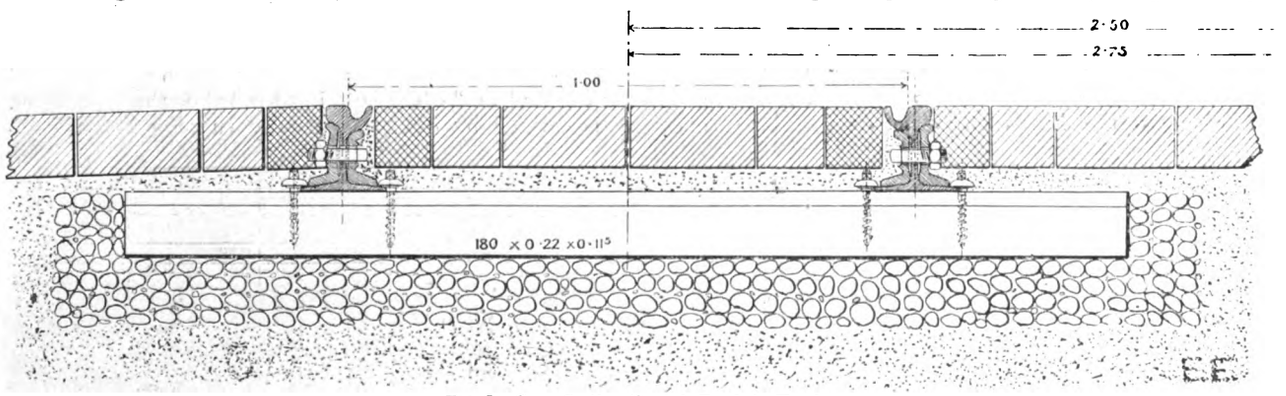


FIG. 8.—Cross Section through Track in Haarlem.

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specially for the purposes of the tramway. One bridge has four spans, each 49ft. 6in., and the other two spans of the same length, all mounted on piles.

Through the village of Halfweg there are two sections of single line. These short sections are controlled by an automatic electric signalling device of the Siemens-Schuckert

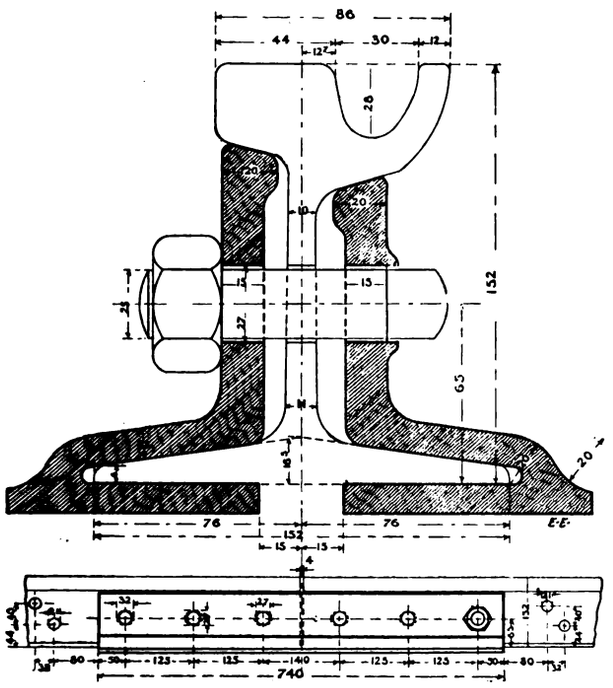


FIG. 9.—Details of Grooved Girder Rail and Continuous Rail Joint used in Haarlem.

Company. This apparatus is designed to prevent two cars entering upon a section at the same time in opposite directions, when both ends of the section cannot be seen by the driver at one time. The connections are shown in the accompanying diagram (Fig. 7). At each switch point this toothed wheel is a contact wheel, *h*, with one segment, *i*. The segment, *i*, forms, with the spring, *k*, an arrangement for breaking contact in the circuit of the light signals in such a manner that the contact is usually broken; therefore, no light burns when the section is free—that is to say, when no car is passing between A and B. As soon, however, as a car enters the section in the one or other direction, a turning movement acts on the toothed wheel, the lamps are lit, and when the green lamp is alight the signal is free, and when the red lamp burns the signal is at danger. When, now, the car leaves the single-track section and touches the contact apparatus in connection with the trolley wire, the toothed wheel is turned in the opposite direction, by means of which the spring, *k*, slips off from the segment and the lamps are extinguished. It is easy to see that the apparatus works in exactly the same manner for several cars following one after the other, and that the number of cars is only limited by the number of teeth on the toothed wheel. By the entrance of each car into the section, the wheel is turned forward one tooth, and by the same car leaving the section it is turned back by one tooth, so that the lamps are extinguished only after all the cars have passed out of the section. If we now follow the course of a car from A to B (Fig. 7), we notice that the car on nearing the point A touches the contact piece *b*, and through a stirrup operates the relay as above described. The spring, *k*, touches the segment, and the green lamp lights up, and is seen from the car, showing that the track is open. At the point B the red danger signal appears; the section, therefore, is closed for cars coming from the direction of B. After the car has passed the stopping place, it passes through the single-track section, and, making contact with *d*, works the relay in the opposite direction, and the lamps are extinguished. The same process is gone through when cars pass from B to A, with this difference, that the relay at B lights or extinguishes the lamps. Should the two cars make contact at *b* and *c* simultaneously, red and green lights appear on both sides. But the arrangement is such that in this case the car coming from B will see only the green light, which means "free track." The car coming

FIG. 10.—Special Track Work at Kleine Houtweg, Haarlem.

where cars enter and leave, similar contact pieces, *a*, *b*, *c*, *d*, are installed, which by the passing of a car are connected by means of a stirrup with the trolley wire, current being thereby caused to flow for a brief period through the windings of an electromagnet, *e*, whereby the armature of the magnet is drawn up, and a ratchet, *f*, is engaged with a toothed wheel, *g*, and at the same time this toothed wheel turns through one section of its circumference. Firmly connected to from A, however, will see from its stopping place only the red light danger signal, and will, therefore, be obliged to wait until the first car has passed the section. The apparatus and signal lights are attached to poles near the switch points. The contact pieces through which the relays are operated are spaced a short distance from the signal lights on the span wire, while the signal wires of silicon bronze, 2mm. in diameter, are carried by porcelain

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insulators attached to cross-pieces of angle iron, which in turn are fixed to the poles between the cross-arms carrying the feeder cables and telephone wires.

At what is called the "Amsterdam Gate" the line enters the city of Haarlem. The terminus in Haarlem coincides with the terminus of the Zandvoort line, belonging to the E.N.E.T. system. Grooved girder rails, weighing 84lb. to the yard, are used in Haarlem. They rest directly on the sleepers, spaced 2ft. 6in. centre to centre, except at the joint, where the spacing is 2ft. The dimension of the sleepers is the same as for the Vignoles track. Fig. 8 illustrates the track construction mostly employed in Haarlem, while Fig. 9 gives the details of a continuous rail-joint also used, special work in course of execution being the subject of Fig. 10. In this town it was necessary to reconstruct a swingbridge, entirely rebuild three other bridges, and to construct a new bridge for the tramline only at the Amsterdam Gate. The new car-shed (Fig. 11) was constructed alongside the existing power station of the E.N.E.T. The car-shed track rails are supported directly on cast-iron columns. These columns have flanged bases, resting on the piled foundations. The length of the columns is 7ft. 3in., and the depth of the pit in the clear 4ft. 6in. The distance from centre to centre of the columns is 6ft. 6in. The rails bridge this distance without any additional support. This construction gives the minimum of obstruction in the pits, and is simplicity itself. Vignoles type rails, with a rolled guard-piece bolted on, as shown in Fig. 12, are used for the curves into the car-shed.

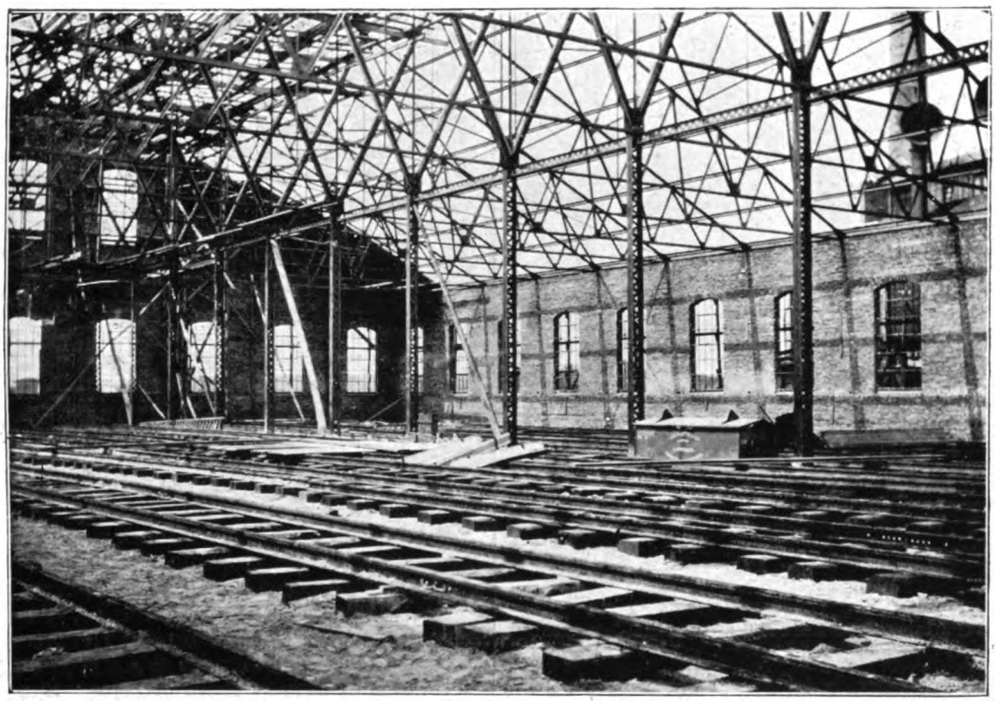

FIG. 11.—Car Shed in course of erection, Haarlem.

## Power Station.

The power station is situated at Halfweg, which is practically the best position for distributing power to the line, being almost central. It adjoins the Ringvaart Canal, which will afford cheap carriage for coal and other supplies, besides abundance of water for feed to boilers and jet condensation. Owing to the nature of the subsoil at the site, an elaborate arrangement of piling was necessary, the entire site being piled with 46ft. long by 9¾in. diameter piles, placed 4ft. 1in. apart, each pile being estimated to carry four tons. On top of these piles runners 7⅞in. by 9¾in. are carried, and support a floor 3in. thick over the space occupied by the building. The piling is carried below the water-level to a distance of 3ft. 7⅜in., and from this point the foundations rise to the floor level, a height of 7ft. 2⅜in.

The buildings (Fig. 13) are of brick, substantially and neatly finished with stone trimmings. The area of the site is about 9,150 square feet, with sufficient additional ground for future extensions. A wharf (shown in the section, Fig. 14), 26ft. 3in. wide, is erected alongside the canal, and immediately adjoining this is the boiler-house, measuring 88ft. 7in. by 52ft. 6in. The engine-room is 59ft. by 34ft. 7½in., by 21ft. 4in. high from floor-level to top of wall. Situated at one end of the boiler-house is a coal storage room, 50ft. 8in. by 35ft. 4in, with storage capacity for 400 tons. An outhouse for offices communicates with the engine-room. The walls of the buildings are 14in. thick above and 21in. thick below the ground line, being strengthened by pilasters 14ft. 9in. apart and 21in. thick, which are carried to the top of the walls for supporting the roof principals. These latter are of tee section rafters, with angle struts and flat bar ties securely riveted to suitable plates. The purlins are of channel iron with wooden runners, and supported by angle-iron brackets fastened to the principals. The whole of the slopes are covered with red tiles secured to a wood lining, which is fastened to the purlins.

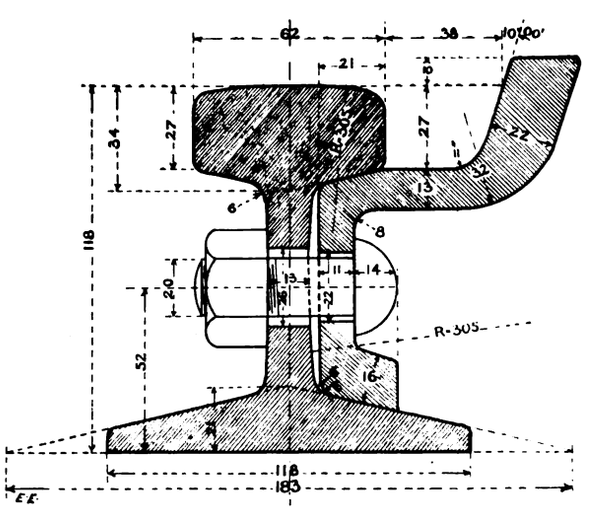


FIG. 12.—Rolled Guard for Tee Rail.

A monitor, 9ft. 10in. wide, is formed along the full length of boiler-house, each side being filled in with nine rows of louvre boards. Wooden gutters with zinc linings are provided along the tops of walls, with suitable drain pipes, which convey the rain-water to the ground-level, or to a tank placed on the roof, the supply from which is utilised for washing purposes. Good light is obtained throughout the entire building by large glass windows with iron frames, and ample door space is provided for bringing machinery into the building. The travelling crane works over an area of the engine-room at a height of 15ft. The gantry

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construction is of tee rail resting on wooden beams and supported on brick arches.

## Equipment of Power Station.

*Boilers.*—The boiler-house (see Fig. 15) contains six Lancashire steel boilers, by Stork, of Hengelo, Holland, the heating surface of each boiler being 926 square feet, grate area 35 square feet, steam pressure 160lb. per square inch. The boiler shell is 7ft. 6in. diameter by 27ft. 10in. long and contains two furnaces, each 2ft. diameter, and having five Galloway tubes. The boilers are stoked by hand. There are also six superheaters. These are placed in the flues directly behind the boilers, and arranged to work at a temperature of 500deg. F. Each superheater has a heating surface of 330 square feet, and consists of 10 rows of coils, the ends of which terminate in two cast-steel headers, 8ft. 11½in. apart, the coils being bound by steel straps bolted together. The steam enters the one header, passes through the tubes, and discharges at the other. Fixed to the discharge steel header is a 1½in. safety valve, a 1in. blow-off cock, and two small holes for testing purposes. The foundations for the boilers are composed of brick arches filled in with sand, and rise from the wooden floor. The boilers are further encased in heavy brickwork walls, and supported on cast-iron stools. By the arrangement of dampers adopted the gases can be made to pass either through the superheater, after passing through the internal flues of the boiler, or the superheater can be cut out, in which case the gases pass along the sides of the boiler to an underneath flue which adjoins the main flue. A round brick chimney, 131ft. high and of 5ft. 5in. internal diameter, is situated free from the building at the end of the boiler-house. This chimney is lined with firebrick set in fireclay, extending from the bottom to a height of 65ft., the foundations consisting of a large bed of concrete 23ft. square by 6ft. deep, and supported by wooden piles 9¾in. diameter by 46ft. long, placed 2ft. 2in. apart.

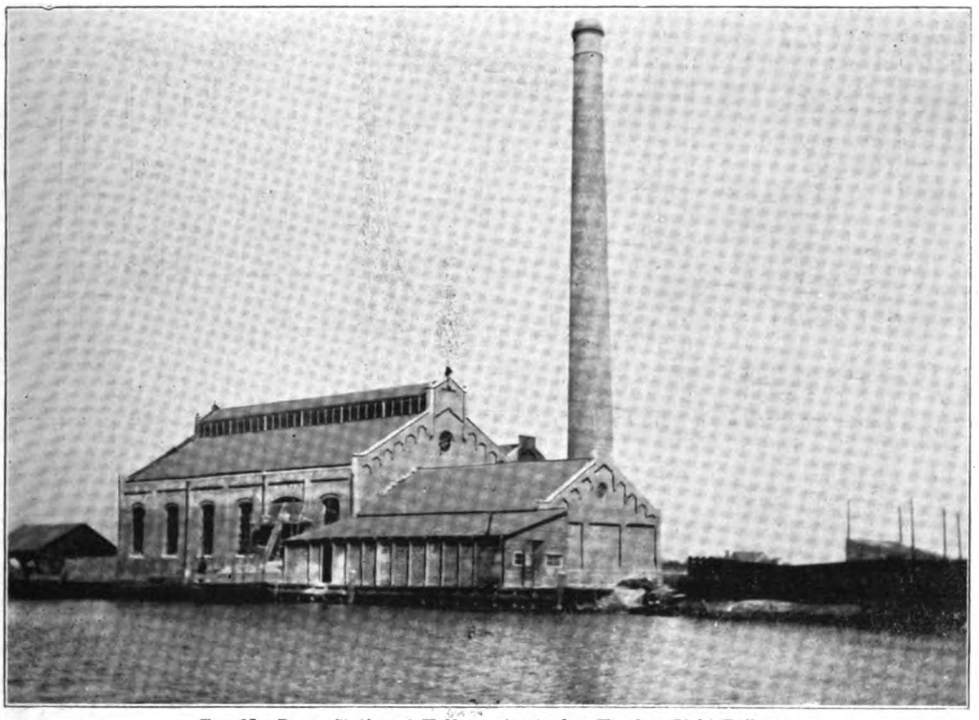

FIG 13.—Power Station at Halfweg, Amsterdam-Haarlem Light Railway.

*Feed to Boilers.*—The feed water for the boilers, as already mentioned, is taken from the adjoining canal. The supply contains a certain amount of suspended matter, necessitating recourse to filtration. Under the stoking floor a duplicate arrangement of brick tanks has, therefore, been provided. Each system consists of a filter tank with reservoir, the filtering medium being composed of sand and clinkers, supported on a wooden perforated floor, thus allowing the water to percolate through the medium to the reservoir. A branch pipe connecting both reservoirs leads to a hot-well. Inside of the hot-well, and fixed to the side of the tank, is a ball-float valve, with connecting pipe to the water inlet supply to the condensers, the latter being used as an automatic emergency water supply in the event of the filtering tanks failing to supply the hot-well. The

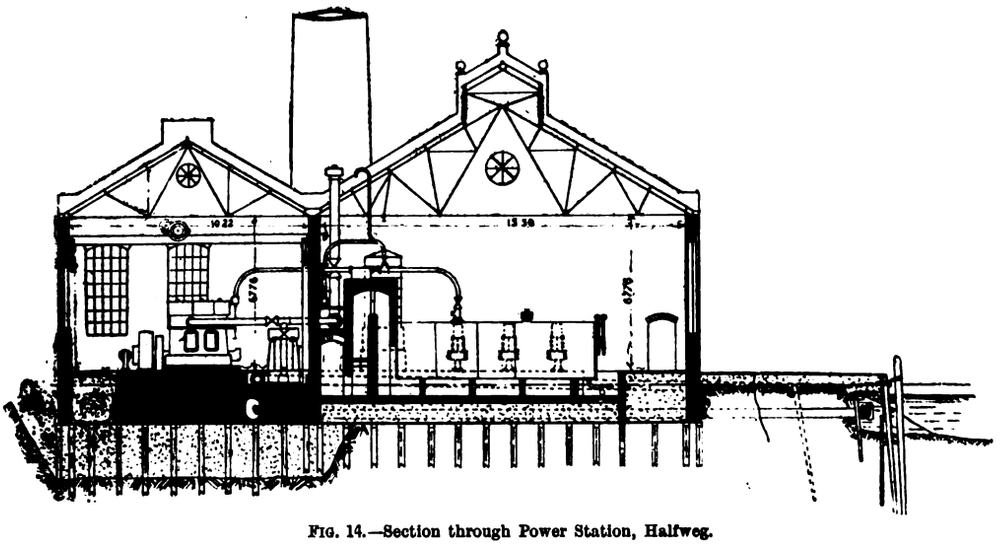

FIG. 14.—Section through Power Station, Halfweg.

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area occupied by the filter tanks is about 710 square feet. Three sets of direct-driven horizontal duplex feed pumps, 6in. by 3½in. by 6in., made by the Buffalo Pump Company, N.Y., are installed, each capable of delivering 2,400 gallons per hour against 300lb. per square inch, the working steam pressure being 160lb. per square inch. A vertical exhaust feed-water tube heater 9ft. 7in. high by 24⅝in. diameter, by the Wheeler Condenser and Engineering Company, is placed directly behind these feed pumps, the feed water entering at the bottom and leaving at the top, the exhaust steam *vice versâ*. The shell is made of cast iron, while the tubes are made of the best quality seamless drawn brass, fastened to the tube plates at the top end by ferrules and asbestos packing, the bottom end being secured by screwed joints. By removing the upper cover of the heater and the bottom hand-hole plates the tubes can be readily cleaned.

*Main Steam-Piping.*—From the angle stop valves on the boilers 6in. pipes join the cast-steel header of the superheaters, and then branch into the main header, from which the engines take their supply of steam. The piping, which is extra heavy throughout, is arranged by closing valves in the main header to permit the operation of this plant as three independent units. Owing to the high temperature of steam, ample allowance has been made for expansion and contraction, and the piping is designed in such a way that any condensation of steam in the pipes connecting the main header collects in the latter, and is drawn off by three drains of large size, one in each section, so as to prevent any accumulation of water in the pipes. The three drains being coupled to two steam-traps, which can be worked independently, discharge into a drip main, which runs along the division wall between the engine and boiler rooms to the hot-well. A stand-pipe from the drip main

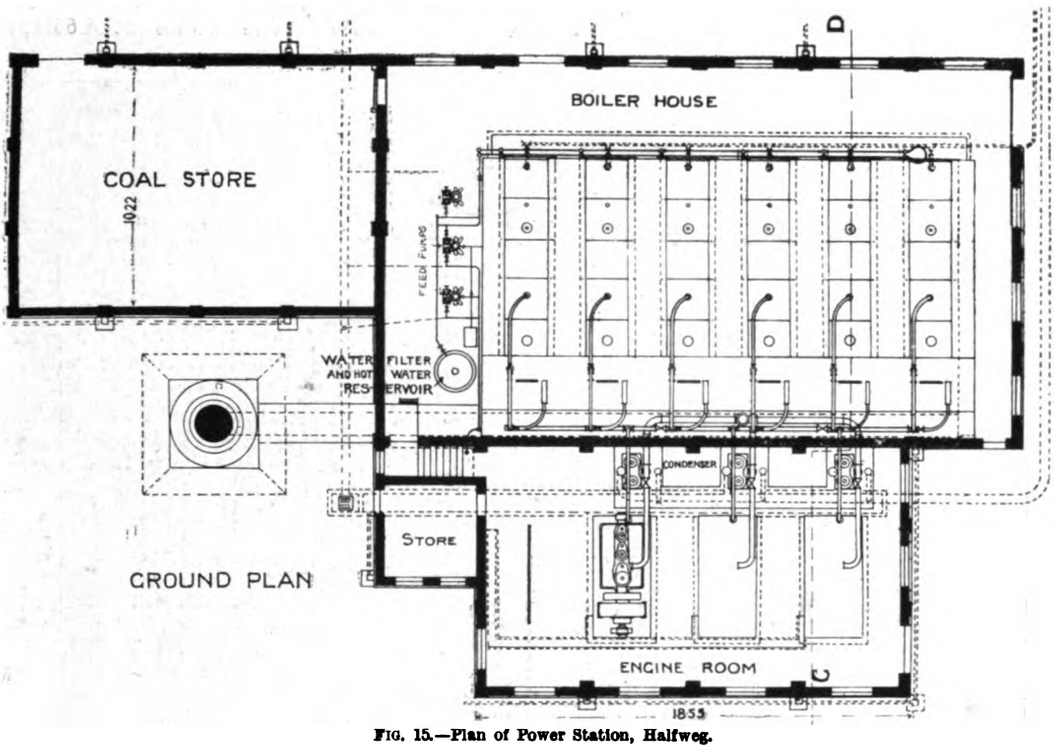


FIG. 15.—Plan of Power Station, Halfweg.

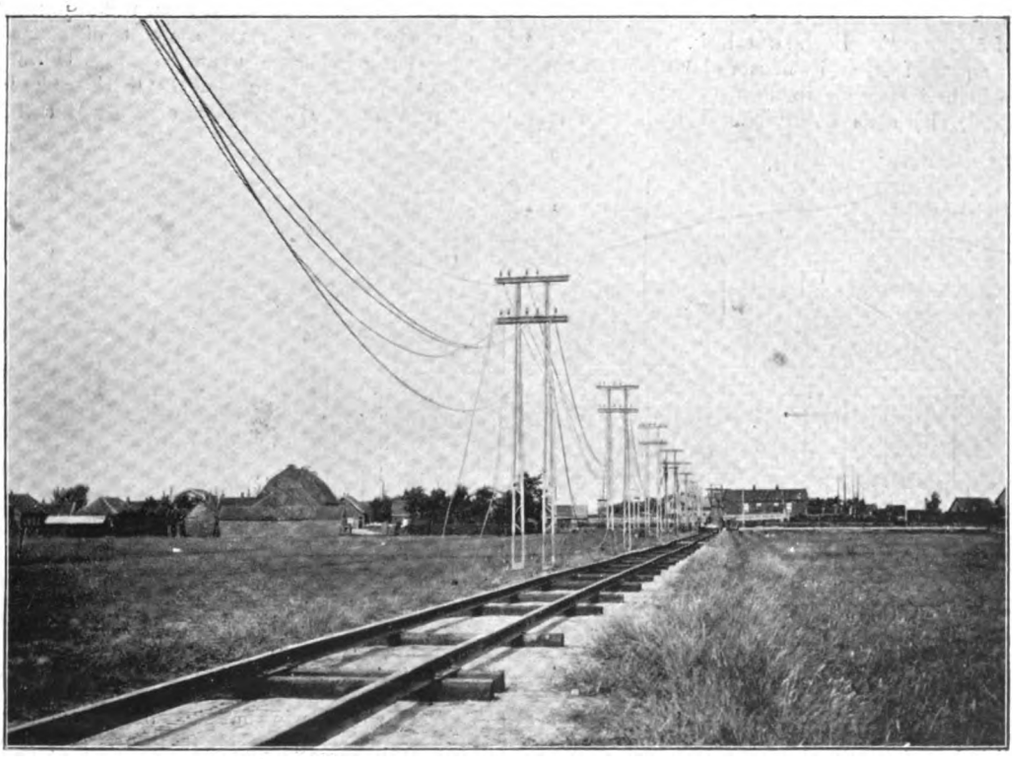

FIG. 16.—Feeders and Returns at Power Station Site, Halfweg.

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is placed in a prominent position in the boiler-house with its end open, so that any excessive discharge of steam will draw attention to a defective trap. Following are the dimensions of the main steam piping: main header, 8in. diameter; diameter of pipe from stop valve to superheater, 6in.; diameter of pipe from superheater to main header, 4½in.; diameter of pipe from main header to engine, 4½in. From each of the angle stop valves on the boilers a drain is connected to a drip main, which discharges into the hot-well. This drain will only be used in the case of any of the boilers being shut down, so as to prevent water from accumulating in the valve. From the stop valves on the engines are drains leading to traps, which connect with the common drip main and run off to waste.

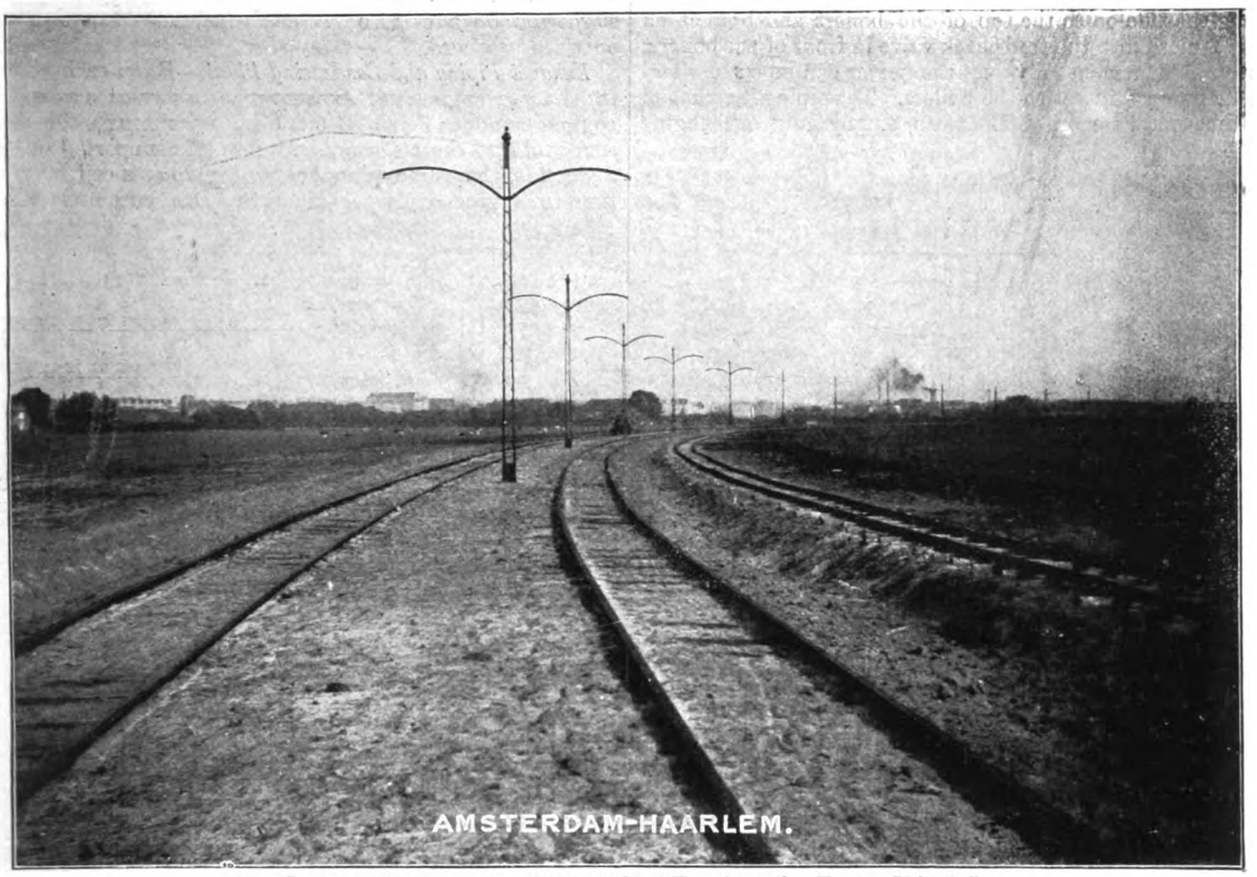


FIG. 17.—Centre Pole Construction, Private Right of Way, Amsterdam-Haarlem Light Railway.

FIG. 18.—Side Pole Construction, Government High Road, Amsterdam-Haarlem Light Railway.

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*Feed Piping.*—The feed-water piping to the boilers is arranged in duplicate. The discharge from the pumps passes through the heater into one of two mains which run along the side on to the top of the boilers and branch off to a Y-piece into the feed check valve in front of the boilers. By an arrangement of valves the heater can be cut out and water pumped direct to the boilers. The piping is arranged so that one or more boilers can supply any one engine

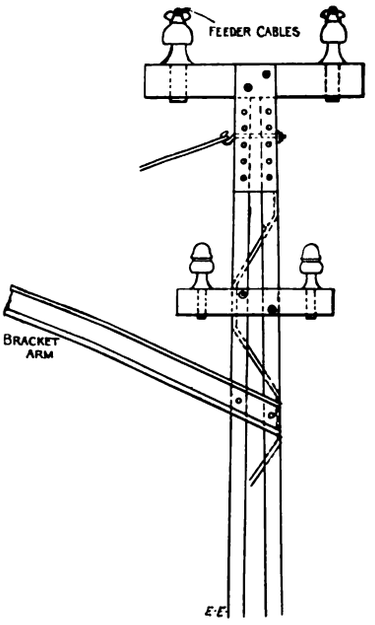


FIG. 19.—Details of Side Pole Construction, showing method of carrying Feeders and Telephone Wires.

independently of the others, and allow the consumption of steam in the engine to be determined at any time. Each of the feed pumps installed is capable of supplying the full amount of feed water required by all the boilers.

*Engines and Generators.*—The main plant consists of three Belliss patent self-lubricating, three-crank, triple expansion engines, each of 430 b.h.p. at economical cut-off, and having a steam consumption of 13½lb. per brake horse-power hour with superheated and 17lb. with saturated steam, with 26in. vacuum. The speed is 375 revolutions per minute, and its regulation is within 3 per cent. even with sudden variations from full to no load. The engines are of the enclosed type, supported on a heavy cast-iron frame, and secured by nine foundation bolts. The cylinders are respectively 12in., 17in., and 26in. diameter with 13in. stroke. To these engines are direct-coupled three continuous-current compound-wound six-pole generators supplied by the Société Anonyme Westinghouse, Le Havre. The output of each machine is 300 kw. at 525 to 575 volts when running at a speed of 375 revolutions per minute. Each generator is supported on a cast-iron frame, which also supports the outward bearing.

*Exhaust Piping and Condensing Plant.*—From each of the three main engines an exhaust pipe is carried across the engine-room at a height of 6ft. 6in, and through the division wall into the boiler-house, where it is supported on the main flue, the three pipes connecting up at a central position to a pipe of larger diameter. An automatic relief

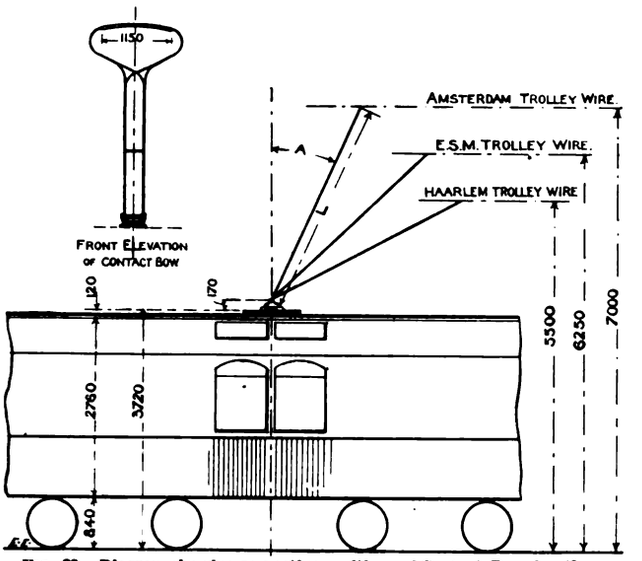


FIG. 20.—Diagram showing respective positions of Contact Bow for the different sections of route.

valve is provided in the vertical pipe leading to the atmosphere, an exhaust header being also attached. A branch pipe is taken from each engine exhaust into an independent jet condenser, by valves situated conveniently in the piping. The arrangement will permit of any one engine working in conjunction with any condenser. The condensation in the pipes drains back into the condensers. The condensing plant itself was made by the Nederlandsche Fabrick, Amsterdam, and consists of three jet condensers, each capable of condensing 9,000lb. of steam per hour. The pumps are of the vertical type, with cylinders placed side by side, and supported by a cast-iron frame. Directly below are the Edwards air pumps. The condenser and injection water inlets are situated behind the pumps, the pumps discharging into a large air vessel placed in front of the pumps. The position of these condensers behind the main engines is shown in Figs. 14 and 15.

FIG. 21.—Motorcar, Amsterdam-Haarlem Light Railway.

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The inlet water is taken from the canal through a pipe into a channel reservoir built into the foundations of the engine-room, from which channel the suction pipes of the condensers take their supply. A valve placed at the pipe entrance enables the water to be cut off if necessary. The discharge from the condensers takes place into a main which has ample capacity for two additional units, and flows thence into the canal.

It may be added here that the auxiliary units (feed pumps and jet condensers) are worked with saturated steam taken from branches off the main steam-pipe between the stop valves and superheaters. The branches are joined up to a loop system, alternate boilers connecting up one side of the loop. From this, again, a main is taken through a separator into the engine-room, where it branches off to the three condensers. Other branches are taken from the loop to supply the feed pumps.

The exhaust from each of the three condenser engines joins into a main pipe which passes through the division wall into the boiler-house, where it meets a main exhaust pipe from the three feed pumps to the heater, the latter being by-passed through butterfly valves, which can be operated to divert the steam either through the heater into the atmosphere or into the atmosphere direct. Valves are placed in the piping, so that any unit can be isolated when required.

between Amsterdam and Haarlem, the remaining section from the last-mentioned town to Zandvoort being supplied from the E.N.E.T. station, extension plant for which was included in Messrs. J. G. White and Co.'s contract.

## Overhead Equipment of the Line.

A good general idea of the overhead construction along the two principal sections of the line—that is to say, the private right-of-way and Government high road—will be obtained from the accompanying illustrations (Figs. 17 and 18). The poles, it will be noticed, are different to anything met with in this country, being of the latticed girder type, and exceedingly light in appearance. They are of three different weights, respectively 550, 700, and 1,300 lbs. The lightest and medium weight poles are constructed of two channel sections braced together, the heaviest being composed of angle pieces. Heel plates are attached, and the poles are set in concrete to a depth of 6½ft., notwithstanding which it has been found necessary to also provide guy ropes in some cases. The bracket arms each consist of two channel sections braced together, this construction being employed throughout, except in Haarlem, and the poles carry both the feeders and telephone wires. The feeders consist of two bare copper conductors, each of 194 square millimetres section, and are carried at the top of the poles on cross-arms, as shown in Fig. 19,

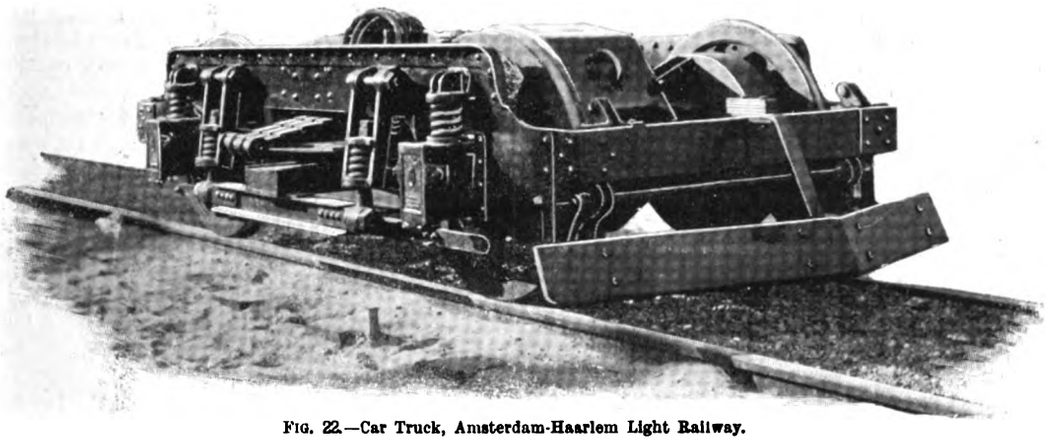

FIG. 22.—Car Truck, Amsterdam-Haarlem Light Railway.

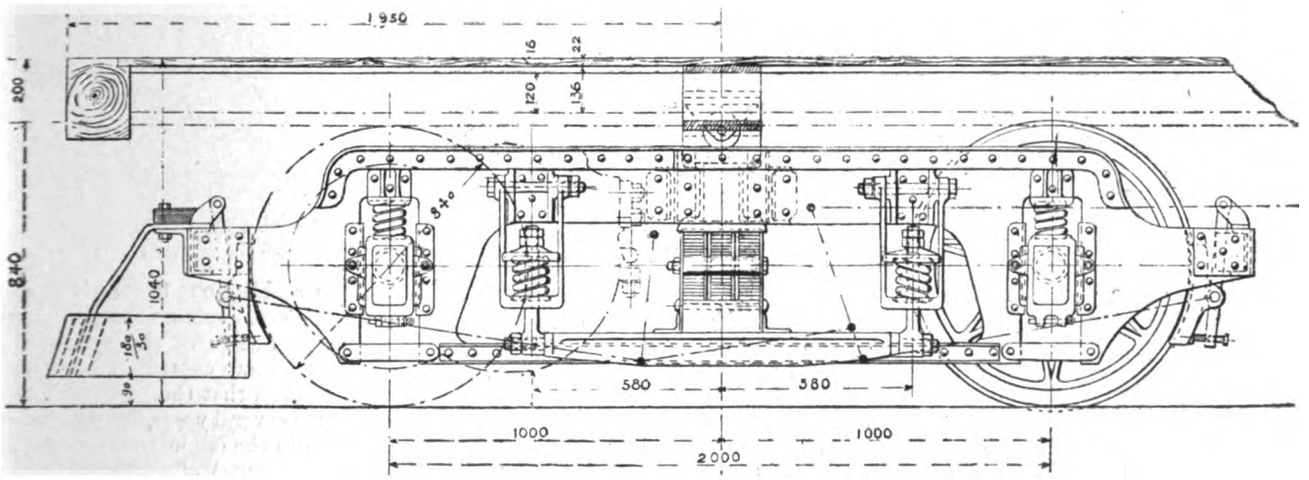


FIG. 23.—Elevation of Car Truck.

*Switchboard.*—The switchboard was supplied by the Société Anonyme Westinghouse, Le Havre. It consists of five marble panels (three generator and two feeder), fitted to a steel frame, and is erected on the floor at one end of the engine-room. The usual complement of instruments, switches, etc., is provided. The cables from the generators are led into a trench which runs along the ends of the machines and terminates behind the switchboard. This trench is covered by chequered plates. The method of carrying the feeders and return cables from the power station to the line is shown in Fig. 16. The voltage on the line differs from that at the switchboard by the amount of loss due to transmission—that is to say, it varies from 575 to 500 volts. It must be remembered that the power station described in the foregoing has to serve only that portion of the line lower arms being provided for the telephone wires. The trolley wire is 68 square millimetres in section, and is zig-zagged, in order to equalise the wear on the bow collectors with which the motorcars are equipped. On that part of the route from Haarlem to Zandvoort bow contact is made with two wires simultaneously. The wire is secured and held up by means of mechanical clips, which, with the bow, ensure noiseless running. The height of the trolley wire from the ground varies for the different sections of the route, as shown on the diagram Fig. 20. This variation in height caused at first considerable trouble with the bow collectors, but at present the bow base is so arranged as to keep an equal tension on the bow at the respective heights. The wear on the bow has been noticed to be very rapid at high speeds when the wire is coated with ice. Lightness pro-

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vided without loss of strength may be said to characterise the overhead construction throughout.

## Rolling-Stock.

There are 34 motorcars of the type shown in Fig. 21. These were built by La Metallurgique at Nivelles, Belgium. Each car is divided into two compartments, for seating 22 and 12 passengers respectively, being also vestibuled. The smaller compartment is for smoking. Besides the usual hand brakes, the equipment includes a Christensen air-brake, supplied by Messrs. R. W. Blackwell and Co., Limited, London. The air-pumps are worked by an electric motor automatically regulated. The trucks (Figs. 22, 23, and 24) are noteworthy in that the swing hangers are pivoted on the outside of the truck frame. This permits a maximum distance between the supports of the spring plank and a maximum distance centre to centre of the swing hangers. The result of this construction has been most satisfactory, the riding of the cars being remarkably easy even at the higher speeds of 35 to 40 miles per hour. Two motors of 50 h.p. each are used on each car. These were furnished by the Union Elektricitäts-Gesellschaft, now incorporated with the Allgemeine Elektricitäts-Gesellschaft.

## Conclusion.

We need not repeat here the observations as to the prospects, etc., of the above undertaking contained in our issue for Dec. 2 last. Suffice it to say, our personal inspection of the line impressed us with the thorough substantiality of the work throughout and the careful regard for local conditions evidenced by every detail of the scheme. The result reflects great credit upon Messrs. J. G. White and Co., Limited, whose indefatigable representative on the spot during the execution of the contract was Mr. Wood. We trust it will lead to the firm being entrusted with other large schemes on the continent of Europe.

In conclusion, we have to express our indebtedness to Messrs. J. G. White and Co. for the materials from which this article has been prepared.

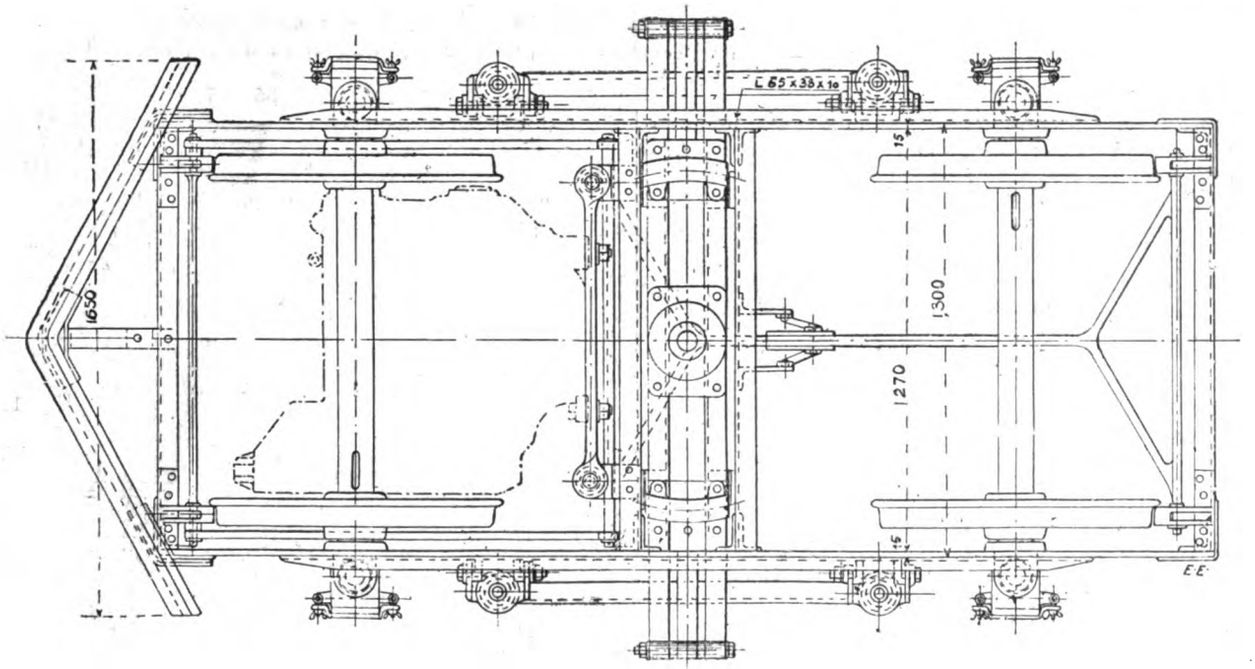


FIG. 24.—Plan of Car Truck.

## DISTANCE-CONTROL SWITCHES AND THEIR LAY-OUT IN STATIONS.

BY W. E. WARRILOW, A.M.I.E.E.

In previous articles contributed to this journal the author has dealt with the design of high-tension, extra high-tension, and low-tension switchgears from various points of view. The present series has for its subject the chief types of oil switches in use, their design and assembly in conjunction with other apparatus to form a power-house or sub-station switchgear. The superiority of the oil switch, and more recently the oil circuit breaker, over the air switch and fuse is now established beyond all dispute where high voltages and large capacities need controlling, so that the respective merits of these types will not be considered. It will be sufficient to draw attention to the effect of opening an air-break switch as shown in Fig. 1, where a very considerable arc is evident across the terminals of a small switch to emphasise the necessity for an oil break under all circumstances. There can be no denying that air-break switches are now in use where present practice would suggest or even compel the employment of oil circuit breakers. But this is no argument for their efficiency. It may be said, rather, that where installed such switches are the bane of the operators, while the management will continually live in fear of breakdown.

The development of the distance-controlled switch has been a comparatively slow one, in that its employment has depended on the size of the plant controlled. In fact, only in really large power-houses has it merited adoption, and, strangely enough, it is in America that it has been most extensively used. Until comparatively recently the large Continental power plants have maintained a supply with air-break switches, while many to this day are entirely dependent on them. In collecting data for this article enquiries were made of electrical engineers of repute on the Continent and in America, and but one firm only among the former supplied particulars of remote-control gears. Whether this is in any way indicative of the attitude of Continental engineers towards remote control it is difficult to say. Of course, it is well known that the basement type of gear has been used abroad for several years, the gear being lever-operated from a platform in the engine-room. As far as the author is aware, few Continental electrical engineers manufacture electrically-operated switches, and such as have them in contemplation are at present reticent in giving details of their design. To America, then, must the credit be given for the exploitation on a large scale of the electric distance-control switch, and English engineers who come later into the field with their power schemes are compelled to adopt their designs even if the apparatus is manufactured in this country. Whatever we may do in the way of making such switches of English design, we are still indebted to America for enterprise and forethought in developing so important an adjunct to large power stations.

In introducing this subject, it will be easier for the reader to follow if the types now employed of distance-control gears are classified under two heads: (1) the manual control and (2) the electrical control. In treating with both these the switches themselves will be first described, and the lay-outs of such subsequently treated at the end of

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each section. This procedure will enable ready reference to be made to the types of gears coming under each section.

The arrangements and apparatus described in this article are intended to illustrate what is now being chiefly done with extra high-tension switchgears handling pressures now considered as best kept at a distance from the operator. If these are compared with the high-tension gears previously dealt with by the author in this journal, an interesting record of progress will be noticeable, together with that of changes occasioned by the use of much higher pressures and greater powers. Where at one time anything would do for a high-tension gear, and the operator's life or the fate of the station were apparently unimportant, now the operator, or at least the attendant, is completely isolated from the board, and the greatest possible precautions against fire are taken by sub-dividing the gear and isolating the sections thus formed from each other. Seeing that serious arcing

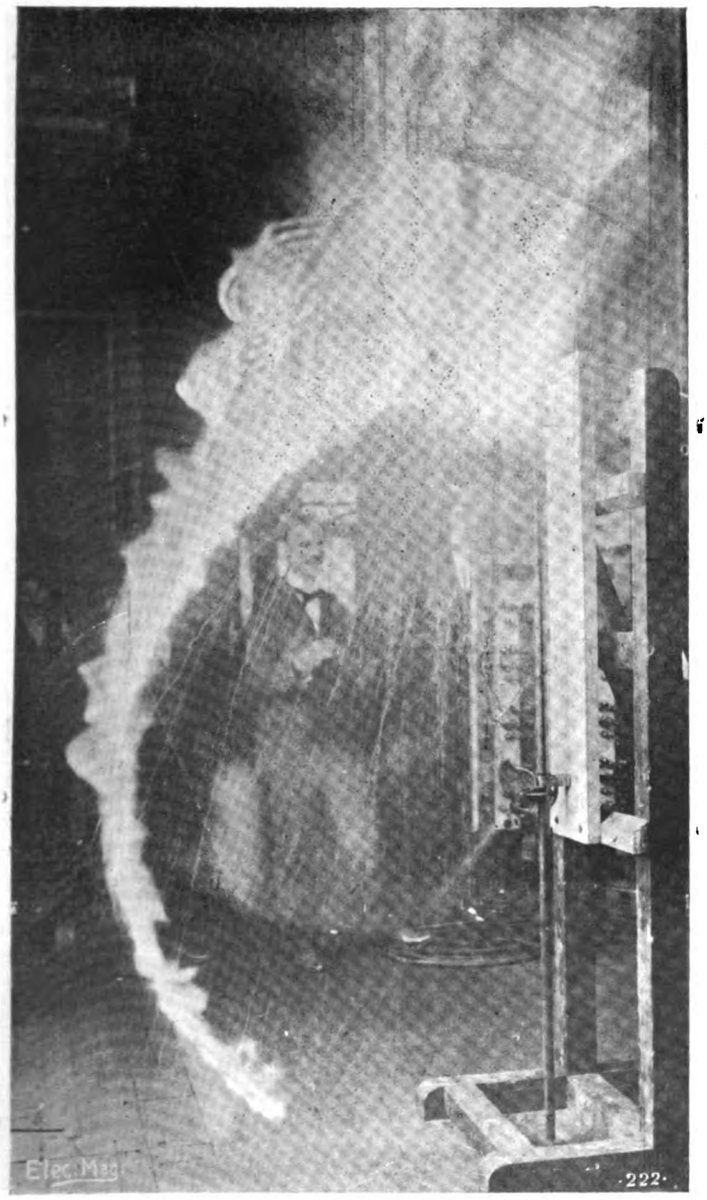


FIG. 1.—Arc produced at Opening.—Air-Break Switch.

if allowed to occur and spread will quickly transform a valuable controlling gear into a heap of ashes, and, perhaps, involve the whole plant, precautions which are really such must be taken to confine that arcing, which will take place on rare occasions, to the faulty apparatus. Unless this is done the gear cannot be safe or considered so. When some individual switch is called upon to deal with the entire output of a station, the necessity for complete isolation becomes even more evident, as failure means that the whole plant will pour its energy into the failing switch.

Perhaps equally important is isolation of phases or parts working at different potentials. In some lay-outs, especially where connections are made to the 'bus bars on the same wall face, assuming the cables enter the bar chamber from below, the first cable presents no difficulty, but the other two must pass through the bottom and middle chambers respectively of the other phases before reaching their particular bar. This method compels the use of insulating tubes for the leads of opposite phase crossing the other bars. Seeing that the most feasible place for the connection is behind the bar, and that the tube may become covered with dust, the arrangement is not conducive to maintaining that standard of safety so closely observed in other parts of the gear. Isolation, if undertaken at all seriously, should be thorough, each particular phase being distinct from generator cable to 'bus bar, from 'bus bar to feeder cable. In no case should it be identified with the other phases or parts from which it differs greatly in potential.

With an air-break lay-out the switches are invariably placed at the top of the board above all other apparatus. Since oil circuit breakers have been used it has often been considered safe to incorporate them in the body of the gear, placing other apparatus above them. This arrangement seems reasonable enough, based as it is on the excellent reputation of the oil circuit breaker. To take every precaution against accident, however, the oil switches should always be placed at the top of the gear, *with nothing between them and the roof* of the switch-house. If partitioned off from their neighbours, any trouble would be confined to the switch itself, and only under abnormal conditions spread to the adjoining gear or plant. Similarly, the cable connections should be *unexposed* in the switch-room, and, where possible, should be below the switch itself. In case of fire destroying the latter, another switch might be quickly got into place, and the cables would have remained intact. The 'bus bars also should be below the switches, and without difficulty can be assembled with the cables (feeder and generator), the instrument transformers, and the section switches. By this method, and with two or three tiers or galleries for the gear, probably the best arrangement to conform to the chief dictates of experience will be found. The relative advantages of manual and electrical control cannot well be discussed here. As the switchgear is the most vital accessory to electricity supply between power plant and consumer, the simpler it can be made, and the less reliant it is on external sources, so much the more immune from breakdown will be the plant be. With lever control, complete confidence is placed in the switchman, on whose muscular efforts its operation will depend; with electrical control, the switchman is still there, but, in addition, some source of electrical energy is needed, and two have to be depended upon instead of one. The ease and flexibility of electric control, however, gives it a powerful advantage over a mass of levers and cranks, and where batteries can be used there should be no trouble from failure of supply. The system requires more thought and skill in its operation and maintenance, but that should not be reckoned a real detriment to its installation. With continued experience of electrical control, we may yet see an automatic switchgear developed, seeing that so much otherwise complicated apparatus can be readily controlled by electrical means. With the questions of 'bus-bar arrangements, selector switches, and sub-division of plant, it will not be possible to deal in this article. Should opportunity arise, these matters will be considered on a future occasion.

## MANUAL CONTROL.

Associated with the development of distance-control switchgears is the small oil "box" switch for hand operation. Various types of these have been constructed, and

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though largely employed singly in isolated positions, their adaptability for distance control with links and levers justifies some reference to them here. Such switches are remarkably compact for the power they control, while they are free from that *bête noir* of many oil switches—leakage from the containing tanks. They possess another interesting feature which makes possible standardisation of type for many different pressures, thus adding materially to the ease of manufacture. For low pressures the contacts can be enclosed in a single oil bath, hung from the contact support. As the pressures to be dealt with are increased, the contacts can be enclosed in *separate* oil-tanks, while for

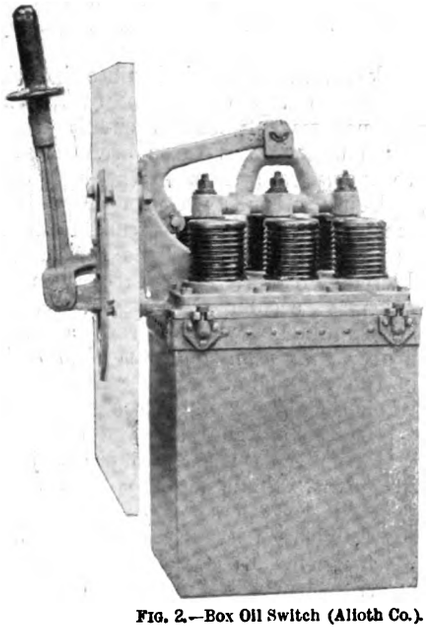

FIG. 2.—Box Oil Switch (Alioth Co.).

higher potentials without increase of power, the contacts can be put in series, giving several breaks under oil in the one circuit. In this case, of course, three switches would be needed, and operation might be cumbersome, though for tandem operation little more room would be required.

As mentioned above, many Continental concerns used the air-break switch for years after the oil switch was its acknowledged superior, but now this fancy for air interruptions and flaming arcs is giving place to a preference for the oil circuit breaker. Fig. 2 illustrates a type made by the Alioth Company, Munchenstein, Bale, a glance at which will at once reveal marked similarity to American practice. In Fig. 3, however, which shows a back view of the

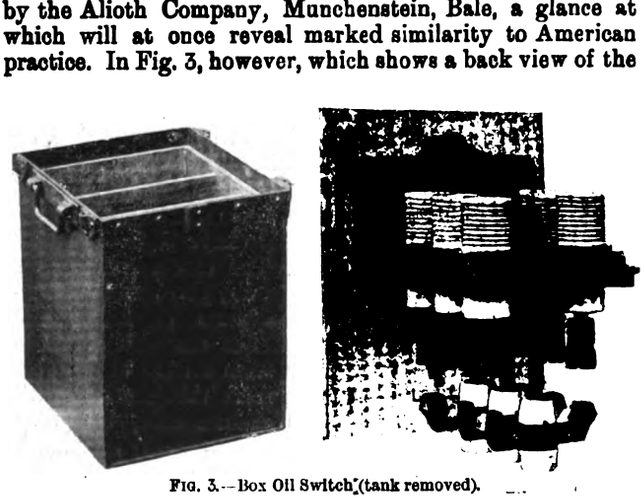

FIG. 3.—Box Oil Switch (tank removed).

switch, the method of mounting the moving contacts will be noticed as dissimilar. A substantial grooved insulator at the end of the vertical rod is used to clip on the bridge contact piece, while the fixed contacts themselves are formed of four distinct strips, which can be readily replaced. A system of parallel links and levers engaging with the casting coupling the switch rods together, and terminating in the main handle, serves to operate the switch. A knuckle joint serves to hold the switch in the "on" position, and when opening, the joint is moved over the dead centre, when the switch mechanism falls sharply by its own weight. The switch is also fitted with a tripping solenoid for operation on overload or reverse currents. The tripping can be derived from a direct-current source or the alternating-current supply through the medium of current transformers. Fig. 4 illustrates the connections for the latter on a three-phase circuit, the secondaries being connected in series through the tripping coil. An armature attracted by the relay normally

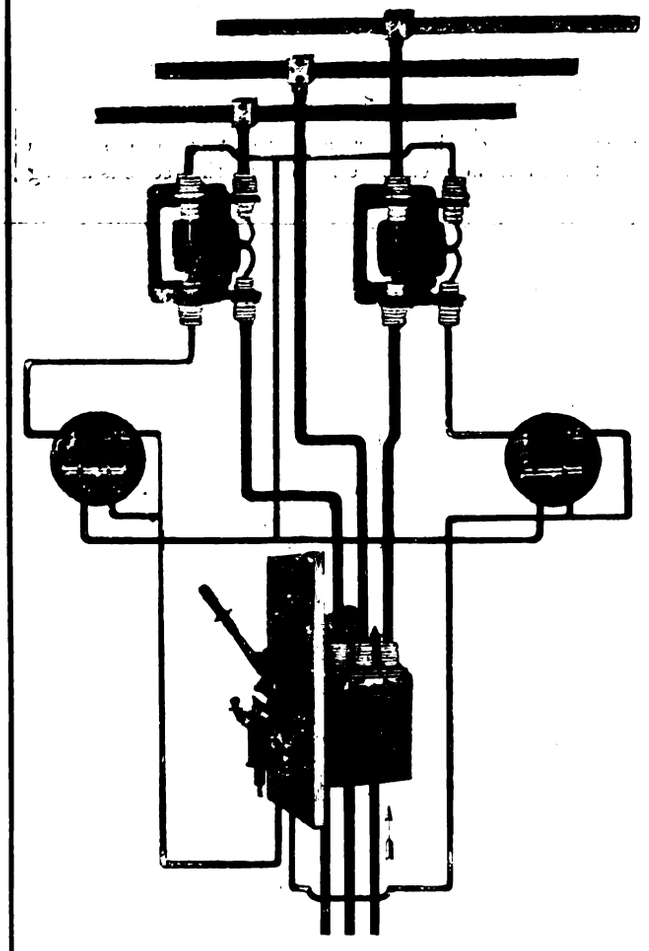

FIG. 4.—Diagram of Tripping Relays and Transformers for Three-Phase Operation.

short-circuits a parallel circuit to the solenoid, but on either relay operating, the solenoid is cut in and operates the switch. The connections and relays are for a maximum-current relay. The author has not been furnished with details of the reverse-current device. Obviously a switch of this character can be operated at any convenient distance, and in the lay-outs to be afterwards described it will be seen that such a switch can be very successfully employed in this particular.

*To be continued.)*

## THE PROPOSED TELEPHONE DEAL.

BY ALFRED R. BENNETT.

The Post Office in the past has admittedly made many mistakes about telephones. It is now about to face a larger and more important operation than ever before, one of which the consequences will be enduring and permanent, whether for good or evil. It is desirable, therefore, to enquire into some of the possible consequences of the contemplated action, and to discuss the various steps or stages which may lead up to it.

As a guide, it would not perhaps be out of place to review what happened when the Post Office acquired the trunk lines some dozen years ago, and discover how we stand now as the result of that proceeding. There can be no doubt that the amount paid for the trunk lines was largely in excess of their actual value. The company was unwilling to sell (as a matter of fact, the sale was an unparalleled and irretrievable blunder on its part), and it

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very properly drove a good bargain so far as payment for the actual plant was concerned. The blunder lay in the mistaken policy—from the point of view of the company's own interests—of relinquishing the splendid hold on the country which the possession of a trunk system gave it. The Post Office had no power to force a sale otherwise than by giving notice to acquire the whole concern in accordance with the terms of the license. The advantages to the company other than the handsome price it received were illusory, and the directors dropped the real meat while grabbing at a shadow. As the company did not benefit, it might be contended that the Post Office, as the other party to the transaction, must have done so, but that view will not hold good when one reflects that the Post Office acted as representing the taxpayers of the kingdom, and that it could only score a triumph by making a bargain satisfactory to the whole community. This it did not do. Much of the plant it bought was already worn out; much was of antiquated construction and already obsolete in 1892; much, again, was little better than temporary work, insufficient conductors supported on inefficient insulators fixed to inadequate poles; and much was on ground for which no proper wayleaves existed. But the price paid was equal to the cost of the best work quite new. No sooner did the Post Office come into possession than the task of pulling down and re-erecting began, and has continued since until probably there is little or none of the purchased plant in actual operation to-day. The trunk lines have consequently been paid for twice over, and it is not surprising, therefore, that the Post Office find it necessary to charge trunk rates about twice as high as they ought to be, and twice or thrice what are found adequate by Continental telephone administrations. Moreover, it is reported that it makes a heavy loss on the trunk system all the same, but as no proper accounts are published, it is impossible for an outsider to tell whether this is true or not. A by-question that may pertinently be put here is, why no separate and understandable accounts are rendered? But, in addition to the high trunk rates, the Post Office let itself and the public in for what are known as terminal fees, which for short distances amount to as much as the trunk rates themselves, and are a burden always. The effect of these are to put telephone exchanges owned by itself (the Post Office) at a permanent disadvantage as compared with exchanges owned by the National Telephone Company, and their existence has no doubt been one of several reasons why Post Office exchanges have never prospered, but have always been outclassed, sometimes actually run out of existence, by the company's competing systems.

The corporation telephone exchanges suffer under the same disability as a consequence of the ineptitude of the Post Office bargainers of 1892, and if they hold their own, as they do, the fact is in no way due to the Post Office, but rather in spite of it. Again, the Post Office has not done its duty by the trunk lines. One of the reasons assigned for purchase was that the company or companies would connect only the larger towns, which would yield a good return on the capital cost, and neglect all others, although, as a matter of strict fact, a good many small towns had already been joined together several years prior to 1892. As early as 1887-1890 the present writer had connected most of the towns in Scotland, as well as in Cumberland, and had erected the first trunk line across the Border. Most of the towns then dealt with were small, such as Whitehaven, Workington, Maryport, Carlisle, Dumfries, Selkirk, Hawick, Galashiels, Stirling, Dunfermline, Kirkcaldy, etc.; and it may be cited as a curious example of the respective merits of company and government administration that not one of the many trunk lines erected by the author failed to pay interest on its cost within two or three months of its opening. Some yielded a very handsome profit. But what has the Post Office done about small towns? In very many instances it has *refused* to connect them at all in default of a guarantee from the local authority, the subscribers, or even the National Telephone Company itself, of a certain minimum revenue. In fact, it has been less enterprising than the company was before the transfer. As regards the larger towns, it has been quite as remiss. Complaints from chambers of commerce and other bodies of inadequate trunk communication between important centres of commercial activity are constantly being recorded, and with every justice. Glasgow and Paisley are only six miles apart, and ought really to be in the same telephone area, and not separated by trunk lines. The number of trunks between them is entirely inadequate, and long waits of anything up to 40 or 50 minutes are common. The state of matters between Glasgow and Edinburgh is even worse. Brighton and London is another case in point—in fact, prompt trunk connection between busy centres is often impossible, and can never be reckoned upon. Had Paisley been one of the places in the Glasgow telephone area permissible for the Glasgow Corporation to deal with, that body would have laid an underground cable containing 100 circuits all the way, and so provided for efficient connection between the two towns. In some cases the Post Office duplex the trunk lines, making two lines serve for three simultaneous talks. This is cheap but bad, as the least fault on any of the wires concerned throws the whole out of gear, and conversations are overheard by people for whom they are not intended.

This is a brief sketch of the outcome of the first purchase negotiated by the Post Office. Compared with what is now contemplated, it was quite a twopenny-halfpenny transaction. What guarantee have the public that the same errors will not be repeated on a more gigantic scale? The danger of such a disaster is far from remote, but leaving that point for the moment, let us enquire how, supposing the purchase to have been decided upon, the price to be paid may be ascertained. The methods open to negotiators appear to be three in number: (1) the market value of the shares; (2) the book cost of the system; (3) "tramway terms"—*i.e.*, buy only what is actually required by the Post Office at a fair valuation considered as plant only, giving nothing for goodwill.

The first appears to me quite out of the question. When prospective purchase was announced the preferred shares rose to 108-9, and the deferred to 102: on what grounds or expectations it is difficult to imagine, the spirit of gambling apart. The ordinary shares have been split at least once; on many of them nothing was ever paid up, they being given away for patents long since expired though never written off, promotion, purchase of competing concerns, etc. Yet many people have bought into the company on these terms in expectation of making a profit out of the projected purchase. They must be either very well or very ill informed. Such a deal is simply inconceivable.

Not much more practical is the second method. The book cost will cover plant already scrapped and done away with, and much that is rapidly approaching that stage, as well as the fancy prices paid for the old competing systems. Purchase on these terms would mean an exact repetition of the trunk-line fiasco.

The third or "tramway terms" method would be fair, and, if it can be shown to be compatible with cheap rates, probably acceptable, *except to the sellers*. This fact, doubt about the outcome as regards future rates, and the difficulty, practically insurmountable, of giving effect to it in time to be of service to the nation, will, in my opinion, make it equally impossible with the other two. It must be remembered that the National Telephone Company are not under any obligation to sell unless they like. The Post Office having failed to give notice by June 30 to avail themselves of the last break in the license, all power of compulsion is over, and the two parties meet on equal terms to make a bargain or disagree just as they may decide. Is it likely, therefore, that the National Telephone Company can consent to sell on any such terms? Even if the directors were bold enough to recommend it, the shareholders would not agree. Where would the profit of those who have bought in at 108 or so be? Instead of a profit, the transaction would probably mean the writing off of a large proportion of the share value because the arbitrator could not give cost price, much less a premium, for old plant. He would have to knock off depreciation and, perhaps, obsolescence, and what would remain would certainly not be accepted by the company. Very likely some of the plant would not be purchased at all. From the company's point of view "tramway terms" are impracticable, from which fact may

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be deduced the generalisation that anything that the company *would* accept would be an astonishingly bad bargain for the country.

Let us now look at the matter as taxpayers and telephone users. Why does the Post Office want to buy the telephones? Is it to benefit telephone users, give them lower rates, and improve and extend the service? Only on some such grounds can purchase be justified at all. But the Post Office record, as I have shown, qualifies it but poorly for the playing of any such important part. The trunk lines speak eloquently as to that. The Post Office is not a reforming institution: it is neither progressive nor sympathetic with public needs and ideals. Its idea of work is to do nothing till forced, and then to leave off again as soon as may be. Can it be trusted to make a bargain for the benefit of the people? Not at all, in my opinion. If left to itself it will probably recommend Parliament to buy at a price which will make cheap telephones simply an impossibility ever afterwards, or, alternatively, will land the country into a standing deficit on telephones as bad as, or worse than, the standing deficit on telegraphs.

It is true that a Select Committee has been promised, but this may mean anything or nothing, according to the terms of reference. On a former occasion—the trunk-line purchase—it must be remembered that the Postmaster-General repeatedly promised that the House would be afforded an opportunity of discussing the agreement before signature, but that ultimately it was laid on the table with the intimation that the Government were pledged to it, and no amount of discussion could alter it one iota. And so the House was jockeyed and the people's birthright sold. What has happened once may well come about again. It is significant that the *Nottingham Daily Guardian* of Dec. 26 and the *Darlington North Star* of Dec. 28 both speak of the agreement as concluded, and of the company as having already incurred considerable expense in anticipation of transfer at the request of the Post Office. Are the shady manœuvres of 1892 to be repeated?

The people's part is to make quite sure *in advance* that no foolish contract is entered into. What is wanted are cheap rates such as are charged by the British corporations who own telephone systems, by the National Telephone Company itself wherever it is face to face with competition, by the Continental telephone administrations, and by the independent telephone companies in the United States. All these show that a rate of between £5 and £6 per annum for an exclusive direct line to the exchange with unlimited calls is remunerative, and that is what must be insisted on in this country. If the Post Office cannot pledge itself to that in advance, then it has no right to buy the telephones. It is no use fixing a price and then discovering too late that, in order to earn interest on it, a rate of £8 or £10 a year must be charged. The business way is to calculate beforehand the maximum sum that is admissible on the basis of, say, a £5. 10s. rate, and if the company will not take it, drop the matter once and for all until the flux of time gives again the right to buy compulsorily by arbitration. But the price must be a very low one because, as was the case with the trunk lines, quite as much as the Post Office gives for the *plant will have to be expended in order to bring it up to date.* When this is thoroughly realised purchase will appear more than ever impracticable. If no purchase is effected the company will remain free till Dec. 31, 1911. If, in the six intervening years, the corporations be encouraged to start competing exchanges, the company will then be found in a much more lamb-like and amenable frame of mind, and telephone users will be in possession of both cheap rates and improved service, because competition and emulation will have produced their usual beneficial effects.

Another and very cogent argument against Post Office purchase is the inability of the Department to find the money for extensions. Few realise to what an extent the telephone system of the country is bound to grow within the next few years, or how many millions of pounds will have to be expended in order to keep pace with the demand. The Post Office depends on the Treasury for its supplies, and the Treasury is often unwilling to oblige. It may have guns to provide, new ships to build, many matters apparently more pressing than telephones to finance, and it will bid the Post Office "go whistle." This has happened already many times in respect to trunk-line construction, and at least once since the Post Office started its London telephone system. Last year for several months it had no money to join up subscribers with or construct trunk lines. Is the telephone system of the country to be hampered in this way for ever? The fact that the demand for money for telephone extensions will be both heavy and incessant and will be resented by the Treasury, is a factor that must not be overlooked.

There is another and extremely important phase of the question which I have left to the last. Hitherto I have written on the assumption that the parties are really serious on the subject of purchase. But is it quite certain that this is the case? The writers and organs identified with the National Telephone Company's interests have recently been arguing against purchase, urging that the company should be left alone till 1911. With a keen appreciation of who provides the real opposition to the company, these articles also plead that no more licenses shall be issued to corporations—but that by the way. It is quite possible that the company has no intention of selling at all—I have shown that it can only do so at a loss—and that the plan is to amuse the Post Office with negotiations, luring it on week by week, month by month, and year by year by an apparent prospect of clinching a bargain, but never reaching that point. If all this time the Post Office declines to issue any more licenses to corporations on the plea that it is negotiating for the nationalisation of the telephones (it has already practically refused a license to Bournemouth Corporation on this ground), it is quite within the bounds of possibility that the parties will find themselves so close to 1911 that there will be no time left for the corporations or anybody to start effective opposition, and then the company's most probable game—prolongation of its license and not purchase—will be won, and the public diddled once more. Once past the stage at which effective opposition may be set up, the Post Office must either buy the company, as provided in the license (which cannot be done in 1911 any more than in 1905, without making cheap rates impossible), or prolong its license. The moral of it all is that monopoly is bad, and that there ought to have been free trade in telephones from the very beginning. The remedy lies in adopting loyally and freely the recommendations of Mr. Hanbury's Committee, and encouraging the corporations to compete, for the only effective opposition which the company has ever met has proceeded from them. No dawdling negotiations should be permitted. If, when Parliament meets, the Postmaster-General is not prepared with a scheme, the idea of purchase should be shelved and the cudgels of opposition given the fullest play.

The eagerness displayed to sell the telephones to the Post Office constitutes a thorough exposure of the hollowness of the outcry against municipal telephone undertakings as being destructive of private enterprise. What is the Government but an exaggerated municipality labouring under the disadvantage of slow, uncertain, and ponderous procedure, with the further disability of not understanding the requirements of specific localities; and what becomes of private enterprise once the telephones are transferred to it? It is extinguished, of course.

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**Electrical Exhibition.**—The Lighting Committee of the Islington Borough Council propose holding an electrical exhibition at the Hornsey-road baths from Feb. 27 to March 11 inclusive, provided the Council at its meeting to-day approve the scheme. We understand that the three largest baths will be utilised for the exhibition, which will include not only machinery in motion and all kinds of electric lighting, heating, cooking, and power appliances, but also electrical novelties of all kinds, electric fountains, illuminations, etc.; while the men's large first-class bath will be used for swimming and diving entertainments, model yacht races, trips on electric boats, musical entertainments, etc. The idea is to not only attract intending consumers, but also the general public, thereby greatly increasing the value of the exhibition to the exhibitors as a medium of advertisement.

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## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### MOVING-IRON INSTRUMENTS AS AFFECTED BY THEIR "MAGNETIC HISTORY."

SIR,—In view of the interesting figures given by Mr. G. F. C. Searle in his recent paper before the Institution of Electrical Engineers, it occurred to us to investigate the possible error introduced into the readings of moving-iron ammeters and voltmeters working at low magnetic inductions.

It is well known that for many reasons it is of great importance to keep down the induction in instruments of this description when used for alternating currents, but it appeared possible that in the case of direct-current instruments the low inductions employed might introduce errors due to varying "magnetic histories." To determine this point, a low-reading "Universal" moving-iron ammeter was tested, and calibration curves taken under various conditions. It may be noted that the induction in the moving iron in these instruments is kept exceptionally low so as to avoid frequency errors when used with alternating current; hence it was thought possible that the readings might be affected by a direct-current overload.

In the first place, the instrument was thoroughly demagnetised, and a set of up-readings taken. It was then again demagnetised, and a downward curve obtained. After this the instrument was overloaded to the extent of some 700 per cent., and another upward and downward curve obtained. It was found that the mean difference in the reading, brought about by this exceptionally drastic treatment, was as follows: at full load, ·5 per cent.; at two-thirds full load, ·1 per cent.; at one-third full load, ·6 per cent.

It will thus be seen that the influence of the previous "magnetic history" can for all practical purposes be entirely neglected in this type of instrument as manufactured by us.

Yours, etc, EVERETT, EDGCUMBE, AND CO.

### THE METRIC FALLACY.

SIR,—In your issue of Dec. 2 you publish an article on the "Metric Fallacy," on which, with your permission, I should like to make one or two comments.

The question is emphatically *not* one between scientific men on the one hand and practical men on the other. It is true that the Decimal Association is supported by the majority of scientific men in this country, but names such as Sir William Preece, Lord Kelvin, Sir Andrew Noble, Sir Guildford Molesworth (president of the Institution of Civil Engineers), Mr. Alex. Siemens (president of the Institution of Electrical Engineers), Sir Alfred L. Jones, Sir Hiram Maxim, Sir Douglas Fox, Sir Benjamin Baker, Lord Avebury, and Sir Wm. Ramsay, do not suggest mere professors and students of abstract science. We have to deal, in fact, with an agitation by practical men for a scientific system of weights and measures for, as your article well puts it, the simplification of work and the getting of business.

It is true that Sir Frederick Bramwell maintained the superiority of the existing system of British weights and measures over the "much-belauded metric system," and it is not a little curious that the British Weights and Measures Association should be so soon formed for the purpose of standardising and simplifying this British system. Let me quote from their manifesto what they say of our weights and measures: "To architects and builders this confusion of quantities is most vexatious and productive of misunderstandings, loss of time and money. Similar absurdities exist in other trades."

If the contentions of Sir Frederick Bramwell are carefully considered it will be found that he was protesting, not against the metric system, but against the compulsory use of decimals to the exclusion of vulgar fractions. A great deal is made of the contention that in France the metric system has not entirely ousted all the old measures, and this is taken as an argument against the superiority of that system. It is true that in some parts of France the *names* of old weights and measures are still used, but they are old names applied to metric measures. I think, however, that these arguments are beside the point. Our present system has been legalised in the British Islands for about 80 years, and yet we have a list of about 50 "customary," or illegal, weights and measures still in use in this country. Is this to be taken as an additional argument against the British system of weights and measures?

The American author referred to in the article appears to prove that Americans have no need of the metric system, and are content with our existing system of weights and measures. Let your readers judge for themselves. Within the last few years the United States have adopted a ton of 2,000lb., and have adopted a yard derived from the metre. This will show whether present-day business needs tend in the direction of decimalised weights and measures, in harmony with our universal scale of notation, or not.

The concluding part of the article on the metric fallacy contains a curiously inaccurate deduction—"the Latin races against the Anglo-Saxon." Does the writer think that Germany, Holland, Norway, and Sweden are of no account, or that they belong to the Latin races?

The majority of nations have adopted the metric system, and even America is no longer with us, inasmuch as, besides deriving her yard from the metre, and her pound from the kilogramme, the U.S.A. gallon, quart, and pint are all one-fifth smaller than our present ones.—Yours, etc,

E. JOHNSON, Secretary, the Decimal Association.

## FORTHCOMING EVENTS

MONDAY, JAN. 9.

**Institution of Mechanical Engineers (Graduates' Section).**—Paper on "A Mechanical Method of Discharging and Storing Grain," by Mr. A. O. Laird.

TUESDAY, JAN. 10.

**Institution of Civil Engineers.**—(And the 11th).—At 8 p.m., Sir W. H. White will deliver an address, entitled "The Recent Visit to the United States and Canada."

**Institution of Electrical Engineers (Glasgow Section).**—At 8 p.m., "Street-Lighting by Electric Arc Lamps," by Mr. H. B. Maxwell.

THURSDAY, JAN. 12.

**Institution of Electrical Engineers.**—At 8 p.m., resumed discussion on Mr. Adams's paper, "The Combination of Dust Destructors and Electricity Works Economically Considered," and, time permitting, Mr. W. H. Booth and Mr. J. B. C. Kershaw will present a paper on "Fuel Economy in Generating Stations."

FRIDAY, JAN. 13.

**Tramways and Light Railways Association.**—At 8 p.m., "Overhead Equipment," by Mr. H. M. Sayers.

**Junior Institution of Engineers.**—At 8 p.m., "The Theory of the Incandescent Mantle," by Prof. Vivian B. Lewes.

**Institution of Electrical Engineers (Manchester Students Section).**—"Electric Heating," by Mr. A. E. Jepson.

**Institution of Civil Engineers (Students' Section).**—"Theory of Electricity and Magnetism," by Mr. J. Swinburne.

Jan. 27.—The following papers will be read at the Physical Society: "Action of a Magnetic Field on the Discharge through a Gas," by Dr. R. S. Willows; "Action of Radium on the Electric Spark," by Dr. Willows and Mr. J. Peck; "The Slow Stretch in India-rubber, Glass, and Metal Wires when subjected to a Constant Pull," by Mr. J. Phillips; "Determination of Young's Modulus for Glass," by Mr. C. A. Bell; and "Some Methods for Studying the Viscosity of Solids," by Dr. Boris Weinberg.

## PERSONAL.

The Worcester City Council have appointed Mr. Cyril M. Shaw, of Wakefield, electrical engineer to the Corporation, at a salary of £400, rising by annual increments to £500.

The Bridgend Urban District Council have accepted the resignation of Mr. F. C. Williams, electrical engineer, who has received an important appointment in Natal.

Mr. A. A. Blackburn, A.M.I.E.E., car-shed superintendent of the Manchester Corporation tramways, has been appointed to the position of car-works superintendent to the Belfast Corporation tramways, at a commencing salary of £300 per annum. Mr. Blackburn has been with the Manchester Corporation tramways for 2½ years. He takes up his new duties on Feb. 1, 1905.

On the occasion of the transfer of the Belfast Street Tramways to the Corporation, Mr. Andrew Nance, the general manager of the system for the past 23 years, was presented by the staff and

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employés with his portrait, painted by Mr. Harry Douglas, and with an address in album form from the conductors and drivers, while Mrs. Nance received three massive solid silver rose bowls with suitable inscriptions, accompanied by a beautifully illuminated address to Mr. Nance from the more prominent officials.

Mr. Harold W. Seymour has been appointed car-shed superintendent to the Blackburn tramways department.

Mr. E. Banner has been appointed clerk of the works for the extension of the Derby electrical tramways from St. Peter's street to the Market-place, and for the construction of a cross-over in Victoria-street, at a salary of £3. 10s. per week.

## APPOINTMENTS VACANT.

**Electrical Engineer**, Hanley Corporation. Salary £300, rising to £350 by annual increments of £10. Applications to Town Clerk by Jan. 10

**Junior Assistant**, King's Lynn. Commencing salary, £65 per annum. Applications to Borough Electrical Engineer by Jan. 7. See advertisement in last issue.

**Assistant in Charge of Meter Department**, Hammersmith. Commencing salary, £2. 10s. per week. Applications by Jan. 18. See advertisement.

**Three Electrical Engineering Assistants**, City and Guilds Central Technical College. Salaries commencing respectively at £200, £150, and £150 per annum. Apply to Prof. Ayrton, Exhibition-road, London, S.W. See advertisement.

**Second Assistant Electrical Engineer**, Bradford. Salary, £250 per annum. Applications by Jan. 19. See advertisement.

**Improver**, Stretford Urban District Council. No premium required. See advertisement.

**Switchboard Attendants**. Wages, 20s. per week. See advertisement.

**Canvasser** for a municipal borough. See advertisement.

**Switchboard Attendant**, Carlisle electric light and power station. Salary, 25s. per week. Applications to the City Electrical Engineer by Jan. 10. See advertisement.

**Electrical Adviser.** The Secretary of State for India has sanctioned the appointment of an adviser on electrical matters to the Government of India at a salary commencing at £70 per month, rising to £110. Private practice will be allowed, but not for municipalities or district boards, as it will be part of his regular duties to advise such bodies.

## LEGAL INTELLIGENCE.

### OBSTRUCTING THE TRAMS.

Before the Borough Bench, John Padley, carrier, was summoned for driving a horse and cart in Belgrave-road in such a manner as to obstruct an electric tram.

The motorman deposed that on the day named he was going from the Clock Tower to Belgrave, when he noticed defendant, who was driving a carrier's van. The van was on the metals in front of the car. Witness rang the bell very loudly several times, and defendant put his head round the corner of the tilt and laughed at him, saying "Don't be in a hurry, boss." Defendant then drew off, but this was near Melton turn, and witness had to stop to pick up passengers. During this defendant drove in front again, and obstructed him for a considerable distance. Witness then took defendant's name and address, and told him he would be reported.

A passenger corroborated.

In the second case, the motorman of another car said the defendant's van obstructed him for a considerable distance.

Defendant said that as to the first case three cars had just passed, and he did not dream that another was coming so soon. As soon as he heard the gong he drew off on to the road. He did not wilfully obstruct the trams on either occasion.

He was fined 20s. in each case, or 14 days.

## COMPANIES' MEETINGS AND REPORTS

### MANX ELECTRIC RAILWAY.

A meeting of this Company was held on Wednesday at the offices, 78, Cornhill. Particulars of the report appeared in our issue of the 23rd ult.

On the motion of Mr. Ernest Schenk, who presided, the report and accounts were adopted. The net earnings of the year were £13,538, and, after payment of the debenture interest, a dividend of 2½ per cent. on the preference shares, and placing £1,000 to the renewal fund, the balance of £780 was carried forward.

### DOUGLAS SOUTHERN ELECTRIC TRAMWAYS.

The ninth annual general meeting of the shareholders of the Douglas Southern Electric Tramways Company was held on Friday last in Manchester. The report and statement of accounts showed that the Company's season this year consisted of 134 days, as against 123 days last season, whilst the mileage run was 35,075·97, as against 32,343·77 last year. Notwithstanding the splendid summer, there had been a great falling off of visitors, caused by the crisis in the cotton trade, and the Manx season had suffered severely. It was a matter for congratulation that the receipts had kept up very fairly, being only £176 below those of last season. The total receipts this season were £4,785, as against £4,961 in 1903. The net profit for the year was £1,681, as against £1,965 last year, which, added to £209 balance from last year, gave a total disposable balance of £1,890. The directors recommend a dividend of 6 per cent. upon the preference shares, which would absorb £1,558, and leave a balance of £332 to be carried forward, subject to directors' fees. From and after Nov. 1, 1905, an additional payment of 5 per cent. of the gross receipts became due to the Marine Drive Company.

**The Chairman** (Mr. T. J. Hutchinson), in moving the adoption of the report and balance-sheet, said Douglas, like other watering-places to which Lancashire people resorted, had suffered from the depressed state of the cotton trade. The shareholders of that Company might congratulate themselves that under the circumstances the depreciation in their receipts had been trifling. The weather during the summer was of the best, but, unfortunately, the people who usually kept the watering places going had not the money wherewith to enjoy themselves. There was a slight increase in their working expenses, but their equipment generally had been maintained at the highest state of efficiency. The directors recommended the payment of a dividend of 6 per cent. per annum upon the preference shares, and the carrying forward of a balance of £332 to next year's accounts.

**Mr. W. Davenport**, who seconded the resolution, hoped that they would soon be in a position to make some return to the ordinary shareholders.

A **Shareholder** wished to know whether a scheme could not be devised for amalgamating the Southern Electric Tramways and the Marine Drive Companies with a view to the curtailment of expenses.

**The Chairman** said the question with regard to amalgamation was premature.

The resolution was passed.

Mr. W. Davenport was re-elected a director of the Company, and Messrs. E. Guthrie and Co., chartered accountants, Manchester, were reappointed auditors.

## NEW COMPANIES REGISTERED.

**Bergtheil and Young, Limited.**—Messrs. Bergtheil and Young, 12, Camomile-street, E.C., have converted their business into a limited company. The company will take over the business hitherto carried on by them as from Jan. 1, 1905, the following having become directors of the company: Messrs. Arthur Bergtheil, Henry Wilson Young, Edward Bergtheil.

**Tramways Development Company, Limited.**—Capital, £100. Objects: to own tramways, railways, omnibuses, and vans, and to equip, maintain, and work the same by electrical, steam, horse, or other power, etc. No initial public issue. Registered without articles of association.

**Rushworth Bros., Limited.**—Capital, £30,000. Objects: to carry on the business of consulting and mechanical engineers, iron and brass founders, millwrights, brewers' engineers, electrical engineers, plumbers, machinists, boilermakers, manufacturers of and dealers in lifting and hoisting machinery, stone, marble, and granite cutting, working, and polishing machinery, builders' and contractors' plant, hand, steam, and electric cranes, motors, etc. Registered office: Crane Works, Primet Bridge Foundry, Colne.

**John W. Sutcliffe and Co., Limited.**—Capital, £5,000. Objects: to acquire the business carried on at 7, Castle-street, Finsbury, E.C., as Hans Neumann and Co.; to adopt an agreement with A. Peltesohn; to act as manufacturers' agents; to trade in electrical and general supplies; and to carry on the business of electrical, gas, and general engineers, etc.

**Manchester and Milford Engineering Company, Limited.**—Capital, £10,000. Objects: to carry on the business of mechanical engineers, ironfounders, ironworkers, tramcar, motorcar, locomotive, and rolling-stock manufacturers, makers of signalling apparatus, telegraphs, telephones, etc. Registered office: 22, Conduit-place, Spring-street, Paddington.

**Herbert Plumpton, Limited.**—Capital, £6,000. Objects: to acquire the business and carry on at the Excelsior Toolworks, Liverpool-road, Warrington, the business of tool manufacturers, engineers, ironmasters, wire-drawers, galvanisers, iron and brass founders, electrical engineers, electric cable manufacturers, coppersmiths, electricians, suppliers of electricity for light, heat, power, or otherwise, electric and other car manufacturers, etc. Registered office: Samuel-street, Warrington.

**Meadows, Teeton, and Minshall, Limited.**—Capital, £1,000. Objects: to acquire and carry on the business of W. A. Meadows and H. W. Teeton, as Meadows and Teeton, at 7-9, Albion-street, Hanley, as electrical and mechanical engineers, manufacturers of and dealers in electrical, magnetic, telegraphic, telephonic, and other appliances, suppliers of electricity, manufacturers of electric lamps and fittings, etc. Registered office: 7, Albion-street, Hanley.

**New British Electric Supply Company, Limited.**—Capital, £2,000. Objects: to acquire the business of electrical manufacturers recently carried on by the New British Engineering Company, Limited; to adopt an agreement with Bergtheil and Young; and to carry on the business of electrical and mechanical engineers, suppliers of electricity, manufacturers of and dealers in all kinds of electric, magnetic, galvanic, chemical, and other appliances, etc.

**Mors, Limited.**—Capital, £15,000. Objects: to acquire English patents relating to motorcars of the Société Anonyme d'Electricité et d'Automobiles Mors or others; to manufacture and sell in the United

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Kingdom and British colonies and dependencies motor-boats and accessories in accordance with such patents; to deal in motorcars and accessories made by the Compagnie Française des Voitures Electromobiles, and to carry on the business of garage proprietors, motorcar and vehicle manufacturers, agents and merchants, electrical and general engineers, etc. Registered office: 55-59, Shaftesbury-avenue, W.C.

### Liens Registered.

**North-West London Electric Supply Company, Limited, London, E.C.**—Trust deed dated Dec. 7, 1904, registered Dec. 22, for securing £20,000 debentures (£10,000 issued). Trustees: A. H. P. Strickland and P. A. M. Hoare, bankers, 37, Fleet-street, E.C. Charged on the undertaking and all the property, including the uncalled capital.

**Newcastle and District Electric Lighting Company, Limited.** Issue on Dec. 16 of a 4 per cent. debenture for £25,000, part of a series created Jan. 30, 1903, to secure not more than half the paid-up capital. Property charged: the company's undertaking and property, present and future, except uncalled or unpaid capital (as a first and floating security). Holders: Lloyds Bank Limited, Lombard-street, E.C. No trustees. Total amount previously issued of same series, £11,085.

**Bath Electric Tramways, Limited, London, E.C.**—Trust deed registered Dec. 13, for £135,000 debenture stock. Trustees: Sir F. L. Robinson, of Campden-hill, S.W., and H. P. Sturgis, of Leatherhead. Charged on the tramway undertaking and all other assets, present and future, including the uncalled or unpaid capital.

**Buenos Ayres Grand National Tramways Company, Limited.** A trust deed, dated Dec. 9, 1904, supplemental to a trust deed of Feb. 16, 1900, securing £700,000 conversion debenture stock (which includes £100,000 second preference debenture stock covered by the principal trust deeds, to be exchanged under the terms of the present deed for the same amount of conversion debenture stock), has been registered. Dates of resolutions authorising series—March 6, 1903 (shareholders and 6 per cent. debenture holders), and March 11, 1904 (second preference debenture stockholders and Board). Property charged: the company's undertaking and all its concessions, lands, tramways, premises, and property in the Argentine Republic. Trustees: the Trustees, Executors, and Securities Insurance Corporation, Limited, Winchester House, Old Broad-street, E.C.

**Electric Law Press, Limited (London).**—Issue on Dec. 8 of £200 7 per cent. debentures, part of a series created by resolutions of June 23 and Sept. 30, 1903, to secure £500, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £240.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Oporto.**—The Municipal Authorities require tenders for lease of their electric tramways. Tenders by March 15.

**Halifax.**—The Corporation invite tenders for coal conveyors. Tenders by Jan. 31.

**Paris.**—The Under-Secretary for Post and Telegraphs, 103, Rue de Grenelle, requires tenders for accumulator batteries. Tenders by Jan. 18.

**Algiers.**—Tenders are required for the erection of an electrical plant at the Abd-el-Kader Fort at Bougie. Tenders to the Mayor of that place by Jan. 17.

**Giurgu (Roumania).**—Tenders are required for a concession to establish electric lighting in the town. Particulars may be obtained from the Mayor. Tenders by Jan. 28.

**Liria.**—The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

**Caen (France).**—The Prefect requires tenders for concession of a tramway from Ryes to Caen *via* Creully for goods and passengers. Particulars from the Prefect of Calvedos, Caen. Tenders by Feb. 1.

**Completion of Works.**—A local authority in possession of powers for the electric lighting of its area is open to negotiate with suitable persons for the execution and completion of the works. See advertisement in last issue.

**Grimsby.**—The Corporation invite tenders for (No. 30) motors; (31) water-purifying plant; and (32) 12 months' supply of stores. Tenders for 30 and 31 by Jan. 23, those for 32 by Feb. 1. Particulars in advertisement columns.

**Bradford.**—The Education Committee invite tenders for the lighting of the Dudley-hill new Council Schools by electricity. Tenders to Mr. Tho. Garbutt, secretary, Education Offices, Manor-row, Bradford, by 10 a.m. on 9th inst.

**Port Elizabeth.**—Messrs. Davis and Soper, 54, St. Mary-axe, E.C., agents of the Municipal Corporation of Port Elizabeth, South Africa, invite tenders for various works in connection with the Corporation electricity supply undertaking. Tenders by Jan. 16, 1905.

**Erith.**—The Urban District Council invite tenders for overhead line equipment, poles, etc.; underground feeder cables, boxes, etc.; rotary converters, transformers, and motor-booster; and main high and low tension switchboards, cable connections, etc. Tenders by Jan. 9.

**Pudsey.**—The Corporation invite tenders for underground electric mains, switchboard, etc. Specifications, etc., may be obtained on application to Messrs. Shepherd and Watney, consulting engineers, Greek-street-chambers, Leeds. Tenders to the Town Clerk by Jan. 20.

**Gravesend.**—The Education Committee invite tenders for the electric lighting of King-street National School. Specification and form of tender may be obtained on application to Mr. C. F. McInnes, Electricity Works. Tenders to Mr. H. H. Brown, town clerk, by 16th inst.

**London, N.**—The Metropolitan Asylums Board invite tenders for installation of fire-alarms at Northern Hospital, Winchmore Hill, N., in accordance with plan and specification prepared by Mr. W. T. Hatch, M.I.C.E., M.I.M.E., engineer-in-chief. Tenders by 10 a.m. on Jan. 24.

**Swindon.**—The Corporation invite tenders for the supply and erection of one 30ft. by 8ft. Lancashire boiler with down-take superheater, steam, exhaust, and feed piping, etc. Tenders to be delivered before 10 a.m. on Tuesday, Jan. 24, 1905, to Mr. Robt. Hilton, town clerk. See advertisement in last issue.

**Ormskirk (Lancs.).**—The Guardians invite tenders for the necessary apparatus for electric lighting at their workhouse, Wigan-road. (Section 1) steam exhaust, &c., piping and erection of plant; (2) booster; (3) storage battery; (4) wiring of buildings and underground cables. Tenders to Mr. Alfred Dickinson, clerk, Railway-road, Ormskirk, by 9 a.m. on 12th inst.

**Drax (near Selby).**—Tenders are invited for electric light installation, also electric pump, etc., capable of delivering 500 gallons per hour, at Read's Grammar School. Apply to the headmaster, Mr. W. St. G. Drennan, at the School, who will supply all necessary particulars. Tenders to be delivered to Messrs. E. and T. Clark, solicitors, Snaith, R.S.O., clerk to the Governors, by noon on 28th inst.

**Johannesburg.**—The Council invite tenders for Vignoles rails, fishplates, angle steel guard-rails, bolts, nuts, coach screws, and dog-spikes. General conditions, specifications, and forms of tender may be seen at the offices of the Council's consulting engineers, Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster, S.W., and may be obtained on payment of five guineas. Tenders by Jan. 26.

**South London Electric Supply Corporation.**—The Directors invite tenders for the construction, supply, and erection at their works at Bengeworth-road, Loughborough Junction, S.E., of one 750-kw. steam alternator with pipe connections and sundry ironwork. Sealed tenders must be forwarded to the secretary of the company, Mr. H. H. Boyer, Bengeworth-road, Loughborough Junction, S.E., before noon on Jan. 16.

**Shanghai.**—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Pook and Co., 63, Leadenhall-street, E.C. Tenders by March 31, 1905.

**Plasencia.**—Tenders are required for the concession for 10 years of the lighting by electricity of the town. Adjudication of tenders will take place on Jan. 28, and tenderers, if not appearing in person, must be represented by a duly authorised agent. The conditions of concession are set out in the notice in the *Gaceta*, which may be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C., any day between the hours of 10 a.m. and 5 p.m. (Saturdays, 10 a.m. to 1 p.m.).

**Copenhagen.**—The Public Lighting Office of Copenhagen invite tenders for the installation of a central electrical station at the Valley gasworks in accordance with conditions and drawings which can be inspected at the Ostre and Valley Gasworks, or obtained therefrom on payment of £1. 2s. 3d., which will be returned provided a tender is sent in in due time, accompanied by the drawings, etc. Tenders must be sent in to the Director for Public Lighting, 22B, Vestre Boulevard, Copenhagen, by noon on Jan. 23.

**Melbourne.**—Tenders will be received at the office of the Deputy Postmaster-General until noon on Feb. 7 for the supply and delivery of (1) 3,500 trunk-line multiple jacks, in strips of 20; (2) 1,320 yards of 64-wire wool-insulated switchboard cable. Specifications may be seen at the General Post Offices at Melbourne, Sydney, Brisbane, and Adelaide. Tenders, endorsed "Tender for ——," as the case may be, addressed to the Deputy Postmaster-General, Melbourne, may be deposited in the tender-box at the General Post Office, Melbourne, or, if sent by post, must be prepaid and registered. The deposit to be enclosed with the tender is 5 per cent. on the total amount.

**Johannesburg.**—The Municipal Council are prepared to receive tenders for 100 electric tramcars, two electric water-cars, one five-ton travelling crane, one electric car traverser, and various workshop tools, including erection at Johannesburg, to Specification No. 10 of their consulting engineers, Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W. Copies of the specification may be seen on and after Jan. 7 at the Council Offices, Johannesburg, and at the Consulting Engineers' Offices in London, and may be obtained on payment of five guineas, which will be returned on receipt of a bona fide tender. Duplicate copies of the specification may be bought for 10s. each (not returnable). Tenders must be addressed to Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W., and must be received by them not later than March 6. The Council will not be responsible for any expenses incurred in tendering.

### RESULTS OF TENDERS.

**Aberdeen.**—The Town Council have accepted the tender of Messrs. Babcock and Willcox for shifting boilers at Cotton-street and fitting them with chain-grate stokers, etc., at £870.

**St. Andrews.**—The power station having been completed, the Electric Supply Association have now begun to lay their electric cable. The Lighting Committee of the Town Council are negotiating for the laying of a special cable with the view of eventually adopting electricity for street-lighting.

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# BUSINESS NOTES.

## TRACTION.

**Derby.**—The contractors have promised to complete the Market-place route by the 17th prox.

**Lancaster.**—The Electricity Committee are considering the advisability of establishing a motor omnibus service.

**Newcastle.**—The Tramways Committee have decided to recommend the Corporation to proceed with the Shieldfield extension.

**Eastbourne.**—An enquiry has been held into the application of the Town Council for a loan of £1,850 for two additional motor 'buses.

**Ilford.**—Referring to our note last week, it has been decided to put by half the profits year by year and devote the other half to the general rate.

**Perth.**—The Corporation have received sanction from the Secretary for Scotland to the raising of a loan to defray the cost of the additional plant at the electricity works for supplying power for the tramway.

**Musselburgh.**—The controversy upon Sunday running has led to a tentative arrangement, the Corporation giving their sanction for one year, on the expiration of which they will be guided by the experience gained during that period.

**Bath.**—The directors of the Bath Electric Tramways, Limited, have declared a dividend at the rate of 5 per cent. per annum upon the cumulative preference shares, calculated from the due dates of the various instalments to Dec. 31, 1903.

**Halifax.**—The Corporation are about to resume the direction of its parcel traffic, which for the past two years has been undertaken by a contractor. Telephones are to be installed at each 1d. stage to facilitate communication with headquarters, the estimated cost being £550.

**The Metropolitan.**—The electric service from Baker-street to Harrow was successfully inaugurated on Saturday. The first train ran from Baker-street at 8.35, and the last at 5.34. There will still be steam trains running on the line until the whole has been electrified, but in the course of a few days the majority of the trains will be electrically driven.

**South Shields.**—The Tramways Committee having had under consideration the replies received from 62 towns as to whether the work of constructing the lines had been carried out by contract or by workmen employed by the Corporation direct, the committee decided to adhere to their resolution, recommending the Council to advertise for tenders, and this has been approved by the Corporation.

**Crewe.**—Several promoters are suitors for the privilege of installing a tramway, and as the Corporation expect to make a good thing out of it by supplying the current, they will probably approve one of the schemes; but they have informed Dr. Rhodes, of Manchester, who asked the Council to support a private electric tramway company, and Mr. S. Jackson, who offered to promote a service of steam motor omnibuses, that the Council cannot give their sanction.

**Kirkcaldy.**—At the meeting of the District Committee on Saturday the Wemyss tramway provisional order was approved. Petitions in support of the scheme were read from the adjoining burghs. The tramways are to cover a distance of about eight miles from Kirkcaldy to Leven, and only about two miles will be on the public road, the remainder being within the domains of Mr. Wemyss, of Wemyss Castle. Private enterprise is responsible for the undertaking.

**Maidstone.**—The Corporation adopted the following resolution after considerable discussion: "That the sum of £25,000, authorised to be raised by Section 73 (1) of the Maidstone Corporation Light Railways Order, 1903, be borrowed from the Royal Insurance Company, repayable within a period of 40 years by equal yearly instalments, the rate of interest to be £4 per annum, payable on the outstanding balance of principal due, and that the common seal of the Corporation be affixed to the mortgage deed."

**Radcliffe.**—The Radcliffe New-road section of the Radcliffe tramways system, which was completed and formally inspected on Tuesday, was opened for traffic on Wednesday. Two decorated cars left Whitefield with members and officials of the town councils interested. The destination of the car was Radcliffe Bridge, and there was a large crowd awaiting its arrival. This length of track will give through travelling facilities from Radcliffe to Bury, Manchester, and Salford. The Bury Corporation supply the service of cars, and the Radcliffe Council the current.

**Central London Railway.**—A breakdown at the Bank Station on Wednesday occasioned considerable inconvenience. The mishap occurred through the motor of an empty train, which was being shunted from one road to another, leaving the metals at the cross-over. Some difficulty was experienced in replacing the engine on the track, and for some time no trains ran beyond the Museum Station, where the next shunting place is situated, the 'buses reaping a harvest during the interval. The whole line was cleared, however, in time for the homeward rush in the early evening.

**Electrical Machinery for Japan.**—Last week a special train consisting of 42 wagons left Dick, Kerr, and Co.'s Preston works, carrying 250 tons of electrical machinery being shipped in connection with that company's contract for the complete equipment of the Tokyo Denki Tetsudo Kabushiki Company's tramways. This tramway system, when finished, will cover over 60 miles of line and operate some 250 cars. The complete installation is being carried out by Dick, Kerr, and Co., under the supervision of a staff of their engineers, and it is surprising to learn that the only effect the war has had on the progress of the work is in connection with the transportation of the machinery from Yokohama to Tokyo, the railway being congested with war material.

**Mexborough and Swinton.**—The Mexborough and Swinton Tramways Company, which was incorporated in 1902, has deposited a Bill for next session, under which Parliament will be asked to grant an extension of time for three years from Aug. 8, 1905, within which to complete the tramways duly authorised. This extension of time extends to the tramways authorised in the urban districts of Rawmarsh and Greasborough, which were sanctioned by the Rawmarsh Urban District Council (Tramways) Act, 1900, whose powers have been transferred to the company. The Bill also proposes to empower the company to issue "any portion not exceeding £75,000 of their authorised capital of £150,000 as preference shares," bearing interest at 6 per cent. per annum.

**Belfast.**—In connection with the formal handing over of the tramways undertaking by the company to the Corporation, a luncheon was given to several members of the Corporation and officials of the company by the directors in the Grand Central Hotel on Saturday afternoon, when complimentary speeches were exchanged. Mr. J. Barber Glenn (secretary of the company) took a philosophical view of the transfer, remarking that when the time allotted by the Act for handing over the undertaking came it was worse than useless to repine, and as he had to part with the control of the system to the municipality, he cordially did so, and wished them all possible success. He believed that under the administration of their committee, presided over by so experienced a business man as Sir Daniel Dixon, and with the invaluable help of the manager (Mr. Nance), they could not avoid achieving success.

**Aberdare.**—On Monday a statutory meeting of the Urban District Council was held to pass a resolution in support of the parliamentary Bill for the construction of an electric tramway from Trecynon to Cwmaman and Capcoch and the erection of a refuse destructor. Mr. E. M. Hann, general manager of the Powell Duffryn Collieries Company, and chairman of the Parliamentary Committee, moved the formal resolution in favour of the Bill. He explained that the discrepancy in the original figure of £62,000 and the present figure of £93,000 was due to additional schemes having been included in the Bill, apart from the tramway. There is also the extension to Capcoch, the cost of which will be £6,000. The bridge at Aberaman and the diversion of the road would have to be carried out apart altogether from the present scheme. The cost of this had been put down at £5,116, but of this the County Council and the Powell Duffryn Company would pay £3,336. After some discussion the motion was carried, and the scheme will now be proceeded with, subject to the sanction of a public meeting.

**Fire and Water Proof Dynamos.**—The following incident, which occurred recently in the United States, testifies to the extent to which modern well-made electrical machinery will stand ill-usage. The New England Building at Cleveland, Ohio, is electrically lit throughout by a plant consisting of three Westinghouse 62·5 kw. engine-type generators, installed in the basement, which, through some carelessness, recently became the scene of a rather serious fire. The heat to which the machines were subjected was sufficient to completely burn away the insulation on the outside of the field coils, and for an hour they were played upon by six hose pipes. Within an hour of the extinction of the fire the first of these machines was carrying its full load, and another followed suit in a short time, the two dealing with the entire lighting of the building, that under normal conditions was negotiated with three machines. With the exception of the outer layer on the field coils, which was burnt away, the insulation was fireproof, and easily withstood a heat that was sufficient to burn and blister the paint on the frames. The two elements most fatal to electrical machinery were thus resisted in a manner quite beyond expectation, which speaks eloquently for the quality of the manufacture.

**Motorcars.**—A writer in the *Manchester Guardian* thus sums up the position of the British motorcar industry: "The British motorcar maker is a little too apt to assert that if only the British investor would move capital all would be well. It is possible that in the later phases of development the industry has been hampered by want of capital, but capital will be forthcoming when we pass from the stage of the pleasure car to the more permanent and more remunerative industrial car. A pleasure car is subject to the whims of fashion, and is no way a sure guide to the future. The fluctuations in the trade done by various motorcar manufacturers demonstrate this. But the moment when industrial motorcars become practicable and economical, we may rest assured that the British investor will be equal to the occasion. At all events, the rise of the British motorcar industry during the past five years is one of the most striking events in contemporary commercial history. There are as yet a good many loose ends to be drawn in, and more effective combined action on the part of the makers is desirable, but the growth, such as it is, reflects the greatest credit upon British makers. The Comte De Dion said in 1896: 'We (the French) have got this trade, and we mean to keep it. It is of no use your trying. You may try, but you will never beat us.' All honour to the French and German makers for what they have done. We are not jealous of their success. Our congratulations are hearty and sincere. But the British engineer, the British mechanic, and the British business man, when once they have taken hold of an industry in earnest, do not easily let go. The motorcar industry of Great Britain has come to stay; it is growing rapidly; year by year it extends its activities in new directions; its future is bright; and under our present system of free trade it has the world's market at its disposal."

**Westinghouse Turbine.**—A memorable incident of the morning following the close of the St. Louis Exposition was the formal shutdown and inspection of the 600-h.p. Westinghouse steam-turbine generating unit in the Palace of Machinery, after a continuous run of over 3,962 hours—a remarkable performance in the history of the steam-turbine. This machine was started on its long run at 9.20 o'clock on the morning of Monday, June 20, shortly after its installation at the Fair, and was stopped at 11.32 o'clock on the morning

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of Friday, Dec. 2. During the 5½ months that the unit was in operation it supplied current for light and power throughout the Westinghouse exhibits in the Palaces of Machinery, Electricity, and Transportation. Mr. C. F. Foster, chief operating engineer of the Exposition, Mr. H. M. Holman, supervising engineer at the Government Exposition gas engine tests, formerly president of the St. Louis Board of Public Works, and a number of Westinghouse representatives, including Messrs. Wallace Franklin, of Detroit, C. C. Chappelle, of Chicago, and W. K. Dunlap, managing director of the Westinghouse exhibits, were present when the engine was stopped. It was found to be in perfect condition, and there were no signs of wear, the bearings still retaining the tool marks as they had come from the shops. There have been at least two instances on record in America in which piston engines have been run continuously for about the same length of time as that of the record run of the Westinghouse turbine. The remarkable feature of the turbine run, of course, was the maintenance under load of a speed of 3,600 revolutions a minute for such a long period. From 8.30 o'clock in the morning to 10.30 o'clock in the evening, the load carried throughout the Exposition varied from 25 per cent. underload to 25 per cent. overload. The total number of revolutions almost touched the billion mark, according to the American system of notation—viz., 855,792,000.

**London Road Car Co.**—The manager of this company, Mr. Duff, stated to an interviewer the other day that in less than four years he expects motor omnibuses will be running over all the routes at present traversed by the company's vehicles, and other routes as well where steep gradients or other difficulties have rendered horse haulage an impossibility. The change will be begun at once, and will continue until the entire system is converted. It will be carried out as rapidly as possible. Work has already been begun on the first batch of 50 omnibuses, and contracts for the motors and frames have been placed with three English and two Continental firms. The bodies of the vehicles will be built by the company at its own works, where their existing rolling-stock has been constructed. Each motor built will displace about 15 horses. The new vehicles will cover a daily mileage of 100, instead of 70 or 80, as with animal haulage. In less than six months the company expects to have displaced 700 horses A comparison of the cost of running of the two classes of vehicles is in favour of the mechanical method. Repairs will cost less because the body of the car will sit on a solid frame, and not on four springs as now. Mr. Duff intimated his opinion that the cars will be worked as cheaply by petrol as with horses, while he looks for the earning power to be increased by 50 per cent. The latter calculation is based on the experience the company has gained from the experimental running of the four motor omnibuses which have been for some time on the road from Shepherd's Bush to Oxford-circus. Most of the omnibuses which have been already ordered will have a carrying capacity of 32 or 34, as compared with the 26 for which the existing vehicles are designed, but there will also be smaller ones to accommodate 14 passengers without roof seats. These will be used on routes where there may be very steep gradients or where public necessity does not call for the larger car. It is estimated that 350 motor omnibuses will suffice to accommodate the traffic which is now dealt with by the 466 horsed vehicles which the company has daily running, but apart from the reduction in number street congestion will be relieved, as each motor will take up considerably less space than a horsed omnibus. The first of the new vehicles will probably be put on the road about the end of February, and the 50 cars now being built will all be delivered by the end of May. The Shepherd's Bush and Oxford-circus route will be the first favoured.

**Liverpool.**—Under their Bill the Corporation are seeking powers to construct lines of electric tramway from the docks for the conveyance during the daytime of merchandise to various parts of Lancashire on the lines of the South Lancashire Electric Tramways Company. If the necessary permission is granted, it is proposed to construct one of the lines connecting with the docks at the South-end of Liverpool, and the other at Bootle connecting with the North Docks. The Royal Southern Hospital is situated on the route, and it is reported that the proposal has been received with some alarm by those responsible for its management, on the ground that the noise of the traffic would have a detrimental effect upon the patients, and that during the administration of anæsthetics in operations it would be absolutely dangerous. The tramway authorities, on the other hand, state that there is no reason to fear any such annoyance or ill-effects from the proposed service. It is pointed out that it would be impossible to deal with the merchandise from the docks and transship it to various parts of Lancashire during the night-time on the ordinary passenger tramlines. The night traffic would be too costly, and further, there would only be an interval of four hours in which to work the traffic, and as a rule much of the repair work to the lines is carried out during the night-time. As an alternative the tramways authorities are desirous of constructing lines quite apart from the passenger lines to deal with the merchandise from the docks. For years leading Liverpool merchants have agitated for some method by which goods could be transferred straight from the ship in dock to vehicles which would distribute them in the various districts, and thus avoid repeated handlings, with their increased cost, to say nothing of railway delays. Since the advent of that fine service belonging to the South Lancashire Tramways Company this desirable end has been rendered easier of accomplishment. It is considered that once a through connection from the docks to the South Lancashire Company's system at Knotty Ash is made, a new industrial era will begin to open up. The area to be served is an enormous one. The South Lancashire Company's system at present embraces a very extensive mileage of street tramways, tapping all the busy manufacturing centres in the county, like Bolton, Warrington, Leigh, Atherton, Blackburn, etc., and taking into account the connections with other tramway systems bordering on to Yorkshire, there are at present about 700 miles of street tramways over which a goods traffic might be carried on. It is pointed out that land is comparatively cheap in the outskirts, and that it would pay manufacturers to erect works in positions adjacent to the tramways, and where a through connection could be made by means of a short siding for the works. They would thus have the advantage of a cheapened transit of goods, as compared with the present high railway rates. It is not unlikely, if the project is carried through, that the line of railway along the docks will be electrified and joined to the tramway, thus forming a circular system. The Dock Board, it is reported, have given consideration to this question of electrification, and have undertaken to look further into it if a feasible scheme is devised. The vehicles for the new tramways would be merchandise cars of the American type, each constructed to carry 15 or 20 tons.

## LIGHTING AND GENERAL.

**Wimbledon.**—Large extensions to the central-station plant are under consideration.

**Barking.**—Application is to be made for a loan of about £9,000 for electric supply extensions.

**Sale of Plant.**—Particulars of a sale of a 25-h.p. compound undertype engine will be found in another column.

**Shipley.**—The Urban District Council are experimenting with the idea of extending the arc lighting in their streets.

**Finchley.**—The Urban District Council have fitted and opened an electrical showroom at 3, Market parade, East Finchley.

**Halifax.**—About two miles of streets in the centre of the town are lit by electricity, the cost being at the rate of £849 per mile.

**Gloucester.**—The City Council have approved of a scheme for the extension of electric lighting at an estimated cost of £15,000.

**Frizington.**—The Arlecdon and Frizington District Council have asked Mr. Rook, of Workington, to report on the cost of a scheme of electric lighting.

**Removal.**—Messrs. Chas. F. Quicker and Co., electrical, mechanical, and consulting engineers, have removed their offices and stores to 315, Euston-road.

**Hull.**—The street-lighting now consists of 24 arc lamps, 20 ½-ampere Nernst lamps, and 24 ½-ampere Nernst lamps. The arc lamps are of 1,000 c.p., and cost £22 per lamp per annum.

**Tonyrefail.**—The electric lighting undertaking at Tonyrefail was formally inaugurated on Tuesday by Mr. Godfrey Clark, J.P., Talygarn, chairman of the Llantrisant District Council.

**Electric and General Investment Co.**—The warrants for the interim dividends on the 6 per cent. cumulative preference shares and of the 10 per cent. per annum on the ordinary shares of this company have been posted.

**Edmundson's Electricity Corporation.**—The directors have declared an interim dividend of 5 per cent. per annum on the ordinary shares of this company, payable on 14th inst., for the half-year ended Sept. 30, 1904.

**Clyde Valley Power Co.**—The equipment of the generating station at Yoker is nearly completed, and current will probably be shortly available for distribution. The Motherwell generating station will be at work a few months later.

**Shrewsbury.**—The Town Council have agreed to a preliminary expenditure of £508 on extension works in connection with the electric lighting undertaking. The estimated cost of the further extensions will be approximately £5,295.

**Barnstaple.**—The engineer reported at the last Town Council meeting that since the last meeting he had received application for light equal to 155 8-c.p. lamps. It was resolved that application be made for permission to borrow a further sum of £3,000 for the purpose of extension of the lighting.

**Loughborough.**—The Corporation are notifying that they are prepared to supply electrical energy for the purposes of general supply to ordinary consumers in the streets through which distributing mains have been laid. The prices to be charged until otherwise determined are as follows: for lighting, 5d. per unit; and for motive power, 2½d. per unit.

**Rotherham.**—The electric lighting was suspended for two hours recently owing to the fusing of a cable. The electricity department took prompt steps to locate the failure, and just before eight o'clock the service was restored. This is the first occasion an accident of the kind has occurred, although the works have been in operation for about three years.

**Leeds.**—In the course of a few weeks' time the chief tramway thoroughfares for a radius of one mile from the centre of the city will be lighted by electricity in place of gas. The present number of arc lamps will be nearly trebled, and the Corporation propose to reduce on and after March 25 next the prices of electrical energy supplied for lighting purposes to large consumers.

**Kettering.**—The current was switched on for the first time at the Trades Club on Christmas Eve in the presence of several representatives of the Urban Council and members of the club and affiliated bodies. The contract for the wiring was in the hands of Messrs. Thompson and Co., of Wellington-street, Kettering. Altogether 72 lights have been installed with a total power of 18 amperes.

**Dewsbury.**—The users of the telephone in the district are called upon to pay £10 per annum for a similar service to that for which £5 or £6 is charged in other towns where competition with municipal schemes has to be faced, and it is suggested in the local Press that the present area covered by the Dewsbury telephone exchange is large enough to make a local scheme self-supporting.

**Heckmondwike.**—The Urban District Council are making a feature of street electric lighting, the cost being the same as that

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for gas. About one-third of the street lamps are lighted by electricity, and although there is a diversity of opinion as to whether incandescent gas or electric light is the more effective, so satisfied are the authorities with the arc lamp illumination that they contemplate an extension.—*Yorkshire Post.*

**Arbroath.**—An agreement has been come to between the Arbroath Electric Light Committee and the Empire Electric Lighting Company, Limited, London, with a view to the introduction of the electric light into the town, so that nothing further requires to be done except the execution of the formal deed after it has been approved of by the Board of Trade. The company are to start operations immediately after they obtain possession of the site for the works. The ground will be available on May 28 next.

**Liege Exhibition.**—Further information has now been received from the Association of Chambers of Commerce of the United Kingdom to the effect that, in consequence of applications which have been made by intending exhibitors, the British Commissioner-General is negotiating with the authorities for an extensive increase of space for British exhibits in the machinery hall, and he is, therefore, in a position to receive further applications for the display of machinery in motion. The Commissioner-General is Mr. Thomas Cope, to whom all applications for space should be addressed at the British Commissioner-General's Office, 54, Great Tower-street, London, E.C.

**Grimsby.**—We are informed that, owing to the general satisfaction given by the installation of electric light and power for sterilising and cautery purposes in the operating theatre of the Grimsby and District Hospital, the Management Committee have decided to entrust the lighting of the nurses' bedrooms and waiting-hall to their former contractor, Mr. D. J. Dolby, 59, Victoria-street, Grimsby. Mr. Dolby has just completed a contract for the electric lighting of the Union of London and Smith's Bank, Limited, Victoria-street, and manager's residence, comprising 130 lights. The installation is in solid-drawn steel conduit, with draw-in boxes, the conductors being drawn after the plastering was completed. The fittings for the manager's residence are of the latest designs in wood by Messrs. Henry Limited, London.

**Glasgow.**—The current supplied by the Corporation in November, 1904, was 18 per cent. above the total of the corresponding month of the previous year. The supply shows an increase of 73 per cent. over the amount supplied in November, 1903. The motors already connected or in process of connection aggregate 7,500 h.p. Most of these are of small size, only about six exceeding 50 h.p. Early this year two three-phase electric generators, driven by steam-turbines of 4,000 h.p. each, will be installed at Port Dundas, and one direct-current plant of 2,000 h.p. in the South Side station. The three-phase generators will supply electric power at high pressure—6,500 volts—and this will be transmitted to sub-stations, where it will be transformed to direct current at 500 volts (as in the case of the tramway supply) for distribution to consumers for power and lighting.

**India.**—*Indian Engineering* notes that sanction has been accorded to an expenditure of over one lakh of rupees for the supply of electricity to the house, etc., occupied by the East Indian Railway Company's servants at the Jamalpur Station. The work will be completed before June next. With regard to the electric installation at the Government Press at Madras, our contemporary states the value of the electric plant introduced in July, 1903, at Rs 80,000. This electrical plant was obtained to improve the method of lighting the whole establishment, and to give power in several departments which the steam-engine could not do. The installation consists of two water-tube boilers, three steam dynamos, nine motors of various sizes for driving the machinery, one constant-current transformer for electrotyping, 523 lamps, and four fans. The incandescent lamps are of 16 c.p., and have been installed throughout the Press.

**Bread without Flour.**—On Wednesday the Shredded Wheat Company, Eastcheap, gave a demonstration at 223, Tottenham Court-road of the process by which they transform grains of wheat into palatable and nutritious biscuits and cakes, which being so easily digestible, might be specially recommended to invalids and children. The process is a particularly clean one, and its interest for us centred upon an electric heater, in which the shredded wheat is cooked during four minutes after it has emerged from the shredding machine. The latter consists of a hopper, into which are placed the grains of wheat, which have previously been cleaned and boiled for half an hour. Thence they fall between two rollers of hardened steel. One of these is smooth, the other grooved; the wheat is pressed into the grooves, and removed from them automatically by a set of needles. The wheat, in the shape of thin threads, falls into a tray, which conveys it to the oven aforementioned.

**Bridlington.**—The Council have adopted a report by Mr. Beckett, borough electrical engineer, on public lighting, showing the average price of 36 towns per lamp and the proposed charge in Bridlington. The average cost per annum of an arc lamp is quoted at £20. 19s. 6d., the proposed charge being given at £15; average cost of Nernst lamp, proposed charge, £5; average cost incandescent 120-watt £7, proposed charge £5; average cost of incandescent 90-watt £4. 15s., proposed charge £4; average charge incandescent 60-watt £3. 10s., proposed charge £3. At those charges Mr. Beckett proposed in the report to introduce 32 arc lamps (660 watts), 15 Nernst (120 watts), 85 incandescent lamps (120 watts), 197 incandescent (90 watts), and 113 incandescent (60 watts), the total cost being estimated at £2,107, and the total candle-power 43,703. The report finally pointed out that the Corporation were at present paying £1,349 for gas lamps with a total candle-power of only 8,384.

**"Maxim" Arc Lamps.**—We are informed that, after severely testing 12 different makes of arc lamps, the Underground Electric Railways Company of London have placed an order with the Sir Hiram Maxim Electrical and Engineering Company for a very large number of "Maxim" DC/Traction Circuit arc lamps. These lamps are intended to burn five in series on 550 volts direct current, and are provided with self-contained line and substitutional resistances and automatic cut-out, and an isolating switch by which one lamp can be trimmed or examined while the other four are burning. The mechanism chamber is completely separate from the resistance, and the over-all length of the lamp is only 28in. A full trim of carbon, 12in. 12 millimetres top and 5in. 12 millimetres bottom, lasts 90 hours with single enclosure globe, and the carbon left in the top holder in just long enough for the bottom holder for retrimming. The isolating switch is operated by means of a key inserted through a watertight self-replacing latch in the case.

**Wrexham.**—The electrical engineer's last report contains the following figures: November, 1904: Used for tramways, 12,444 units; used for lighting, etc., 34,711—total, 47,155. November, 1903: Used for tramways, 14,962; used for lighting, etc., 28,716—total, 43,678. Total number of consumers, November, 1904, 152; November, 1903, 124. During the past few days seven consumers had been connected, and 14 applications were on hand. The distributing cables had been laid from the works along Willow-road, Wrexham Fechan, part of Bennion-road, Salisbury-road, Percy-road, and part of Talbot-road. The trench cutting was rendered more expensive owing to the employment of men out of work. The work of connecting consumers' premises and public lamps was being proceeded with. The minimum charge to consumers on the easy payment system is to be discontinued during the summer months, and current consumed and meter rent only will be debited. The next sections of the mains extension will be (1) along Chester-road to Neville-street, (2) Chapel-street, Poplar-road, and Ruabon-road.

**Bradford.**—The Electricity Committee of the Corporation have now adopted the report of the city electrical engineer (Mr. A. S. Blackman) on the subject of the distribution of electricity. Mr. Blackman recommended (1) that the tramway distribution cables should be augmented as soon as possible upon the present system of supply, with the exception of the Leeds-road and Stanningley and Manchester road routes, for the supply of which sub-stations fed by high-tension three-phase current at 6,000 volts pressure should be employed; (2) that mains extensions outside the area supplied by the existing consumers' network should be carried out upon the three-phase system for both transmission and distribution, and that the introduction of this system should be made at once, commencing with Wakefield-road; (3) that the high-tension current should for the present be generated by means of plant installed in the works for stepping up the low-tension continuous current. The summary of the contemplated expenditure was: for the tramways distribution, including a spare 500-kw. feeder laid into each sub-station, £26,185; for high-tension feeders for general supply to Wakefield-road, Park-avenue, and Otley-road, £4,432; for transforming plant at the works, £10,250—total, £40,867. Since the report was first presented a deputation from the committee has visited Newcastle, Dublin, and Erith to investigate the working of systems similar to that recommended by Mr. Blackman.

**Retford.**—The Mayor of Retford has said, according to the *Lincolnshire Mercury*, there was no doubt in his mind that a system of electric lighting and power was of the first importance for Retford. Referring to arguments used against it at the Traders' Association meeting, he said it was an absurd mis-statement to say that the rich people wanted it for their own special benefit. They could supply their own requirements, as some had already done, without any difficulty, but if Retford was to hold its own and keep abreast of the times, there would have to be an electric installation for the public use. It was more especially useful for small users of power. As a residential town it was also important to them, and he did not think they could afford to lag behind in these days of advancement. They saw small places with from 5,000 to 6,000 inhabitants adopting electrical supply, and in an agricultural town like Stamford it had been a success. It would, he thought, be detrimental to Retford if it remained without a supply of electrical power and light, and he thought the Town Council committed a great blunder when they refused to adopt the very reasonable scheme put before them by Mr. Mountain. It would not have been a burden to the town, but a source of profit, although, of course, it would not begin to pay the first year. He looked upon it as a serious blunder, and it only showed the weakness of municipal government. Although it had grown slowly up to the present, there were possibilities of Retford becoming a large and important town, but it would certainly be retarded by this decision of the Town Council.

**Torquay.**—An enquiry has been held into the application of the Town Council for sanction to borrow £42,000 for a new electric light and power station, to be erected in Upton Valley, near the refuse destructor. Of this total £14,000 will be required for the high chimney and buildings, and £28,000 for the machinery. The new station is an absolute necessity, in consequence of the present station on Beacon Quay being overloaded, and the impossibility of increasing the power there because of the inability to augment the boiler capacity. The increased demand last year over the previous year was 20 per cent., and this year has also shown a 20 per cent. increase over last year, therefore in the event of even a temporary breakdown to one of the sets it would become necessary to shut down the 52 arc lamps in the main streets in order that the spare machinery might supply the current demanded for the shops, hotels, and private houses. With regard to the current for the trams, the Act of Parliament of the Dolter Company provides that the first 100,000 units are to be supplied at 2d. per unit, the next 50,000 at 1½d. per unit, and all above this at 1½d. per unit in any one year. Approximately, the additional cost of the station rendered necessary to supply this current will be about £10,000, being £8,000 for machinery and £2,000 as part of the buildings. It is anticipated that the interest and sinking fund charges upon these two sums will be amply met by the revenue derived from the supply of current to the trams, even after allowing an ample amount for the cost of generation and establishment charges. It is contemplated that, should no unforeseen delay occur, the new station will be practically completed during 1905.

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**South Africa.**—The demand for electric lighting apparatus throughout Africa is insatiable, says the *African World*. Here are some up-to-date illustrations from the south of the great continent. At Cape Town the Corporation are seeking the sanction of the ratepayers for the completion of the central electric light station, Dock-road, at a cost of £75,000. Even little Greytown, in Natal, has gone in for extensive plant and overhead mains—an indication of what other local authorities all over South Africa will soon be doing—while new dynamos and engines, with double the present capacity, will be required in the New Year. The Port Elizabeth Municipality are calling for tenders in connection with their extensive supply undertaking, including boiler-house plant, engine-room plant, accumulators and boosters, switchboard and instruments, overhead crane, lamps, pillars, motor and electrolytic meters, workshop equipment, etc. All the big towns of South Africa are overhauling and perfecting their telephone systems, and while many orders have already been placed and executed others are in preparation, and will fall to the most enterprising firms. At Johannesburg determined efforts are being made to do away with the causes of dissatisfaction and complaints, and with the New Year many improvements will come into effect, while others are contemplated. In the basement of the telephone tower in Plein-street has been instituted a power plant, constituting two complete duplicate charging outfits, each set consisting of a 60-cycle, single-phase, 100-volt, alternating-current 5-h.p. motor, directly coupled to a generator furnishing 200 amperes at 30 volts. Each motor-generator has sufficient capacity to operate the full ultimate capacity of the storage battery at the normal charging rate. For the purpose of ringing the subscribers' bells there are provided two small motor-generators supplying alternating current at 25 volts, and 1,000 cycles per minute. These machines will later be equipped with the howler, busy-back, intermittent ringing attachments for party-line working, etc. At the side of the generator stands an elaborate power board, while the storage battery is located in the next room. The battery is arranged in two sets, each set consisting of 10 cells of type Tudor storage battery in glass tanks and has a capacity of 580 ampere-hours. The duplicating of the plant ensures continuous service. The British L. M. Ericsson Company were the contractors for the supply of the whole plant.

**Islington.**—At to-night's meeting the Council will consider the following report of the Lighting Committee: "Our attention has been called to the provisions of the London Electric Lighting Areas Act, 1904, by Section 4 of which the Board of Trade are empowered to confirm agreements for the transfer of areas necessitated by the operation of the London Government Act, 1899. The Act affects Islington in conjunction with the County of London and Brush Provincial Electric Lighting Company. The heads of an agreement between the company and the Council were settled during the passage of the Bill through Parliament, as reported to the Council on Oct. 7 last, and we have since been in negotiation with the company as to the amount to be paid by the company and the Council respectively in consideration of the transfer in the one case of such parts of the borough of Finsbury in which the Council are, by their special Act, at present authorised to supply electricity, and in which they have laid electric lighting mains, and in the other case of such portions of the borough of Islington as the company are at present authorised to supply, together with the mains and other works (other than trunk works) in such portions. The borough treasurer has gone carefully into this matter, and for the purpose has made an examination of the company's books. He reports that upon the basis laid down by the agreement referred to the Council have to pay the company in consideration of capital expenditure and three years' purchase of annual revenue a sum of £2,053. 14s. 10d., whilst they will receive from the company a sum of £194. 19s. 9d. only. The difference is explained by the fact that the company had a comparatively extensive system of mains and pipes in those portions of Finsbury which the Borough Council have taken over, while in the portion to be surrendered the Council have invested but little. The Council have already recognised the desirability on the ground of autonomy of giving effect to this transfer, and as the transfer brings with it an estimated additional annual revenue of £382. 12s. 7d. we have no hesitation in recommending that no time be lost in giving effect to it. We have forwarded to the Finance Committee an estimate of £1,858. 15s. 1d., the difference between the amount to be paid by the Council and the company respectively, and subject to its being adopted and submitted by them we recommend: (*a*) That the estimate of £1,858 15s. 1d. submitted by the Finance Committee be approved, and that application be made to the London County Council for their sanction to the borrowing of the amount; (*b*) that the town clerk be authorised to complete the agreement between the County of London and Brush Provincial Electric Lighting Company, Limited, on the basis of the figures above mentioned, and to affix the seal of the Council thereto."

**Electrical Engineering in Scotland.**—An interesting *résumé* of the last year's progress in electrical engineering in Scotland appears in the "Glasgow Herald Shipbuilding and Engineering Annual, 1904." It is divided into two parts—one dealing with the West and the other the East of Scotland. With regard to the former, a Glasgow expert says that electrical engineering has shared during 1904 in the general depression of trade and unsatisfactory scale of prices, the producing power being much in excess of the present demand for plant. The last International Exhibition in Glasgow had led to the discovery by many foreigners and others of the possibilities of electrical business there, and many who came to exhibit had established agencies in Glasgow and energetically entered the field. The local electrical manufacturers had, however, been able to hold their own, and the stress of competition had been met by improvements in design. A given output was now obtained from a considerably smaller and lighter, and, therefore, cheaper machine than formerly. Foreign competition was now almost restricted to electric generating plant of large sizes. He refers to the satisfactory progress made, especially in respect of power supply, in the electricity departments of Glasgow and other Scottish Corporations. He also notes that during 1904 three Clyde shipyards have been completely equipped with electrical plant, and many others have largely extended their electrical machinery, while the field of application of electricity in collieries was also broadening. He concludes by saying electrical engineering generally had been more active during the last three months of 1904 than at any time earlier in the year, and the prospects were all in favour of better business during the ensuing year. On the East of Scotland an Edinburgh expert says that while the closing year had not been signalised by the inception of many such colossal electrical enterprises as were undertaken in 1903, the progress which had been made was of a notably healthy and sound order, indicating that the electrical power movement had gone far beyond the firework display age. He cites specially the progress made with the schemes of the Fife Electric Power Company and the Scottish Central Electric Power Company, and anticipates that with a supply of electric power available at cheap rates a great impetus will be given to trade in the East of Scotland, while owing to the inherent advantages of electric motors, quite apart from the primary point of economy, the condition of the workers as regards cleanliness, comfort, and sanitation will be greatly improved. The British Electric Plant Company, Limited, Alloa, had been able, owing to the largely increasing demand for their products, to give employment to a greater number of hands than in the previous year. Among the principal contracts obtained during the year he cites the following: Some 800 h.p. to 900 h.p. of motors, mostly with self-contained geared shafts, for the Central Marine Engine Works, West Hartlepool; three 250-h.p. generators for Messrs. James Ross and Co., Philpstoun Oilworks; a complete electric power plant, including new electric cranes, etc., for Messrs. Stewarts and Lloyds, Limited, Clydesdale Steelworks, Mossend; extension electric power plant (steam generator and motors), for the Coombs Wood Tube Works of the same firm; several hundred horse-power of motors for Messrs. Peter Spence and Sons, Limited, chemical manufacturers, Manchester; complete electric lighting plant at Mount Melville, St. Andrews; power plant of 650 h.p. and some hundreds of horse-power of motors for the Alloa Coal Company; motor balancers for the Singapore Municipality and for the Northampton Electric Lighting Company; motor-driven plant for the County of Durham Electric Supply Company; shiplighting and power generators for several large liners; and a third repeat order for printing-press equipment from the proprietors of the *Glasgow Herald*.

## PROVISIONAL PATENTS, 1904.

DEC. 19.

**27638. Improvements in vapour electric apparatus.** Charles Proteus Steinmetz, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Dec. 19, 1903, being date of application in United States.) (Complete specification.)

**27640. Improvements in the manufacture of metal caps for to make electrical metallic contact with carbon.** Henry Nehmer, 36, Clifton-street, Finsbury-square, London.

**27683. Improvements in kummeters or instruments for the measurement of wave-lengths in wireless telegraphy.** John Ambrose Fleming, University College, Gower-street, London.

**27702. Method of winding for asynchronous electrical machines for producing a variable number of poles in the propertion of 1 : 2.** (Siemens-Schuckertwerke Ges. mit bes Haft., Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Feb. 13, 1904, being date of application in Germany.) (Complete specification.)

**27705. Improvements in alternating-current electric motors.** Benjamin Garver Lamme, The Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Feb. 27, 1904, being date of application in United States.) (Complete specification.)

**27707. The manufacture of an indestructible filament for gas and electric lamps for lighting and heating purposes.** Georges Michaud and Eugène Delasson, 4, South-street, Finsbury, London.

**27713. Process for the formation of incandescence bodies for electric incandescence lamps.** William Phillips Thompson, 322, High Holborn, London. (Deutsche Gasglühlicht Akt.-Ges., Germany.) (Complete specification.)

**27714. Electric incandescence lamps with incandescence body fused in the conducting wires.** William Phillips Thompson, 322, High Holborn, London. (Deutsche Gasglühlicht Akt.-Ges., Germany.) (Complete specification.)

**27755. Improvements in counting mechanism more especially intended for use with electricity meters.** Hermann Aron and Oskar Runge, 47, Lincoln's inn-fields, London. (Complete specification.)

**27762. Improvements in electrical apparatus for regulating and distributing electric currents.** Charles Guthrie Conradi, 104, Savernake-road, Hampstead, London.

**27763. Improvements in coin-freed mechanism.** The British Thomson-Houston Company, Limited, and Kenneth Francis Kingwell, 83, Cannon-street, London.

DEC. 20.

**27773. Improvements in and relating to the electro-deposition of metals or alloys on aluminium.** Charles Mason, 6, Finkle-street, Stockton-on-Tees.

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**27783. Improvements in the method of and means employed for supporting and connecting the trolley wires of overhead electric systems.** Thomas Dawson, Penny Bank-chambers, Halifax.

**27786 Improvements applicable to electric installations.** Frederick Kershaw and William Jasper McSweeney, 4, St. Ann's-square, Manchester.

**27804. Improvements in self-regulating dynamos for train-lighting and analogous purposes.** Charles Dixon Charlesworth, 24, Temple-row, Birmingham.

**27809. Improvements in hydraulic lifts electrically operated** Edmond Meyer Tudor Boddam, Jaffa, Alperton, Middlesex.

**27831. Improvements in incandescent electric lamps.** William Goulton, 114A, Chancery-lane, London.

**27842. Improvements in electric tool drivers.** Philip Arthur Newton, 6 Breams-buildings, Chancery-lane, London. (The American Inventions Company, United States.) (Complete specification.)

**27844. An improved method of controlling electric lifts, elevators, conveyors, or any similar contrivance having a moving car and stations.** Henry Charles Edward Jacoby, 21, Finsbury-pavement, London.

**27859. Improvements in and relating to self-acting cell-switches.** Elektricitäts-Akt.-Ges. Westfalia, 6, Lord-street, Liverpool. (Complete specification.)

**27869. Forming tank for accumulator elements.** William Gardiner, 65, Chancery-lane, London. (Complete specification.)

**27861. Accumulators.** William Gardiner, 65, Chancery-lane, London. (Complete specification.)

**27862. Accumulators.** William Gardiner, 65, Chancery-lane, London. (Complete specification.)

**27869. Improved construction of lock and electrical contact maker and breaker for lifts.** Arthur Charles Burnett and Joseph Richmond, 173, Fleet-street, London.

**27887. Improvements in vapour electric apparatus.** Ezechiel Weintraub, 83, Cannon-street, London. (Date applied for under Patents Act. 1901, Dec. 21, 1903, being date of application in United States.) (Complete specification.)

**27900. Secondary batteries.** William Gardiner, 65, Chancery-lane, London. (Complete specification.)

**27901. Storage cells.** William Gardiner, 65, Chancery-lane, London. (Complete specification.)

**27902. Secondary batteries.** William Gardiner, 65, Chancery-lane, London. (Complete specification.)

**27903. Secondary batteries and grids therefor.** William Gardiner, 65, Chancery-lane, London. (Complete specification.)

**27904. Secondary batteries.** William Gardiner, 65, Chancery-lane, London. (Complete specification.)

**27905. Grid or element for secondary batteries.** William Gardiner, 65, Chancery-lane, London. (Complete specification.)

**27906. Improvements relating to magneto-electric ignition devices for explosion engines.** Gustav Michalek, 7, Southampton-buildings, Chancery-lane, London.

**27913. Improvements in telegraphy.** Robert James Sheehy, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**27916. Improvements in locking apparatus for watchmen's electric controls and the like.** Horst Hindersin, 8, Buckingham-street, Strand, London. (Complete specification.)

**28166. System of connections for the generation of electric oscillations.** Gustav Eichhorn, 216, Friedrichstrasse, Berlin, Germany. (Date applied for under Patents Act, 1901, Dec. 20, 1903, being date of application in Germany.) (Complete specification.)

DEC. 21.

**27926. Improvements in or connected with electric demand or rebate indicators.** Frank Michael Lewis and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, Strand, London.

**27929. Improvements in electrically-operated block signalling apparatus.** Charles William Skinner Turner, Norfolk House, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Dec. 22, 1903, being date of application in United States.) (Complete specification.)

**27950. Improvements in fused electric motor switches.** Francis John Everson Clarke and George Arthur Pope, 138, Birchfield-road, Handsworth, Birmingham.

**27963. Improvements in or relating to storage and other batteries.** The N. S. Electric Storage Company, Limited, and Job Thomas Niblett, 139, Queen Victoria-street, London.

**28018. Improvements in safety discharge apparatus for excessive voltages in electric circuits.** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens-Schuckertwerke G. m. b. H., Germany.) (Complete specification.)

**28044. Improvements in electricity meters.** Stanley Matthews, 4, South-street, Finsbury, London.

**28036. Means for automatically connecting up with each other the subscribers to telephone exchanges.** Josef Peticky, Ivan Cizek, and Frantisek Suchanek, 72, Cannon-street, London. (Complete specification).

**28062. Improvements in treated carbon and in methods of producing same.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**28063. Improvements in scouring machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

DEC. 22.

**28113. Improvements in electrical heating apparatus, especially applicable to flatirons and the like.** William Eastman and Alan Warne, 40, Chancery-lane, London.

**28114. Improvements in automatic controlling apparatus for operating electric switches or cut-outs.** Charles Mark Dorman, Reginald Arthur Smith, and Herbert George Bagge, Ordsal Electrical Works, Salford.

**28122. Improvements in and relating to electric ignition devices for internal-combustion engines.** James Paxman and Davey, Paxman, and Co., Limited, 70, Chancery-lane, London.

**28123. Improvements in and connected with counting apparatus for electric current, gas, water, or similar meters.** Fritz Biermann, 37, Chancery-lane, London. (Complete specification.)

**28129. Improvements relating to permeable diaphragms for use in electrolytic cells, filtering apparatus, and like purposes.** Heinrich Hertz, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**28147. Improvements in or relating to electric vapour apparatus, especially electric lamps of the character known as electric vapour lamps, or vapour arc lamps in part applicable to other electric vapour apparatus.** Charles Orme Bastian, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**28154. Improvements relating to the manufacture of light-emitting bodies for electric incandescent lamps.** Hans Kuzel, 322, High Holborn, London.

**28155. Improvements in dynamo-electric machines.** The Phœnix Dynamo Manufacturing Company, Limited, Robert Pohl, and Felix Pohl, 322, High Holborn, London. (Complete specification.)

**28156. Improvements relating to the construction and ventilation of field coils of dynamo-electric machinery.** The Phœnix Dynamo Manufacturing Company, Limited, and Robert Pohl, 322, High Holborn, London. (Complete specification.)

**28157. Improvements in and relating to actuating apparatus for magneto-electric spark ignition apparatus and the like.** Gustav Adolf Unterberg, 322, High Holborn, London. (Complete specification.)

**28163. Improvements in telephone systems.** John Young, 21, Gloucester-walk, Campden-hill, Kensington, London.

DEC. 23.

**28175. Improvements in and relating to electric tramways and railways.** Frederick Walter Baynes, 51, Elmside, Exeter.

**28176. Improvements in the method of and means employed for regulating electrical energy in an alternating-current circuit.** Harold Emmott, Penny Bank-chambers, Halifax.

**28179. Improvements in telephone indicators.** William Aitken, care of British Insulated and Helsby Cables, Limited, Edge-lane, Liverpool.

**28208. Improved trolley head.** James Burns and James Douglas Allan, 65, Chancery-lane, London.

**28211. An improved electric lamp for use by divers and others under water.** John Briggs Stewart, 100, Wellington-street, Glasgow.

**28212. Improvements in connection with trolley poles for overhead electric traction.** Frederick George Squirrell, 55, Chancery-lane, London.

**28235. Improvements in electric arc lamps.** John William Ewart, 36, Chancery-lane, London.

**28238. Improvements in alternating-current motors.** Bruce Peebles and Co., Limited, and Jens Lassen La Cour, 34, Castle-street, Liverpool.

**28252. Improvements in or relating to electrical switches, plugs, and the like.** William Winstanley Strode and George Hendry White, 111, Hatton-garden, London.

**28253. Improvements in or relating to incandescent lamp holders.** William Winstanley Strode, 111, Hatton-garden, London.

**28254 Improvements in electric telegraphs.** Foster Ritchie, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**28255. Improvements in electrical relays.** Foster Ritchie, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**27268. Improvements in and relating to telegraph transmitting instruments.** Frederick Herbert William Higgins, 18, Southampton-buildings, Chancery-lane, London.

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**23270. Improvements in or relating to safety devices and appliances for use in connection with suspended electric conductors.** Alfred Charles Bray and William Aitken, 30, Moorgate-street, London.

**23278. Improvements in instruments for indicating the charged or uncharged condition of electric cables or other electric appliances.** William Mundell Thornton, 18, Buckingham-street, Strand, London.

**23279. Improvements in electric arc lamps.** William James Davy, 40, Chancery-lane, London.

**23301. Improvements relating to electric welding.** Sebastian Ziani de Ferranti, 18, Southampton-buildings, Chancery-lane, London.

## COMPLETE SPECIFICATIONS ACCEPTED

*To be published Jan. 12, 1905.*

1904.

**2495. Electric gas or vapour lamps or like apparatus.** von Recklinghausen.

**2707. Electrostatic wattmeters.** Wilson.

**3010. Electric traction on a road contact or like system.** Ross and Matthews.

**3305. Electrical measuring instruments and apparatus for use therewith.** Fisher.

**3340. Controlling apparatus for electric motors.** Klinkenberg.

**3384. Alternating-current motors.** British Thomson-Houston Company, Limited. (General Electric Company.)

**3391. Electrical energy meters.** Lake. (Arno.)

**3396. Method of and means for protecting apparatus on alternating-current systems.** Merz and Price.

**3935. Electric cable troughs or conduits.** Seacombe Pressed Brick and Tile Works, Limited, Wilson, and Jones.

**3995. Electric couplers.** British Thomson-Houston Company, Limited, and Cubitt.

**4059. Electric furnaces.** Simm, Simm, Storey, and Sellers.

**4134. Arc lamp electrodes.** Levis. (General Electric Company.)

**4336 Means or apparatus for controlling incandescence electric lamps.** Ferguson.

**15343. Electric railways and tramways on the overhead conductor system.** Anderson and Dunne.

**17532. Electric filters.** Hinkson and Hey.

**19366. Galvanic cell.** Ziegenberg.

**19997. Apparatus for regulating the voltage of electrical circuits** Stuart. (Date applied for under International Convention, Sept 26, 1903.)

**22355. Telephone installations.** Deutsche Telephonwerke R. Stock und Co., G. m. b. H. (Date applied for under International Convention, Aug 25, 1904.)

**22695. Thermo-electric generators.** Howorth. (Haskell.)

**22880. Process for smelting nickel ores in an electric furnace, and crucible therefor.** Société Electro-Metallurgique Française. (Date applied for under International Convention, Oct. 30, 1903.)

**23769. Telephone system.** Barnes.

**23907. Trolley restorers.** Calahan. (Date applied for under International Convention, Nov. 6, 1903.)

**23932. Trolley wire supports.** Paton.

**24360. Arrangement of electric emergency lamps in theatres and like buildings.** Brandt.

**24951. Medical electric and magnetic appliance.** Cooke and Cooke.

**25078. Electric ignition devices for internal-combustion engines.** Aron. (Boulez.)

**25106. Apparatus for regulating the current through an electric lighting circuit.** Prested.

**25114 Electric accumulators.** De la Croix and Joel.

**25128. Fireproof, acid-proof, and electrically insulating material.**

**25129 Electric braking apparatus.** Thompson. (Stamm and Lewis.)

**25218. Enclosed electromagnet.** Perrett. (Date applied for under International Convention, March 12, 1904.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ¾-¼ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 15/32-9/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 .... | 5 | – | 5¼-5⅜ |
| —— 5 per cent. Cum. Pref., 1-100,000 ..... | 5 | – | 5¼-5⅜ |
| —— 4½ per cent. Mortgage Debentures ..... | 100 | – | 101-104 xd |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. ..... | 100 | – | 101-103 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 ..... | 5 | – | 2⅝-2¾ |
| —— 4 per cent. Mortgage Debenture Stock ..... | 100 | – | 88-90 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,751 .. | 2 | – | ⅜-¼ |
| —— Non. Cum., 6 per cent. Pref. ..... | 2 | – | 1¼-1½ |
| —— 4½ per cent. 1st Debenture Stock ..... | 100 | – | 93-96 |
| —— 4½ per cent. 2nd Debenture Stock ..... | 100 | – | 72-75 xd |
| Callender's Cable, Debentures ..... | 100 | – | 103-106 xd |
| —— Ordinary ..... | 5 | – | 9½-10 |
| —— 5 per cent. Pref. ..... | 5 | – | 5-5½ |
| Crompton and Co. ..... | 3 | – | 1⅝-2 |
| —— 5 per cent. Debentures ..... | 100 | – | 96-98 xd |
| Edison and Swan United, "A" Shares, 1-98,361 ..... | 3 | – | ⅜-⅞ |
| —— "A" Shares, 01-017,139 ..... | 5 | – | 1-1⅛ |
| —— 5 per cent. Debentures ..... | 100 | – | 79-84 |
| —— 4 per cent. Deb. Stock, Red. ..... | 100 | – | 77-82 xd |
| Electric Construction, Limited, Nos. 1 to 112,100 ..... | 2 | – | 1⅛-1⅛ |
| —— 7 per cent. Cumulative Pref. ..... | 2 | – | 2⅛-2⅜ |
| —— 4 per cent. Perp. 1st Mort. Deb. ..... | 100 | – | 98-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 | – | 9½-10 xd |
| —— 4 per cent. 1st Mort. Deb. Stock ..... | 100 | – | 91-96 |
| W. T. Henley's Telegraph Works, Ordinary ..... | 5 | – | 10⅛-10⅜ |
| —— 4½ per cent. Preference ..... | 5 | – | 5⅛-5⅜ |
| —— 4½ per cent. Debentures ..... | 100 | – | 110-112 |
| India Rubber, Gutta Percha, and Telegraph Works ..... | 10 | – | 15-16 xd |
| —— 4 per cent. Debentures ..... | 100 | – | 99-102 |
| Parker, Thos., Limited, Ordinary ..... | 10 | – | 10-10½ |
| Telegraph Construction and Maintenance ..... | 12 | – | 38-40 |
| —— 5 per cent. Bonds ..... | 100 | – | 101½-103½ xd |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary ..... | 10 | – | 12-13 |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 ..... | 10 | – | 9½-10 |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 .... | 10 | – | 11-12 |
| —— 4½ per cent. Debenture Stock. Red. ..... | 100 | – | 104-106 xd |
| Bromley (Kent) Electric Light and Power Co. ..... | 5 | .. | 5⅛-5⅜ |
| —— 4½ per cent. 1st Debenture Stock, Red. ..... | 100 | – | 101-104 |
| Brompton and Kensington, Ordinary ..... | 5 | – | 10½-11 |
| —— 7 per cent. Preference ..... | 5 | – | 10⅛-10⅜ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 .. | 5 | – | 8¼-8⅜ |
| —— Nos. 60,001-80,000 ..... | 5 | – | 5¼-6 |
| Cambridge Electric Supply Company, Ltd., £10 Ord. .... | 8 | – | 12½-13⅜ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 104-107 |
| Charing Cross and Strand, Nos. 1-70,000 ..... | 5 | – | 8⅛-8⅜ |
| —— 70,001-80,000 ..... | 5 | .. | 8-8⅛ |
| —— 4½ per cent. Cum. Pref. ..... | 5 | – | 5 9/16-5 13/16 |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 4 15/16-5 1/16 |
| —— 40,001-80,000 ..... | 5 | .. | 4 15/16-5 1/16 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 | – | 101-103 |
| Chelsea Electricity Supply ..... | 5 | – | 6⅝-7 |
| —— 4½ per cent. Debentures ..... | 100 | – | 107-109 xd |
| City of London, Ordinary ..... | 10 | – | 10⅜-11¼ |
| —— 6 per cent. Cumulative Pref. ..... | 10 | – | 13½-14 |
| —— 5 per cent. Debenture Stock ..... | 100 | – | 121-125 xd |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) .. | 100 | – | 100-103 xd |
| County of London Electric Supply, Ordinary ..... | 10 | – | 9 9⅛ |
| —— 6 per cent. Cum. Pref. ..... | 10 | – | 12-12½ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 101-103 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. ..... | 100 | .. | 106-109 xd |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000.. | 5 | – | 6¼-6⅝ |
| —— 6 per cent. Cum. Pref. ..... | 5 | – | 6-6⅛ |
| —— 4½ per cent. First Mort. Deb. ..... | 100 | – | 108-110 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 1⅛-2⅛ |
| —— 5 per cent. Debenture Stock, Red. ..... | 100 | – | 86-91 xd |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000..... | 5 | – | 5¼-6 |
| —— 4½ per cent. First Deb. Stock, Red. ..... | 100 | – | 102-105 |
| Havana Electricity, Limited, 1-15,000 ..... | 10 | – | 9¼-10⅛ |
| Hove Electric Lighting, Limited, Ord., 1-13,000 ..... | 5 | – | 7⅛ 8 |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 100-102 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 ..... | 1 | – | 9/16-11/16 |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | – | 12¼-13 |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red ..... | 100 | – | 102-104 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅜-10⅛ |
| London Electric, Ordinary ..... | 5 | – | 2⅛-2⅜ |
| —— 6 per cent. Pref. ..... | 5 | – | 5 9/16-5 13/16 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red... | 100 | – | 96-97 |
| Metropolitan Ordinary ..... | 10 | – | 17½-18 |
| —— 4½ per cent. First Mortgage Debenture Stock .... | 100 | – | 110-115 |
| —— 4½ per cent. Cum. Pref. ..... | 5 | .. | 5 7/16-5 9/16 |
| —— 3½ per cent. Mortgage Debenture, Red. ..... | 100 | – | 86-88 |
| Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb.. | 100 | – | 92-95 xd |
| Newcastle-upon-Tyne Electric Supply, Ordinary ..... | 5 | – | 98-101 |
| —— Preference ..... | 4 | – | 100-102 |
| Notting Hill Electric Lighting ..... | 10 | . | 14½-15 |
| —— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.) .. | 100 | | 102-104 |
| Oxford Electric, Ordinary, 1-96 and 4[illegible] -14,310..... | 5 | – | 6¼-6⅜ |
| —— 4 per cent. Debenture Stock ..... | 100 | – | 99-101 |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures ..... | 100 | – | 100-102 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000.. | 5 | – | 2⅜-3¼ |
| —— 4 per cent. Debenture Stock ..... | 100 | – | 83-87 |
| South London, Ordinary ..... | – | – | 4¼-4⅜ |
| South Metropolitan Electric Light and Power Co., Ord... | 1 | .. | 13/16-15/16 |
| —— 7 per cent. Cum. Pref. ..... | 1 | .. | 1⅛-1 7/16 |
| —— 4½ per cent. 1st Mort. Deb. ..... | 100 | .. | 107-110 |
| —— Ditto, June, 1904 ..... | | .. | |
| St. James's and Pall Mall, Ordinary, 101-20,080 ..... | 5 | – | 13⅛-14¼ |
| —— 7 per cent. Pref. ..... | 5 | – | 8¼-9 |
| —— 3½ per cent. Deb. ..... | 100 | – | 98-100 xd |
| Urban Electric Supply Co., Ordinary, 8-30,007 ..... | 5 | – | 5-5⅛ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5 1/16-5 3/16 |
| Westminster, Ordinary ..... | 5 | – | 12⅜-13⅛ |
| —— 5 per cent. Cum. Pref., 110,101-138,851 ..... | 5 | – | 6-6½ xd |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-250,007 ..... | 5 | – | 5 7/16-5 9/16 |
| —— Ord. ..... | 5 | – | 7 13/16-8 |
| —— Permanent 6 per cent. Debenture Stock. 1888 .. | 100 | – | 140-143 xd |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 104-105 xd |
| Barcelona Tramways, Limited, Ord., 1-20,000 ..... | 10 | .. | 11⅜-12⅛ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 ..... | 10 | .. | 9¼-10 xd |
| —— 5 per cent. Deb., Red., 1-600 ..... | 100 | .. | 99-102 |
| —— 4½ per cent. Red. Deb. Stock ..... | 100 | .. | 96-100 |
| Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606.. | 1 | .. | ⅜-½ |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 ..... | 1 | .. | ⅜-1 xd |
| Belfast Street Tramways, Ord., 1-26,600 ..... | 10 | .. | 10-11 |
| Blackpool and Fleetwood Tramroad ..... | 10 | – | 13⅜-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 ..... | 5 | – | 1⅛-2 |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 ..... | 5 | – | 3⅝-4⅛ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 91-98 xd |
| British Columbia Electric Railway Co., Ord. Def. ..... | 100 | – | 100-103 |
| —— Ord Pref. ..... | 100 | .. | 100-103 |
| —— Non. Cum. 5 per cent. Pref. ..... | 10 | – | 10⅛-10⅜ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 | – | 102-104 p s |
| —— 4½ per cent. Vancouver Power Deb. ..... | 100 | – | 98-101 |
| British Electric Traction Ord. 1-300,000 & 60,001-80,000 | 10 | – | 9¼-10 xd |
| —— 6 per cent. Cm. Pf., 30,001-60,000 ..... | 10 | – | 10 13/16 11 1/16 |
| —— 5 per cent. Perpetual Debenture Stock ..... | 100 | .. | 118-120 |
| —— 4½ per cent. 2nd Deb. Stock ..... | 100 | | 96-98 |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 | 3½-3⅝ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | 5⅜-5½ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | 5½-5⅝ |
| —— 5 per cent. Deb. Stock, Red. | 100 | 104-105 xd |
| —— Prov. Cert., all paid | 100 | 101-104 xd |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | 94-97 xd |
| Calcutta Tramways, Limited, 1-102,268 | 5 | 8¼-8⅜ |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | 106-108 xd |
| Cape Electric Tramways, Nos. 1-480,000 | 1 | 1⅛-1⅜ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | 4⅞-5¼ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | 99-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | 101-104 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | 9½-10 |
| —— 5 per cent. Cum. Pref. | 10 | 11-12 |
| —— 4 per cent. Debentures | 100 | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | 13-14 |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 | 15-16 |
| —— 5½ per cent. Mort. Debs., 1-5,000, Red. | 100 | 94-97 |
| Imperial Tramways Ordinary | all | 18-19 |
| —— 6 per cent. Cum. Pref. | all | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000 | 5 | 3¼-4 |
| —— 4 per cent. Debenture Stock | 100 | 88-91 xd |
| Kidderminster and District Lighting and Traction, Pref. | 5 | 8-8¼ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | 10⅜-10⅝ xd |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | 101-103 xd |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 | 101-103 xd |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016. | 1 | ⅜-7/16 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | 15/16-1 |
| —— 4½ per cent. Deb. Stock, Red. | 100 | 102-104 xd |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000 | £1,000 | 108-113 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 | 100-103 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 | 103-105 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000 | 5 | ¼-1½ |

| Name. | Amount paid. | Last price |
|---|---|---|
| | £ | £ |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | -12½ |
| —— 5 per cent. Cum. Pref. | 10 | 9⅜-9¾ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk. | 100 | 101-104 xd |
| Potteries Electric Traction, Ordinary 20,001-40,000 | 10 | 8-9 |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | 8¼-8½ |
| —— 4½ per cent. Debenture Stock | 100 | 99-102 |
| South Lancashire Electric Traction and Power Company | | |
| —— £250,000 Ordinary | 1 | 1 |
| —— £101,152 6 per cent. Preference | 1 | 1 |
| —— £528,093 4½ per cent. Debenture Stock | 100 p.c. | 100 p.c. |

## Electric Railways.—

| | | |
|---|---|---|
| Central London, Ordinary | 100 | 91-93 |
| —— 4 per cent. Pref. | 100 | 101-103 |
| —— ,, ,, deferred | 100 | 84-86 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | 108-110 |
| City and South London, Consolidated Ordinary | 100 | 46¼-47¼ |
| —— 4 per cent. Debenture Stock | 100 | 104-107 |
| —— 5 per cent. Pref. Stock '91 | 100 | 122-125 |
| —— ,, ,, ,, '96 | 100 | 117-120 |
| —— ,, ,, ,, '01 | 100 | 116-119 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | 10-10¼ |
| —— Ordinary, 1-50,000 | 10 | 3¾-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — | 99-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | — | 97-98 |
| Waterloo and City, Ordinary | 100 | 89-91 |

## Telephones.—

| | | |
|---|---|---|
| National Telephone, Preferred | 100 | 108¼-109¼ |
| —— Deferred Stock | 100 | 102-104 |
| —— 6 per cent. Cum. First Pref. | 10 | 13-15 |
| —— 6 per cent. Cum. Second Pref. | 10 | 12-13 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | 5 5/16-5 7/16 |
| —— 5½ per cent. Deb. Stock, Red. | 100 | 86-88 xd |
| —— 4 per cent. Deb. Stock, Red. | 100 | 101½-103½ xd |
| —— 4 per cent. Prov. Cert. | — | 101½-103½ xd |
| Oriental Telephone and Electric Company | 1 | 1-1⅛ |
| —— 6 per cent. Cum. Pref. | 1 | 1⅛-1⅜ |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1904. | 1903. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Passenger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Dec. 31 | 1,291 | 1,470 | − 179 | — h | 19¼ | 19¼ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | ,, 31 | 179 | 216 | − 37 | + 464 | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 316,049 | 1·03 | 10·11 | 1,770 | 5·04 |
| Barking Corporation | ,, 31 | 61 | 41 | + 20 | + 112 | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | Jan. 1 | 991 | 935 | + 35 | − 635 | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,319,701 | 1·158 | 9·98 | 2,383b | 6·1 |
| Birmingham Corporation | Dec. 31 | 379 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | ,, 31 | 5,401 | 5,301 | + 295 | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 16 | 765 | 723 | + 42 | + 3,353 | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10·94 | — | 4·59 |
| Blackpool Corporation | ,, 29 | 337 | 336 | + 1 | + 5,937 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 31 | 224 | 224 | — | + 406 | 16½ | 16½ | Dec. 31 | 32,021 | 2,253,984 | 600,757 | 3·34 | 12·75 | 2,001 | 7·05 |
| Bolton Corporation | ,, 25 | 1,625 | 1,884 | − 259 | + 298 | 38 | 38 | March 31 | 94,151 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·89 |
| Bournemouth Corporation | ,, 28 | 1,031 | 946 | + 35 | + 2,042 | 10·15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 17 | 3,729 | 3,366 | + 363 | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | Jan. 1 | 904 | 729 | + 175 | + 3,441h | 9 | 7½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | Dec. 30 | 5,546 | 4,838 | + 708 | — | 51½ | 51½ | Dec. 31g | 253,150 | 44,391,439 | 6,033,528 | — | — | — | — |
| Burnley Corporation | ,, 31 | 1,089 | 857 | + 232 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 25 | 262 | 349 | − 87 | — | 8½ | — | March 31j | 11,574 | 2,556,134 | 282,378 | 1·08 | 9·84 | 1,570 | 7·57 |
| Cardiff Corporation | ,, 31 | 2,113 | 1,782 | + 330 | + 1,973 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 31 | 184 | 190 | − 15 | — | — | — | Dec. 31g | 9,987 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 31 | 6,291 | 6,591 | − 295 | + 7194 | 6 | 6 | ,, 31 | 362,471 | 44,933,938 | 1,292,674a | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | Jan. 1 | 3,221 | 3,272 | − 51 | — h | 6⅛ | 6⅜ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Colchester Corporation | Dec. 28 | 235 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 22 | 446 | 482 | − 36 | − 2,515 | — | — | ,, 31g | 25,657 | 6,353,323 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | ,, 30 | 257 | 239 | + 18 | + 106 | 7·23 | 7·23 | March 31a | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 31 | 214 | 179 | + 35 | — | 4½ | 4½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0·94 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | ,, 31 | 158 | 176 | − 18 | — h | 7 | 6¾ | Dec. 31g | 6,234 | 588,905 | 107,164 | 3·88 | 14·09 | 932 | 7·39 |
| Dublin U. T., electric cars | ,, 30 | 4,049 | 3,575 | + 474 | } — | 47 | 46 | ,, 31g | 134,643 | — | 3,429,356 | — | — | — | — h |
| Dublin S. District, Electric | ,, 30 | 858 | 709 | + 149 | | | | | | | | | | | |
| Dundee City Tramways | ,, 28 | 855 | 810 | + 45 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 31 | 680 | 5 9 | + 91 | + 1,521 | 10·77 | 10·75 | March 31 | 34,312 | 12,950,269 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 31 | 14,108 | 14,965 | − 757 | — h | 143 | 123 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Gloucester Corporation | ,, 28 | 279 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 28 | 2,198 | 2,377 | + 121 | + 4,192 | 33 | 30½ | March 31 | 68,289 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,069 | 8·77 |
| Huddersfield Corporation | Nov. 12 | 1,260 | 1,173 | + 87 | — | 35 | 35 | ,, 31 | 65,545 | 11,893,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | Dec. 31 | 2,302 | 2,140 | + 162 | + 10,619 | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | ,, 17 | 352 | 322 | + 30 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | ,, 28 | 120 | 138 | − 18 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 28 | 201 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 31 | 5,747 | 5,269 | + 477 | — | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | ,, 31 | 2,182 | — | — | — | 7¼ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | ,, 24 | 10,473 | 10,838 | − 365 | + 14,283 | 103 | 103 | Dec. 31g | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | Jan. 1 | 1,433 | 1,553 | − 120 | − 2,315h | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — e |
| London County Council | ,, 24 | 11,118 | 9,655 | + 1,493 | — | 46¼ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 31 | 167 | 154 | + 13 | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | ,, 29 | 145 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 31 | 11,972 | 11,134 | + 838 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Metropolitan Elec. Tramways | ,, 30 | 2,327 | 1,029 | + 1,298 | + 14,915h | 10 | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 31 | 117 | 91 | + 26 | + 1,301 | 2½ | — | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newcastle-on-Tyne Corptn. | ,, 31 | 3,652 | 3,746 | − 94 | — | 45 | 38½ | ,, 25 | 185,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111b | — |
| Newport (Mon.) Corporation | ,, 17 | 511 | 414 | + 97 | + 692 | 15 | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 17 | 1,437 | 1,374 | + 63 | + 5,792 | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·16 | 12·39 | — | — |
| Rochdale Corporation | — | — | — | — | — | 4½ | 4½ | 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 29 | 559 | 549 | + 20 | — | — | — | ,, 31 | 20,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·68 |
| Salford Corporation | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | — | — | — | — | — | 7⅞ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | Jan. 1 | 5,190 | 4,620 | + 570 | + 4,161 | 34½ | — | ,, 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | Dec. 29 | 918 | 810 | + 107 | − 2,316 | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | — | — | — | — | — | 6¼ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 30 | 454 | 414 | + 40 | + 7,956 | 11¼ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 18 | 1,116 | 1,072 | + 44 | + 1·052 | 19·54 | 18·48 | ,, 31 | 62,506 | 14,848,958 | 1,433,463 | 1·01 | 10·46 | — | — |
| Swindon Corporation | — | — | — | — | — | 3¾ | — | — | — | — | — | — | — | — | — |
| Wallasey U.D.C. | ,, 31 | 680 | 587 | + 93 | + 1,941 | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,100 | 7·60 |
| West Ham Corporation | ,, 29 | 1,261 | — | — | — | 8·62 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 28 | 930 | 452 | + 478 | — | 7½ | — | ,, 31g | 20,878 | 4,263,066 | 417,335 | — | 12·006 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.
Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**Liege Exhibition.**—An interesting feature has been decided upon by the organising committee of the Liège Exhibition (electrical section), which will be at once useful and novel. In addition to the large firms and inventors, a considerable space will be specially reserved for working electricians. No employer of more than five men will be admitted, and the employer himself must be a working electrician. Small employers will pay a small charge for space, which will be free to workmen exhibitors. The purpose of this reservation is to throw open a field for apparatus and inventions which would otherwise seldom come before the public.

**Bournemouth.**—The recent arbitration between the Corporation and the Poole and District Electric Traction Company illustrated how experts may differ. The company claimed £427,619, and one of their witnesses, Mr. More, estimated the value of the undertaking at nearly £460,000. The most modest estimate on their behalf figured at £377,732. For the Corporation, who offered £55,000, the appraisements ranged from Mr. F. W. Lacey's £55,379 to Mr. Waller's £70,400. The Corporation are very well satisfied with the award, which fixes the purchase price at £112,000, in addition to which a sum of about £6,000 is to be paid for items previously agreed upon. We hope to see the different lines linked up at an early date, and welded into a harmonious and successful system.

**Free Lamps.**—The need of seeing that lamps of good quality are used by light consumers has been recognised by the Twickenham and Teddington Electric Supply Company, Limited, who have decided to renew lamps gratuitously. The consumers will, in fact, be allowed to exchange them as frequently as they wish. This judicious step will doubtless do much towards removing complaints as to indifferent light, which are commonly traceable to the practice of many consumers in buying cheap and inferior lamps. It is gratifying to see that electric light undertakers are evincing a spirit of enterprise with a view to relieving electric illumination from the handicap under which it has laboured. The greater satisfaction of the consumers, and the resultant increase in their numbers, may be depended upon to defray, and, in the course of time, to more than recoup, the outlay under this head.

**Nobel Peace Prize.**—The Board of Education has received through the Foreign Office an intimation that, in order to be eligible for the Nobel Peace Prize, which will be awarded in December, 1905, candidates must be proposed to the Nobel Committee of the Norwegian Parliament before Feb. 1. The following persons only are qualified to recommend candidates: members of the Nobel Committee of the Norwegian Parliament; members of the Legislatures and Governments of different countries, and of the Commission du Bureau international permanent de la Paix; members and associates of the Institut de Droit international; professors of law and political science, of history, and of philosophy in the universities; and winners of the Nobel Peace Prize. The Nobel Peace Prize can be granted to an institution or an association, not only to an individual. Enquiries for further information should be addressed to the Comité Nobel du Parlement Norvégien, Victoria-terrasse 4, Christiania, Norway.

**St. Louis Exhibition.**—The closing ceremony in connection with the great fair is thus picturesquely described by the *Western Electrician* of Chicago: "Promptly at 12 o'clock midnight President Francis, surrounded by a crowd estimated at 100,000 persons, threw a switch which had been arranged at the foot of the Louisiana Purchase Monument, and slowly, as though reluctant to lose its beauty, the grand illumination dimmed. Simultaneously, the current which operated the cascades was cut off, and with the darkening of the main picture the beautiful torrents of foaming water were for ever silenced." It will be seen that the electrical department, which has been so conspicuous throughout the exhibition, died hard. The final statement of the officials in regard to the attendance throughout the 187 days places the total at 19,694,855, of whom, however, only 12,804,616 paid for admission, which, it may be remarked, is less than half the number for the Chicago Exhibition. The concluding day was naturally crowded, 203,101 sightseers being present.

**Wireless Telegraphy.**—An agreement has been concluded between the Italian Government and the Marconi Company for the construction of a powerful station at Coltano, intended to communicate with stations in Great Britain, Erythrea, the Netherlands, and other countries. In connection with the agreement entered into between the company and the British Government for the transmission of messages to ships at sea, the Postmaster-General has authorised the use of abbreviated or registered telegraphic addresses of firms or individuals in sending wireless messages to or from the vessels, subject to the same regulations as those governing inland telegrams. It is reported that arrangements are being made to fit up the trains of the New York Central and the Lake Shore Railroads with wireless telegraphy apparatus to enable passengers to send and receive messages at any time. Satisfactory experiments are stated to have been made of a combination of the present signalling system and wireless telegraphy by which engine-drivers can be warned of any danger.

**Reduced Cost of Electricity.**—A lady writing in a New York journal bewails the increased cost of living in the States, particularly in that city. Her contention is amply exemplified in two columns of figures, which demonstrate the advance in prices that has occurred during the past decade, especially in the necessaries of life. Besides this, our esteemed contemporary the *Electrical World* weighs in with an important exception to prove the rule—electricity. There is not a department of electrical service to the public that is not cheaper and better in 1904 than in 1894. Trolley rides for five cents are much longer, the universal transfer system has cut the fare to much below five cents, and the service is infinitely improved, on surface, overhead, or underground. Telephony is better, quicker, much cheaper, and available to everybody. Electric light and power are both cheaper and better, all over the country as in New York, and while the cost of every constituent item entering into production has risen—fuel, wages, rent, taxes, etc.—the price of current has been persistently lowered.

**Poor Potsdam!**—The Kaiser is exceedingly jealous about anything concerning Potsdam, for it was there that his "never-to-be-forgotten" ancestor the great Frederick was born. Lately it has become recognised as imperative that electric traction shall supersede the old horse trams, but in the middle of the road connecting the town with the railway station are the remains of the old linden tree around which the people were wont to attend upon Frederick with petitions. This would have to be removed, and though it is but a remnant of decayed timber, encased in zinc and propped up by iron supports, the Kaiser insists that sentiment shall prevail over utility. His Majesty, however, is not actuated by historic considerations alone. In the character of æsthete he also objects to the use of the overhead system on this road, and suggests that the best plan would be to use an alternative route, which should also be

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well away from the palace. It is estimated that an additional expenditure of over £60,000 would be entailed, but "the Kaiser has promised that the State shall bear half." As the Potsdam coffers are not overloaded, even a moiety of this sum represents a substantial tax, and a number of the inhabitants consider hero-worship rather dear at the price; but it looks as though the town will have to acquiesce—or, at any rate, to pay.

**The L.B. and S.C. Experiment.**—It is now definitely announced that the section between Peckham Rye and Battersea Park is to be converted to electric traction by way of experiment. This section, which is five miles in extent, is in the centre of the company's heaviest suburban traffic. For some two years the details of the scheme have engaged the attention of the company's consulting electrical engineer, Mr. Philip Dawson, who, with his marked predilection for the overhead system, has convinced the directors of its advantage. When the electrification of this section has been completed, it is intended at first to run a few trains during the late morning and early afternoon on the "shuttle service," passengers for a longer distance than the one electrically traversed having to change at each end. By this arrangement the quick transit of the early workers will not be interfered with. The general manager and consulting engineer have great confidence in the success of the experiment, which they expect to result in the prompt electrification of the lines to London Bridge and the West-end. It will be remembered that when Mr. Dawson gave evidence before the London Traffic Commission he advocated electric traction in the most unmistakable manner. The company is building a power station at New Cross for lighting purposes, but an outside supply will probably be obtained for running the experimental trains.

**The Clock of the Future.**—Mr. Henry Cunynghame has just completed his interesting course of Christmas lectures at the Royal Institution on "Ancient and Modern Methods of Measuring Time." At the conclusion of Thursday's lecture he showed an electric clock which had been connected with wires to two dials in the gallery of the theatre, and said that no doubt the electric clock, when one clock in a house gave the time to any number of dials, was the clock of the future. He showed how, by the aid of a few dry cells, clocks are made to wind themselves automatically, never requiring to be wound by hand, and how one single master clock of this kind could be arranged to send a current every minute or half-minute to any number of dials in the same house or town, so that their hands would move on step by step with those of the master clock, and would always show the same time as it did without any attention for winding. In the course of the concluding lecture Mr. Cunynghame showed various apparatus by means of which minute divisions of time are measured, including an electrically operated tuning-fork. Mr. Esmond Morse, who had rigged up some of these instruments, assisted in their demonstration. The course concluded with a demonstration of the well-known mirror arrangement for the testing of the speed of light, and an earnest appeal by the lecturer to parents to allow their children as much as possible the use of instruments in order to assist them in their studies of physical phenomena.

**The Northumberland Clause.** — Hitherto St. Stephen's has been the venue for contests over the Bermondsey or Northumberland clauses, but the Torquay Gas Company initiated a departure the other day by appearing before the Local Government Board inspector, and preferring a request that sanction to the Corporation's application for a loan of £42,000 for new electricity works should be conditional upon the observation of the Northumberland clause. This procedure, if not *ultra vires*, is of a novel character, and we notice that it elicited scant encouragement from the inspector, who stated that he was in attendance to enquire into the merits of the scheme, and not into any conditions. The *Gas Journal* seeks consolation in the circumstance that "it is not an unknown thing in recent times for the Local Government Board to look a little more closely than of old into applications from the point of view of how the ratepayers are likely to fare in respect of the scheme for which the money is required." Allowing our contemporary's statement that the undertaking has only just made both ends meet, and that the present station is unable to meet any increased demand, the enlarged works will more than enable the Corporation to supply the Dolter Traction Company, leaving a margin for new light consumers. The gas company, by the way, are indefatigable rivals. It will be remembered that they were very busy last year with their opposition to the tramway scheme. They claimed special protection against electrolysis, and their activity has evidently not abated.

**Hiring of Motors.**—In the same way that electric light undertakers have found it advisable to adopt some system of free wiring to increase the number of consumers and the hiring out of motors and other accessories for the development of their power department, so the large power companies are experiencing the need of a somewhat similar method in their case. We have recently been informed that the Lancashire Electric Power Company have inaugurated a special branch with the object of hiring out apparatus to new consumers on the hire-purchase system, so as to develop their business in the large area over which they have the right to supply power. A would-be consumer of power is faced with a heavy charge for installing electric motors, and, at the same time, he frequently has still to bear the standing charges on the engine and boilers which have previously furnished him with the power required in his factory. Consequently, the initial expense attendant upon the purchase of motors is often the deterrent which militates against a change of driving system to the electric on the part of manufacturers. The hire-purchase system now being organised in Lancashire will, however, largely dispose of this obstacle. The saving in annual cost from the use of electric power will soon wipe out the hire charge, and the payment for the apparatus being spread over a number of years becomes less onerous. We understand that this system is already having a good effect in bringing in business, and that Mr. Philip C. Pope has been appointed engineer-in-charge of the department.

**The Telephone Situation.**—The rumour freely circulated in the daily Press at the end of last week to the effect that the Government had acquired the undertaking of the National Telephone Company, was promptly contradicted by an official communication from the Postmaster-General. It will be remembered that Lord Stanley gave an assurance last session that he would not conclude any such agreement before Parliament had had an opportunity of considering the terms. The following passage in the official disclaimer suggests, however, that a pronouncement from his lordship is to be expected on the reassembling of Parliament: "The negotiations between the Government and the company are not yet concluded, and in any case no announcement on the subject will be made till Parliament meets." The rumour speedily reflected itself on 'Change, though a financial contemporary suggests it was just as likely that the reverse was the case, and that a rather unusual amount of buying early on Friday last may have prompted the rumour. Whatever the cause, the deferred stock gained 11 points in a day, receding five points on Lord Stanley's announcement, which, by the way, does not preclude the possibility of a conditional understanding having

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been arrived at. A suggestion has gained currency that the company may be transformed into an authorised Government agency, the country becoming proprietors of the company's undertaking—and of its liabilities—while the company would conduct the service in return for a share in the net profits. In any case, it is to be hoped that Lord Stanley will make a definite announcement in regard to the Government's policy early in the new session.

**North-Eastern Railway Company.**—For some weeks past there has been friction between the company and the holders of first-class season tickets on the electrified section. This culminated in a meeting of the aggrieved passengers at Newcastle on Monday, when the services of a duke — his Grace of Northumberland — were enlisted as president. In the end the ticket-holders resolved, like the telephone users of Paris, to constitute themselves into a protection association. The company have sought to amalgamate the classes on the electric trains, and have inserted a clause in the first-class contract tickets that passengers may travel first class only when accommodation is provided. At present the accommodation is alleged to be inadequate, overcrowding general, and the number of conductors insufficient. One of the speakers said that first-class season-ticket holders were compelled to travel with drunken men, who used objectionable language and spat on the floors. The Duke of Northumberland, referring to a notice just issued by the company that the limited supply of first-class carriages did not apply to main lines, became scathing in his criticism. The company, he said, knew better than to act in such a manner where main lines were concerned, because they came into competition with other railways. A series of resolutions embodying the complaints was duly carried. One can sympathise with the company in their desire to have a uniform class of compartment, but the demand for first-class accommodation on this line appears to be decidedly strong. A little while back, if we recollect aright, the company made a provisional promise to the first-class season-ticket holders. Would it not be as well if a definite statement of policy were now made?

**Faraday House.**—The January issue of the *Journal*, which will probably be the last number in its present form, opens with some entertaining paragraphs, and Faradians contribute articles upon "The Artificial Lighting of Picture Galleries," "The Electrical Engineers, R.E.V." (illustrated), and "The Best System of Alternating-Current Traction for Long-Distance Lines" (illustrated). There is a portrait and biographical notice of Mr. Robert Hammond, an account of the litigation over the "ancient lights" question (from which the society emerged successfully two or three weeks ago), and some miscellaneous features. In his notes on the lighting of picture galleries, Mr. W. T. Wheeler says that, although the acetylene gas light is hard to beat, preference must be given to the incandescent electric light on account of its all-round convenience. He considers it desirable to over-run the lamps, or to use high-efficiency lamps, owing to the better quality of the light obtained for this special purpose. For large pictures Mr. Wheeler advocates Nernst lamps, and in his conclusions he emphasises the point that in a picture gallery the light should illuminate the pictures, not the spectators. The article on the Electrical Engineers traces the progress of the corps from its first commanding officer, the late Dr. John Hopkinson, up to the present time, and there are several excellent photographs. In his paper on "The Best System of Alternating-Current Traction for Long-Distance Lines," which was awarded the prize for third-year students, Mr. H. W. Swann sums up favourably to the Winter-Eichberg repulsion series motor, pointing out, however, that it would be premature to deliver a definite pronouncement. It will be seen that the final issue of the present publication lacks nothing in interest.

**More Rapid Telegraphy.**—The high-speed telegraph system just devised by Messrs. Siemens and Halske requires only one wire for the transmission and reception of messages. Another advantage is that the receiving apparatus prints the message in plain printed characters. In the first place the messages are written on a typewriter, which, instead of printing letters, perforates holes in a paper ribbon. This ribbon is then inserted into a transmitter which reproduces the perforated dispatch at its destination. A disc with trans parent letters revolves in front of the ribbon perforated at the receiving station, and by means of a small electric lamp each letter, on which the electric light shines through the perforations, is photographed on a ribbon of sensitive paper. A special paper has been invented for photographing the messages. This goes on at the rate of about 2,000 letters per minute. It will be seen that the system is almost a photographic equivalent of the tape machine so familiar in clubhouses. In case of a lengthy dispatch several typewriters are employed in perforating the messages. It is proposed to set up perforation writers with ordinary typewriter keyboards in various offices, so that messages can be handed in ready for transmission. In dispatching messages through various stations, it is only necessary to use the perforated ribbon received on the fresh transmitter, a great saving of time being thus effected. It is reported that the system has been tried with success over the Government wire between Konigsberg and Berlin—a distance of over 500 miles. The inventors of the Pollok-Virag system desired to exploit their apparatus here because there was not sufficient work for it to do in their own country, and it seems as though the Siemens and Halske method also will only be used to its full capacity between large commercial centres.

**Iron and Steel Institute.**—The following circular has been issued by the council with regard to the Andrew Carnegie research scholarship: "A research scholarship or scholarships, of such value as may appear expedient to the council of the Iron and Steel Institute from time to time founded by Mr. Andrew Carnegie (president), who has presented to the Iron and Steel Institute 64 1,000dol. Pittsburg, Bessemer, and Lake Erie Railroad Company 5 per cent. debenture bonds for the purpose, will be awarded annually, irrespective of sex or nationality, on the recommendation of the council of the institute. Candidates, who must be under 35 years of age, must apply on a special form before the end of February to the secretary of the institute. The object of this scheme of scholarships is not to facilitate ordinary collegiate studies, but to enable students who have passed through a college curriculum or have been trained in industrial establishments to conduct researches in the metallurgy of iron and steel and allied subjects, with the view of aiding its advance or its application to industry. There is no restriction as to the place of research which may be selected, whether university, technical school, or works, provided it be properly equipped for the prosecution of metallurgical investigations. The appointment to a scholarship shall be for one year, but the council may at their discretion renew the scholarship for a further period instead of proceeding to a new election. The results of the research shall be communicated to the Iron and Steel Institute in the form of a paper to be submitted to the annual general meeting of members, and if the council consider the paper to be of sufficient merit, the Andrew Carnegie gold medal shall be awarded to its author. Should the paper in any year not be of sufficient merit, the medal will not be awarded in that year."

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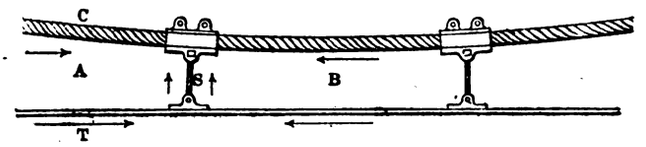
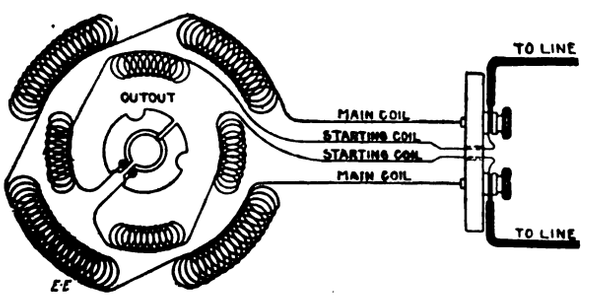
**An Alternating-Current Rectifying Effect.**—A recent issue of the *Electrical World* contains a letter from Mr. I. D. Paton containing the remarkable proposition that a direct current flows between a copper trolley wire and its steel suspension cable when both are employed in parallel with alternating-current railway motors. In Section A of the accompanying diagram the current is flowing from left to right. Mr. Paton states that by virtue of the inductance of C there will be a lag in the rise of E.M.F. to a maximum relative to that in T for equal distances between the point of application and the withdrawal of energy, so that there will be a balancing current from T through S. The balance will occur when the E.M.F. crosses the zero line.



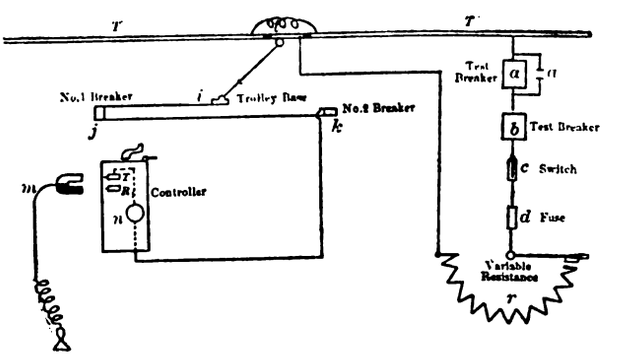

Similarly, in case B, where the current is flowing in the reverse direction, the same action takes place, and a balancing current will again flow from the copper trolley up the suspenders to the cable. As both the steel suspension cable and the copper trolley wire carry alternating currents in parallel, it is not obvious why a rectified current should flow through any of the suspension ears. Although the different resistance and greater inductance of the steel cable, as compared with the copper trolley wire, would cause a delay in phase with respect to the current in the trolley wire, this difference in phase does not seem to involve any interchange of current, and if interchange of current took place, it would be an alternating current. The difference in the metals presents a number of secondary possibilities, such as thermo-electric action, but we echo the suggestion of our contemporary that their correspondent should make some measurements of the alleged rectified currents so as to elucidate this interesting phenomenon.

**Single-Phase Induction Motor.**—A new type of small automatic starting induction motor has been put on the market by the Emerson Electric Manufacturing Company, of St. Louis, a description of which appears in the *Western Electrician* of Chicago. The sizes range from $\frac{1}{10}$ h.p. to $\frac{1}{60}$ h.p., on 60-cycle current, with speeds of from 1,150 to 1,800 revolutions per minute. A feature of them is the limited




space required. While they have less radiating surface than those hitherto made by this company, they are guaranteed to carry full rated loads without injurious heating. They operate at a constant speed, which cannot be changed. Speed is dependent upon the number of field poles in the winding and the frequency of the current—*e.g.*, a four-pole motor will operate on 7,200 alternations (60 cycles) at a speed closely approaching 1,800 revolutions per minute. The motors are not designed to start under any great proportion of full rated load. They are constructed with a patented divided-pole form of field winding, comprising an equal number of main and auxiliary or phase coils. The latter, which are used for starting, are entirely independent of the main field coils, and are in circuit with the line only when the motor is starting. As shown in the illustration, they are controlled by an internal automatic switch, which disconnects them after the motor has attained sufficient speed. The armature is of the squirrel-cage type, and has no insulated winding at all. In the binding post arrangement the main field coils are connected in series, and the leads are attached to the binding posts inside the motor. The starting coils are connected in series with the automatic cut-out, and these leads are brought out through the binding-post block and connected to the binding posts outside. The motor may be readily reversed by changing these leads to opposite binding posts. These motors operate satisfactorily on current exceeding their rating by not more than 10 per cent.

**Testing Car Circuit Breakers.**—A simple method of rapidly testing a car circuit-breaker adjustment is the subject of an article in the *Street Railway Review* by Mr. E. C. Parham. Assume that the house service trolley wire, denoted as T' T' in the accompanying diagram, has a short length insulated from it by line breakers on both ends Circuit breakers, *a*, *b*, in series with each other, are likewise in series with switch, *c*, fuse, *d*, and variable resistance *r*, which may be a water rheostat. Breaker *a* has a pair of contacts which close the circuit after it has been momentarily opened, the object being to obviate the loss of time consequent upon reclosing the breaker by hand.




When all breakers, switches, and fuses through the test path are closed, the short insulated section is alive, so that if the trolley wheel of a car bears up against this section, and one of its controllers is advanced to an operating notch the car will take current through its normal working circuit and tend to start. To obviate this the author employs the forked device, *m*, of which the unshaded tongue is made of flat copper, and the shaded tongue of hard flat insulation, and which terminates on a flexible lead grounded to a track rail, with the result that the current cannot reach the motor circuit as long as the controller is not advanced beyond the first notch. Taking the standard adjustment of the car breakers for the purpose of calibrating the test circuit as 200 amperes, breaker *a* is adjusted, by means of an ammeter and the variable resistance, *r*, to operate at about 190 amperes, and breaker *b* about 210 amperes, the margin being corrected later after experience. A car is located so that its trolley wheel rests on the insulated section, and the controller nearest the car breaker to be tested is advanced to the first notch, and the forked contact, *m*, placed under controller fingers, T and $R_1$. The test breakers are then closed and the rheostat operated to gradually increase the current until one of the breakers acts. If breaker *a* operates first, it is an indication that 190 amperes are insufficient. If the car breaker under test operates next, it becomes certain that its adjustment lies between 190 and 210 amperes, which would be considered a good condition. If breaker *b* acts before the car breaker, the adjustment of the latter needs a greater current than 210 amperes, entailing a slacking off of the breaker adjusting screw. Operation of

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the car breaker before breaker *a* would show the former to be adjusted for too low a current, impeding the operation of the car. It will be seen that, in general, a breaker which operates between *a* and *b* is safe.

**The American Institute.**—We have received a copy of this society's *Transactions* for December, which contains papers on "Heavy Electric Traction" and "The Maximum Distance to which Power can be Economically Transmitted," by Messrs. O. S. Lyford, jun., and Ralph D. Mershon respectively. In the latter paper the author rests his calculations upon the present condition of electrical science, which he acknowledges may prove a doubtful basis. He hints at the possibility of devising some better mode of transmission, "not involving the use of lines," and considers it not improbable that skill and experience will eventually so modify methods of construction as to greatly affect his present conclusions. Besides this, industrial and financial conditions may undergo a change favourable to electrical engineering. In his present calculations the maximum amount of power dealt with is 500,000 kw., which he states is probably too high to be seriously considered to-day, but he gives 200,000 kw. to 300,000 kw. as within the range of immediate future possibility. On these figures he gives the maximum distance for the present outlook as about 550 miles. The limit, he finds, is fixed, not by physical, but by economic, conditions. Thus, "all the elements in the annual cost per kilowatt for transmitting power, except those dependent upon the line conductors, may be continually reduced by increasing the amount of power to be transmitted. The annual cost per kilowatt due to the line conductors cannot be so reduced. It can be determined only by such other means as will reduce the first cost of the conductors. As the first cost of the line conductors can be reduced only by increasing the voltage of transmission, and as there is a limit to which increase can be carried, it follows that *the limiting distance to which power can be economically transmitted will depend, finally, upon the cost of the line conductors and upon this alone.*" The author found to his surprise that the limit of voltage is also governed, not by atmospheric losses, but by economic conditions; but he predicts that when the demand comes for units of the large capacities contemplated, voltages greatly in excess of those now used will be practicable, larger transformers facilitating construction for this purpose. The issue also contains the discussion on "The Telautograph" and "The Transposition of Electrical Conductors."

**Institution of Civil Engineers.**—A large audience assembled in Great George-street to hear Sir William White's account of the American tour undertaken by the institution last year during his term of office. Sir William White prepared his paper at the express wish of the president and council, who desired that the *Proceedings* should contain a record of a visit paid to America for the first time in the history of the institution by a representative body of its members. The party mustered in New York to the number of 72, exclusive of many ladies, and had to face a hard month's work in order to fulfil numerous engagements at places far distant from each other, and to inspect many important works The first reception of the party by the American Society took place on Sept. 13. A notable feature of the gathering was the presence of Mr. Charles Haswell, the "father" of living engineers, who is in his ninety-seventh year. He was the first engineer-in-chief to the United States navy, more than 60 years ago. Sir William referred to the engineering achievements of Greater New York, embracing bridges, tunnels, trains, trams, deep-water approaches to the harbour, berths and warehouses for shipping, great steam ferries plying across the noble rivers, telegraphs and telephones, "sky-scrapers," water supply, and great sewage systems. The new rapid-transit subway was duly inspected. Sir William remarked that the opportunity of inspecting a number of the largest high buildings was the more valuable in view of the growing adoption of steel structures for building purposes in this country, and it was satisfactory to note that in the production of special sections of steel joists and girders suitable for such buildings the most recently designed British steelworks compared favourably with those of the United States. In both countries built-up sections were giving place to rolled sections, and in both countries H-shaped joists up to 2ft. in depth were now obtainable in the greatest lengths required for buildings. He found the spectacle presented by the sky-scrapers from the harbour of New York remarkable and interesting, but, in spite of their advantages in concentrating business, he was personally not desirous of seeing a similar group of buildings in any city of Great Britain. In Chicago, the birthplace of the sky-scraper, a law had been passed limiting the height of new buildings to 150ft., and that example would probably be followed elsewhere. On Sept. 19 the party left New York by special train for Montreal, whence they went to Quebec, Ottawa, Toronto, and Niagara. No engineer visiting Canada, said Sir William, could fail to be impressed by the enterprise and courage with which the Government and private associations were facing great schemes for the development of the Dominion's resources—the construction of a new transcontinental railway, the fuller utilisation of numerous sources of water power for electrical purposes, and the improvement of the waterways between the great lakes and the Atlantic. The party were enabled to see some examples of the most characteristic features in these developments. At Quebec they saw the works in progress for the new railway bridge, to be constructed on the cantilever principle, with a channel span of 1,800ft. (100ft more than the Forth Bridge), containing a suspended span of 675ft. and two cantilever spans each of 562½ft. They visited the Soulanges Canal, the electrical equipment of which was described in our last week's issue. Many opportunities were afforded to see examples of the utilisation of water power, and no one could fail to realise the enormous possibilities of development in the pulp and paper industry, with cheap power and a good supply of labour. At Niagara, on the Canadian side, three new undertakings were being rapidly advanced, together giving over 400,000 h.p., while a fourth would yield 40,000 h.p. When these were completed the grand total of power derived from Niagara on both sides of the river would be about 700,000 h.p. Sir William paused to lament that two of the three big undertakings on the Canadian side were practically due to American capital and enterprise. Subsequently the party arrived at St. Louis, and attended the International Engineering Congress. In conclusion, Sir William remarked that this visit would undoubtedly be of benefit to British engineering, since it included exceptional opportunities for obtaining particulars of the latest American and Canadian practice. Beyond that, however, the friendly intercourse would tend to strengthen the amiable feeling already existing between the United States and the British Empire, and must result in a better understanding between the mother country and Canada, whose loyalty to the British Empire was undoubted, and had been established by noble deeds. The development of the Dominion was in an early stage, but those charged with the responsibility of government were fully alive to the grandeur of its resources and its potential greatness. A vote of thanks was accorded to Sir William with acclamation.

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## ELECTRIC TRAMWAYS IN HONG KONG.

Although little more than 60 years have elapsed since the island of Hong Kong became a British possession, its rise in importance, both as a commercial and naval centre in the Far East, has been both rapid and unique. Situated near the mouth of the Canton River, and distant about 90 miles from the ancient Chinese city of Canton, it possesses one of the finest and most beautiful natural harbours in the world. This must have been recognised by the Chinese themselves hundreds of years ago, as the Chinese characters representing the name of the island signify "Good Harbour." The island itself is some 11 miles long and from two to five miles broad, and consists of lofty uncultivated hills. In the younger days of the colony it was considered a most unhealthy place, owing to the virulence of malaria, but to-day the efforts of the Sanitary Board on the one hand and the Afforestation Department on the other have completely altered these characteristics. During the summer months the humidity of the atmosphere renders the heat very trying to Europeans, but from September to March the weather is all that could be desired. The population of Hong Kong is estimated at 284,000, and of these 274,500 are Chinese. Its trade is estimated at £50,000,000 per annum. It has excellent dock accommodation, is strongly fortified, and is the permanent naval base in the Far East.

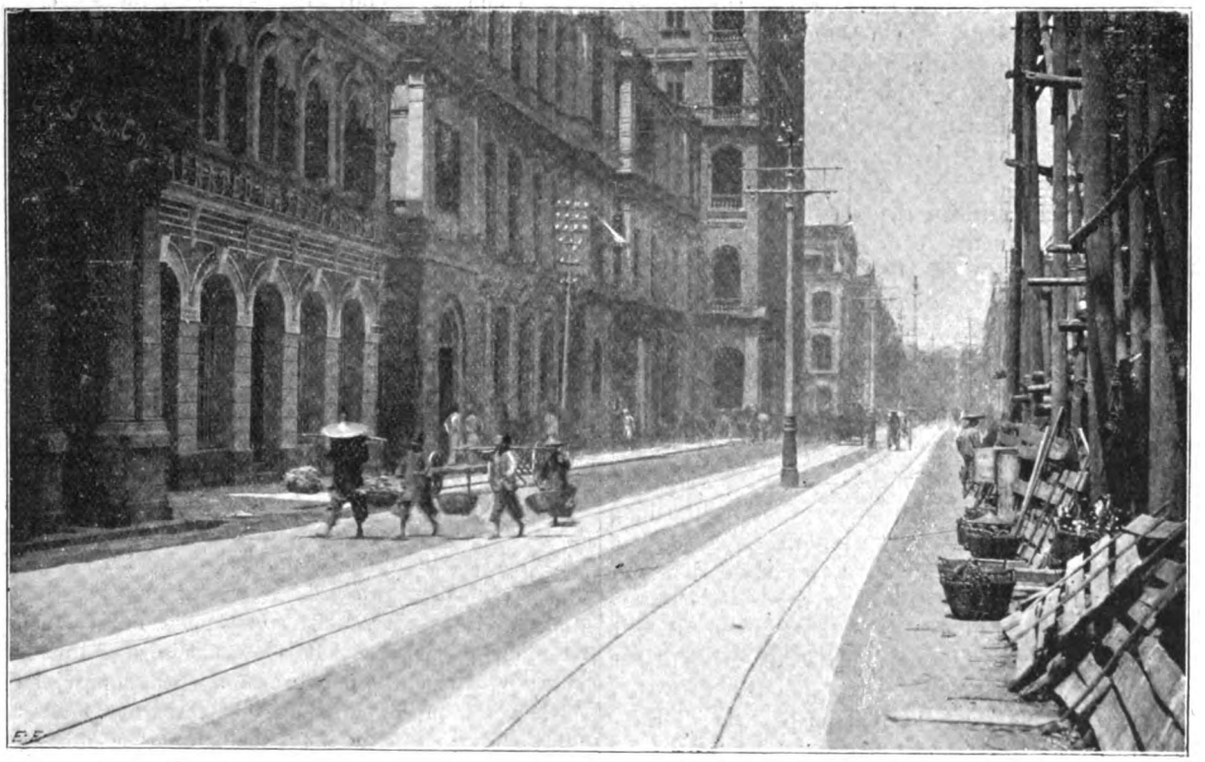

FIG. 1.—View of the Des Voeux Road in Hong Kong, showing Trolley Standards and also the Overhead Lighting Wires.

In 1902 an ordinance was passed by the Legislative Council of Hong Kong authorising the tramways to be laid down by the Hong Kong Tramways Electric Company, an English company with its headquarters in London, and work was commenced in May, 1903, and completed last July. The detailed plans and specifications were prepared by the company's consulting engineers, Messrs. Alfred Dickinson and Co., of Birmingham, who appointed Mr. Harold Hackwood to act as their representative in Hong Kong as resident engineer in charge of the construction. The contractors were Messrs. Dick, Kerr, and Co., of London, who carried out the whole of the work.

The total length of single track is 14½ miles, which is laid in 9¼ miles of route. The track is laid to a gauge of 3ft. 6in., with rails of the girder type, weighing 86lb. per lineal yard. Each rail joint is double bonded with 6/0 S.W.G. copper bonds. The lines within the city are laid for the most part as centre-pole construction (Fig. 1), but the eastern portion of the route being outside the city boundary, is laid as single line with passing places, and is equipped on the side-pole system. With the exception of a short branch line, which runs to the racecourse, the route runs parallel with the water front, and with the exception of a short length at Quarry Bay is practically level. At Quarry Bay a short length of road grading has been done, the original grade of 1 in 10 having been reduced to 1 in 15. Beyond Quarry Bay is the eastern terminus of the line, where is situated the small Chinese village of Shankiwan. Owing to the varying nature of the ground, three forms of permanent-way construction have been adopted. Where the ground was solid the rails were bedded on a concrete beam 18in. wide and 6in. deep; where the ground was not so good a bed of concrete 6in. deep and 7ft. 3in. in width extending under the whole track, and 1ft. 6in. on either side, was adopted. Over doubtful ground, which had been recently reclaimed from the sea, this concrete bed was increased to 8in. in depth. The concrete used was mixed in the proportion of 6 to 1, Portland cement of local manufacture and exceptionally good quality being used. After the rails and the bottom concrete were laid, the road surface was made up to rail level with concrete and finished off with a smooth surface to the proper camber of the road.

The overhead construction has been carried out in a very neat manner, the length of arms on the centre poles (Fig. 1) not exceeding 2ft., while the arms on the side poles vary in length, the majority of them being 6ft. long. The poles are of mild steel, 28ft. 3in. in length, 7in. in diameter at the base, tapering to 4in. in diameter at the top. They are set 6ft. in the ground in a solid block of concrete. Within the city ornamental base castings greatly add to the appearance of the poles, which are still further enhanced by the addition of wrought-iron scrolls on the bracket arms. The trolley wire is divided into half-mile sections by means of section insulators, and at each of these points the main feeder cables are tapped and current is taken to supply each section of trolley wire. This is accomplished by running the feeders through a feeder pillar containing the necessary switches and fuses, the connections from the feeders to the trolley wires being made with rubber-covered $^{37}/_{16}$ cables, carried up inside the poles and along the sides of the bracket arms. The pressure on the trolley wire is 500 volts. A lightning arrester is provided in each feeder pillar, and also a telephone giving direct communication with the power-house. The feeder cables were supplied by the Callender Cable and Construction Company, and laid on the solid system. In addition to the main feeders running east

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and west from the power station, a return $^{37}/_{13}$ booster feeder has been laid in each direction to within a mile of the two distant termini, where it is connected to the rails. It also makes connection with the rails at each feeder pillar.

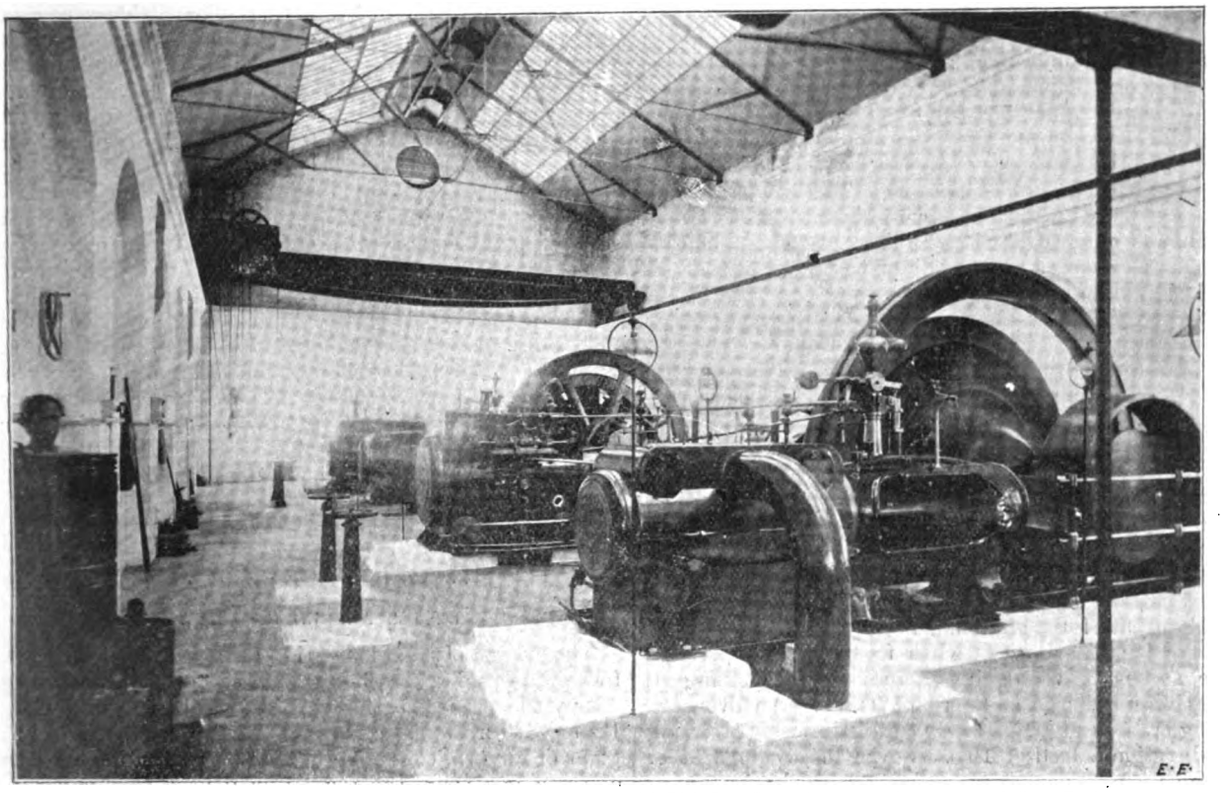

FIG. 2.—The Engine Room of the Hong Kong Tramway Station, with Dick-Kerr Generators coupled to Yates and Thom Engines.

A three-core pilot cable has also been laid from the power station to each terminus, one core being connected up for testing purposes and the remaining two cores being used for telephone service.

the fact that a very few years ago it was reclaimed from the sea, and consequently no good foundation could be obtained for either buildings or machinery. However, as it was the best site obtainable in all other respects, this difficulty had to be overcome, and efficient foundation were obtained by the driving of over 5,000 piles These were spaced so as to support the whole weight of the buildings themselves, the ground (which greatly varied in solidity) being left as an additional factor of safety. China fir poles, 15ft. in length and 5in. in diameter, were used as piles under the buildings and machinery, special 7in. poles, 18ft. in length, being used for the chimney foundations. The depôt comprises engine-room and basement, boiler-house and coal store, car-shed and machine shop, smithy,

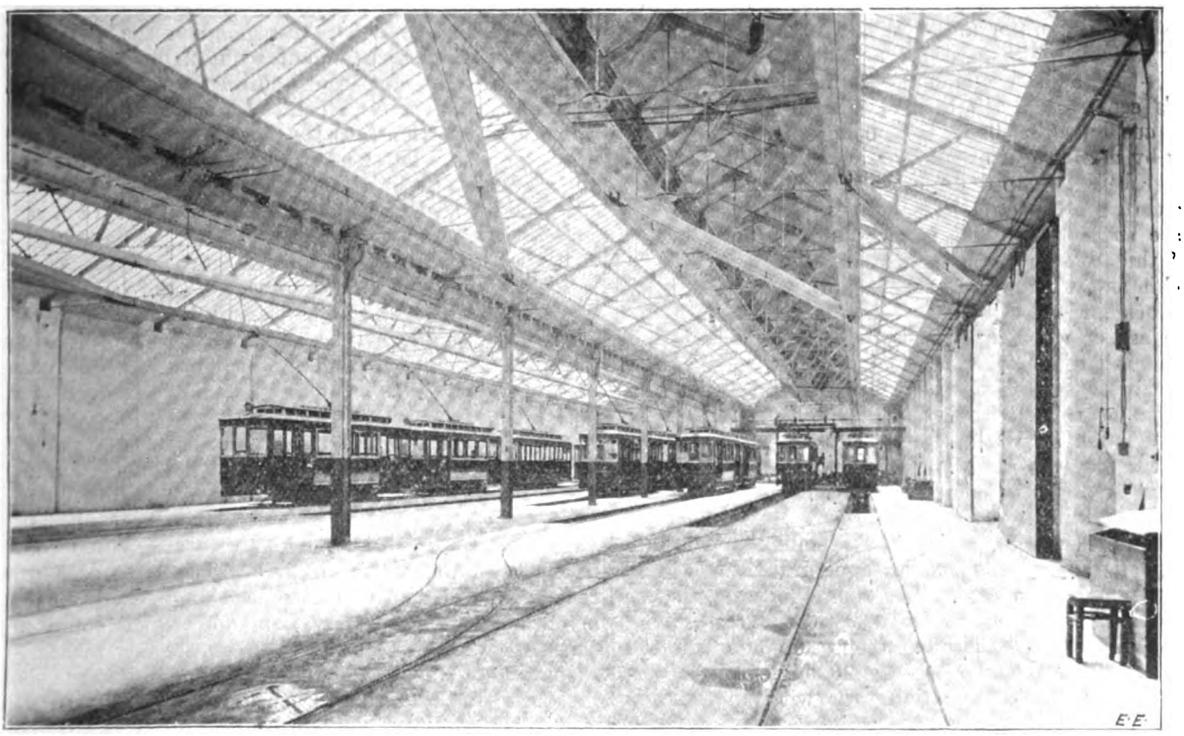

FIG. 3.—The Carshed at Hong Kong.

The generating station is as nearly as possible in the centre of the system, a convenient site having been obtained alongside the Bowrington Canal, from which water for condensing purposes is obtained, and which enables coal and materials to be delivered by barges direct on the site. The only objection which could be found with the site lays in

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paint shop and carpenter's shop, and also offices. The engine-room (Fig. 2), which is lofty and well lighted, contains two Dick-Kerr continuous-current, direct-connected railway generators of the multipolar type, compound wound, giving a potential of 550 volts, and running at 100 revolutions per minute. They are designed to run either separately or in parallel. The generators are keyed direct on to the main shaft of the engines, which are of the horizontal cross-compound type, each engine being equal to a maximum load of 557 b.h.p. The engines, built by Yates and Thom, are each provided with a Wheeler surface condenser of the Admiralty pattern, and may be worked either condensing or non-condensing. The condensers are fixed in the basement below the engine-room, as also are all the steam and other pipes, thus leaving the engine-room free and open. Circulating water is obtained for the condensers from the Bowrington Canal, which is alongside the site, the water first passing through sumps fitted with gratings and strainers to exclude obstructions. In addition to the two traction sets there are two smaller plants for the arc and incandescent lighting of the depôt, one set being driven by a small high-speed engine, and the other by a motor running from the 500-volt circuit. The lighting circuit is supplied at 100 volts pressure. The switchboard, which is of Dick-Kerr's standard type, consists of nine panels. It includes a main station panel, two generator panels, two feeder panels, one Board of Trade panel, and three lighting panels. The main station panel contains recording instruments of the latest pattern, including a recording wattmeter showing the total output of the station. The Board of Trade panel is arranged for receiving test wires from different parts of the line, and is provided with instruments for making all the tests required by the Board of Trade. An overhead travelling crane is provided capable of lifting and traversing in any direction a load of 10 tons over the whole area of the engine-room.

The boiler-house, which is at a lower level than the engine-room, contains two double-drum water-tube boilers, of the Babcock and Wilcox type, arranged to burn ordinary Japanese engine slack. Each boiler has 3,654 square feet of heating surface, evaporates 12,000lb. of water per hour, and works at a pressure of 160lb. per square inch. In addition to the steam and water gauges, each boiler is fitted with a spring safety valve and a dead-weight safety valve. Water is supplied to the boilers by two Blake and Knowles feed pumps, which take water from either the storage tank or the hot-well, and feed the boilers either direct or through a Green's economiser. In case of mishap the economiser may be cut out, the flue gases being conveyed to the chimney by means of a by-pass or auxiliary flue, and the feed water being pumped direct into the boilers without passing through the economiser tubes. Two feed-water filters are supplied, and all water passes through one or other of these before entering the boilers.

The chimney, which is circular, is built of brick, and is 153ft. in height. As Chinese bricklayers are unaccustomed to this class of work, it presented greater difficulties in construction than any other part of the work, and as Hong Kong is subject to typhoons of noted severity, exceptional care had to be taken with both the foundations and the building of the shaft. With the exception of the foundations and the chimney cap, the whole of the brickwork is built in lime mortar of special composition, as is also the brickwork of the buildings.

The car-shed (Fig. 3), which is a rectangular building 220ft. in length, contains six lines of track and gives accommodation for 35 cars. The roof is of iron, in two spans, partly glazed and provided with louvres, giving plenty of light and ventilation. Inspection pits run the whole length of the shed. There are 26 single-deck motor-cars, 10 being of the combination type with an enclosed portion in the centre and an open platform provided with seats at either end. The remaining 16 cars are of the open cross-bench type. The over-all length of the cars is 29ft., the total width is 6ft. 6in., and the wheel base 6ft. 6in. The combination car has a seating capacity for 32 passengers, and the cross-bench cars for 48 passengers. Each car is mounted on a truck of the Brill type, and is equipped with Dick-Kerr 25A motors, and the standard metallic shield blow-out controllers and the usual hand brakes. The trolleys, which are of the lateral type and provided with a swivel head, are 16ft. 6in. in length, and enable the trolley wire to be fixed 10ft. away from the centre of the track where necessary. The car bodies were built at Preston by the Electric Railway and Tramway Carriage Company, and were shipped to Hong Kong in sections, where they were fitted together and connected up in a very short space of time. At one end of the car-shed is a well-equipped workshop, containing screw-cutting gap lathe, wheel lathe, wheel press, and drilling machines, the whole being driven by a 500-volt motor. A suitable smithy, carpenters' shop, and paint shop are also provided.

Before the introduction of electric traction into Hong Kong the popular ricksha drawn by a Chinese coolie was the principal means of locomotion, and of these nearly 2,000 were licensed for hire, in addition to a large number owned privately. Although rather slow, the ricksha is hard to beat for general convenience; the fight for supremacy between the out-of-date ricksha and the new electric car will be of interest, but must of necessity end in the victory of the latter. As this is the pioneer system of electric traction in China, it is to be hoped the venture will meet with a well-deserved success, and that electrically-equipped lines will shortly be laid in other parts of the Celestial Empire by English contractors.

## THE ELECTRIC LIGHTING OF RAILWAY TRAINS.

BY DR. ALFRED GRADENWITZ.

The system of electric lighting for trains described in the following was designed by Mr. Aichele, and is being brought out by the Aktien-Gesellschaft Brown, Boveri, und Co., of Baden, Switzerland. In this system each car has a lighting plant of its own, consisting of a dynamo, a storage battery of some few cells, the regulation device, conductors, and lamps. This will greatly increase the value of this system, which may be applied both to ordinary and express trains, as well as to international through trains on the one hand and mixed trains on the other. Only the conductors and lamps are arranged inside the cars, while the remaining parts (any one of which is self-contained and interchangeable) are located outside the wagon on the truck, so as to be easily accessible (see Fig. 1).

The dynamo, which is suspended in the middle of the truck, is a shunt machine of about 2 h.p., being enclosed in a dust-tight cast-iron housing, and driven from one axle of the wagon by a belt. Its speed will thus, in any case, be proportional to the speed of the train. On the direction of the latter being reversed, its poles are changed automatically by shifting the brushes on the commutator. The storage battery includes 9 or 2 × 9 cells of a capacity of about 140 ampere-hours, corresponding to a lamp voltage of 18 or 36 volts. The system may, however, as well be designed for any desired number of cells, and any voltage at the terminals of the lamp. Each set of nine cells is located in a box, and so as to be accessible at any time. They do not, however, supply current except at very low speeds of the train, as obtaining immediately before and after stoppages, and when standing in the stations themselves. The capacity of the cells may therefore be very small as compared with the output of the plant. Throughout the remainder of the run they receive charging current of an intensity that is independent of the speed of the train, while adapting itself automatically to the actual condition of charge of the storage battery. The latter, accordingly, remains permanently under working conditions most favourable for its preservation, and which could not be excelled even in the best of stationary plants. This regulation of the charging current according to the speed of the train and the charging conditions of the battery, as well as the connecting and disconnecting of the dynamo, is effected automatically by an extremely precise and reliable regulation device, which at the same time adjusts the voltage at the lamp terminal so as to prevent any increase in voltage resulting from the charging current. As a consequence of this, the lighting will not undergo any appreciable variation, either on the speed of the train being varied or on the passage of the train from the station to the track, and *vice versâ*. This regulator, which is fitted in a small

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iron casing, may be either located outside on the truck, as shown in Fig. 1, or inside in the coach.

The internal arrangement of the apparatus is shown in Fig. 2, the essential parts being the switching apparatus, C,

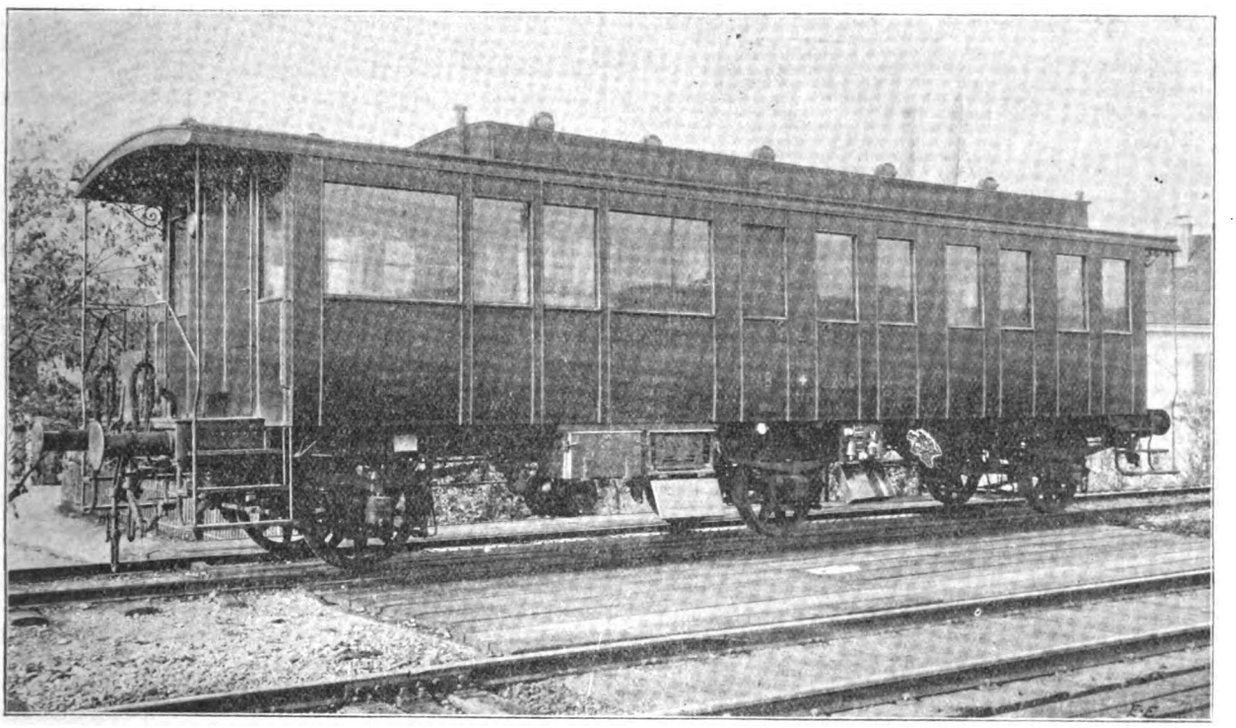

FIG. 1.—First and Second Class Passenger Car with Train-Lighting Outfit (apparatus below the car).

and the regulating motor, R. The latter consists of a bell-shaped electromagnet, including two independent coils—one of thin wire, which is permanently connected to the terminals of the dynamo, and one of thick wire, which is traversed by the machine current. If, under the magnetising action of these coils, the core of the apparatus be lifted, some fork-shaped copper springs, which are attached to the upper end of the core, will touch an opposite metal plate, thus completing the connection between the dynamo and battery. By a plate spring located sideways below these copper springs on the core of the apparatus there will be closed at the same time a second circuit serving for the purpose of regulation, as seen from the following. The core of the

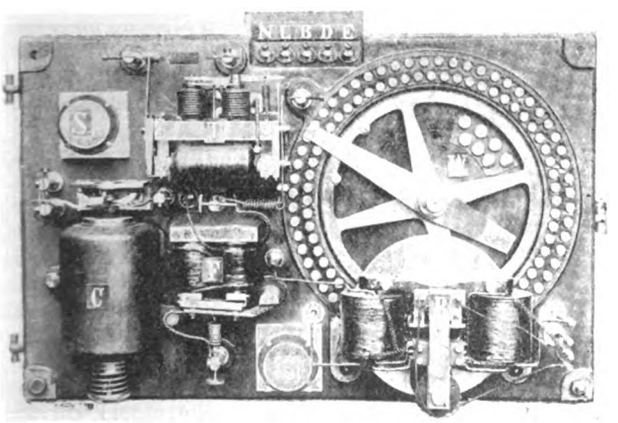

FIG. 2.—View of Regulation Apparatus, first design.

apparatus is raised under the influence of the thin wire coil, *a*, connected to the terminals of the dynamo (see diagram of connections, Fig. 3) or of the apparatus, C, as soon as the train exceeds a speed of about 15 miles per hour, when the voltage at the terminals of the dynamo has reached the battery voltage. The connection between the dynamo and the battery will accordingly be effected without any sparking, thus ensuring a permanent preservation of the contact points. On the speed of the train being further increased, the battery will begin to be traversed by the charging current, passing through the second coil, *b*, of the switching apparatus, C, where it acts in the same way as the current in the coil, *a*, thus securing the automatic adjustment of the shunt regulation resistance of the dynamo which controls the current supplied by the latter. To this effect a small toothed wheel mounted on the motor axle is made to engage with a smaller one that is connected to the lever, H, of the shunt regulating resistance of the dynamo. On the armature being rotated (which occurs at slow speeds only while the regulation is being effected) the lever, H, will slide on the circular resistance contacts, these movements being damped by an aluminium disc mounted on the motor shaft and located in the field of an electromagnet.

The motor magnets bear three independent exciting coils, marked I., II., and III. respectively in Fig. 3. As long as there are no lamps switched in, the coil I., traversed by the machine current, and III., which is applied to the battery terminals, will work simultaneously. If any lamps are thrown in, the coil III. will be replaced by the coil II., which is traversed by the lighting current, so that the coils I. and II. now work simultaneously. Under the action of I. the lever, H, will be displaced so as to effect an increase, and under the action of II. or III. a diminution of the resistance in the exciting circuit of the dynamo. In both of these cases the lever, H, will thus be adjusted under the influence of two magnet coils of the regulation motor, acting in opposite rotary directions, so as to weaken the excitation of the dynamo as soon as the effect of the coil I. traversed by the machine current becomes the stronger, on account, for instance, of an increase in the speed of the train. The lever, H, will then slide on the contacts of the shunt regulation resistance, E, as the speed of the train increases until the effect of the coil I. corresponds accurately to the effect of the coils II. or III., thus balancing the latter. If this state of equilibrium is attained, the motor will remain at rest until, on account, for instance, of a decrease in speed, the equilibrium of the two magnetising coils of the motor is once more disturbed, when the motor, under the influence of the now prevailing coil II. or III., turns the lever at the regulation resistance in an opposite direction, so as to increase the excitation of the dynamo, until the charging current traversing the coil I. has returned to its previous value, thus re-establishing the equilibrium between the coils I. and the antagonistic coil. This arrangement will thus regulate the machine current, and accordingly the charging current, with any speed of the train, so as to cause the coil I. traversed by the same to exert an effect

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which always accurately corresponds to the effect of the coil III. or the coil II. By applying to the coil III. the voltage of the battery, there is thus obtained, in the first case, a regulation to constant intensity of the charging current, while, in the second case, by causing the lighting current to traverse the coil II. the charging current is adjusted automatically in accordance with the lighting current, and at the same time the increase or decrease of the latter charging current is regulated by increasing or decreasing by steps the effect of the coil II. (traversed by the lighting current), through a gradual modification of a resistance inserted in parallel. To this effect, the contacts of the resistance, W, connected in parallel to the coil, are so arranged as to be touched by the lever, H, on its first or last movement, thus increasing or decreasing gradually the resistance, W. In a similar way the two electromagnets, F and T, throw the coils II. or III. out of action, partly or completely, thus effecting an adjustment of the regulation apparatus to a very small charging current.

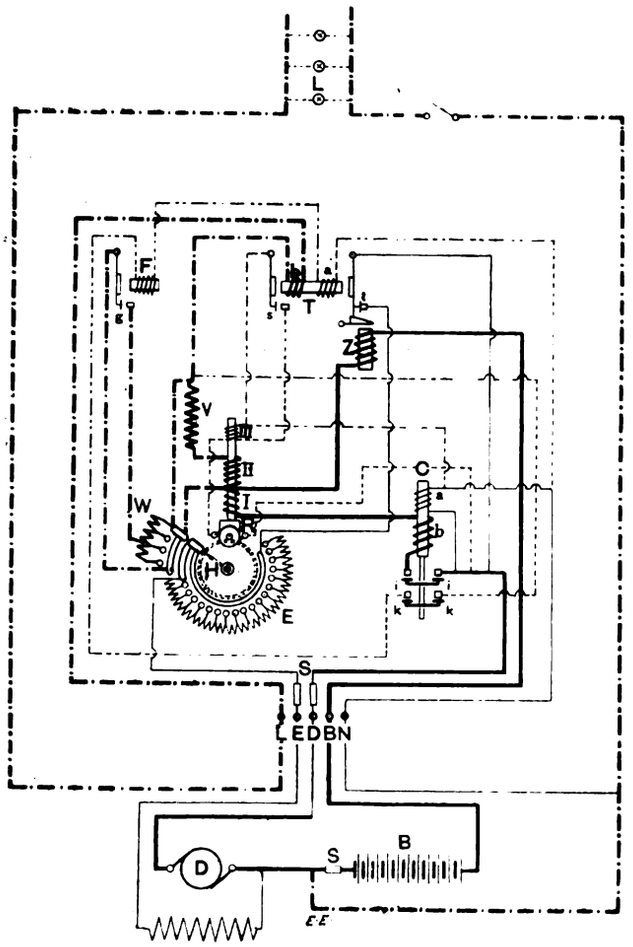


FIG. 3.—Diagram of Connections.

In addition to the above appliances, the housing of the regulation apparatus contains two safety fuses for the main and shunt circuits of the dynamo respectively, as well as a device for automatically interrupting the excitation circuit of the latter. The purpose this device is intended for, as well as the common working of the remaining parts (already alluded to) of the regulation mechanism, will be seen from the following: During the stoppage of the train the connections between the dynamo and the battery, B, will be interrupted in the switching apparatus at *i i* (Fig. 3), when the lamps derive their current from the accumulator battery. The lever, H, has been placed during the preceding stoppage of the train, owing to the action of the coils II. (traversed by the lighting current), on the magnet of the electromotor, R, in the extreme position shown in Fig. 3, where the shunt regulation resistance and the coil II., inserted in the lighting circuit, as well as the shunt resistance, V, before the lamps, are short-circuited. The lighting current will, therefore, in the beginning exert no magnetising effect on the magnets of the electromotor, R, the lamps being applied to the battery terminals without any shunt resistance. The relay, T, having attracted its armature under the influence of the coil *b*, traversed by the lighting current, the contact will be completed, and the coil III. will be out of action.

On the train starting there will, as soon as the speed of the dynamo has become sufficiently increased, a dynamo voltage equalling the voltage obtaining at the terminals of the battery, when the magnetising effect of the coil *a* in the switching apparatus, C (which is being permanently applied to the terminals of the dynamo), suffices to lift the core of the apparatus, thus completing the connection between the dynamo and battery. The corresponding speed of the train is about 15 miles per hour. If the speed increases further, the tension at the terminals of the current generator will be augmented so that the battery is traversed by a charging current. This current, traversing the coil *b* of the switching apparatus, C, will act there in the same sense as the current in the coil *a*, that is to say, will secure the connection between the dynamo and battery that has been effected by this coil. In addition, the charging current will, however, traverse the magnetising coil I. of the electromotor magnet, turning the lever, H, from the extreme position to the nearest contact of the resistance, W. Instead of the short-circuit, part of the resistance, W, will now be placed in parallel to the coil II. and the shunt resistance, V, when part of the lighting current traverses the coil II., which by its magnetising effect balances the coil I. traversed by the charging current, so that the lever is stopped in this position, until on account of the increasing speed of the train the effect of the machine current in

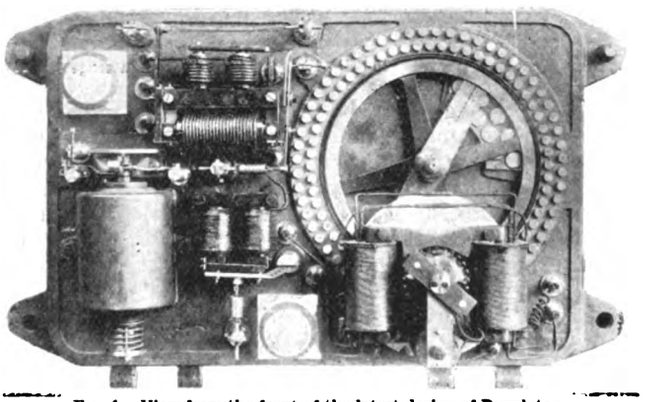

FIG. 4.—View from the front of the latest design of Regulator.

the coil I. becomes stronger. Then the lever, H, turns on to the second contact of the resistance, W, thus altering once more the distribution of the lighting current in the two parallel branches so that the portion traversing the coil II. and the shunt resistance, V, becomes greater and compensates for some moments the machine current traversing the coil I. The lever, H, will thus stop also in this second position for some moments until the machine current becomes sufficient to move it on. During the increase of the charging current the lever, H, thus slides slowly over the various contacts of the resistance, W, while the portion connected in parallel to the coil II. and the shunt resistance, V, increases continually until it becomes infinite, when the lever, H, has left the contacts of W. The shunt resistance connected to the lamp, and which consists of two parallel branches (coil II. and shunt resistance, V, on one side and inserted portion of resistance, W, on the other) will thus be increased by steps which are adjusted automatically according to the actual intensity of the increasing charging current. The fall in voltage undergone by the fixed lighting current in this variable combined resistance thus corresponds at any moment to the increase in voltage at the battery terminals, due on one side to the disappearance of the discharging current, and on the other to the increase of the charging current. The charging current is thus thrown in and augmented without any oscillation in the luminous intensity of the lamps, though the same battery be simultaneously applied to the lamps and connected to the dynamo. After the lever, H, has left the contacts of the resistance, W, on the train being further accelerated, the full amount of lighting current will traverse the coil II. The adjustment of the lever is effected by the simultaneous

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action of the two antagonistic coils, I. and II., which are traversed by the machine and lighting current respectively. The zero position of the lever with the various speeds of the train corresponds always to an intensity of the charging current that bears a constant ratio to the intensity of the lighting current. The former will, therefore, undergo an alteration only in the case of the number of lamps inserted being altered, increasing and falling along with the lighting current.

Some important advantages in operation are due to this arrangement. The fall in voltage produced by the lighting current in the shunt resistance connected to the lamps will always be accurately compensated for by the increase in voltage produced by the charging current at the terminals of the battery, so that in the present system, in opposition to other schemes, the lamps can be switched off or in at will without having to be replaced by compensation resistances to keep the voltage at the remaining lamps constant. For the same reason, there will on a lamp burning out be no increase in voltage on the remaining lamps. At the same time, however, there is obtained an operation as economical as possible, as any losses of energy in compensation resistances are avoided. The ratio of the number of turns in the two coils I. and II. is so designed that the charging current traversing the battery remains in any case below the admissible limit. Especially in express trains which traverse great distances without any stoppages, the battery will frequently approach a completely charged

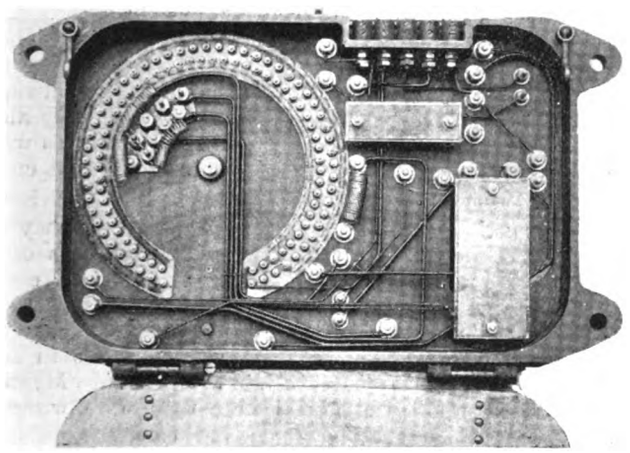

FIG. 5.—Back View of Regulator of the latest design.

condition. When under the influence of the increasing charging voltage, the electromagnet, F, will attract its armature, inserting, in virtue of the contact, *g*, part of the resistance, W, which is connected in parallel to the coil II., when the latter is no more traversed by the full amount of lighting current, but only by part of the same, so that the current in the coil I. of the magnitude of the lighting current suffices to compensate the magnetising effect of the coil II. The lever, H, accordingly moves into a zero position corresponding to these conditions, while the coil I. is traversed only by the lighting current supplied from the dynamo, the battery receiving no charging current, so that its voltage decreases This alteration will, however, not be felt in the lamps, as by the insertion of the resistance, W, the total resistance connected to the lamps has undergone a corresponding diminution. The increase in voltage obtaining in the last stage of charging at the terminals of the accumulators will thus not be felt in the lamps, while at the same time any regular overload on the battery is avoided. Should any decrease in battery voltage be produced on account of the current supplied from the accumulators in the station, the electromagnet, F, would release its armature, thus opening the contact, *g*, of the resistance, W, so that in the subsequent journey there is an instantaneous charge of the battery with a corresponding increase in the shunt resistance connected to the lamps.

In case the running speed decreases, the electromagnet would, under the magnetising influence of the constant lighting current, first move the lever, H, into positions corresponding to the smaller resistances in the shunt circuit of the dynamo, until the lever, H, has reached the contacts of the resistance, W, when the resistance is connected in parallel to the coil II., and the shunt resistance, V, so that the same process as on the starting of the train occurs in an inverse order—namely, a slow decrease of the charging current occurring by steps and being accompanied by a step-by-step diminution of the shunt resistance connected to the lamp. The charging current will have disappeared completely after the lever has returned to the first contact of W, when in the switching apparatus there will only be left the attracting effect of the coil *a*, which just suffices to maintain the core of the apparatus in the attracted position. The voltage of the dynamo has again reached the value with which the core of the switching apparatus, C, was attracted, thus being equal to the accumulator voltage. In the subsequent moment the dynamo voltage will, on account of the further decrease in the speed of the train, fall below the voltage of the accumulator battery, the core of the switching apparatus, C, dropping so as to discontinue the connection between the dynamo and battery. This decrease in the charging current and break in the connection between the dynamo and battery occurs without the luminous intensity being altered to any appreciable degree. During the lighting period the battery thus receives charging current as soon as its state has become different from the condition of perfect charging, while at the same time,

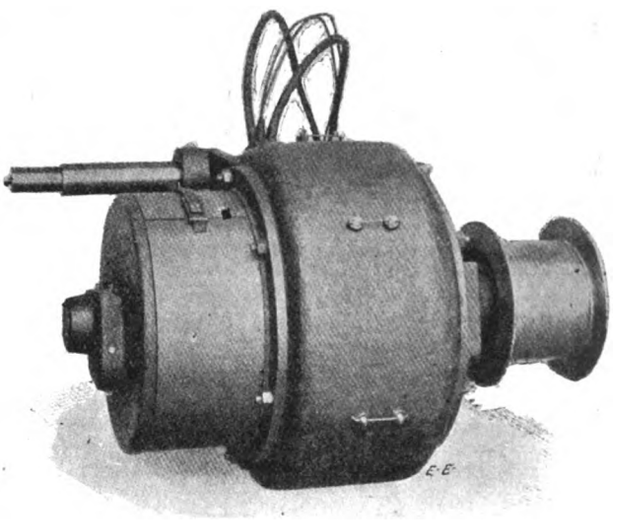

FIG. 6.—Direct-Current Dynamo for Train Lighting.

the lamp current is supplied from the dynamo. The charging current is maintained constant independently of the speed of the train, being altered only in case the number of lamps is altered. Its magnitude is readily adapted to the most different conditions of operation by grading the effect of the coil traversed by the lighting current on the motor magnet by a permanent connection in parallel of part of the resistance, W, to the coil mentioned above.

As soon as the perfect charge of the battery has been attained, the charging current disappears automatically, any switching made for its regulation occurring automatically and exerting no appreciable influence on the candle-power of the lamps. When all the lamps are switched off the lighting circuit the effect of the coil *b* on the core of the apparatus, T, will accordingly disappear. The armature of this apparatus remains, however, in an attracted position under the influence of the coil *a*. As soon as the train has reached a station, the circuit, including the latter coil, is interrupted by the switching apparatus, C, so that the armature of the apparatus, T, being released will open the contact, *s*. The coil III. on the magnets of the electromotor, R, will thus be actuated so that in the subsequent journey of the train the motor under the action of this coil (which is applied to the battery terminals) and the coil I. (which is traversed by the charging current), regulates the charging current so as to maintain it constant independently of the speed of the train. Before each stoppage, the switching apparatus, C, discontinues the connection between the dynamo and battery, re-establishing it in the subsequent journey. As the complete charge of the battery is reached, the increase of voltage obtaining in the final charging condition at the accumulator

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terminals will be sufficient to produce the attraction of the core of the electromagnet, T, thus completing the contact, S, and discontinuing the effect of the coil III. on the magnet of the electromotor. The latter will accordingly, under the action of the magnet coil I. (which is traversed by the charging current), adjust the field excitation of the dynamo to smaller values until the charging current has disappeared completely. Any supply of energy by the dynamo will thus be discontinued, while at the next station the switching apparatus, C, interrupts the circuit of the coil *a* at the contacts *k*, so that in the subsequent run the coil III. on the motor magnet is switched in once more, the electromotor adjusting accordingly once more to the normal charging current intensity, in case any consumption of current from the battery has taken place during the stoppage. The present regulation system thus regulates the charge of the accumulator battery in the same way as in a stationary plant.

Any overload of any parts of the system is prevented in the normal course of operation by the very efficient automatic regulation. In order, however, to protect the apparatus against the occurrence of any excessive current intensity, safety fuses, S, have been inserted both in the dynamo main and shunt circuits, and in the battery circuit. In addition, a special safety device has been connected to the system, preventing in the event of any disturbance of the regulation resulting from an interruption in the battery circuit (as might arise from the breakage of a connecting plate between two cells), the voltage of the dynamo from reaching any figure prejudicial to the lamps. The electromagnet, T, is fitted with a second armature, the spring of which is so adjusted that only the effect of the coil *a* resulting from an overload, in conjunction with an increase of current in the coil *b*, will be sufficient to overcome its tension. In this case the exciting circuit of the dynamo is interrupted at *t*.

Some tests of this train-lighting system were made with a registering voltmeter of Elliott Bros., and a hot-wire ampere-meter of Hartmann and Braun, on a car of the Zürich-Chur express train. The speed of the train was measured by means of a Klose speedmeter. From the records obtained, it is clear that the maximum variations in the lamp voltage did not exceed ±0·4 volt, while the current from the dynamo remained constant to within about ± five amperes.

## ELECTRICITY IN INDIA AND BURMA.

BY E. C. DEEPHOLT, A.I.E.E.

It has often struck me, as a young Anglo-Indian engineer anxious to see the success of the electrical industry not only in the mother country, but also in his own, why British manufacturers are and have been so backward in endeavouring to initiate the manufacture of electrical machinery, apparatus, cables, etc., by opening branch factories in far Eastern India.

It would be too long a subject to venture to discuss or narrate fully, and, consequently, ere I proceed I desire to impress on my readers that the attempt I have made is only to give a brief account of the gradual progress of electricity at the present day as well as its great future in India and Burma, adding a few items which may interest my brother engineers in this country. By so doing I hope it may be a means for future discussion and consideration amongst British manufacturers, which may lead to making the Indian Empire some day equal to any other in the electrical world. There is no doubt that the experiment would be welcome as well as meet with success; nay, be a boon to the country were a few of the British firms to start manufacturing in this country. For when one comes to consider the charges for freight, duty, packing, carriage, etc., and other items of expense, which necessarily must occur by the present system, there are grave reasons why people in India are somewhat reluctant to invest in large schemes for improvements which this great power affords us.

Although, on consideration of the short time England has had towards the civilisation of the country, the success of electricity and its use has been paramount. In order that I may give a fair idea of the same I thought it would be better to dwell on each Presidency of the Empire individually, by noting a few of the more important undertakings.

*Bengal.*—Commencing with Bengal, it is very pleasing to see how great and rapid has been the demand for electricity lately in this vast Eastern Presidency, and how it has risen to the front, not only with up-to-date machinery but also with more than there is in any other part of India. In Calcutta, already the success of the new electric tramways, introduced by Messrs. Dick, Kerr, and Co., London (a British firm which has not only set the example but has also earned a great reputation in the East), has been marked, and the extensions in progress and under consideration are very numerous. The demand for electricity by private consumers for use for fans, light, and power may also be interesting to note. It is so much that a second, and even a third, supply station has had to be built by Messrs. Kilburn and Co., Calcutta, in the districts of Alipore and Howrah, to meet the demand. In these, no doubt, Crompton's machines and Babcock and Wilcox boilers are rendering loyal service, each in their respective capacities; and there is every hope to see in the near future at least all the principal thoroughfares bright with the rays of the electric light. Several other large schemes in Howrah and on the banks of the Hooghly are being carried out with success. Darjeeling, the great hill station in the Himalayas, as well as Dacca, have resorted to electric light installations, and several other towns and districts in Bengal are about to follow suit by introducing electric tramways and lighting of the principal thoroughfares. Large railway workshops, mills, factories, coal and gold fields, and irrigation works, for which India has always been noted, are anxiously awaiting the day when they also may be worked more favourably and scientifically, as well as with less expenditure for maintenance and initial cost, by up-to-date electric installations.

*Madras and Mysore.*—Turning now to the Presidency of Madras and the independent State of Mysore, it is only fair to state the very great good the American engineers of the General Electric and British Thomson-Houston Companies have done, and how they have carried everything before them in the southern states in the electrical line. The valuable gold mines of Mysore have yielded wonderful profits since they were worked electrically, the power being derived from the natural waterfalls of the Cauvery, and the current transmitted by overhead conductors over miles and miles. Lately very large schemes have not only been contemplated but undertaken for the further development and use of this great power in the adjoining districts. Bangalore and the city of Madras, which latter has already electric traction, are about to be improved by the introduction of a larger system of tramways, as well as for the supply of electric lighting. Even the Nizam's Government of Hyderabad has acknowledged its benefits, and consequently sanctioned certain concessions towards the introduction of its use within his dominions.

*Bombay and the North-West Provinces.*—Although these two presidencies have been somewhat behind and slower in acknowledging the benefits of this vast power by practical application, yet one cannot help remarking that the day will not be far distant when both shall be on a par with their sister states in the south and east. For lately visible signs and efforts are in course in the former's capital, and the triumph of the electrical installation laid in the Great Mogul city at Delhi by Messrs. Kilburn and Co., of Calcutta, on the occasion of the King's coronation, will be unsurpassed for some time in India. Great credit is due to Major Joly de Lotbiniére, who has spent much time on various schemes for the improvement of the Indian Empire, in this particular branch, and there is no doubt that Mussoria and Simla, two great hill stations, will meet with the necessary sanction of the Indian Government to carry out their proposed schemes. There is also great hope of seeing the electrification of the Kalka-Simla Railway, for which there is every possibility at no distant date, as well as the electric lighting of Kashmir and the great Amir's capital in Afghanistan and several important military districts in the Punjab.

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*Burma.*—Last, though not least, comes Burma, which means to hold her own against any state in India in the utilisation of electricity, as well as in everything else. Again Messrs. Dick, Kerr, and Co., London, were the first in the field by introducing electric traction at Mandalay, whilst Rangoon intends electrifying her tramway system, as well as introducing electric lights along all the principal streets of the town. And one may feel confident, with the extravagant and luxurious desires of the Burmese gentlemen, there will be in a very short period of time an exceptional demand for electricity both from private installations and from public mains. It may also be well to state that the Burma ruby mines, which did not work very well at first, have of late years been most successful after the working of the same by electricity, the plant for which was supplied by Messrs. Johnson and Phillips, of Old Charlton, Kent.

*Education of Engineers, etc.*—Although it may be somewhat out of place to introduce the point of education into this subject, yet, on second consideration, I thought it would be interesting to say a few words on the subject with reference to the training of enginers, more especially on account of reading a few of the recent great discussions on the subject in various electrical papers. It needs the pen of Rudyard Kipling to describe the great success of the education of the natives of India. These are, no doubt, under great debt to the Indian Government for the very grand opportunities afforded them, both rich and poor, by the introduction of not only free schools and colleges, educational and technical, but also such big institutions for engineering as are at Roorkee and Silepur, which may be compared favourably with any in the United Kingdom for a thorough, complete practical and theoretical training and foundation in engineering before the launching out of a young man into the world. I shall take, *e.g.*, the Civil Engineering College, Silepur, and describe briefly the engineering department, manned by a large staff of English professors, who have qualified in the best English colleges, such as Cooper's Hill, Cambridge, and Oxford, each in his particular branch. It admits annually a certain number of students, rich or poor, native or Anglo-Indian, on free, reduced, or full fees, according to his parents' position and his own qualifications before entering. Equal opportunities are afforded to all, although the natives reside in separate blocks of buildings from the Christians, and there is no distinction between rich and poor amongst either class. Before the student is qualified to call himself an engineer of the college, he has to remain three, five, or even more years if he is determined to pass. The training he receives is not purely civil, mechanical, or electrical individually, but is a combination of the fundamentals of the three together, which is compulsory at the present day. So that when leaving college for service in the Indian Public Works—for which the training at the college is principally adapted—or anything else, he has had a good, sound, practical foundation in engineering, and may then choose any special branch most suitable to his experience in years to come.

*Details.*—He has to pass a strict annual examination in both practical and theoretical work, besides gaining a certain percentage every month; if he fails to pass he is obliged to leave the college for good and look for something else perhaps more suitable to his abilities than engineering. In the practical work the course consists of a severe test in the blacksmith's, carpenter's, and fitter's shops, after about nine months' training in each; besides, he spends some time in the turner's, moulder's, and boat-building shops, under suitable and capable foremen. For theory, he has the laboratories—physical, chemical, electrical—the lecture-rooms for mathematical and engineering subjects, in which all young engineers should have a good and thorough foundation; the drawing class, where plan, machine, and geometrical drawing is taught, besides which sketches and measurements of machines, houses and bridges, etc., have to be taken from typical examples, to be drawn to scale and painted. And last, though not least, he has to pass in estimating, and on the field in a complete course of surveying and levelling with different up-to-date instruments. For the encouragement of which, a prize is awarded to the best party of seven students who on being sent out to a different district, up country, lays out and plots the most accurate and best road or railway project, as the case may be.

In former years it was chiefly the aim of the college to train students for service in the Indian Public Works, but, owing to large and extensive improvements lately, thanks to the principal and staff, as well as to the Government, it gives the young engineer a further chance by affording the six senior students of the college, in order of merit, every year, the working and running of the college electrical plant, consisting of gas, steam, and oil engines, with direct and alternating current machinery, so that he may have a fair idea of electricity before he launches out into the world to gain experience and compete against his brother who has served his five years wholly in a workshop or dockyard. As electricity is at present only in its infancy, and there are very few facilities to gain experience at the present day in India, young college men who wish to get on have to visit the mother country or any other to enlarge their knowledge on electrical matters; whilst the man from the shop goes to sea to become a marine engineer. It will, therefore, be a great day and a boon to young Anglo-Indian engineers who are anxious to improve themselves in electrical matters, when British manufacturing firms set up branch factories in India.

Returning again to the subject, it would be well to mention a few of the principal advantages of the experiment, and leave men of experience to discuss its possibility in the near future. Compare the cost in labour between the native and British workman, for be he fitter, moulder, journeyman, carpenter, engine-driver, cable jointer, blacksmith, wireman, or labourer, or anything else, it is wonderful to note that the former is satisfied with on the average 25 per cent. of the wages which the latter would accept. Consequently initial cost and maintenance would be decreased a great deal. If such big firms, factories, and ironworks as are on the banks of the Hooghly and elsewhere, as Messrs. Burns, Jessops, and the railway workshops at Jamalpur, besides various other industries and factories, have proved successful, why should not the electrical industry, though perhaps needing a much greater initial cost, meet with as good a result? It would have the advantage of the help of the parent firms in England to enable it to supply the great demand in India, where water power is plentiful, land is cheap, and so is unskilled labour. The native workman is, however, easily trained. It is to be hoped that some day British subjects in India may be able to boast that in electrical manufacturing and the applications of electricity they can compare favourably with any other nation in the electrical world.

## DISTANCE-CONTROL SWITCHES AND THEIR LAY-OUT IN STATIONS.

BY W. E. WARRILOW, A.M.I.E.E.

(*Continued from page 24.*)

An American switch of this type is shown in Fig. 5, and in this case the breaks are at right angles to the operating handle instead of parallel, as in the previous instance. A different system of operating is also employed, the pull on the main rod being obtained through a short lever with three points, one pivoted to the switch case, another to the handle link, and the other through a long link to the top of the rod carrying the main contacts. This switch has a normal capacity of 3,000 kw. at 1,500 volts. If installed in compartments it will break 8,500 kw. on emergency, but if placed on a switch panel, up to 5,000 kw. will be opened successfully. In Fig. 6 the switch in a modified form can be seen, arranged for overload tripping coils. The switch in this case will only deal with smaller loads. Its normal capacity is 800 kw. at 7,500 volts, but in emergency it will open circuit 2,500 kw. without trouble. The above switches are made by the General Incandescent Arc Light Company, of New York, to whose electrically-operated switches reference will be made later.

Another switch of this type is shown in Fig. 7 (the oil-tank is not included), and the same overhung arrangement of contacts will be noticed. A heavy cast-iron support is

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fitted with substantial insulators holding the fixed contacts, and a compact system of operating levers is used to connect the contact beam with the handle. The contact bridges are fixed in horizontal insulators with large creeping surface, the supporting rod being clipped on at the centre of the bridge. Renewable spring clip contacts are fitted.

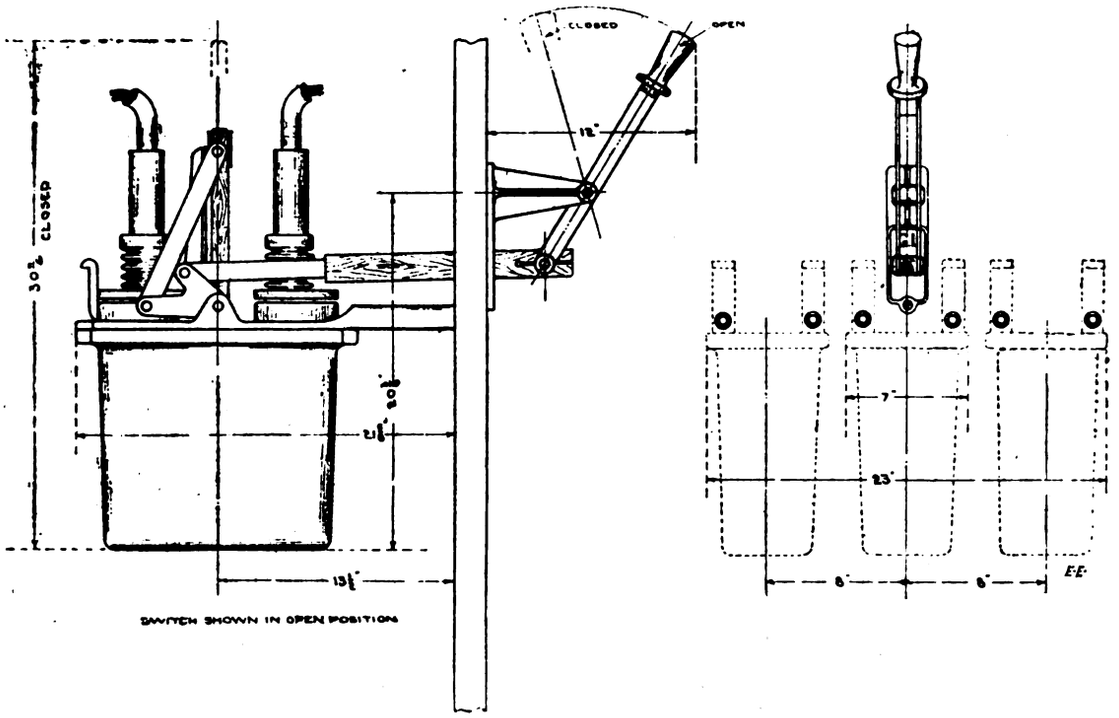


FIG. 5.—Box Oil Switch (American Type).

A larger switch of somewhat similar design is illustrated by Fig. 8, and, in addition, a special synchronising switch is fitted behind the main switch, thus coming into operation when the handle is raised to "half-cock." These switches are made by Witting, Eborall, and Co., Limited, and reference is made to their lay-out in board form later. They are fitted with automatic tripping coils (except Fig. 7) and are connected by bridge pieces depending from vertical rods coupled by a cross-beam above the terminal base, and fitted with a heavy weight sliding on parallel rods. The weight is provided at the back with an extension piece which projects over a catch controlled by a tripping solenoid. When the switch is closed, the weight is raised with some little play between it and the cross-beam. The weight

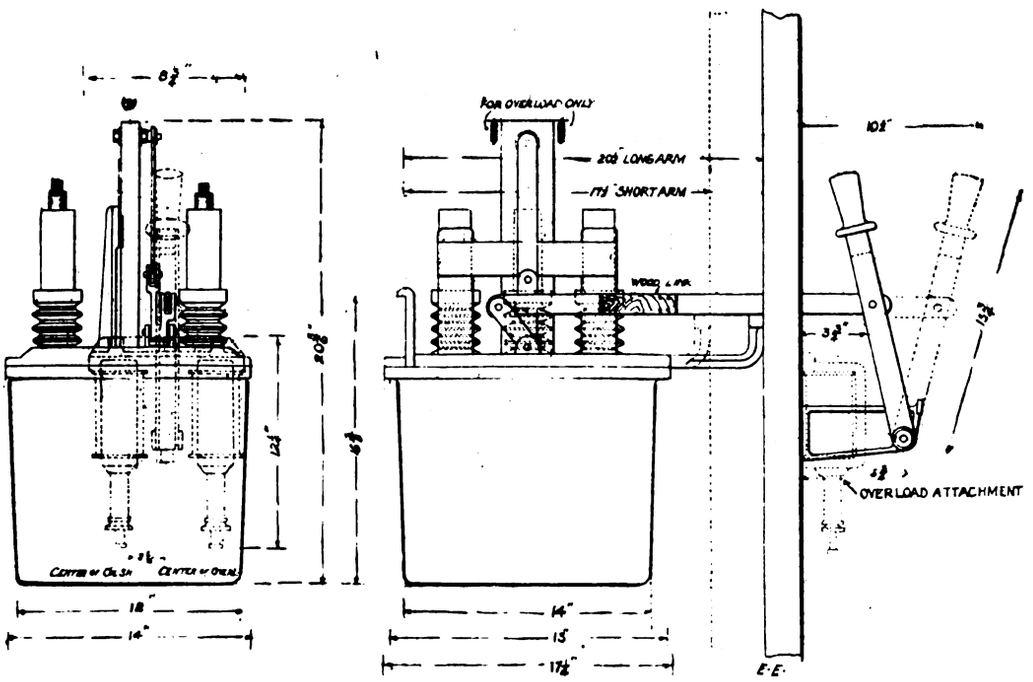


FIG. 6.—Box Oil Switch, with Overload Release.

placed one on each side of the handle, as shown in Fig. 9. In this the release trigger and adjusting screws for the plungers can be seen. The switch can be opened by closing the hand on both handles, drawing them together as one, and pulling both downwards. The synchronising notch is visible about half-way up the slot in which the handle lever travels.

A lever-control switch for high-pressure work has recently been introduced by Dick, Kerr, and Co., Limited. This is illustrated in Fig. 10, and will be noticed as embodying several novel features. The switch proper is not mounted directly behind and on the marble slab, but is supported on cast-iron legs with openings back and front for inspecting purposes. The fixed contacts overhang the oil-bath, when released by the trip coil, falls, and strikes the switch smartly out of its contacts. The weight has an advantage over springs, in that it does not fatigue like the latter when compressed for a long time in use. The action of the switch can always be relied upon where weights are used. The oil-box is divided into compartments, and arranged to be lowered clear of the contacts by a winch and handle. The operating handle is placed some distance

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from the switch itself, being coupled to it by levers and cranks. The handle moves in a slot, and is held in the

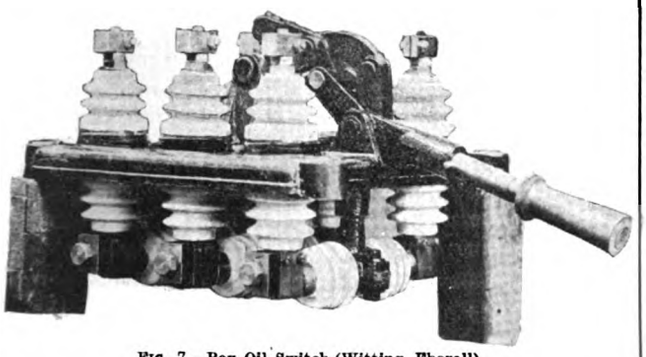

FIG. 7.—Box Oil Switch (Witting, Eborall).

"on" position by a spring bolt dropping into a slot at the end of the sector. This belt is withdrawn when

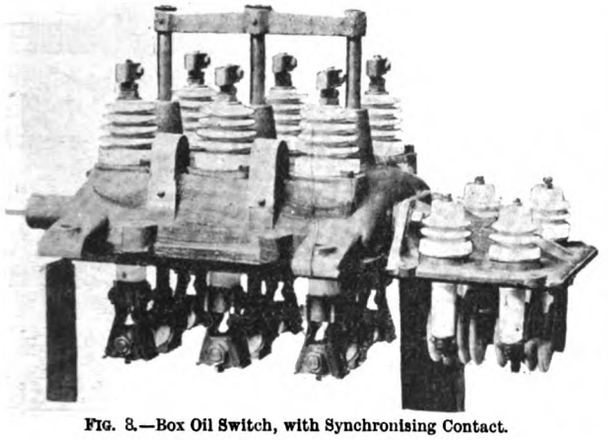

FIG. 8.—Box Oil Switch, with Synchronising Contact.

opening the switch by hand, the weight being released as with the tripping coil. The small switch above the handle is for closing the coil circuit when the switch must be opened in emergency. No-voltage and overhead releases can also be fitted to this type of switch.

*(To be continued.)*

## THE PURIFICATION OF WASTE LUBRICATING OIL.

BY F. H. DAVIES.

The purification or filtering of lubricating oil is one of those minor engineering economies that are so easy to make and tend so much in the long run to the reduction of costs. Considering the price of oil and the proportion that it bears to total works costs, one might expect that few would be found to dispute its utility; and yet the small outlay that is entailed by the installation of some suitable device to deal with dirty oil is often deemed unwarrantable or not absolutely necessary, with the result that an entirely preventable waste goes on that in a short time costs much more than the apparatus that would have obviated it.

Doubtless much of this apathy on the part of some power users has been encouraged by the introduction of the self-oiling bearing, which, if large enough, to a great extent acts as its own purifier by a settling process. But

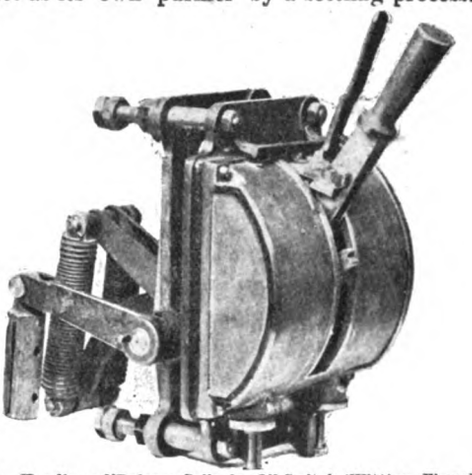

FIG. 9.—Handle and Release Coils for Oil Switch (Witting, Eborall).

such bearings become dirty in time, and in any case they only form a small portion of the lubricated surfaces in power installations using engines; consequently all the oil that finds its way from drip and siphon lubricators to the crankpits, etc., is absolutely lost, although perhaps quite fit for further use but for a little dirt that may easily be eradicated. In all but the largest installations the subject

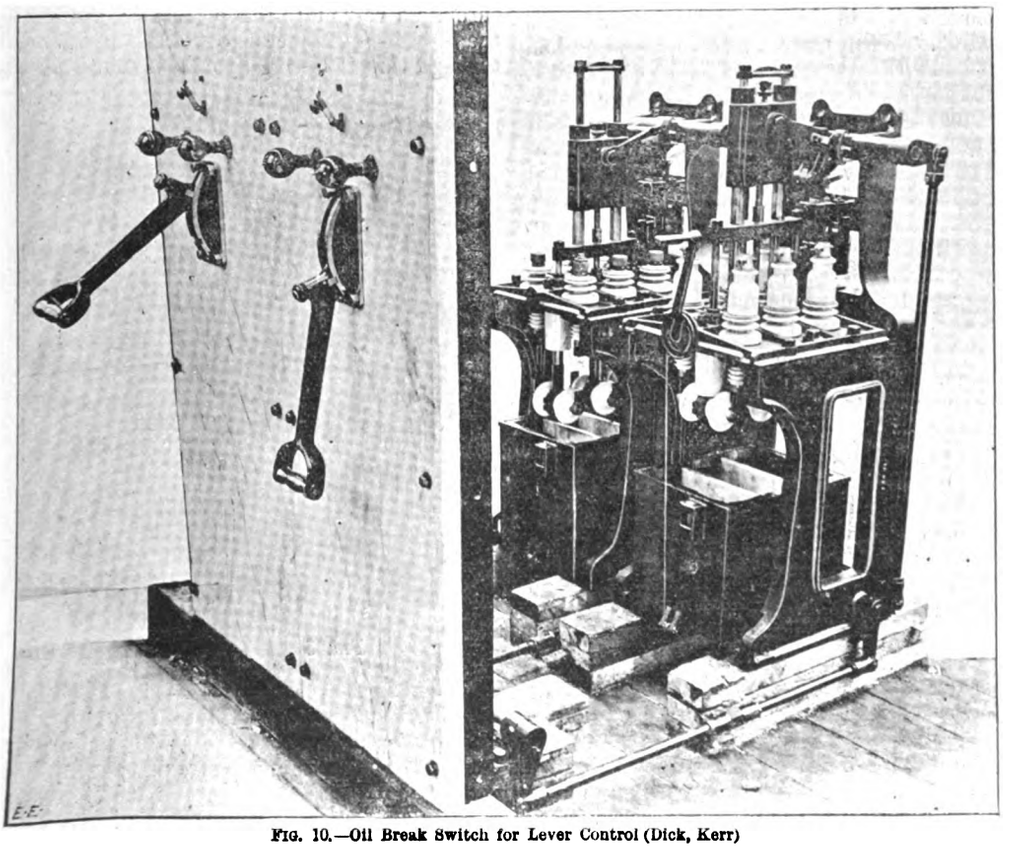

FIG. 10.—Oil Break Switch for Lever Control (Dick, Kerr)

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is a small one, hence it is often overlooked; but as it is obvious that in practically every case purification of waste oil must have an appreciable bearing upon economy, it follows that suitable apparatus for effecting it should always be provided and considered as of equal importance in its own sphere to any other saving device.

The impurities found in waste oil are often very numerous and different in their nature. They may be roughly divided into two heads—chemical and mechanical, and according to which class they belong, so the means for eradicating them will differ. Chemical impurities must be treated chemically, while those of the second class may in all cases be removed by filtration in one or more of its several forms. Oil that is exposed for a long period to the heat of an enclosed engine crank chamber will often become charged with fatty acids consequent upon decomposition, and, needless to say, their presence is always highly undesirable, and may even become dangerous. Filtration will not remove them, but treatment with an alkaline solution has been found very effective. The extraction of mechanical impurities as performed in filters may be either by the action of settling, with or without agitation; siphoning, in conjunction with subsequent settling; percolation, or various combinations of the three. The former—viz., settling without agitation—is the simplest, as the apparatus consists only of a large and deep tank, to the bottom of which the impurities sink by their own weight; but purification by this means, although effective, is a somewhat lengthy process, and one that may be easily upset by careless handling of the apparatus in adding or withdrawing oil.

Fig. 1 represents in diagram a filter of this class, adapted for greater speed and convenience of working by the addition of the agitation principle, combined with a heating arrangement. It will be noticed here that after passing through the first strainer that removes all large impurities the oil sinks down a pipe, the end of which is immersed in water kept warm by the steam heating device placed beneath in a separate chamber. Many of the larger impurities immediately sink to the bottom, others are thrown out by agitation or the rapid rise of the oil through the water (represented in all the figures by broken lines), and the whole of the time the oil is in this compartment settling is gradually proceeding. When the oil (shown in unbroken lines) reaches the top of the centre pipe, it wells over, falling into the funnel-shaped receptacle in the lower compartment. Its head—exaggerated in the figure—forces it down the pipe, and it emerges in drops at the bottom, passing through cold water and a perforated plate that serves to lengthen its path to the body of pure oil floating on the water. The remaining impurities now settle out, and the oil at the surface is clean and ready for drawing off by aid of the top cock, the bottom one being used for withdrawing the water and for cleansing purposes.

Fig. 2 shows a thoroughly good modern filter, in which the percolating principle is used in addition to that of settling by agitation. The dirty oil is poured into the upper tray, and, passing through the filtering material, in this case cotton waste enclosed in a metal strainer, drips into the receptacle surrounding the perforated head of the down pipe. As in Fig. 1, it emerges from the bottom and is distributed through the water (heated by a steam coil at the base), shaking out the remaining impurities, and rising to the top, where it is drawn off. Many filtering agents have been tried in oil purifiers, blotting paper, meat rags, felt, and other like substances; but waste seems to be most generally used, as for a given cleaning power it allows of the greatest speed of operation. Blotting paper is a thoroughly good material from the filtering point of view, but it gets very rotten, and is, on the whole, more expensive than waste, and needs more careful packing.

The filter shown in Fig. 3 is similar to Fig. 2 in that percolation and settling with agitation are both used and accelerated by means of heat, but the processes are reversed, the former coming after the latter. Such a filter would effect the desired end of purification very well, but its action would be slower than that of Fig. 2, since the latter provides a much greater weight of oil on the filtering substance than is represented by the comparatively small quantity contained in the down pipe of Fig. 3. Unless this pipe is always kept more or less full, according to the quantity of pure oil in the upper chamber, the filter obviously will not work. In this latter respect the filter shown in Fig. 4 is an improvement, as there is always a greater store of comparatively dirty oil forcing its way through the filtering pad, situated as shown on the left-hand side of the inner vessel. The two processes of agitation and percolation are repeated in the same order as in Fig. 3, and a disc is provided at the foot of the pipe to lengthen the path of the oil through the water, which is not heated. The small pipe on the left-hand side allows air to escape from the inner chamber as the oil

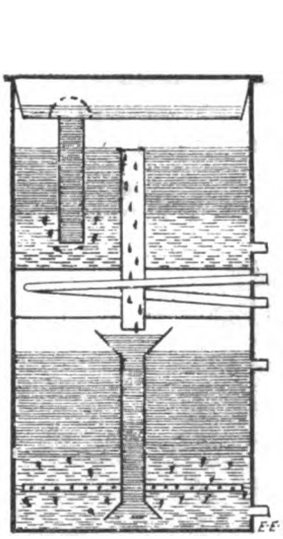

FIG. 1.

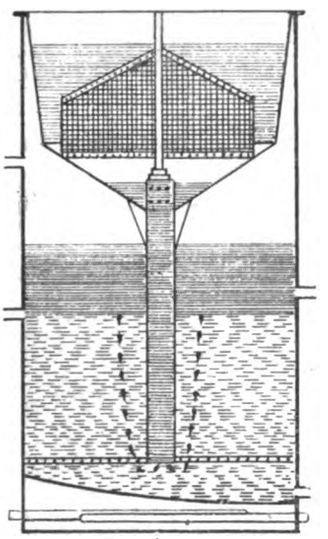

FIG. 2.

rises in it, and those on the right communicate with the clean oil and draining cocks respectively.

The remaining four figures show modern methods of oil purification that dispense altogether with the agitation principle, adhering only to filtration pure and simple and the ordinary process of settling. Fig. 5 shows some novel and ingenious points. The dirty oil is poured into the funnel and fills the outer chamber, passing from thence through a valve into the bottom of the container holding the filtering substance. By virtue of the head it now rises through this, following a tortuous course between the plates,

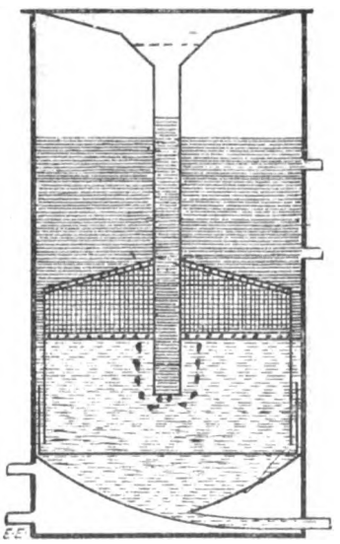

FIG. 3.

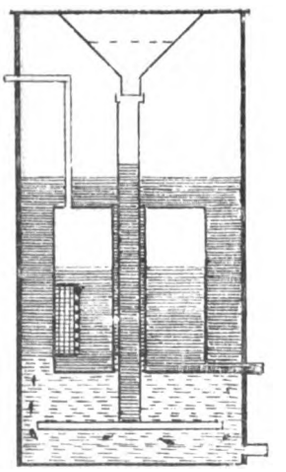

FIG. 4.

so placed as to secure a long path. It rises from the top of the filtering bucket and flows into the inner vessel, from which it is drawn as wanted through the pipe on the right-hand side. The chief novelty of the apparatus lies in the automatic valve, into the case of which the filter bucket is screwed by aid of the handle shown. In the absence of the bucket the valve is kept closed by the spring at the bottom, and hence the former may be taken out for cleaning or repair without emptying the oil from either the inner or outer containers. When the bucket is replaced the act of screwing it down opens the valve without allowing the two oils to mix, and permits the filtering process to go on as before.

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Fig. 6 shows a three-stage filtration method, combined with settling processes in the first and second stages. The top chamber containing the first filter is removable, so that water and large refuse may be cleaned out frequently. The course of the oil is through the holes in the upper part of the first cylinder, and from thence through both filters to the large settling chamber, where most of the impurities deposit out. It then rises through the bottom of the third cylinder into the pure oil vessel, which is fitted with a cock. As the first two filters are only meant to deal with the larger impurities they are lightly packed and should be frequently cleansed, but the last stage requires better and

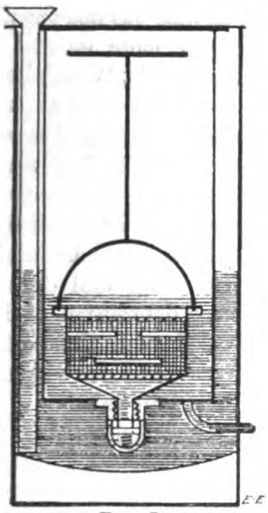

FIG. 5.

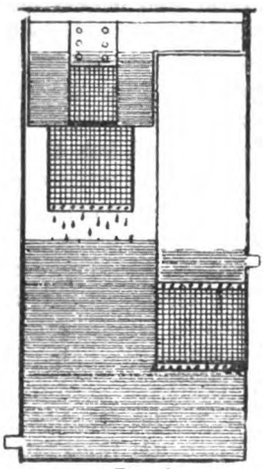

FIG. 6.

tighter packing, and in view of the settling action that takes place before it is reached, less cleaning.

Fig. 7 shows another three-stage filter, of different construction but based on the same idea of settling processes in the first and second stages. It is, however, primarily different, in that siphoning is introduced prior to the first filtering, replacing the perforated cylinder arrangement. On emerging from the bottom of this stage, the oil passes through outlet tubes and falls into the second compartment, where it settles, and rises over the top of the second filter, pursuing its course straight through the third, and arriving at the bottom receiver in a purified state. The filtration

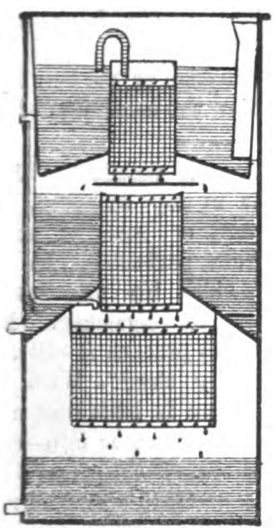

FIG. 7.

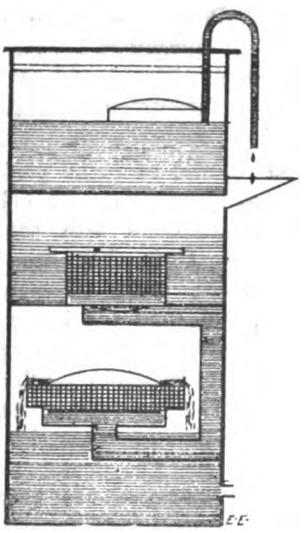

FIG. 8.

by this method is most complete and the apparatus will deal with the dirtiest of oil.

Fig. 8 represents a well-known and efficient filter, in which the first or settling stage is followed by a double percolation process. The floating siphon, shown in the upper compartment, is a good feature, as by this means, despite the level of the oil, only that on the very surface is passed to the filtering pads. The oil enters on the periphery of that in the first chamber, and, passing through, emerges into a channel that conducts it to the underneath side of the second pad, from the top of which it flows over to the lower or pure-oil chamber.

Other methods of waste oil purification are based on capillary and centrifugal actions, the former consisting of arrangements of siphoning wicks that naturally will not allow impurities to pass. In this respect they are very effective, but by far too slow for the average works requirements. The centrifugal method is good in that it gets rid of the dirt quickly and thoroughly, but it takes some power, and is rather costly when used on a small scale. On the whole there is nothing to beat a good filter built on scientific and common-sense lines. The material through which the oil percolates should be cheap, and so placed as to render renewal both easy and quick, and the whole apparatus should come to pieces so that it may be inspected and cleaned with facility. This type of filter should be so arranged as to make the later stages independent within a reasonable amount of the dirty oil fed into the first strainer—that is, they should always hold a good reserve—and it is important that the process of filtration should not be forced by continual filling up and working at full capacity. In the same way, the settling type of filter works best at light load, and will only give poor results when supplied with too large a quantity at once.

## GLASGOW LOCAL SECTION.

The Glasgow Local Section of the Institution is in full force this winter with a number of important papers, some of them of more than local interest. The paper read at the December meeting by Dr. Henderson, of the University of Glasgow, on "Armature Reaction in Alternators," was one of these. The investigations described in the paper had been carried out in the James Watt laboratory of the University of Glasgow by the author and Mr. J. S. Nicholson. The paper was divided up into a number of different headings, each of which was largely illustrated by mathematical formulæ and curves. First of all the theoretical armature reactions were considered, and then the author went on to deal with the demagnetising and cross magnetising components of the armature reaction. The experimental research was carried out on an armature of the Electrical Company's standard make, having rotating field poles, and a periodicity of 50 cycles per second when run at a speed of 750 revolutions per minute. The normal voltage was 200, and the current at full load was 87 amperes per phase. Summarising the results at the end of the paper, Dr. Henderson said: "The theoretical load curves of the three-phase generator which have been calculated in the paper by a method like Blondel's, employing a Fourier analysis of the armature M.M.F.'s, do not agree with the experimental load curves within the limits of the experimental errors, but deviate from them in certain well-defined respects. The limits of experimental error are a small fraction of the maximum deviation, and the deviations themselves are so small as to be negligible in matters of design."

In the discussion which followed, Prof. BAILY was the principal speaker. He said that the higher the harmonic the more effective would the amortisseur coils be, because the higher the periodicity the greater the inductive effect, and the greater the effect on the field magnets in obliterating the variation of current. It would be very interesting to know if the coils gave large indications of reversing currents or obliterating currents.

Mr. H. A. MAVOR said he would like to know if Dr. Henderson's experiments could be carried out on a larger machine. The cross magnetising effects which were negligible on small machines would be much greater on machines with three or four times the radial depth.

Mr. HIRD wished to know how the ordinates of the square curve in one of the figures had been arrived at.

Dr. HENDERSON, in reply, said it would be interesting to experiment further along the lines suggested by Mr. Mavor. The results, however, would depend on the ratio of the pole breadth to the pole pitch. His experiments had been begun with a view to finding out how far those M.M.F.'s in the analysis of the total armature M.M.F., which theory indicated should be stationary over the poles, could account for the effects obtained in practice, and the results had been most satisfactory.

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### TO CORRESPONDENTS.

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## TELEPHONY AT PARIS.

It has been suggested that the two reports of Mr. Herbert Laws Webb to the Association of Telephone Subscribers of Paris provide food for thought and comment. They do. The moral underlying the text of these reports is just the same as that underlying the "passing of our fleet" or the "regunning our army." Progress leads to what is termed antiquation or obsolescence. Time acts very much the same on humans; and we are often taunted with being antiquated old fogeys, who ought long ago to have given up all interference with the world's work and left it to younger men with whom time has not yet played havoc, and who possess more energy, more go, and claim more up-to-date knowledge. Practically Mr. Webb's lesson is a variant upon the theme that you cannot look as well in old clothes as your neighbour does in a brand-new suit. The conclusions at which he arrives are obvious, and will not be disputed, but Mr. Webb does not and cannot, nor can anyone, show us how to overcome the initial difficulty, which is to provide apparatus which will never be improved upon, nor become old. What he does, and does well, is to give an exceedingly interesting description of how a telephone service should be installed with the best that exists now to be efficient. The requisites to which each subscriber is entitled are tabulated as follows:

1. Uniformly good transmission, comprising
   - (*a*) Good hearing.
   - (*b*) Good talking.
   - (*c*) A line with no extraneous noises, what telephonists term a "silent" line.
2. A uniformly prompt answer from the exchange.
3. A uniformly courteous answer from the exchange.
4. A uniformly prompt and accurate connection with the number desired; or, failing that,
5. A uniformly polite and businesslike report of the reason why the desired number cannot be obtained.
6. No interruption of the conversation with his correspondent by the operators or by third parties.
7. Prompt attention of the operator in case of difficulties.
8. A uniformly prompt disconnection of the two lines connected immediately after the conclusion of the conversation.

Of course, as great perfection as is possible in these points is necessary for efficiency in any exchange, and the report deals with the reasons, or some of them, why in Paris they are far from perfection. In the first place, every subscriber provides his own instrument, and even a primary battery for signalling. Mr. Webb states that "the origin of this practice is obscure, but its unfortunate results are very clear." With the latter phrase we quite agree, but there is little obscurity in the origin of this practice. We cannot enter into—and we have no right to do so—questions of French politics, but the origin of the obnoxious practice, also the real causes of staff inefficiency, must be sought, like so many things, in the realm of politics. Mr. Webb admits that he has had no experience from the inside. We understand "the president of the association has made formal application to the administration for Mr. Webb to be allowed to make an official inspection of the Paris telephone exchanges with a view to reporting on their condition and on the apparatus and methods employed." As regards the reports we are referring to, he has relied upon his general knowledge of the Paris telephone service "acquired from published descriptions and from observations made during various visits to Paris in the past few

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years, and not upon a detailed inspection of the system, such as would be necessary for a statement in detail of the technical and financial considerations involved in a reorganisation of the system." This admission fixes the position of the reports, and we trust it will be thought complimentary to them if we object to accepting them as having any particular value in Paris criticism, but as undoubtedly having a high value as general guides, and as indicating precisely the lines upon which a rigid specification should be constructed so as to obtain not only an efficient system at Paris but anywhere. Mr. Webb practically says this is the present condition of our knowledge; this is what the subscriber wants; and this is how, in his opinion, it should be installed to obtain efficiency and economy. His discussion of details is necessarily general, and, as we say, does not specially apply to Paris, but holds good for any place. His conclusion is to "reconstruct with modern central offices and subscribers' station apparatus"; in that of the three periods into which he classifies telephone development, Paris still retains most apparatus that belongs to the first, little that belongs to the second, and none that belongs to the third. Drastic remedies involving reconstruction require a very careful consideration of all conditions. Your capital expenditure is increased to the cost of the new construction in addition to the remaining capital of the old, and the question depends upon the total of the new revenue. If that will carry the capital, the outlook is favourable; if not, you must have a loss. Mr. Webb thinks that the telephone business in Paris would enormously increase, and if his figures are even approximately accurate, his suggestion for complete reconstruction is amply warranted.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### THE METRIC FALLACY.

SIR,—Thanking you for having inserted my last letter, may I be allowed to briefly refer to your second article on "The Metric Fallacy," appearing in your issue of Dec. 23.

You allude to the rejection by the French of the 10-hour day. It would seem almost unnecessary to point out that the metric system of weights and measures, as advocated by the Decimal Association, has nothing whatever to do with the division of the circle. In fact, there exists a very common confusion of ideas between the proposal to adopt the metric system of weights and measures and a supposed desire to decimalise everything. Another mistaken idea is that by the adoption of the metric system vulgar fractions would be abolished. Just as now with our present system we often find it convenient to use decimals, so with the adoption of the metric system we should often find it convenient to use vulgar fractions.

It is quite true that a gallon of water weighs 10lb., and we have in that fact a connection between our measures of capacity and weight, but it is far from an ideal one. If a cubic inch of water weighed an ounce or some recognised unit of weight we should be much happier. Compare the connection with that in the metric system, a cubic centimetre of water weighing a gramme, by which the weight of any given volume of water may be estimated at sight.

With regard to your allusion to British consuls, it is not my business to defend their character as men of capacity and as having some regard to British interests, but I should like to refer to the reply sent by our diplomatic representatives in answer to a circular issued by Lord Salisbury in 1899, asking for information, amongst other things, as to the effect the adoption of the metric system had had upon the commerce of the nations using it. The general tenour of the replies was, that the adoption of the metric system had facilitated internal trade, that it was also beneficial to trade with other countries using the metric system, and that in no country was there any desire to revert to the old weights and measures.

But after all, sir, the question centres round the retention of our present units, which, after long use and familiarity, we are, naturally enough, loth to dismiss.

We find our inch very serviceable. The table connecting it with the higher measures is admittedly bad, but taken by itself it is a good unit (so is the yard, so is the pound), but the chief disadvantage of our present lack of system is that the inch and the pound are not inter-related, as I have shown above, by any simple and workable connection; and it seems impossible by any reform of our existing system to bring about such a connection.

We may regard a system of weights and measures as part—and a very important part—of the machinery of our national trade, and, like other machinery, we require it to be up to date. At present we have no system, but a "farrago" of weights and measures, as Lord Kelvin has called them.—Yours, etc.,

E. JOHNSON,
Secretary, the Decimal Association.

---

SIR,—In your issue of Jan. 6 there appears a letter under the above heading from the secretary of the Decimal Association, which is very apt to mislead those who are not well posted up in the weights and measures question.

The writer states that "If the contentions of Sir Frederick Bramwell are carefully considered, it will be found that he was protesting, not against the metric system, but against the compulsory use of decimals to the exclusion of vulgar fractions." If the writer, in using the words "metric system" in this paragraph, refers to the principle whereby length, volume, and weight are co-related, Sir Frederick was not against the metric system, but if he leaves the readers of your paper to understand—as they undoubtedly will understand—that the words "metric system" used in the aforesaid paragraph refer to the system based on the metre, then Sir Frederick was one of the strongest opponents, and for the reason that the use of the metre and its derivatives compels the use of decimals to the total exclusion of vulgar fractions, except the very simplest.

The argument about the list of 50 "customary" weights and measures still used in this country is an argument that has been trotted out for the last 50 years, and is still used as being a truthful statement, notwithstanding the very successful efforts which have been made during the last 10 years, particularly by the Standards Department of the Board of Trade, and the various weights and measures authorities throughout the kingdom, to replace them with imperial units.

There is also a statement that "even America is no longer with us," because, forsooth, they express their yard in terms of the metre and their pound in terms of the gramme, and they have a different gallon, whilst they use a ton of 2,000lb. The contention is most ridiculous. Let me give the official figures of the English Board of Trade and the United States Bureau of Standards, and then let your readers judge of how true is the statement that "America is no longer with us":

United Kingdom: The yard $= \frac{3600}{3937}$ metre. The pound = 453 59243 grammes.

United States: The yard $= \frac{3600}{3937}$ metre. The pound = 453·5924277 grammes.

It will be seen that the only difference is that English commonsense has stopped after dividing the already small weight of a gramme into 100,000 parts, but the United States Department has carried the fraction two points still farther; but even then it is not finality, and could be carried on much farther still.

To say that the United States is not with us on account of its having adopted a 2,000lb. ton is childish in the extreme. We might with just as much truth say that Liverpool corn merchants are not with us because they have adopted the sensible weight of 100lb. cental, instead of 112lb. hundredweight.

Respecting the volume measures of the United States,

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the difference is accounted for by their still retaining our old Winchester wine gallon, which was replaced in this country by our present and more scientific gallon, and which is defined as "a vessel that will hold 10lb. weight of water."

If such puerilities are the best arguments (?) that can be used to support the metric system, then it is very evident that the organisation of the opposing forces has begun none too soon.—Yours, etc, GEO. MOORES.

## TURBINE NON-STOP RUNS.

SIR,—In your issue of Jan. 6, 1905, I notice under "Business Notes," p. 30, that you speak of a 600-h.p. Westinghouse steam-turbine having run for 3,962 hours—"a remarkable performance in the history of the steam-turbine," as you put it. You further speak of this performance as "the record run of the Westinghouse turbine." This may be the case for a Westinghouse machine, but both Messrs. Parsons and Messrs. Brown, Boveri, and Co., Limited, have machines which have been in continuous service for longer periods.

For your information I beg to enclose herewith copy of a telegram addressed to Messrs. Brown, Boveri, and Co. in connection with a 600-h.p. Brown-Boveri-Parsons steam-turbine which ran for *17,200 hours—i.e.*, more than four times as long as the Westinghouse machine—without absolutely any repairs or adjustments being necessary, and this machine is at the present day in successful continuous operation. I think that this constitutes a record for a prime mover of this output.—Yours, etc,

EXCELSIOR.

## SOME NOTES ON HIGH-SPEED FEED PUMPS AND THE REASONS OF THEIR INEFFICIENCY.*

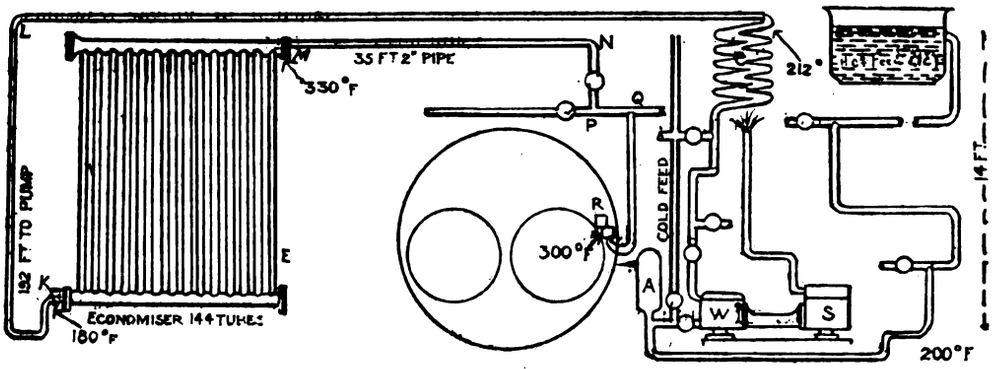
BY E. C. BARTON.

Most of us have, at some time or other, bestowed an infinity of pains on one thing and found out afterwards that it was not so important as it looked, and some other neglected matter grew to be such a source of trouble as to bring all our exertions to naught. Such thoughts were suggested to the author when studying the matter of steam pumps by a perusal of the troubles of an electrical engineer in England, who had charge of a large electric plant fitted with the very latest appliances, engines with a steam economy guaranteed down to three places of decimals, and mechanical stokers, superheaters, coal conveyors—in fact, everything needed to make a perfect plant, but which in the ordinary work suffered from big coal bills, owing to the losses in the "auxiliaries." When one reads that a Mr. Jeckell had found a pump using 1lb. of steam to feed 1lb. of water, it becomes interesting to find reasons. It appears that the pump was of the high-speed type, and was working slow, but even at ordinary speeds a delivery of 30lb. of water (per pound of steam used) was a record, while pumpmakers assert 35lb. to be attainable.

On investigating the matter the first difficulty to solve is, why is the water end of a steam-pump so much smaller than the steam end? A catalogue (Worthington's) was consulted, and gave the following ratios: 3, 4, 3, 2¼, 2·7, 2·5, 2·8, 3·5; another catalogue (Marsh's) gave 3, 3, 3, 2·75, 2·25, 2·5, 2·8; while another (Weir's) gave 1·9, 1·8, 1·8, 1·7, 1·8 as the ratio between the steam-cylinder area and the water-cylinder area. Thus the average ratios are 2·97 for Worthington, 2·72 for Marsh, and 1·8 for Weir, and from the mere sizes of the cylinders a Worthington should take 2·97lb. of steam to do the work which a Weir will do with 1·8lb. This statement may be made more accurate by substituting cubic feet for pounds, but it is substantially correct, because the period of rest at the end of each stroke, even in a duplex pump, is generally sufficient to bring the pressure in the cylinder up to full pressure, and any throttling of the steam in the steam stop valve is thus rendered insignificant as far as economy goes. The full-speed diagram of the steam end of a pump is generally a right-angled parallelogram with a small peak at the end of the stroke. At lower speeds, due to throttling the steam supply, the average pressure is lower, but the final peak is just the same at the end of the stroke, and that peak means that the cylinder takes a full supply of steam, at any speed, before exhausting, or nearly so.

Leaving the steam end losses and turning to those at the water end, the greatest source of inefficiency in a steam pump is discovered—*i.e.*, friction of packings. It is here that resides the difference in efficiency between a slow-moving 7½in. by 15in. Weir at 17 strokes per minute and a quick-speed duplex 2¾in. by 4in. Worthington working at 200 strokes each cylinder (equivalent to 400 strokes of one cylinder). At the above speeds both pumps are approximately of the same output—*i.e.*, 18,000lb. per hour—but the friction losses are in the quick-speed small pump more than double those incurred in running the large slow-speed pump. The reason lies in the fact that the work expended in friction is in each case proportional to the surface swept by the piston, whereas the discharge of water is proportional to the volume swept by the piston.

The author, having under consideration the replacement of an existing Worthington pump by a Weir, had occasion to make the following calculations in comparing the relative advantages of the two types of pump. The existing arrangements of the Worthington pump installation are shown in the accompanying diagram, wherein T is the tank,




K is the suction pipe, P is the water cylinder, S is the steam cylinder of pump, A is the air vessel, C is a heating coil, E is a Green's economiser, and B is one of a battery of Lancashire boilers. The essential data concerning the Worthington pump, the proposed Weir pump, and the pipe system are given below: Worthington pump—steam cylinder, 4½ by 4; water cylinder, 2¾ by 4; Weir pump—steam cylinder, 10 by 15; water cylinder, 7½ by 15; length of suction pipe, 70ft.; length of delivery pipe from pump through auxiliary heater to economiser, 195ft.; length of delivery pipe from economiser to boiler, 35ft.; internal diameter of pipe, 2in. To the friction losses caused by the movements of the piston or plunger must be added the losses arising from the friction in the gland stuffing boxes, which, although usually small compared with the former, may by the zeal of the attendant be indefinitely increased. These losses are, in the case of the quick-speed pump, about 10 times larger than with the slow-moving pump.

The next serious loss arises from slip, which is partly due to leakage past the piston, but is also due to leakage through the valves. Slip is not a factor in determining cylinder ratios, but it is a serious factor in lowering efficiency at slow speeds. In some local tests I have found it amount to 10 per cent. on the full speed output, but

* Paper read before Queensland Institute.

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with fresh packing and true cylinders it should not exceed 3 or 4 per cent. Unfortunately, slip remains nearly constant, while the output varies with the speed, and it is possible to run a pump so slowly that the whole of the displacement of the piston just equals the slip, and the delivery of water is nil. The slip may then be said to be 100 per cent. One of the most interesting pump questions is that relating to the flow of the water in the suction and in the delivery pipes, as the inertia of the water and the friction are appreciable factors in the working of pumps, especially of the quick-speed type, firstly, because they increase the amount of work required of the pump, and, secondly, because they cause a difficulty in dealing with hot feed water or long suction pipes.

Following up the case of the local pump above mentioned, it can easily be shown that the full speed of 200 strokes per minute per cylinder involves stopping and starting the column of water (continued in the pipes) 400 times per minute. In proof of this may be mentioned that this pump will not work if the check valve, V, at the economiser is removed. In the case under observation the column is 200ft. long and 2in. in diameter. It must travel the distance of 7½in. every stroke, and, therefore (if starting from rest), it must attain a velocity of 15in. per stroke—*i.e.*, the average speed will be 4ft. per second, but the velocity attained will be 8ft. per second by the end of the stroke, so that the acceleration of 8ft. per second must be given to this column of water in $\frac{1}{400}$ minute (·15 second). This means 60lb. per square inch added on to the boiler pressure. The calculations relating to the above are as follows: the weight of water in the pipes = W.

$$W = \frac{200 \times 2 \times 2 \times 3{\cdot}14 \times 63}{12 \times 12 \times 4} = 300\text{lb.}$$

The quantity of water moved by the piston at each stroke must travel in the pipe a distance which is as much greater than the length of the stroke as the area of the piston is greater than the area of the pipe, hence movement of water in pipe per stroke:

$$\frac{4 \times 2{\cdot}75 \times 2{\cdot}75}{2 \times 2} = 7\ 3\text{in.}$$

If the pump is working at full speed, the water in the pipe must travel this distance in $\frac{1}{400}$ minute—*i.e.*, its average velocity must be 2,920in. per minute, or about 48in. per second (4ft. per second). This column never stops, but probably its velocity varies from 2ft. to 5ft., and therefore an acceleration of 3ft. per second must be imparted to it 400 times per minute—*i.e.*, in ·15 second. This is equivalent to producing an acceleration of 20ft. per second in one second. The force required to impart this acceleration to 300lb. of water is

$$\frac{20 \times 003}{32}$$

= 180 (32 = gravity acceleration). This force requires pressure of 60lb. per square inch added to the boiler pressure of 160lb. The friction losses in the pipe are small in comparison; they amount to about 2lb. per square inch.

In the delivery pipe the inertia causes increased work to the pump, but in the suction pipe it causes further troubles, especially with hot feed or long lifts, owing to the inability of the column in the suction pipe to follow the pump piston. Even with an elevated supply tank and cold feed water this trouble may arise, but with hot feed the trouble is very serious, owing to the vapour tension. In the case under the author's observation the feed water comes to the pump at about 200deg., which corresponds to 12lb. absolute, and leaves only 2¾lb. surplus of atmospheric pressure to assist the column. The supply has 12ft. head, but even then it was found impossible to maintain a steady feed without an air vessel on the suction side. An air vessel was tried on the delivery side, but the results were alarming—the pump ran away violently. Even with cold feed it is well to have an air vessel on the suction side, or an open standpipe if the supply tank is elevated.

Pump troubles are so serious, and pump efficiency is so low, that any study bestowed upon them is well invested, but the subject is of too wide a scope for a single paper, and hence the crankshaft pump and the flywheel pump have been ignored, as also the permissible lift of water-valves, piston packings for hot feed water, the author's attention being confined to seeking an explanation of the inefficiency of the small high-speed pump as compared with the large slow-moving feed pump.

## TRADE NOTICES AND NOVELTIES.

### Small Three-Phase Motors.

From the Lahmeyer Electrical Company, Limited, 109-111, New Oxford-street, London, W.C., we have received an illustrated description of their small three-phase motors—types D and Ds. These motors represent a recent departure, and are manufactured in eight standard sizes. The smaller sizes up to 1 h.p. are provided with squirrel-cage rotors, while the larger machines can be supplied with or without slip-rings, as may be required. The motors have end shield bearings and take up very little space. The slip-rings allow of inserting a resistance in the rotor circuit. They are mostly used if it is deemed inadvisable to start from the high-tension stator side or if a high starting torque without an excessive starting current is required. The slip-ring (Ds type) motors can be arranged to give 2 to 2½ times the normal starting torque with a starting current corresponding to about 2½ times the normal full-load current. On the other hand, the squirrel-cage (D type) rotor machines, without slip-rings, will give only a comparatively small starting torque. Their advantage lies in the fact that, with the exception of lubrication, they do not require any attention whatsoever. All the motors are fitted with improved ball bearings, manufactured by the Deutschen Waffen und Munitionsfabriken Berlin, whose agents in this country are Messrs. L. Loewe and Co., London. By means of these bearings the oil consumption and frictional losses are greatly reduced. It will be remembered that we described the principal features of their construction in our issue for Dec. 9 last.

### Lifts and Hoists.

Messrs. Archibald Smith and Stevens, of the Janus Works, Battersea, have forwarded us an excellently-illustrated and up-to-date brochure describing their specialities, which consist of electric and hydraulic lifts and hoists. The technical section discusses the merits of the various types, and gives comparative tables of working costs for electric and hydraulic lifts, which, we may remark incidentally, show a big margin in favour of the former. The new machines devised by this firm comprise direct-coupled, self-starting, and reversing lifts for operation by single-phase alternating current. In a recent test this lift performed 18 complete round trips per unit, raising 10cwt. to an altitude of 45ft. Other features are a single push-button switch, in which many of the usual adjuncts have been dispensed with, and an automatic parcels lift, which can be controlled entirely from one floor. The pamphlet testifies to the amount of attention Messrs. Archibald Smith and Stevens have devoted to improving this class of machinery.

### The Diesel Engine.

Some useful information relating to the Diesel oil-engine is contained in a new illustrated pamphlet issued by the Diesel Engine Company, Limited, 179, Queen Victoria-street, London, E.C. We note that the total horse-power of these engines installed is increasing very rapidly; further, that a unit of 500 b.h.p., coupled direct to a dynamo, will be exhibited at Liège this year. This is claimed to be by far the largest oil-engine ever turned out, but the makers evidently do not intend to rest, having, they tell us, engines respectively of 750 b.h.p. and 1,000 b.h.p. now under construction. As regards the special claims put forward for the Diesel engine, more particularly on the score of economy, we may leave the pamphlet in question to speak for itself.

### Litholite Bushes and Handles.

Messrs. Hunt and Hess, Litholite Works, The Grove, Hackney, London, N.E., have sent us copies of some new sheets showing standard litholite bushes and handles, together with their current price-lists. On the new sheets all the old patterns of the articles in question which have proved useful in the past will be found, besides a large number of new ones. The drawings are to full size scale, with the principal dimensions clearly indicated. We note that Messrs. Hunt and Hess now supply any suitable Whitworth screw with their handles at a uniform charge; also that they supply litholite in various qualities according to requirements. It is claimed that this material affords perfect insulation, and is unaffected by damp.

### Underfeed Stokers.

The various types of underfeed stokers manufactured for internally-fired and all kinds of water-tube boilers by the Underfeed Stoker Company, Limited, Coventry House, South-place, Finsbury, London, E.C., are fully described in a new pamphlet issued by this firm. The illustrations given enable their action to be clearly understood. Over 4,000 of the machines are now at work in various parts of the world we are told. Apart from the descriptive matter, the reports of tests showing important economies, included at the end, should make this pamphlet very useful for reference purposes.

### High-Speed Electric Drilling Machines.

Through the courtesy of Kramos Limited, Lockabrook Engineering Works, Bath, we are enabled to illustrate here-

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with two of the exceedingly handy types of electrical drilling machines manufactured by them. The "Midget" drill (Fig. 1) has a capacity up to ⅝in. holes, and weighs only 15lb. complete. The light weight of this tool is due to its being encased in a solid aluminium casting, while the magnets are of special high-permeability steel, and contain just sufficient metal to ensure the magnetic field required. The armature is also of special type, being longer in proportion to its diameter than is usual. The gearing is machine cut out of solid steel blanks. The drill spindle runs in a long bearing, and is provided with ball thrust plates. Special attention has been given to the brush gear in order to eliminate the possibility of trouble through vibration. The handles for holding the drill are of aluminium, being cast on to the casing. It is noteworthy, also, that the cover has been formed to serve as a breast-plate. An extra strong switch of quick make-and-break pattern is fitted to the machine. It is contained inside the aluminium casing, being actuated by means of a push-button which protudes through the casing, as shown in the illustration. This particular type of machine should prove most useful in repair workshops where a large number of small holes have to be drilled. Fig. 2 illustrates a Kramos "Runthru" drill. This tool is likewise encased in a solid aluminium casting, the inside of which is machined at one operation on a special lathe, with milling attachment, designed by the firm for the purpose. The magnets are of the Manchester type. Two magnet coils are provided, which are compound wound to give a speed variation of nearly 50 per cent. between no load and full load. This is a particular advantage when drilling holes of smaller diameter than 1in., as the speed increases automatically. Two reduction gears are provided. The pinion on the armature has a diameter of 1¼in., and the intermediate gear is of one piece of steel turned out of the solid, and, like the rest of the wheels, machine cut. Much care has been taken to obtain proper bearing and guidance of the drill spindle. A ball thrust bearing is provided. The brush gear and terminal plate are of special design, and all wires and connections inside the drill are embedded in insulated slots. The "Runthru" is capable of developing an output of 1 h.p., and will drill holes up to 1⅛in. diameter, the weight of the machine complete being 60lb. Another important feature of this drill is its small breadth, by

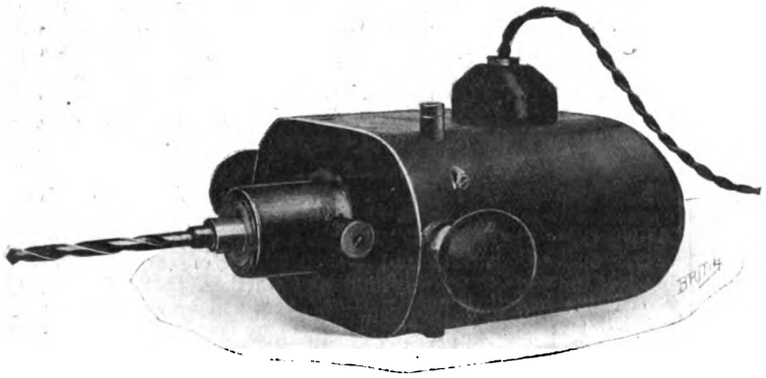

Fig. 1.—The "Midget" Drill.

Fig. 2.—The "Runthru" Drill.

virtue of which it may be used to drill holes in awkward places, the distance between the centre of the drill and outside of casing being only 2½in. With it the firm supply a starter of their original design, containing one Kramos patent resistance piece, a quick-acting switch, and an ammeter. The latter instrument is introduced so as to allow the drill to be run at its full output, and at the same time to prevent overloading. In other words, it enables the feeding pressure to be correctly adjusted when drilling. Every part of the machine is designed to withstand the maximum amount of rough usage to which such apparatus is commonly subjected. We understand that the firm are supplying the Admiralty with a specially designed magnetic brace for use with "Runthru" drills. These drills can be supplied for standard voltages up to 250 volts, direct current. Other interesting types are described and illustrated in the latest list of high-speed drilling machines issued by Kramos, Limited. They include the "Slick" drill, fitted with tapping device, and the "Dandy" drilling machine designed for operating drill heads by means of flexible or telescopic shafts, being particularly suitable for use in shipbuilding yards, railway or other large engineering works. Several magnetic braces designed for special work are also shown in combination with different drills. It remains to add that by specialising the particular class of apparatus under notice, Kramos, Limited, have rendered a considerable service to the British electrical industry. We trust an increasing measure of success will reward them for their enterprise.

## Catalogues, Calendars, etc., Received.

Calvert's Almanac, 1905. (John Heywood, Manchester.)—The thirty-second issue of this useful almanac and workshop companion teems as usual with industrial and interesting information for those connected with mechanical, electrical, engineering, building, and constructive trades.

Nalder Bros. and Thompson, Limited, 34, Queen-street, E.C., makers of N.C.S. measuring instruments.—Calendar and a descriptive card illustrating a new motor gauge which the firm have recently placed upon the market.

G. Clark and Sons, Limited, engineers, brass and iron-founders, Shipley, Yorks.

St. Helens Cable Company, Limited.—This company are circulating a number of picture postcards descriptive of their cables, tyres, wire, and rubber goods.

Power-Saving Pulley Company, 2, Weymouth-street, W., and Manchester and Birmingham.—A few remarks on the transmission of power by belting.

Jackson Bros., electrical engineers and contractors, Broadway and Herbert-street, Plaistow, London, E.

Robt. A. Thompson and Co., Limited, colonial publishers, 5, Tudor-street, E.C.

McClure and Whitfield, dynamo and motor manufacturers, Stockport.—A very serviceable pocket-book, containing, *inter alia*, a description and prices and particulars of the Mersey generator, multipolar type, from 40 kw. upwards, and Mersey ventilated enclosed, totally enclosed, and protected motors.

A. Ransome and Co., Limited, Newark-on-Trent, and 63, Queen Victoria-street, E.C., manufacturers of wood-working and sawmill machinery, cooperage machinery, and castings.

Robert Boyle and Son, ventilating engineers, London and Glasgow.

## NEW COMPANIES REGISTERED.

**A. G. Mumford, Limited.**—Capital, £50,000. Object: to acquire and carry on the business of A. G. Mumford, in Essex, as marine and general engineers, boilermakers, makers of and dealers in machinery, motors, and apparatus for the production and utilisation of electric power for light and other purposes. Registered office: Culver-street, Colchester.

**Shanghai Electric Tramways, Limited.**—Capital, £10,000. Object: to acquire, equip, maintain, and work by electrical, steam, horse, or other power tramways, railways, boats, and other means of communication in Shanghai or elsewhere in Asia, and to carry on the business of electricians, generators, accumulators, and distributors of electrical energy for light, heat, motive power, or otherwise, etc.

### Liens Registered.

**Electric Supply Company of Victoria, Limited, Liverpool.**—Lien registered Dec. 30 for £225,900 5 per cent. debentures, part of £200,000; amount previously issued, £75,000; no trustees; charged on all the property, present and future, the undertaking, goodwill, business, and uncalled capital.

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## STAND-BY CHARGES AND MOTOR LOAD DEVELOPMENT.

BY A. M. TAYLOR, MEMBER.

The following is a short abstract of a paper read on Dec. 14 before the Birmingham Local Section of the Institution of Electrical Engineers.

After discussing the relative costs of gas, oil, and electric motors, the author discusses the actual costs to the station of two representative classes of motor worked under present conditions. He then considers the question of developing the station load by offering exceptionally low rates for motors based on a restricted hours' clause, and investigates in some detail the extent to which such an offer could be carried. He gives a diagram (Fig. 1) which shows conclusively, by assuming almost extravagant proportions to the possible demand for power under such circumstances, that the bogey of "day fogs" is a risk that need not be

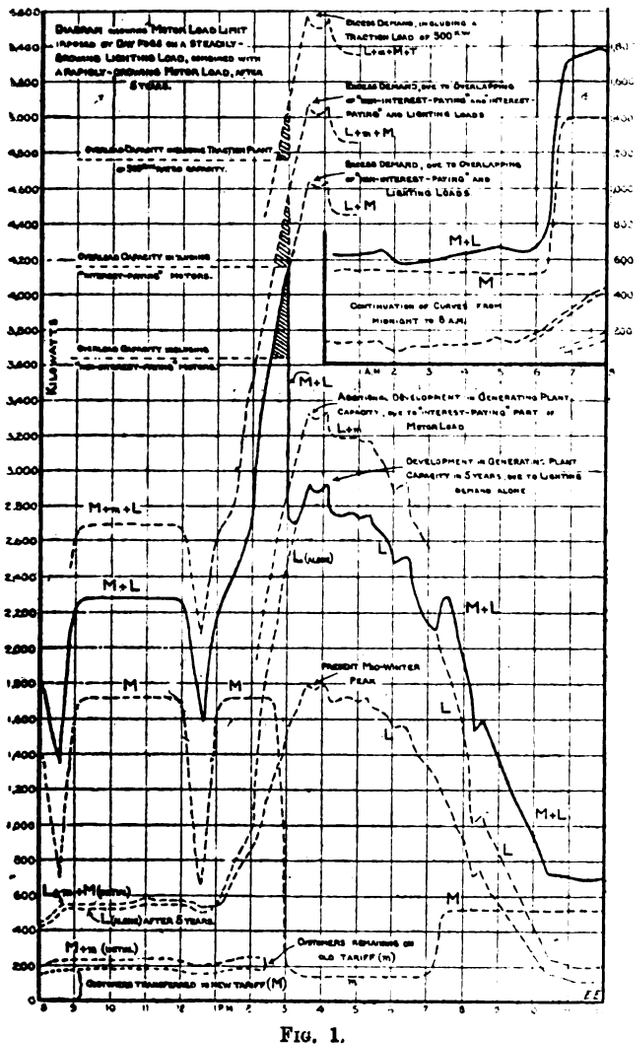


FIG. 1.

seriously considered in most towns. He analyses the charges at present made for lighting, and shows how much of this is often an interest charge on what he calls "unproductive capital," which he defines as "any capital expenditure, whether in plant or mains, which, if the station were started *de novo*, at present prices (and with present plant overload capacities), and put down with only sufficient margin to carry it safely over the next year or two, might be avoided." He gives a diagram to show how, under certain circumstances, stations having a large unproductive capital charge would be warranted in immediately reducing charges.

A diagram (Fig. 7) is given which is intended for central-station engineers, and is an attempt to represent the hourly rate of burning coal in terms of the kilowatts of output of that part of the load curve of the station which may be under consideration. The principle of the diagram is follows: Starting with direct-current kilowatts at 'bus bars, plot a curve connecting this with indicated horse-power, and a little below this curve plot another curve, nearly parallel to it, connecting kilowatts with electrical horse-power. The space enclosed between these two curves will then obviously represent the combined electrical and mechanical losses of the generator for different proportions of its load. Next, use the indicated horse-power scale as the scale of abscissæ, and for the scale of ordinates take pounds of steam delivered by the boiler per hour to the main steam range. Plot first a curve connecting steam consumed by the engine with indicated horse-power; then draw above this (in Fig. 7 it is shown at foot) a line representing excess steam necessary on account of steam feed pumps, then a line above this (also shown at foot in Fig. 7) representing condensation losses in steam-pipes to boiler and engine and in main steam range, then again a line above this representing steam consumed by the air and circulating pump engines. Lastly, take the scale of steam per hour and use it as a scale of abscissæ and set off a scale of pounds of coal per hour as ordinates, and draw a curve connecting these. To settle what scale to employ for the total pounds of coal per hour, we must first decide what evaporation to allow per pound of coal at full load of the boiler. The author has taken a figure of 7·68lb. for feed, as received from economiser, to pressure at, say, 160lb.; but this is a figure which each engineer must determine for himself, as it of course, depends on the coal used and the economiser and boiler efficiency. We now have a combination of three diagrams, and starting with any output in kilowatts, we can readily trace round through the three diagrams to the coal consumption per hour. We can also see the exact effect of "stand-by losses" in engines, dynamos, pipework, condensers, feed pumps, boilers, etc. The diagram is constructed for a station with three sets of 600 kw. each, two sets of 300 kw., and four groups of boilers, each generating steam for 600 kw. of plant. Suppose, now, that we had no battery in the station, and that, at a certain hour of the night, we had only a few amperes leaving the station—fortunately an unpractical condition—requiring, however, that at least one boiler be kept under full steam, and one dynamo maintaining 'bus-bar pressure, we find from the diagram that the stand-by losses are: indicated horse-power = 120; steam per hour = 6,000lb.; coal per hour = 900lb. This is for a boiler whose characteristic curve is given by the author, and an engine of 375 kw., triple expansion, by W. H. Allen and Co.

The author does not put forward any of the figures in Diagram 7 as final. He suggests that each station engineer may construct such diagrams to suit his own plant, and obtain from the engine, boiler, and pump makers curves for the apparatus they supply. If he then combines these, and finds that the pounds of coal per hour, taken for any convenient part of his load curve whatsoever, differ *radically* from that which he is really burning, he will be justified in commencing a search to know the reason why. It is here that the diagram will help him, for there are certain losses in it which must be substantially correct, or their cause would be easily detected. Again, there are others, such as steam-pipe radiation, which cannot be materially different from the plotted values; others, again, whose values, of themselves, are too insignificant to account for his discrepancies, and so on.

The author also gives two tables calculated from this diagram and from Figs. 2 and 4 of his paper, giving coal consumptions for the months of December and July, one of which—that for December—we reproduce. The curve in Fig. 2 of the paper off which this table is calculated is the same as that marked "present mid-winter peak" in Fig. 1, and we do not, therefore, reproduce Fig. 2. In an appendix the author considers more fully the principle on which he constructs Fig. 7 of his paper, and the way in which the diagram correctly represents the steam consumptions, etc., with a number of engines and boilers in parallel not all sharing the load equally.

At the meeting the author also exhibited a diagram (Fig. 7A), reproduced herewith, which is virtually the central part of his Fig. 7 considerably enlarged, which explains the elements of the diagram better than does the original Fig. 7, which is on a much smaller scale. This illustration Fig 7A differs from Fig. 7 in that some of the smaller losses, such as those due to the common steam main

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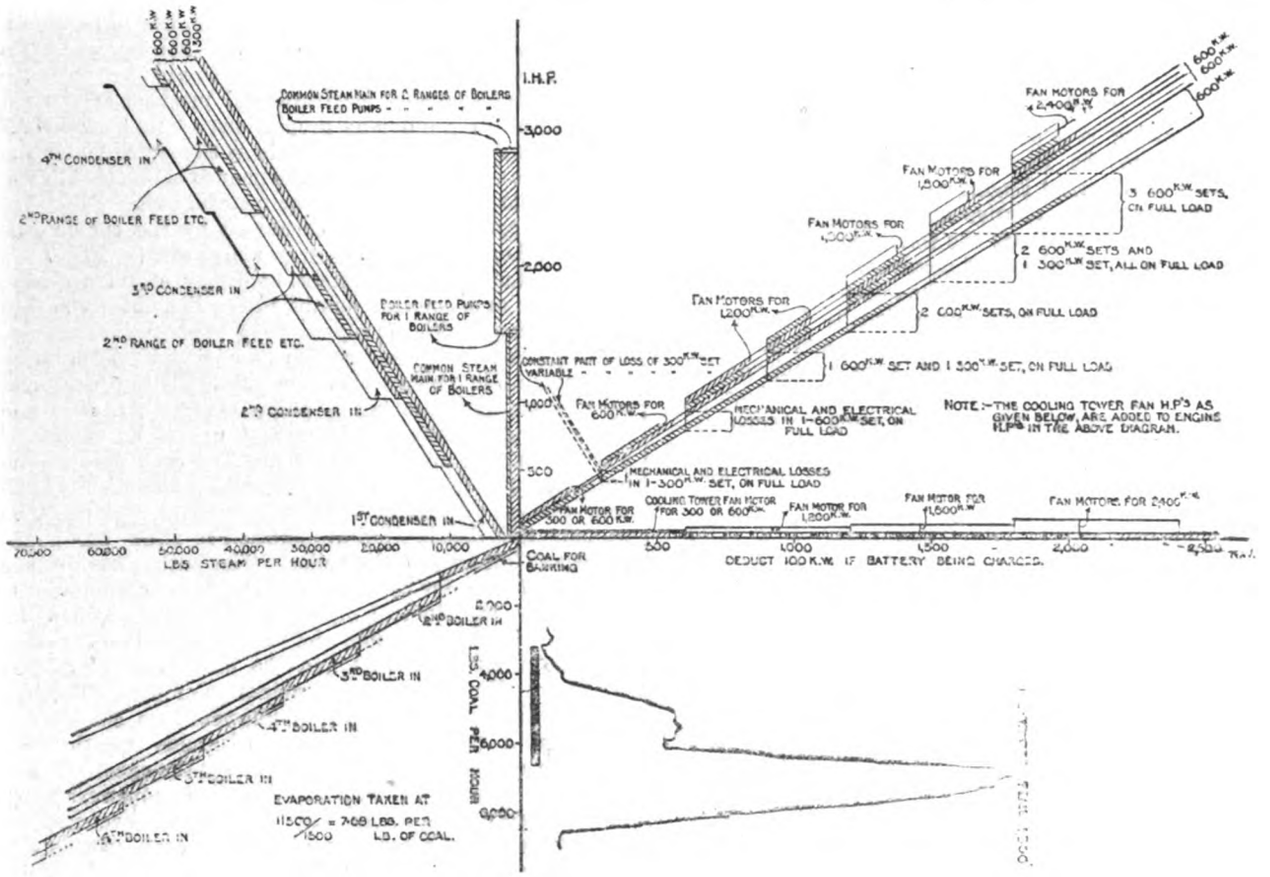


. .— m for ascertaini g graphically the Coal Consumption of a Generating Station at any load.

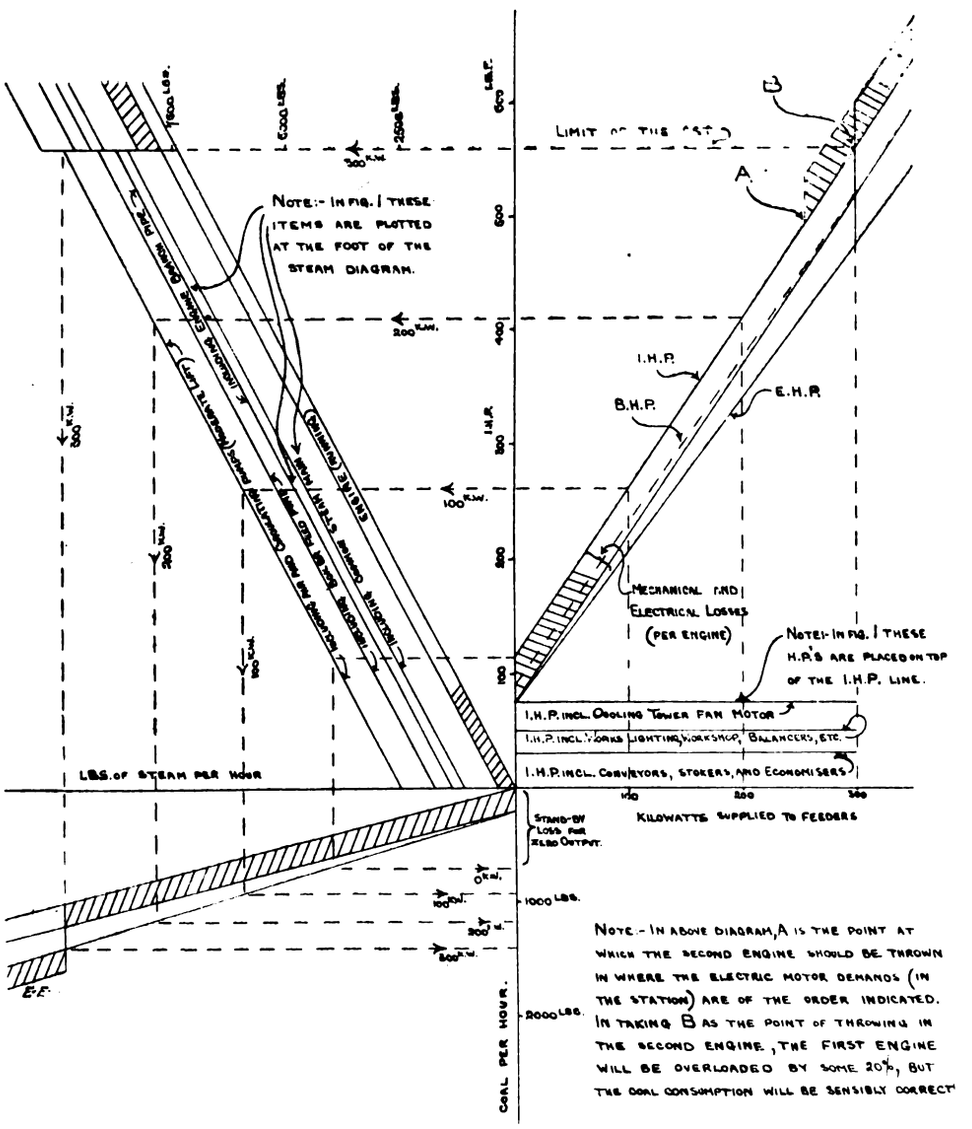


Fig. 7A.—An enlarged piece of Fig. 7 to illustrate more in detail Mr. Taylor's method.

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## COAL CONSUMPTION FOR DECEMBER.

A.—*On Existing Output.*

| Peak and evening load (3·10.30 p.m.) | | | | Day load (6.30 a.m. to 3 p.m.) | | | | Night load (10.30 p.m. to 6 30 a.m.) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Number and capacity of engines running. | Number and capacity of boilers— (R)=running. (B)=banked. | Hours of running. | Coal per month (tons). | Number and capacity of engines running. | Number and capacity of boilers— (R)=running. (B)=banked. | Hours of running. | Coal per month (tons) | Number and capacity of engines running. | Number and capacity of boilers— (R)=running. (B)=banked. | Hours of running. | Coal per month (tons). |
| Kilowatts. | | Hours. | Tons. | Kilowatts. | | Hours. | Tons. | Kilowatts. | | Hours. | Tons. |
| 3×600 | 6 R, 1 B | 1 | 78·5 | 1×600 | 2 R, 5 B | 2 | 59 | 1×300 | 1 R, 6 B | 1½ | 28·2 |
| 3×600 | 6 R, 1 B | 2 | 157 | 1×600 | 2 R, 5 B | 4½ | 139 | 1×300 | 1 R, 6 B | 6½ | 114 |
| 2×600, 1×300 | 5 R, 2 B | 2 | 133 | 1×600, 1×300 | 5 R, 2 B | 1 | 44·5 | | | | |
| 1×600, 1×300 | 4 R, 3 B | 1 | 43 | 2×600, 1×300 | 6 R, 1 B | 1 | 66 | | | | |
| 1×600 | 2 R, 5 B | 1 | 27·3 | | | | | | | | |
| 1×300 | 1 R, 6 B | ½ | 18·8 | | | | | | | | |
| | | Total... | 457·5 | | | Total... | 308·5 | | | Total... | 142 |

Combined total = 908 tons per month. Units generated = 390,000 per month. Coal per unit = 5·22lb.

B.—*With Increased Motor Load (Four Years).*

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3×600 | 6 R, 1 B | 1 | 78·5 | 2×600 | 4 R, 3 B | ½ | 25 | 1×600 | 2 R, 5 B | 1½ | 41 |
| 3×600 | 6 R, 1 B | 2 | 157 | 2×600 | 4 R, 3 B | 1 | 54·8 | 1×600 | 2 R, 5 B | 6½ | 177 |
| 2×600, 1×300 | 5 R, 2 B | 1 | 67·8 | 2×600 | 4 R, 3 B | ½ | 25 | | | | |
| 2×600, 1×300 | 5 R, 2 B | 1 | 67·8 | 2×600, 1×300 | 5 R, 2 B | ½ | 28 | | | | |
| 2×600 | 4 R, 3 B | 2 | 100 | 2×600, 1×300 | 5 R, 2 B | 3 | 197 | | | | |
| 1×600 | 2 R, 5 B | ½ | 14·2 | 2×600, 1×300 | 5 R, 2 B | 1 | 65·5 | | | | |
| | | | | 3×600 | 6 R, 1 B | 1 | 76·0 | | | | |
| | | | | 3×600, 1×300 | 7 R | 1 | 99 | | | | |
| | | Total... | 485·3 | | | Total... | 570·3 | | | Total... | 218 |

Combined total = 1,273 tons per month. Units generated = 641,000 per month. Coal per unit = 4·45lb.

and branch to engines, to the boiler feed pump, and to the cooling tower motor fan, are plotted differently. The first two losses are plotted below the engine diagram, and the last is plotted above the dynamo diagram, in Fig. 7, which is the more correct, though perhaps not so suited for explanatory purposes as the present diagram. In Fig. 7 the second set is shown thrown in when the kilowatts supplied to feeders reaches 300 kw., indicated by the point B on the Fig. 7A. More correctly, it should be shown thrown in at the point A, as the first engine has to supply current for all the motors, etc., in the station before any is available for the feeders, and would be overloaded by some 20 per cent. The discrepancy so introduced does not invalidate the coal consumption readings materially, for the extra indicated horse-power to drive the dynamo which supplies current to the motors is taken account of; and the discrepancy is reduced with each succeeding engine thrown in. It will be noted that the various losses are duly added together, so that for zero output on the feeders 700lb. of coal are consumed per hour. This method of representing the combined losses of several engines and boilers, etc., running at varying proportions of their load, as shown in the present diagram, is of great practical service to station engineers.

[The author requests us to say that he has still a few copies of the paper left, which he will be pleased to send to any station engineers who are interested.—ED. *E E*]

Mr. Taylor, during the reading of his paper, gave the following additional information. He laid stress on the importance of the diversity factor, and said that he found it to be equivalent to the reciprocal of the load factor for the individual motor under consideration, illustrating his meaning by diagrams. He said that the system of charging a low rate to consumers who agreed to take no current for motive power between certain fixed hours during the winter months had proved a great success in Montreal. About 30 per cent. of the total horse-power connected is charged solely on this basis. The charges vary from £9. 12s. to £13 per horse-power annum. The system had been in operation four years, during which time it had not been found necessary to adopt precautions to ensure the switching off of the load at the stated times beyond those mentioned in the paper. They also sell power to small consumers for intermittent use at 1d. per horse-power hour, plus a fixed annual charge of £8 per horse-power intalled. The load factor at Montreal for the month of June was 75 per cent., and was practically the same throughout the year.

### DISCUSSION.

**Dr. W. E. Sumpner** congratulated Mr. Taylor on his paper, and referred to the importance of the subject. With reference to the figures quoted as to relative cost of gas, petroleum, and electric power, he said that these were subject to debate, but that they did not greatly affect the question, because electric motor development was delayed, not so much by the competition of good rival systems, as by the reluctance of owners of old and bad plant to change to a more efficient system. The amount of coal wasted in such old plants, say in the Birmingham district, was enormous, the total waste of coal throughout the country from this cause being probably greater than the amount exported. What they had to deal with was the consideration of how a well-arranged and well-designed station could, without loss, develop a motor load. Mr. Taylor had ably discussed in a scientific manner a method of determining the actual cost of the load at any time of the day, a method which should be extremely useful to engineers.

**Mr. J. E. Vaudrey** said that he had always been much interested in the supply of electric power, and he appreciated the amount of trouble and labour that the paper had evidently entailed. The proposal to cut off the peak of the load presented difficulties. It was not possible to conceive that the average works would be willing to shut down as had been proposed, especially as the amount of energy used forms only a small proportion of the total works cost. Even supposing the peak load to be cut off, he did not believe it possible to bring the charge below 1d. per unit. This is considered to be a bare price even for a traction load. He regarded the suggestion to instal accumulators on consumers' premises, especially on the small scale proposed, as impracticable. Had it been feasible, it would have been done long ago. With reference to the figures quoted by Mr. Taylor in connection with the Montreal supply scheme, he did not consider

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£9. 12s. per horse-power annum as at all a cheap rate under the circumstances.

**Mr. J. A. Jeckell** (Coventry) questioned Mr. Taylor's assumption that 1 b.h.p. required one unit of electrical energy. At Coventry, where the average price obtained for motive power was 1·3d., the revenue obtained was only ½d. per brake horse-power hour. Lubrication in the case of a gas-engine is a big item, frequently 10s. per brake horse-power annum. In the case of electric motors it is small. As regards interest on capital, Mr. Taylor's figure of ·31d. per brake horse-power annum for a 17-h.p. motor working 2,500 hours gave £54. 17s. 11d. per year. He could buy such a motor for £57. He knew an instance in Coventry of a 15-h.p. gas-engine being replaced by a 15-h.p. motor. In the former case, allowing for interest and depreciation, and gas at 2s. 6d. per 1,000, the cost was ½d. per brake horse-power. The motor was hired from the supply company, and allowing for rent and energy at 1¾d. per unit, the actual cost per brake horse-power was ¾d. He did not see why the restricted hours' system should not be offered to consumers, but the special circumstances existing in each town would have to be considered. In Coventry it would not answer, as the chief trade is a season's trade. They never have the full motor load superimposed on the lighting load. Many motors were off at 5.30, and the top lighting load did not occur till 7.30. Wages and repairs should have been considered, as here the advantage lay with the electric motor. All things considered, the figures given by Mr. Taylor did not show electric driving in anything like so favourable a light as they should do.

**Mr. R. P. Wilson** (London) said that Mr. Taylor had shown that electricity could be profitably supplied to continuously-loaded motors at a price which would compete favourably with other prime movers, provided that this supply was not saddled with interest charges; and it therefore followed that within practical limits it could compete for intermittent loads. The actual load factor of such prime movers need not be considered. Such a load—*i.e.*, one that did not overlap lighting or necessitate capital expenditure—was nothing more than a by-product. If gas companies' by-products were saddled with the cost of production on the same lines, there would be no market for them. At Blackheath they were supplying electricity to several large firms at 2d. per unit, except between 5 and 10 p.m., when the price was 6d. He thought these prices financially disastrous as compared with 7d. or 8d. for two hours and 1½d. for 22 hours. At Dudley 6d. and 1½d. had been adopted. He found that manufacturers could almost always alter their hours to suit the price of power. If it was correct to say that the revenue from any class of consumer should be proportional to the plant they monopolise, then the time switch produced the desired result, as was shown by the following figures relating to Dudley: current consumed by shop, 25 per cent. of total; plant monopolised, 43·5 per cent.; revenue provided, 42·7 per cent.

**Mr. C. E. C. Shawfield** (Wolverhampton) could not agree with the pessimistic view that the author had taken as regards cost of electrical energy. He considered it commercially safe to offer a low price for motive power. At Wolverhampton the cost of production was much less than that mentioned. He did not agree with Mr. Vaudrey's statement that a tramway load was more profitable than a motor load, as he found the load factor was greater in the case of motors than for tramways. He criticised Mr. Taylor's statement that the load factor was the reciprocal of the diversity factor. At Wolverhampton the diversity factor was about 2, but the load factor was certainly not 50 per cent. The author's stand-by loss diagram should appeal to station engineers on account of its simplicity.

**Mr. Pringle** (Burton-on-Trent) referred to the question of fuel costs. In connection with this, he thought that allowance should be made for the fact that the boilers were not forced during the day to the extent they were at times of heavy load. They could therefore burn a cheaper grade fuel during the day. The total charge to consumer of ¾d. per unit, estimated by Mr. Taylor, was, he thought, a very safe value, which he considered might well be reduced. Mr. Pringle also wrote to suggest that the £270 additional capital outlay at generating station per kilowatt at motor was high. Many stations six to ten years old could to-day provide plant at station and allocate a fair proportion for mains at a much less figure than £270 per kilowatt.

**Mr. E. A. Chattock** (Birmingham) had been much interested in Mr. Taylor's paper. He would have liked a fuller explanation as to what was meant by continuous and intermittent loads for motors. At Bradford they had had a scale of 1d. for continuous and 2d. for intermittently loaded motors. By continuous they meant that the motor must be running all day, whether actually loaded or not. He had known people to run all day on no load in order to obtain the low rate. The average rate was 1¾d. Under these conditions they found that the motor load just paid for itself. He had suggested a sliding scale based on the amount of current consumed per horse-power per quarter. This system was tried for a short time, but consumers did not like it, and elected to go back to the old rate of charge. He felt sure that a charge of 1d. per unit without restrictions would not pay. It might at first, but after the load had developed the average price received per unit would fall to too low a value. Switching off consumers at certain hours might do in trades where firms can pick their men. He ventured to think that the good results obtained in Montreal are traceable to the fact that they have no trades unions as we have. The trades unions insist on the men working certain hours, which hours overlap the peak of load curve. Another point not yet referred to was that gas companies do not restrict the hours during which gas-engines may be run. Mr. Taylor referred to traction load in time of fog, saying that when the people are using the trams they could not be in the workshop. He would also point out that during fogs less trams were run, so that this class of load was then reduced. He did not agree with the scheme of putting in cells to tide over the peak load. He believed this had been tried by a London company, but had been discontinued, as after two years it was found that most of the cells were ruined. He suggested the hiring out of motors to consumers. Very good motor loads had been secured in this way. There were 600 to 700 motors on hire at Bradford.

**Mr. Morcom** considered that there was a strong case against shutting down at certain fixed hours. He had some figures relating to a factory in which the machinery was driven by electric motors. For every £1 of manufactured goods sold they consumed about one unit of electrical energy. As one of the chief things that has to be looked to is to get stuff out of hand quickly, there would have to be a proportionally heavy drop in cost per unit in order to make it worth the while of a manufacturer to shut down his works. His experience was that the number of units used in machine shops was being continually pushed up on account of the higher speeds of working now adopted.

**Mr. Fennell** (Wednesbury) said that the proposal to supply electricity to day users only at a low rate has been carried out for the past nine months (since commencement of supply) at Wednesbury, and that two-thirds of their motor load is already supplied on that system. To the long-hour user they offer as an alternative the maximum demand system. They had no difficulty in connection with time of cutting off. The electrically driven clock switch of the Reason Company was very satisfactory. It might also be made to act as a throw-over switch in connection with a two-rate meter, where the motor was required occasionally in the evening, a rate of 4d. or more being then charged. In Wednesbury there are a great many intermittent users who may be reached by the special day-load terms, such as corn merchants, pork butchers, breweries, laundries etc. There was little doubt in his mind that the actual field of the electric motor will be restricted to the short-hour and small-power consumer. In dealing with large manufacturers he had found a difficulty in honestly recommending them to take electricity even at 1d. per unit where it is proposed to run a 50-h.p. motor, say, 60 hours per week, at an average load of, say, 30 h.p. A suction producer plant will, in such a case, run with practically no attention, and cost of fuel at Wednesbury will not exceed ¼d. per unit.

**Mr. Holden** said that in most works there was a certain proportion of motors that ran intermittently, and it was always possible to arrange to cut these off at certain fixed hours during the day. He thought that though few manufacturers would turn out existing engines to instal motors, yet many would put in a motor when extending, and in this way drive a number of intermittently-loaded machines. He could name a number of cases where he thought the proposed low rate, with restrictions, would be acceptable. In some wood-working factories the machinery was only used three or four days per week; and in cases where power was required out of doors—hoisting, for instance—the machinery was only used during daylight hours.

**Mr. Arthur Wright**, in a written communication, referred to the success of the Reason Manufacturing Company's time switch at Brighton and other towns. At Brighton there were now 225 of these instruments in actual use. He did not agree with the author in reference to the diversity factor, as he considered that it would vary from a figure over 10 in the case of lift motors, down to 1 in the case of pump motors. This question of diversity factor could not be treated except by the method of probabilities. He considered 5 as a better average figure than 1½. In reference to the author's remarks respecting fog loads, it was an interesting fact that at Stepney, during the darkest fogs they had had this winter, the fog peak had never equalled the evening peak.

In a written communication, **Mr. Christie** (Brighton) said the system they used was most successful in every way. They fortunately had a large and steady demand for lighting in the evening, and the standing charges being met by the higher rate charged for this lighting, they could, at a profit to themselves, supply as much current at 1d. per unit as their day-load consumers liked to use, as they had simply to pay for coal, repairs, and attendance, which was easily covered by the sum charged. He did not know exactly what proportion of 1d. units were sold, but he estimated that it amounted to close upon three-quarters of a million units, which they would otherwise never have obtained, and which had a material effect in reducing the running costs.

**Mr. George Wilkinson**, of Harrogate (communicated), did not agree with the figures regarding gas consumption upon which Mr. Taylor had based his comparisons. Was Mr. Taylor aware of the wonderful advances made in the economy of working gas-engines? He referred to the suction gas plant, by means of which gas is produced in a very simple form of producer by the suction of the engine piston itself. Only recently he paid a visit to works where one of these plants was in operation. The engine was a 25 h.p., and the gas producer supplying its gas fuel was a very simple apparatus indeed, with no moving parts, the selling price of which was £90. This producer and engine was giving 1 b.h.p. per hour for fuel costing ⅛d. when using anthracite coal in the producer, and the engine had been running three months without any attention whatever. In his opinion the power companies have more to fear from competition introduced by the ordinary gas-engine and suction producer plant than from any other competitor, and it was difficult to see how, in face of such practical results as he had quoted, the power companies were going to enter into successful and profitable competition. He had had considerable experience with the Diesel oil-engine, having had one under his supervision for nearly two years; but its economy was not better than the case he had cited, and the capital cost was much greater than for an ordinary Otto gas-engine, plus the suction gas plant.

**Mr. Taylor** made the following remarks in his reply to the discussion. With reference to the objections that had been raised to cutting off the supply at certain fixed times, he thought the best answer he could give was to call their attention to the places where this system had been successfully adopted. At Brighton they were selling 750,000 units simply and solely by this method, using time switches made by the Reason Manufacturing Company. In Montreal 30 per cent. of the motor load was connected on this system. The

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motor load was something approaching 18,000 kw., so that meant about 5,000 kw. so connected. In reply to Mr. Jeckell, he had assumed, for the purpose of comparison, that 1 b.h.p. required one unit. Mr. Jeckell's figures worked out to ·385 unit per horse-power hour, which seemed to point to his having over-estimated the number of horse-power hours obtained from his motor, as even ·746 unit per horse-power hour gave an efficiency of 100 per cent. Mr. Jeckell's deductions from his figures for capital cost charge were also four times too high as he had omitted to note that the motor, as stated in the paper, was working on the average at a quarter of its full load. In reply to Mr. Shawfield, he might say that in calculating the charge to the consumer under case 1 he had considered a small lighting station of 2,000 kw. capacity, with no traction load. He had taken ·7d. as being an average figure for the works cost; but if this could be reduced, the charge per unit could be improved upon. Mr. Shawfield had misunderstood him about the diversity factor. It is only the extreme possible limit of the diversity factor (for a particular class of motor) which is the reciprocal of the load factor, the latter being taken only over the working day, not over the night as well. The actual diversity factor will be anything between unity and this limit. If the limit, for example, is 4, as in case 2 of the paper, it is extremely unlikely that the actual figure will reach 2, and hence 1·5 is a safe value to estimate upon. In reply to Mr. Morcom, the author said that the proposed system of charging was now actually in use on a large scale, which showed that it was quite practicable. Mr. Fennell's remarks bore testimony to the success of this method; and the instances he had mentioned as likely customers might all use power up to 30 h.p., as at Brighton. In reply to a written communication from Mr. Pringle, Mr. Taylor said that the figure he had assumed of £70 per kilowatt in Fig. 9 was for cost of new station and mains, not for cost of extending, but probably the latter was the more correct way of looking at it. In reply to Mr. Wilson, he wished he could endorse his statements; but all he claimed in the paper was that for intermittent loads, and for units not larger than 5 h.p., electricity made the best showing. Only in favourable cases would continuously-loaded motors show so well. As regards Blackheath, he thought that it was a most unsafe proceeding to allow consumers to remain on the cheap rate till such a late hour as 5 p.m., and he understood that at Aston, at any rate, the motor and lighting loads had clashed to a very considerable extent. It was very desirable to know the consumer's diversity factor as well as his load factor; not necessarily with a view to charging him at a different rate, but in order that the cost to the station of each consumer should at least be accurately known, so that, if a flat rate be adopted, the most favourable class of load may be diligently fostered.

## APPOINTMENTS VACANT.

**Assistant in Charge of Meter Department,** Hammersmith. Commencing salary, £2. 10s. per week. Applications by Jan. 18. See advertisement in last issue.

**Three Electrical Engineering Assistants,** City and Guilds Central Technical College. Salaries commencing respectively at £200, £150, and £150 per annum. Apply to Prof. Ayrton, Exhibition-road, London, S.W. See advertisement in last issue.

**Second Assistant Electrical Engineer,** Bradford. Salary, £250 per annum. Applications by Jan. 19. See advertisement in last issue.

**Improver,** Stretford Urban District Council. No premium required. See advertisement in last issue.

**Switchboard Attendants** Wages, 20s. per week. See advertisement in last issue.

**Electrical Adviser.** The Secretary of State for India has sanctioned the appointment of an adviser on electrical matters to the Government of India at a salary commencing at £70 per month, rising to £110. Private practice will be allowed, but not for municipalities or district boards, as it will be part of his regular duties to advise such bodies.

**Switchboard Attendant,** Devonport electricity works. Wages, 30s. per week. Applications to the Borough Electrical Engineer. See advertisement.

**Shift Engineer,** Reading tramways power station. Salary to commence at 35s. per week. Applications by Jan. 18 to the General Manager and Engineer. See advertisement.

**General Manager,** Southampton tramways. Salary £400 per annum, rising by £25 a year to £500.

**Assistant Electrical Engineer.** The Electric Lighting Sub-Committee of the Whitby Urban District Council have recommended the appointment of an assistant electrical engineer to take full charge in the absence of Mr. L. H. King, resident engineer, at a commencing salary of £104, rising by annual increases of £4 to £120 per annum.

## PERSONAL.

The President of the Board of Education has appointed the Right Hon. R. B. Haldane, K.C., M.P., to be chairman of the Departmental Committee which is enquiring into the present and future working of the Royal College of Science and Royal School of Mines, South Kensington, in place of Sir Francis Mowatt, G.C.B., late Secretary to the Treasury, who, while remaining a member of the committee, has resigned the chairmanship owing to complications having supervened on his illness which were not previously anticipated.

The Middlesbrough Corporation have decided to advance the salary of Mr. Telford, chief assistant of the electricity department, from £150 to £165 per year, and the salary of Mr. Scotson, mains superintendent, from £2. 5s. to £2. 10s. per week.

The South Metropolitan Electric Light and Power Company, Limited, inform us that Mr. Wm. May, of 18, Austin-friars, has been appointed a director of the company.

Mr. Lewis D. Landay, an American electrical engineer, who has been resident in London for a number of years, has been appointed general manager of the Singapore Electrical Tramways Company.

The Chesterfield Town Council have appointed Mr. R. L. Acland, the electrical engineer, to the joint offices of electrical engineer and manager of the tramways department at the salary of £350 per annum, rising to £400 at the expiration of a year if satisfactory.

Mr. R. B. Leach, late chief assistant engineer, has been appointed chief electrical engineer and manager to the Farnworth Council.

Mr. J. H. Fooks Bale has commenced his duties as electrical engineer and tramways manager at the Urban District Council electricity works, Walthamstow.

Mr. A. V. Wardrop, formerly of the Corporation electricity works, York, has been appointed electrical engineer to the Elland Urban District Council.

## FORTHCOMING EVENTS

FRIDAY, JAN. 13.

**Tramways and Light Railways Association.**—At 8 p.m., "Overhead Equipment," by Mr. H. M. Sayers.

**Junior Institution of Engineers.**—At 8 p.m., "The Theory of the Incandescent Mantle," by Prof. Vivian B. Lewes.

**Institution of Electrical Engineers (Manchester Students' Section).**—"Electric Heating," by Mr. A. E. Jepson.

**Institution of Civil Engineers (Students' Section).**—"Theory of Electricity and Magnetism," by Mr. J. Swinburne.

SATURDAY, JAN. 14.

**Birmingham Electric Club.**—At 7.30 p.m., "Aluminium and its Electrical Properties," by Mr. W. Smith.

MONDAY, JAN. 16.

**Tramways and Light Railways Association.**—At 3.30 p.m., visit to the works of the Central London Railway Company, Oxford-circus Station.

TUESDAY, JAN. 17.

**Institution of Civil Engineers.**—At 8 p.m., "The River Hooghly," by Mr. L. F. Vernon-Harcourt.

**Institution of Electrical Engineers (Manchester Section).**—At 7.30 p.m., "Electric Driving in Textile Factories," by Mr. H. W. Wilson.

WEDNESDAY, JAN. 18.

**Society of Arts.**—At 8 p.m., "Wireless Telegraphy and War Correspondence," by Captain Lionel James.

**Chemical Society.**—At 5.30 p.m., general meeting.

**Royal Meteorological Society.**—At 7.30 p.m., "The Connection of Meteorology with other Sciences," by Captain D. Wilson-Barker.

**Institution of Electrical Engineers (Students' Section).**—At 7.30 p.m., "The Construction and Maintenance of Large Telephone Exchanges," by Mr. A. L. Stanton.

THURSDAY, JAN. 19.

**Rugby Engineering Society.**—At 8 p.m., "A Novel System of Electric Traction," by Mr. H. S. Meyer.

FRIDAY, JAN. 20.

**Institution of Mechanical Engineers.**—At 8 p.m., "Some Impressions of American Workshops," by Mr. A. J. Gimson; "Waterworks Pumping Engines in the United States and Canada," by Mr. John Barr; "Some Features in the Design and Construction of American Planing Machines," by Mr. A. Kenrick, jun.; "Engines at the Power Stations and at the St. Louis Exhibition," by Mr. Alfred Saxon.

**Royal Institution.**—At 9 p.m., "New Low-Temperature Phenomena," by Sir J. Dewar.

**North-East Coast Institution of Shipbuilders and Engineers.**—At Newcastle, general meeting.

SATURDAY, JAN. 21.

**Glasgow Technical College Scientific Society.**—At 7.30 p.m., "Notes on Tool-Room Organisation and Practice," by Mr. G. Blair.

Jan. 25.—Birmingham Section (postponed from Jan. 18).

Jan. 27.—Municipal and County Club, house dinner.

Jan. 27.—The following papers will be read at the Physical Society: "Action of a Magnetic Field on the Discharge through a Gas," by Dr. R. S. Willows; "Action of Radium on the Electric Spark," by Dr. Willows and Mr. J. Peck; "The Slow Stretch in India-rubber, Glass, and Metal Wires when subjected to a Constant Pull," by Mr. J. Phillips; "Determination of Young's Modulus for Glass," by Mr. C. A. Bell; and "Some Methods for Studying the Viscosity of Solids," by Dr. Boris Weinberg.

**Lancashire and Yorkshire Railway Company.**—At a special meeting of this Company held at Manchester on Wednesday, proposals for merging the 3 per cent. preference stocks of 1897 and 1899, amounting together to £22,724,000, with the consolidated preference stock, amounting to £22,676,900, were adopted.

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# LEGAL INTELLIGENCE.

## EMPLOYERS' LIABILITY ACT.

At the Brompton County Court on Tuesday, before Judge Stonor and a jury, Burt Scott Phillips, electrical fitter, brought an action under the Employers' Liability Act against the Underground Electric Railway Company. The plaintiff's claim was in respect of personal injuries said to have been sustained owing to negligence on the part of the defendants.

Plaintiff was assisting in raising some heavy iron pipe sections on to a temporarily constructed staging. He had been ordered by the "charge hand" to get upon the staging, so as to be ready to also assist in placing the section in proper position. The pipe had been raised a little higher than the staging when the rope suspending it suddenly broke. The fall of the pipe caused the staging to collapse, and plaintiff and two other men fell some 30ft. on to a cement floor.

**Counsel** for the defendant admitted that the rope was unfit for the job, but he submitted that the plaintiff himself was guilty of contributory negligence in having selected and used the rope in question.

The **Plaintiff** bore out his counsel's opening statement, and in cross-examination maintained that it was not a fitter's duty to select the rope in such work as that in question, except when there was no "charge hand." He denied having been promoted to the position of a "charge hand."

For the defence, **Stephen Mathison**, the "charge hand" referred to, said it was the duty of a fitter to see that proper ropes were used in the work, but if the fitter had any doubt about the fitness of the rope, it was his duty to refer the matter to the "charge hand." The plaintiff on the occasion in question did not refer to him any question about rope.

The jury returned a verdict for the plaintiff, assessing the damages at £200.

## TRAMWAY ACCIDENT.

At the Bradford County Court, before his Honour Judge Bompas, K.C., James Arthur Firth brought an action against the Corporation to recover £30 for personal injuries alleged to have been caused by the negligence of the defendants. Mr. W. Walker appeared for the plaintiff, and Mr. Harold Newell represented the Corporation.

**Mr. Walker** stated that the plaintiff was driving across Leeds-road a horse attached to a one-horse block cart, such as is used by builders. As he was crossing from Thornbury-road to Thornbury-street a tramcar came along Leeds-road, travelling in the direction of Bradford. The car was 40 yards away when the cart was about to cross the tramlines, and there appeared to be plenty of time for the plaintiff to get over. Accordingly he proceeded to drive the horse across. He got clear of one set of metals and had almost cleared the second set, when the car came in contact with one of the "dogs," or buffers, that projected from each side of the cart. The plaintiff was in consequence thrown to the ground, and one of the wheels of the cart passed over his shoulder. He suffered injuries to the left hand, his shoulder, and other parts of the body. His forefinger was lacerated, and he was unable to attend to his work for eight weeks.

**Mr. Newell** intimated that there was no dispute about the injuries or the amount of the damages.

Evidence having been given in support of the plaintiff's case, **His Honour**, in summing up, remarked that there was no doubt that there was time for the plaintiff to get across the lines. He thought, however, that drivers of tramcars should allow a fair distance to a cart that was passing in front. He did not think this was a case of a horse suddenly turning stupid and stopping, and he must give his verdict for the plaintiff for the amount claimed.

## TRAMWAY FARES.

Thomas Wilkinson was summoned at Wallsend on Tuesday for having travelled on the Tyneside Tramway Company's service without paying his fare.

The defendant and another man entered a car at Gosforth, and Wilkinson paid for two 2d. tickets. When the car arrived at Bigges Main the conductor told them that was the end of the 2d. stage, and that if they were going on to Wallsend another penny from each would be required. The man with Wilkinson paid the extra 1d., but defendant refused.

**Wilkinson** denied that he had not paid the right fare as shown by the company's bills, contending that when he paid 4d. for the tickets at Gosforth he and his friend were entitled to travel to Wallsend.

The Bench fined defendant 10s. for refusing to pay the fare from Bigges Main to Wallsend.

**Defendant** said it was a serious miscarriage of justice.

The **Chairman** replied that Wilkinson could, if he thought fit, take the case to a higher court.

# CONTRACTS FOR ELECTRICAL SUPPLIES.

**Halifax.**—The Corporation invite tenders for coal conveyors. Tenders by Jan. 31.

**Tourney.**—Tenders are required for the electric lighting of the waterworks. Tenders by Jan. 20.

**Oporto.**—The Municipal Authorities require tenders for lease of their electric tramways. Tenders by March 15.

**West Hartlepool.**—The Corporation require tenders for additional 250-kw. set, with the necessary switchboard, panel, etc.

**Ghent.**—The Municipality require tenders for 15 electric cranes for the harbour works. Provisional estimate, £1,200. Tenders by Feb. 20.

**Paris.**—The Under-Secretary for Post and Telegraphs, 103, Rue de Grenelle, requires tenders for accumulator batteries. Tenders by Jan. 18.

**Bucharest.**—The Government require tenders for the annual supplies to the Regie for lighting materials and accessories. Tenders by Feb. 7.

**Kirkcaldy.**—The Town Council invite tenders for the extension of about 500ft. in length of the present East Pier. Tenders to the Town Clerk by Feb. 4. See advertisement.

**Giurgu (Roumania).**—Tenders are required for a concession to establish electric lighting in the town. Particulars may be obtained from the Mayor. Tenders by Jan. 28.

**Liria.**—The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

**Vienna.**—Tenders are required for telegraph and telephone materials. Particulars may be obtained from the K. K. Post Oeconomie-Verwaltung, Vienna. Tenders by Jan. 31.

**Madrid.**—The Department of Agriculture, etc., invite tenders for installation and working for 60 years of an extension of the electric tramways in the north of the town. Tenders by Feb. 25.

**Caen (France).**—The Prefect requires tenders for concession of a tramway from Eyes to Caen *via* Creully for goods and passengers. Particulars from the Prefect of Calvedos, Caen. Tenders by Feb. 1.

**Grimsby.**—The Corporation invite tenders for (No. 30) motors; (31) water-purifying plant; and (32) 12 months' supply of stores. Tenders for 30 and 31 by Jan. 23, those for 32 by Feb. 1. Particulars in advertisement columns.

**Port Elizabeth.**—Messrs. Davis and Soper, 54, St. Mary-axe, E.C., agents of the Municipal Corporation of Port Elizabeth, South Africa, invite tenders for various works in connection with the Corporation electricity supply undertaking. Tenders by Jan. 16, 1905.

**Pudsey.**—The Corporation invite tenders for underground electric mains, switchboard, etc. Specifications, etc., may be obtained on application to Messrs. Shepherd and Watney, consulting engineers, Greek-street-chambers, Leeds. Tenders to the Town Clerk by Jan. 20.

**Gravesend.**—The Education Committee invite tenders for the electric lighting of King-street National School. Specification and form of tender may be obtained on application to Mr. C. F. McInnes, Electricity Works. Tenders to Mr. H. H. Brown, town clerk, by 16th inst.

**London, N.**—The Metropolitan Asylums Board invite tenders for installation of fire-alarms at Northern Hospital, Winchmore Hill, N., in accordance with plan and specification prepared by Mr. W. T. Hatch, M.I.C.E., M.I.M.E., engineer-in-chief. Tenders by 10 a.m. on Jan. 24.

**Switzerland.**—M. R. Vontobel, of Winterthour, and M. Charles Probst, of Lucerne, have obtained a concession for the construction of a narrow-gauge electric railway from Meiringen to Gletsch. The total cost of the enterprise is estimated at £241,600; £219,600 is to be expended on rolling-stock.

**Swindon.**—The Corporation invite tenders for the supply and erection of one 30ft. by 8ft. Lancashire boiler with down-take superheater, steam, exhaust, and feed piping, etc. Tenders to be delivered before 10 a.m. on Tuesday, Jan. 24, 1905, to Mr. Robt. Hilton, town clerk. See advertisement in last issue.

**Drax (near Selby).**—Tenders are invited for electric light installation, also electric pump, etc., capable of delivering 500 gallons per hour, at Read's Grammar School. Apply to the headmaster, Mr. W. St. G. Drennan, at the School, who will supply all necessary particulars. Tenders to be delivered to Messrs. E. and T. Clark, solicitors, Snaith, R.S.O., clerk to the Governors, by noon on 28th inst.

**Johannesburg.**—The Council invite tenders for Vignoles rails, fishplates, angle steel guard-rails, bolts, nuts, coach screws, and dog-spikes. General conditions, specifications, and forms of tender may be seen at the offices of the Council's consulting engineers, Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster, S.W., and may be obtained on payment of five guineas. Tenders by Jan. 26.

**South London Electric Supply Corporation.**—The Directors invite tenders for the construction, supply, and erection at their works at Bengeworth-road, Loughborough Junction, S.E., of one 750-kw. steam alternator with pipe connections and sundry ironwork. Sealed tenders must be forwarded to the secretary of the company, Mr. H. H. Boyer, Bengeworth-road, Loughborough Junction, S.E., before noon on Jan. 16.

**Shanghai.**—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Pook and Co., 63, Leadenhall-street, E.C. Tenders by March 31, 1905.

**Plasencia.**—Tenders are required for the concession for 10 years of the lighting by electricity of the town. Adjudication of tenders will take place on Jan. 28, and tenderers, if not appearing in person, must be represented by a duly authorised agent. The conditions of concession are set out in the notice in the *Gaceta*, which may be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C., any day between the hours of 10 a.m. and 5 p.m. (Saturdays, 10 a.m. to 1 p.m.).

**Melbourne.**—Tenders will be received at the office of the Deputy Postmaster-General until noon on Feb. 7 for the supply and delivery of (1) 3,500 trunk-line multiple jacks, in strips of 20; (2) 1,320 yards of 64-wire wool-insulated switchboard cable. Specifications may be

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seen at the General Post Offices at Melbourne, Sydney, Brisbane, and Adelaide. Tenders, endorsed "Tender for ——," as the case may be, addressed to the Deputy Postmaster-General, Melbourne, may be deposited in the tender-box at the General Post Office, Melbourne, or, if sent by post, must be prepaid and registered. The deposit to be enclosed with the tender is 5 per cent. on the total amount.

**Johannesburg.**—The Municipal Council are prepared to receive tenders for 100 electric tramcars, two electric water-cars, one five-ton travelling crane, one electric car traverser, and various workshop tools, including erection at Johannesburg, to Specification No. 10 of their consulting engineers, Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W. Copies of the specification may be seen on and after Jan. 7 at the Council Offices, Johannesburg, and at the Consulting Engineers' Offices in London, and may be obtained on payment of five guineas, which will be returned on receipt of a bona fide tender. Duplicate copies of the specification may be bought for 10s. each (not returnable). Tenders must be addressed to Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W., and must be received by them not later than March 6. The Council will not be responsible for any expenses incurred in tendering.

**South Shields.**—The Corporation invite tenders for the execution of the works and the supply of plant in connection with the laying of proposed electric overhead tramways in the streets of the borough: (Part 1) permanent way and construction of track; (2) copper rail bonds, bonding of tramrails; (3) conduits, cables, and overhead equipment. Specification, etc., can be obtained from Mr. J. Moore Hayton, town clerk, on payment of £5. 5s. for each of Parts (1) and (3), and £2. 2s. for Part (2), which sum will be returned on receipt of a bona fide tender for each part. General and detailed plans of the proposed works can be seen as regards Part (1) at the office of Mr. S. E. Burgess, M.I.C.E., borough engineer, Chapter-row, and as regards Parts (2) and (3) at the office of Mr. J. H. Cawthra, M.I.E.E., the borough electrical engineer, West Holborn, South Shields. Tenders to the Town Clerk, Court-buildings, South Shields, by Feb. 20.

## RESULTS OF TENDERS.

**Middlesbrough.**—The Electricity Committee report that the tender of Messrs. Edward le Bas and Co., amounting to £760, for the pipework in connection with the works extension has been accepted.

**Whitby.**—The Urban District Council have accepted the following tenders: Parsons, for the installation of a 200-kw. steam-turbine at £1,550, and Johnson and Phillips for an additional panel to the switchboard at a cost of £92. 10s.

**Swansea.**—The Swansea Telephones Committee have accepted the tenders of the British Insulated and Helsby Cables, Limited, for the extension of the switchboard accommodation and the supply of fresh cables at £270 and £194 respectively.

**Eccles.**—The Town Council have accepted the tender of the Gilbert Arc Lamp Company for five arc lamps and switchgear at £56. 19s., and that of Messrs. Phillips and Hilkirk for three Gilbert arc lamps and four arc-lamp brackets for the sum of £24. 7s. 6d.

**Canterbury.**—The Lighting Committee recommend that the tender of Messrs. Harris Bros., at £390. 11s. 6d., be accepted for boiler and engine foundations. The City Council accepted the following tenders for the supply of the electricity plant: Davey, Paxman, and Co., new boiler and superheater; Dick, Kerr, and Co., new 300-kw. steam dynamo; J. G. Statter and Co., switchboard; E. Green and Sons, extensions to economiser.

**Condensing Plants.**—The Mirrlees-Watson Company, Limited, engineers and founders, Glasgow, report the following orders for surface condensing sets: British Thomson-Houston Company, for County of London Electric Supply Corporation—two sets—(duty per set in pounds of steam per hour, 29,250); Alfred Parry, Manchester, for Calcutta (7,500); Trafford Power and Light Supply Company, Manchester, per Lacey, Sillar, and Leigh (24,000); J. and P. Coats, Limited, for Barcelona (25,500); British Thomson-Houston Company, for London (27,000); Crewe Electricity Works, (20,000); Gwynne's, Limited, London (6,000).

**Admiralty Contracts.**—Messrs. Graham, Morton, and Co., Limited, engineers and contractors, Leeds, have just obtained the contract for the supply, delivery, and erection at the electrical generating station at H.M. dockyard, Devonport, of a complete coal-handling plant, including coal-bunkers, stanchions, girders, flue, and coal-measuring and weighing apparatus, and all accessories appertaining to same. The Lancashire Dynamo and Motor Company, Limited, Trafford Park, Manchester, have received from the Admiralty the order for the equipment of Bull Point Dockyard, also the contracts for the equipment of Sheerness and Malta Dockyards—the total value of the three contracts being upwards of £75,000.

# BUSINESS NOTES.

## TRACTION.

**Perth.**—The Town Council have decided to extend the tramways to the Dankeld-road district at a cost of £4,500.

**Dover.**—The Corporation have passed a formal confirmatory resolution concerning the tramway extension by the requisite two-thirds majority.

**Aberdare.**—The tramway and dust destructor scheme, of which particulars were given in our last week's issue, has been approved by a public meeting.

**Kirkcaldy.**—In response to the projected tramway, to which we have referred in previous issues, the Fife County Council have now given their approval.

**Underground Electric Railways Co.**—At a meeting of the directors of this company Lord George Hamilton, M.P., and Mr. J. Clifton Robinson were elected directors.

**Leeds.**—One of the steam-pipes at the power station gave out on Saturday evening, with the result that the service had to be reduced. After the traffic was over the defect was speedily remedied.

**Bury.**—It is reported that when the resolutions passed by the Corporation at a special meeting last week in favour of tramway extensions and other schemes came up for confirmation they were rejected.

**Glasgow.**—In deference to the views of a number of owners and occupiers in Wilton-street, the Corporation have decided that the proposed tramway in that street shall be abandoned, at any rate for the present.

**Manchester.**—The Urmston District Council have appointed a committee to enter into negotiations with the Corporation with respect to the proposed construction of tramways in Urmston. A conference has been fixed for an early date.

**The Conduit System.**—The Board of Trade, after full consideration of the question, have approved the use of a slot not exceeding 1in. in width in connection with the conduit system for the electrification of the London County Council tramways in North London.

**Cupar.**—The District Committee of the County Council have appointed a committee to consider the question of a light railway from Falkland to Falkland-road Station. The distance is 3½ miles, and the cost of the permanent way is estimated at about £10,500.

**Wigan.**—The Corporation having asked the Aspull District Council for consent to the extension of the tramways to the Finger Post, and enquiring upon what terms they would agree to the widening of Spring Bridge, the District Council have given instructions for an estimate to be prepared.

**Lowestoft.**—The Tramway Committee having reported that the matter of the construction of the East Anglian light railway had been discussed, the town clerk was directed to write Messrs. Hawtayne and Zeden on the matter, with a view to Messrs. J. G. White and Co. interviewing the committee.

**Victoria.**—The Legislative Assembly has referred to the Railways Standing Committee the question of constructing an electric street railway along the eastern foreshore to St. Kilda and several sections within the metropolitan area. It is reported that a private promoter has offered to undertake the system.

**Dundee.**—The trams again show substantial progress on the year's working. During 1904 the number of passengers carried was 11,511,716, an increase of 326,681 as compared with the previous 12 months, while the sum realised in fares was £44,036. 9s. 8d., representing an advance of £667. 3s. 11d. over the last annual return.

**Wednesbury.**—It was reported a little time back that there was some likelihood of the difficulty between the local authorities and the company being settled. Little, however, appears to have been done so far. It is stated that plans have been drawn up for relaying and re-equipping the lines when a settlement of the existing dispute has been arrived at.

**Linlithgow.**—At a meeting of the District Committee of the County Council on Monday a letter was read from Mr. Macnaughton, of Edinburgh, as to an electric tramway between Edinburgh and Queensferry, and asking the District Committee to arrange for an interview with the promoters at an early date. The committee appointed representatives for this purpose.

**Stockport.**—In connection with the taking over of the Hazel Grove Company's system, it has been decided that the Edgeley route shall be extended to Dale-street, and be laid as a double line throughout; also that the tramway into St. Petersgate shall be constructed along Wellington-street and Lord-street. The town clerk has been instructed to furnish a definition of "workmen" to the committee.

**Bradford.**—At the meeting of the Corporation it was reported that the town clerk had taken expert advice which showed that there was no basis for the claim of Messrs. Smith and Illingworth in respect of alleged infringement by the Corporation of their patent for car-top covers. The claim has therefore been repudiated. A line from Odsal Top to Cleckheaton-road has been suggested. The question of ½d. fares is under consideration.

**Hastings.**—A memorial alleging non-compliance with the Standing Orders has been handed in at the Private Bill Office on behalf of the Bexhill Corporation against the Hastings Tramway Company. The memorial will come before the Examiner of Private Bills on the 18th inst. At the meeting of the Corporation last week the provisions of the company's Bill came up for consideration on the minutes of the Tramways Committee. It was resolved that the clauses relating to the use of the overhead system along the front and to a proposed extension of time for completing certain routes could not be assented to. Probably a conference will be held between the committee and company in the course of a few days.

**Private Bills.**—The period allowed for depositing memorials alleging non-compliance with the preliminary Standing Orders in respect of any of the first 100 Bills on the general list of constructive measures relating to public and private works has expired. Only five memorials were lodged—by the Willesden Council against the Metropolitan Electric Supply (Various Powers) Bill; by the Great Northern Company of Ireland against the Mullingar, Kells, and Drogheda Railway Bill; by the Northamptonshire County Council against the Wellingborough and District Tramroads and Electricity Supply Bills; by the Willesden Council against the Metropolitan Railway Bill; and by the Bexhill Corporation against the Hastings Tramways Bill.

**District Railway.**—The Metropolitan District Railway Company has deposited a Bill for next session, the effect of which will be to empower it to raise £400,000 towards the general purposes of the

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undertaking, the cost of adapting the railway for electrical working, providing for any loss on the sale of rolling-stock or plant, and in payment of arrears on the guaranteed stocks. The preamble explains that this sum represents the estimated cost of constructing so much of the railway authorised in 1897 and 1903 which has now been transferred to and is now in course of construction by the Great Northern, Piccadilly, and Brompton Railway Company. This sum not being now required for the purpose for which it was originally sanctioned, is needed for other purposes.

**Belfast.**—The question of passes for members of the Corporation and for the police threatened a little storm at last week's meeting, but in the end it was decided to present each councillor with a pass, and terms will probably be arranged with the police authorities. At a meeting of the Tramway Committee a lengthy communication was read from Messrs. J. G. White and Co., Limited, in reference to the contract and the delay in signing it, and to some of the specifications as to which there had been differences in detail. Considerable discussion took place, and the following resolution was adopted: "That the letter of Messrs. J. G. White and Co., Limited, be referred to the surveyor, electrical engineer, and general tramways manager, with the aid of the town clerk, for consideration and to report, and that one of the firm of consulting engineers, Messrs. Lacey, Sillar, and Leigh, be requested to attend here, if necessary, and to advise with the officers on the question raised. That Messrs. White be informed that the time for performance of the contract must date from the acceptance of their offer."

**West Hartlepool.**—At a meeting of the Corporation the Works Committee reported that a letter was received from the tramway company submitting proposals for settlement of the complaints with reference to the condition of the track, to the effect that the Corporation should waive the right of purchase of the several lines in the borough until 1919, the tramway company at the same time to agree to a reduction of tenure of the Seaton Carew line to that date. The company would then reconstruct the permanent way and the overhead equipment in the early spring. A further letter was received from the company to the effect that they would use their best endeavours to obviate the noise alleged to be made by the cars, but repeated their contention that they were not liable for the sanding of the track where the same is dangerous to traffic through the slipperiness of the wood blocks. The Corporation approved the committee's refusal of these terms, and the notice given to the company that the latter must carry out the several obligations imposed upon them with reference to the matters named under the Acts and orders affecting the company's operations. It has been decided to again institute proceedings against the company to enforce the penalties incurred for not maintaining the track in good repair, for not putting sand upon the wood pavement when slippery, and for not removing the cause of the complaint as to the noise caused by the rattling of the machinery of the cars.

**Adelaide.**—The report of Mr. F. E. Bradford on the electrification of the Adelaide suburban railways, which was laid on the table of the South Australian Assembly, shows that electric traction applied to the line to Glenelg and the Port, Semaphore, and Largs system, besides paying interest on the cost of conversion, would result in an increase of the present profit by £8,912, or a total profit of 3·8 per cent. The cost of conversion is estimated at £151,830, not including power station. A power station large enough to supply power for the above-mentioned lines, and also for the Adelaide tramway system, will cost £882,000. Mr. Bradford thinks the present traffic would be increased by 25 per cent., due to the greater frequency of service, higher speed and greater comfort to the travelling public; but taking 10 per cent. as a safe and conservative estimate, the increase on the present profit would be £17,732, or 7·5 per cent. on the capital. The services would be more frequent and faster than at present, and the train mileage on the Port and Semaphore line would be 50 per cent. more and on the Glenelg line 100 per cent. more than at present. The power station is to be located at Port Adelaide to generate power for all the lines converted, and for the proposed Adelaide tramway system as well. The cost of producing power with the plant recommended by Mr. Bradford, with an output of 10,000,000 units per annum, will not exceed ·4d. per unit, including interest on the cost of construction.—*New South Wales Railway Budget.*

**Bournemouth.**—The Corporation have passed the following resolution: "That this Council has heard with satisfaction the award made by Mr. Justice Lawrence on the recent tramway arbitration, and recognising that the favourable result obtained is largely due to the able and zealous services of the town clerk, the borough engineer, and the chairman of the Tramways Committee, hereby tender its special thanks to those gentlemen for the services rendered by them." The chairman and vice chairman have been appointed a sub-committee to enquire, with the help of the borough engineer and traffic manager, into the feasibility of establishing a regular service of cars between Southbourne and Christchurch Station in connection with the trains. Councillor Elcock enquired if the Council had power to take a poll of the town as to whether the ratepayers were in favour of Sunday trams. The Town Clerk replied that he did not consider any money the Corporation had control of could be legally expended in taking a poll. The committee have replied to a letter from the Malmesbury Park, etc., Ratepayers' Association that they are unable to reconsider their decision as to reducing fares for children. It has been decided to lay the lines up to within a few feet of the borough boundary, and that the surveyor be authorised to arrange, if possible, with the company and the local authorities concerned to make or allow the Council to make their line complete to the borough boundary, but without making any actual connection. The Corporation have replied to the Roads Improvement Association that they do not consider it necessary to transfer to the side of the road the central standards on the line from the Hotel Metropole to Boscombe Hill.

**Swansea.**—An important conference between the Parliamentary Committee of the Corporation and the Swansea Manufacturers and Traders' Association has taken place respecting the new Parliamentary Bill. The association was formed a few weeks ago "to protect the interests of Swansea ratepayers and to ensure the strictest economy compatible with efficient administration of local administration." In regard to the proposals to compulsorily acquire the tramways and widen Castle-lane there was much discussion. The association made it clear that there could be no objection to the Corporation securing an option to purchase the tramways, but it was questioned whether, having regard to the new parallel lines that were now laid down in the centre of the town, the system would be remunerative. On that ground the manufacturers and traders seemed averse to the Corporation rushing into a speculative undertaking, and stated that the views of the ratepayers ought to be obtained before the Corporation is committed to the purchase. It was agreed that the town clerk should take the opinion of counsel as to whether a clause can be inserted in the Bill providing that there shall be a poll of the ratepayers before the Corporation exercise any powers of purchase of the tramways. Draft copies of the proposed leases to the tramways company of the new tramways have been circulated amongst the Council members. The Brynhyfryd section comes under the Tramways Act, and the remaining sections under the light railways orders. Regarding the latter the rent to be paid by the company is to be as follows: an amount equal to the interest which the Corporation have to pay on capital property expended in construction, together with further sum equal to 3 per cent., and in the event of the company paying interest on capital expended on the existing tramways and proposed light railways, amounting to 6 per cent., the company to pay to the Corporation a further sum equal to 1 per cent. per annum. With regard to the Brynhyfryd section, the rent paid is to be as follows: for the first seven years of the lease a sum equal to 5 per cent. upon the capital expended; for the next seven years, 6 per cent.; and for the remainder of the term, 7 per cent. In both instances all rates, charges, assessments, impositions, and outgoings in respect of the tramways and light railways to be paid by the company. In the case of the Morriston section the company are to work this from the Corporation electricity supply, and the following are the prices to be charged for the whole supply of electrical energy: for a minimum of 200,000 units per annum, 1½d. per unit; for the next 150,000 units, 1$\frac{5}{8}$d. per unit; for the next 150,000 units, 1¼d.; for the next 150,000 units, 1$\frac{1}{8}$d. per unit; and for the next 150,000 units, 1d. per unit. All the extra number of units over the 200,000 must be supplied in the same year in order to get the reduced scale of charges. It was stated in committee last week that Messrs. Dick, Kerr, and Co. had two-thirds of a mile more tramways extension to complete, and that the date on which the cars would be running depended on the completion of the lease to the company. The receipts for 1904, less one day, were £27,994, an increase of £864 over 1903.

**South Africa.**—Progress in electric traction receives considerable attention in the current number of the *British and South African Export Gazette*. The completion of the Durban Corporation's tramway system is still productive of fresh orders, and others are likely to follow as unexpected developments occur. For an increased supply of current during certain hours of the day a large storage battery and complete booster equipment has been ordered, the former having been placed with the Tudor Storage Battery Syndicate and the latter with the Lancashire Dynamo and Motor Company, Limited. The battery will consist of 250 cells of a current capacity of 770 amperes per hour. Progress is being made with the various extensions into the outskirts of the city, the work of doubling the single track in the Berea-road, one of the busiest sections of the system, having been commenced. Underground lavatories here, and probably at Greyville, where a sub-station is to be erected, form part of the projected improvements. Extensions of the system to the Park and the Dorp Spruit are also under weigh, while the tenders for the ironwork for the Victoria Bridge, in connection with the latter, are about to be invited. The Pietermaritzburg electric tramway system, begun in September, 1903, was successfully inaugurated in November last, the cost being £105,000. Only part of the system is actually working, bridge construction in one case causing delay, but the whole network will probably be in active operation within a month or two. As in other cases, necessity for extension of the original plans is already being felt, and several short additions are now being considered, involving fresh calls for permanent-way material. The tramway manager has also pointed out the necessity for ordering four more cars, thus bringing the total up to 16. Cabled instructions to the London agents, Messrs. Ford Bros., are expected to be transmitted almost immediately. Although long talked of, electric tramways have not hitherto entered into the programme of Bloemfontein's urgent public requirements, but the recent proposals of a syndicate to lay down an electric tram service under a concession, and an alternative proposition to start a service of motor 'buses, have both been rejected by the Corporation, who are now considering the feasibility of the establishment of municipal tramways on a proper system. The completion of the other public works now in hand may defer a move in this direction for the present, but realisation of such a scheme is regarded as one of the certainties of the early future. The tramway to Alexandersfontein, which the De Beers Company had under construction, has now been completed, and only awaits the rolling-stock. The company have spent about £165 000. The large power station which supplies the current to light Kimberley is also completed, while the supply to the township of Beaconsfield was turned on in October last. A dispute between the Beaconsfield Town Council and Messrs. Gibson Bros. over the royalty to be paid for 1½ miles of tramline under their control, is temporarily delaying the completion of the works. A project for constructing a six-mile electric, steam, or oil-driven tramline from Hillarys, a station on the Natal main line, to the Bellair estate, and supplying light and power to the district traversed, is in the course of arrangement. Parliamentary powers are to be applied for in the next session of the Legislative Assembly, the promoters of the scheme being Messrs. Benjamin Hampson and W. W. Cato, both of Durban. The electrification

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the Springs-Randfontein line of the Central South Africa Railways, to which we referred recently, appears to have been shelved.

**Colchester.**—At last week's meeting of the Corporation the Tramways Committee, having regard to the importance of the decision to be arrived at relative to the proposed extension of the tramway system, submitted a special report giving the principal facts bearing upon the proposal, and a statement of the receipts and outgoings in connection with the tramway undertaking up to Dec. 29. The suggested extension would commence at a junction near the bottom of Military-road with the line in Magdalen-street, and would terminate near the main entrance to the recreation ground, the length being slightly over half a mile. The original proposal as made to the Council was to carry the extension as far as Old Heath, but the committee, on examining with much care into details, came to the conclusion that it is not yet time to extend the system in this direction beyond the point they recommend. The needful expenditure in respect of the permanent way, overhead equipment, and feeders is estimated by the borough engineer and borough electrical engineer at £6 134. To this must be added the cost of new cars, £1,200, and that of the provisional order, approximately £350, making in all £7,684. Of this total sum £1,300 has already been expended by the Council in the purchase from Messrs. White and Co., contractors for the original works, of rails, setts, tiebars, and other materials. These rails and other materials were purchased on very advantageous terms. The committee direct attention to the circumstance that no additional plant would be requisite for the supply of power, and, further, that staff expenses would not be substantially increased—certainly not nearly in proportion to the very considerable augmentation of income which it is believed would result. The area which would derive the greatest direct accommodation from the new section is one of the most populous in the borough, and is at present, to a large extent, cut off from any ready participation in the benefits which the tramway system affords. A careful survey of the district has been made, and the inhabitants may be taken at 7,000, exclusive of the military population of the camp, and the population will probably be largely increased in the immediate future by reason of the development of a portion of the Winsley Charity estate and other properties in the vicinity. Besides this, many thousands of persons resort to the public recreation ground. In the committee's view the length of line proposed would be more remunerative, possibly, than any other route (save, perhaps, that between North Hill and the North railway station) at present embraced within the system, and would be a valuable factor in the successful progress of the undertaking. The success of the tramways, and the benefits which they have conferred upon all classes of the community, have greatly exceeded what were originally anticipated. The system was not opened until July 28, and thus only two of what may be termed the most favourable months of the year have been experienced. Notwithstanding this the weekly average number of passengers carried has been 60,382, and the total number of passengers during the five months since the opening has been 1 337.098. Up to Dec. 29 the accounts show a surplus of about £180. In support of the proposed extension a deputation of the inhabitants attended the meeting, and their spokesman showed that he had studied the question minutely by producing copious figures, the result of his own enquiries. As on a previous occasion, however, a portion of the Council were remiss in their attendance, and as the requisite two-thirds were not available the scheme had to be postponed to a special meeting, for which the mayor has issued a "whip."

## LIGHTING AND GENERAL.

**Arbroath.**—An early settlement of the electric lighting question is anticipated.

**Chili Telephone Co.**—The directors have declared an interim dividend of 3s. per share.

**Norwich.**—The Corporation have reduced the charge for electric light from 5d. to 4½d. per unit.

**Frome.**—Application is to be made for a loan for the purchase of electric pumps at the sewage works.

**Barrow.**—The Town Council have received sanction to borrow £35,000 for electric lighting purposes.

**Swindon.**—Application is to be made for sanction to a loan of £2,000 for arc lamps and small motors.

**Sale of Plant.**—Particulars of sales of cables, induction coil, and trolley standards will be found in another column.

**Globe Telegraph and Trust Co.**—The directors have declared an interim dividend of 2s. each on the ordinary shares.

**Lowestoft.**—A recommendation that more boiler power be provided at the electricity works at a cost of £1,000 is before the Electricity Committee.

**Hampstead.**—For £12,000, being the profits of its electrical undertaking, the Borough Council are purchasing the business of the North-West London Electric Supply Company.

**Engineers' Overalls.**—Messrs. W. J. Ward and Co., 14, Clayton-street, Newcastle-on-Tyne, are making a speciality of American cut dungaree overalls for engineers, motorcar drivers, etc.

**Yarmouth.**—Application is to be made for a loan of £10 000 for new plant, including another 300-kw. engine and dynamo and boilers at £4,500, and an additional water conduit, estimated to cost £3,500.

**Transvaal.**—A meeting of shareholders in the electric light company at Potchefstroom has agreed to the draft deed of sale, whereby the electric plant is municipalised at a cost of £6,000.—*South African World*

**Blaydon.**—The Durham Electrical Power Distribution Company, Limited, have approached the Council with regard to the supply of current under the Blaydon electric lighting order. The matter is before the Electrical Committee.

**Whitwell.**—At a recent meeting of the Parish Council the electric light question was discussed, and it was decided to hold a public meeting on the 16th inst. to discuss the possibility of forming a private company, failing which the Council will enlist the help of the District Council.

**Chester-le-Street.**—The Rural District Council have now consented to the application of the Durham Electrical Power Distribution Company, Limited, to the Board of Trade for a provisional order to supply electrical energy for public and private purposes within the Council's district.

**Direct United States Cable Co.**—An interim dividend of 3s. per share, free of tax, being at the rate of 3 per cent. per annum, for the quarter ended Dec. 31, is payable on the 31st inst., and after setting aside £10,000 to reserve fund account the directors carry forward a balance of about £2,876.

**Egypt.**—A contract has been entered into between the Municipality of Mansourah and the Mansourah Electric Supply Company for the establishment of a system of electric light at Mansourah. We understand that the electric lighting of Helouan is to be carried out by the Metropolitan and Cairo-Helouan Railway Company, Limited.

**Middlesbrough.**—A new cable is to be laid at a cost of £340. The engineer in his last monthly report stated that the revenue for the past month had been £1,647, and the works cost £514. The estimated profit for the month, exclusive of interest and redemption, was £1,132. Applications for 514 more lights have been received.

**Bristol.**—A short partial stoppage of the electric light supply was caused on Tuesday by the burning of a cable between the Temple Back works and the generating station at St. Philip's Marsh. There are six cables in use, and it was only during the transference of the current to one of the other five, which was effected in 12 minutes, that any inconvenience was caused.

**Airdrie.**—The Town Council are forwarding to the Board of Trade objections framed by Prof. Kennedy to the draft provisional order now being promoted by the Scottish House-to-House Electricity Company, Limited, for power to transfer the Airdrie electric light order. Mr. Renwick is conferring with a sub-committee of the Lighting Committee with the view of effecting some better arrangement for the electric lighting of the streets.

**Bury.**—The Electricity Committee have profited by the recent fogs. There has also been a considerable increase in the demand for electric current. During the four weeks ended Jan. 1 the number of units sold for lighting and motor purposes was 78.110, an increase of 14,137 units over the four weeks ended Jan. 3, 1904, and during the two weeks ended Jan. 1 they sold 40,107 units, or an increase over the corresponding period a year ago of 11,727.

**Elland.**—Mr. Emmott is to report upon the consumption of coal at the electric station and upon the efficiency of the accumulators. The output from the electricity works has gradually increased from 403 units per week at the beginning of September to 2,447 units in the last week of the year. It is reported that the destructor, which provided sufficient motive power for the engines until recently, is rendered useless for the time being through lack of refuse and sludge.

**Eccles.**—The Town Council, having received a letter from the Local Government Board stating that the Board would be prepared to allow a period of 10 years for the repayment of any loan they might sanction with reference to the purchase by the Corporation of electrical motors to be let out on hire, have decided to apply for sanction to the borrowing of £500 for the purchase by the Corporation of electrical motors. They have also resolved that £50 per annum of the salary of the electrical engineer be charged to the public lighting account, in respect of his superintendence of this department.

**Hammersmith.**—The last report of the Electricity and Lighting Committee states that the premises of 12 additional consumers, representing a maximum of 406 8-c p. lamps, have been connected to the mains, that 11 consumers have been disconnected, and that the present number of consumers taking current from the mains is 1,533. An application from the Postmaster-General for the consent of the Borough Council to the placing of an underground telegraphic line along the east side of the Broadway, from the existing line outside 23, The Broadway, to the Hammersmith Police Station, has been agreed to.

**Plymouth.**—At the last Council meeting Mr. Radford, in moving the adoption of the report of the Electricity and Street-Lighting Committee, said a deputation representing the Amalgamated Society of Engineers had appeared before the committee and complained of the non-employment of *bonâ fide* engine fitters at the electricity works. The committee resolved that the society be informed that the existing arrangements at the electricity works were conducive to the efficient working of the undertaking, and that they saw no reason to interfere, but that if in the future the deputation desired to make any specific complaint, the committee would give it consideration. The report was adopted.

**Golborne.**—During a debate upon the electric light question at the last Urban District Council meeting a letter was read showing that the gas company are willing to withdraw the clause as to the electrolysis and temporary support provided that the Council agree to insert a clause providing for triennial instead of quinquennial revisions of accounts, and with the following as a sub-clause: "There shall not be made against the district rate, or any other rate, for energy used by the undertakers for the street-lighting or any other purpose, a charge at a higher price than that charged to the consumers using energy for similar purposes and for the like hours of supply." It was agreed that the matter should be decided by the Board of Trade.

**St. Marylebone.**—The electric light loan came again before the Council last week, when a letter was read from the solicitor to the

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London County Council stating that the Council had cancelled its order of July 26, 1904, and had resanctioned the borrowing by the Council of a sum of £435,800, repayable as to £340,405 in 42 years, the first repayment in three years; as to £48,545 within 38 years, and as to £44,850 within 10 years. The Council was prepared to advance £100 000 (on account of the £340,405). £50,000 at once and as to £50,000 at a time convenient to the Council to be repaid with interest at the rate of £3. 15s. per cent. per annum. The Electric Supply Committee advised that the Council should accept the terms proposed.

**Bradford.**—At the last Town Council meeting the Electricity Committee reported that a deputation of the committee had visited London, Dublin, and Newcastle for the purpose of inspecting generating stations and sub-stations on the high-tension alternating three-phase system. The report of the deputation in favour of the adoption of this system in Bradford has been approved; and the committee recommended that the work should be carried out at a cost of £40,876, the town clerk to be authorised to apply for sanction for the borrowing of this money. This was agreed to, as well as the recommendation that a motorcar be purchased at an estimated cost of £325 for the use of the electricity department, the coachbuilding for the car to be done by direct labour at the Thornbury tramcar workshop.

**Worthing.**—At a recent meeting of the Electricity Committee a letter was read from Mr. A. A. Siebold, of the Theatre Royal, stating that he would prefer to continue to take current from the Corporation instead of putting down his own plant, and offering to pay at the rate of 4½d. per unit for the next two years on the understanding that at the expiration of that period the Council would reconsider the matter with a view to a further reduction being then made if found to be practicable. After negotiations the following agreement was arrived at with regard to rates: Over 1,000 up to and including 5,000 units per annum at 6d. per unit, 7½ per cent. discount; over 5,000 up to and including 10,000 units per annum at 6d. per unit, 15 per cent. discount off the whole; if over 10,000 units per annum consumption, the charge to be at the flat rate of 4½d. per unit net.

**West Hartlepool.**—The electrical engineer has been authorised to obtain tenders for an additional 250-kw. set, to be a duplicate of No. 7 set, with the necessary switchboard, panel, etc., and application will be made for sanction to borrow £2,200, the estimated cost of the addition. In his report to the committee the electrical engineer dwelt upon the very urgent necessity of installing additional plant at the electric light station, and said the whole of the plant now installed, with the exception of one single 100-kw. set, had been in use for the last two months, and it was quite to be expected that during January, when the Seaton Carew Ironworks had their 60 b.p. connected, and the Cliff House Foundry were finally connected, that this one single 100-kw. spare set would have to be put on load. There would then be absolutely no spare plant at all. Roughly, the increase during the year had been the equivalent of 100 kw., and he expected the same for the year 1905-6.

**Boilers.**—We learn that the Stirling Boiler Company, Limited, and the Stirling Company of U.S.A. have come to an arrangement whereby litigation which had been pending between the two companies for nearly a year has been satisfactorily settled. The company have acquired all the British and European patents of the American company, and in future all boilers sold in these markets will be of British manufacture. The company are well equipped for dealing with a large volume of trade. They have large works at Motherwell, in the heart of the steelmaking industry of Lanarkshire. We understand that both the American four-drum type and the British five-drum Stirling boiler will be sold in this country. The Stirling boiler is not an experimental boiler, as it has been established for years, and the combined American and British companies will probably be the largest boiler concern in the world. We congratulate these companies on the satisfactory ending of their differences.

**Agencies.**—The Lancashire Electric Power Company, 78, King-street, Manchester, having decided to open a hire-purchase branch in the Lancashire district, have appointed Mr. Philip C. Pope, lately with the British Westinghouse Electric and Manufacturing Company, of Trafford Park, engineer to the hire-purchase and development department. We are informed that there seems to be very good prospects for a considerable amount of hire-purchase business in connection with the supply of power from the mains in this district. The Phœnix Dynamo Manufacturing Company, Limited, of Thornbury Works, Bradford, have opened an office at 17, Victoria-street, Westminster, in charge of Mr. E. W. T. Ward, who has recently joined their staff as London representative. Their telegraphic address is "Phedyna, London," and their telephone number 1,061 Victoria. Messrs. Balcke and Co., condenser specialists, 27, Clement's-lane, E.C., have opened a new branch office at Imperial-chambers, Albert-street, Derby. Messrs. Andrew Brown and Co., 110, Cannon-street, E.C., have been appointed the London and district agents for Messrs. Penman and Co., boilermakers, Caledonia Ironworks, Glasgow.

**Cardiff.**—The subscriptions received in response to an appeal made to equip and furnish the infirmary building with the necessary electrical appliances, and to furnish it ready for use, amount to £438, in addition to £22 collected for an electric magnet. The building, which, according to the *South Wales News*, is one of the most perfect in the provinces, has been built at a cost of £2,000, and this amount has been mainly contributed by an anonymous lady. It has practically stood idle because funds were not forthcoming to equip it, but the generous response to the appeal has removed this difficulty, and the building will be started on its career of usefulness in the cause of humanity and science on Jan. 26. In brief, the work to be undertaken in this most important department of the infirmary is as follows: examination and treatment of patients by means of the electric appliances; photographing fractures, dislocations, and diseases of bones; localisation of foreign bodies; examination of chest, including detection of phthisis in early stages, heart, and kidney. Also the treatment of lupus and certain form of cancer (rodent ulcer), and various skin and other diseases. The electric magnet will be used for removing particles of steel from the eye, thereby in many cases saving the eye. The pavilion will be formally opened on the 26th inst. by Sir W. H. Preece, and all who are interested in the work of the infirmary are cordially invited to attend.

**South Africa.**—The large power station which supplies the current to light Kimberley has been completed, while the supply to the township of Beaconsfield was turned on in October. We understand that the Port Elizabeth Municipality have now decided to advertise for tenders in connection with the lighting and power scheme drafted by Mr. R. Pape, the borough electrical engineer. The electrical engineer of Greytown, near Durban, has notified the authorities of the necessity for doubling the station equipment at an early date. With regard to the electric light scheme for Klerksdorp, the *British and South African Export Gazette* says that the Klerksdorp Town Council recently had under consideration a motion relating to the engagement of a competent engineer to report on a scheme for lighting the town by electricity. The cost of an expert, it was considered, would be considerable, but the advantage of his advice was recognised. In the upshot, the matter was referred back for enquiries to be made as to the probable cost. The town has a population of under 5,000, but is the centre of an important gold, coal, and diamond district which ensures for it great expansion at an early date. The township of Gwelo, Rhodesia, affords an opportunity for a private electric lighting company. The Town Council of Heidelberg, Transvaal, are about appealing to the ratepayers for sanction to a loan of £100,000 for a multiplicity of public works, including public and private electric lighting. The Kingwilliamstown Council are about to acquire the King Electric Lighting Company's assets, and will extend the system.

**Wilmslow.**—At their last meeting the District Council considered the report of the sub-committee on street-lighting, and adopted a recommendation to replace gas lighting by electricity. During the course of the meeting the sub-committee reported on the various tests made with gas and electric light, from which we learn that the contract with the gas company which was in force when the committee was appointed stated that the period of lighting commenced on Aug. 18 and ended on May 14, both dates inclusive, the lamps to be lighted at dusk, and the extinguishment to commence half an hour before midnight, except for six nights during each moon, when such lamps shall not be required to be lighted. The committee approached the Alderley and Wilmslow Electric Supply Company, Limited, of which Mr. Cuthbert W. Bentley is the resident engineer and secretary, with a view to ascertain whether they would be prepared to undertake the electric lighting of the district. The company were willing to do so on condition that if their scheme was accepted a contract for five years would be given to them. The committee subsequently submitted to the company a contract identical to that in force with the gas company, with the exception that for the clause which said that the lamps shall be lighted at dusk, and which was considered indefinite and liable to misunderstanding, the following was substituted; "The lamps must all be lighted within one hour after sunset, and extinguishing be commenced before 11.30." Comparative tests were then made, including a reading test, which consisted of reading the same printed circular at all the lamps tested. Each lamp was tested alternately, the other competing lamps being turned out, and the following are the results given: gas new flat-flame burner, seven yards away; electric 40 c.p., 17 yards away; gas incandescent (new mantle on main road), 15 yards away) electric 70 c.p., 23 yards away; electric 100 c.p. (for Bank-square), 30 yards away. The comparisons made have been between the existing lamps and those they would replace, and the increase in light over the present system would be very great indeed. The recommendation of the committee (which, as above stated, was adopted) read as follows: "That we substitute our present system of street-lighting by gas for that by electricity, and that we place the following lamps: 170 lamps of 40 c.p. on roads other than the main roads at 28s. per lamp, £238; 39 lamps of 70 c.p. from Alderley to Manchester-road at 38s. per lamp, £74. 2s.; one lamp of 140 c.p., Bank-square, to burn from sunset to daylight, at 123s., £6. 3s.; one lamp of 70 c.p., top of Manchester-road, to burn one hour after sunset to daylight, at 70s., £3. 10s.—total, £321. 15s. At present we pay 209 lamps at 32s. 6d. per lamp, £339. 12s. 6d.; two large lamps, £11; one lamp in Moor-lane, extra gas, 15s. 6d.—total, £351. 8s., or a saving of £29. 13s." We understand that the new installation will be ready for the commencement of the next lighting season, Aug. 18, 1905, and also that Edmundson's Electricity Corporation will act as securities for the proper carrying out of the contract. A careful perusal of the committee's report shows that the electric light company undoubtedly beat the gas company at every turn during the trial. The lamps they propose installing are the ¼ and ½ ampere Nernst. The ¼-ampere will be installed in place of the ordinary flat-flame gas-burner, and the ½-ampere replaces the incandescent mantle. The company hope shortly to commence laying the mains for street-lighting and private supply throughout Wilmslow. The total length of these will be about 12 miles, and about three miles of feeders.

**St. Pancras.**—The following report by Mr. Sydney W. Baynes was adopted by the Council on Wednesday: "Having regard to the low charges we have established for motive power in order to promote our day load, and bearing in mind the many advantages of a supply of electricity during the daytime for all purposes to the many commercial industries of this borough, I have studied the problem very thoroughly with a view to placing before you some recommendation which shall popularise electricity in this respect." In order that the committee might be in full possession of the existing state of affairs concerning the various loads carried by the generating plant throughout the 24 hours, a diagram accompanied the report showing a curve in which the vertical figures gave the load in kilowatts, or units per hour, being supplied, and the horizontal figures showed each hour in the day

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throughout the 24. The curve represented the highest load dealt with in November last, which occurred on the 16th. It showed that for 16 hours out of the 24 the current passing from the station only averaged some 600 units per hour, whilst the maximum call upon the station, shown by the greatest height of curve reached a rate of 3,200 units per hour, and as a consequence the committee were compelled to provide and maintain generating machinery and cables capable of supplying this higher rate. "The present rates for electricity are based on this condition of affairs and naturally cover all charges for interest and sinking fund. It is obvious from a study of the diagram that were it possible to increase the day load (shown by the straggling horizontal line on the diagram, between 12.30 midnight and 4.30 the following afternoon we could do so without involving either any additional capital outlay on extra generating plant and mains or charge to revenue in manipulating the existing plant, except the following charges per unit which I have obtained from our last year's balance-sheet: coal, ·61d.; oil, waste, etc., ·07d.; repairs and maintenance, say ·15d.—making a total cost of ·83d. per unit sold. I have taken repairs and maintenance at an estimate of one-half the actual figure because the actual wear and tear is only due to the running of the machinery; there is no depreciation brought about on our mains, whether they are doing full duty throughout the 24 hours or not, and consequently no charges for extra repairs on the mains will occur. With regard to the wages at the generating station, these are in no way increased by the day load, and consequently do not enter into these costs. The above figures give us a total cost of ·83d. per unit for generating electricity if current be taken from us between the hours of 12 midnight and 4·30 the following afternoon. The object of the foregoing is to show that any current sold during the daytime up to the time of peak load will cost us only ·83d. per unit. I propose, therefore: (1) That we should establish a system of day load supply for lighting purposes at the same rate as motive power, provided that the supply is not taken from us between the hours of 4.30 in the afternoon and 8.30 p.m., these being the hours approximately of peak load; any current drawn from our mains during the hours of peak load to be charged at the rate of 6d. per unit. (2) That day load shall only be available to customers who will guarantee to burn during the business hours of the day not less than 10 lamps in their cellars or at the back of their shops as the case may be. (3) Charges for extra meters and switching-over gear to be borne by every consumer availing himself of these specially low rates. (4) All customers receiving current under these special rates will be liable to be cut off at any time that circumstances may necessitate in a similar way to which we reserve the right in giving the special low motor rates now in force. (I need scarcely point out to the committee that this is an emergency that has never yet arisen, but we find it advisable to reserve this right in the case of day loads at special rates, and I see no objection to imposing it in this case.) Again referring to the diagram and tracing the vertical line at 4.30 p.m. we see that the load on the station has begun to rise considerably, and at 8.30 p.m. it has again fallen, so that our plant may be considered fully monopolised for lighting load between 4.30 and 8.30 o'clock in the evening. There are a few consumers who close their premises as early as 7 o'clock in the evening throughout the year. I have carefully investigated the number of hours such a consumer would draw from our supply during the hours of peak load (between 4.30 and 7 p.m.) in order to ascertain, assuming these low rates are in operation, whether they would prove profitable to the undertaking at the proposed new rates; I find their load between 4.30 and 7 p.m. will average 1¼ hours per day throughout the year, and this will be at the higher rate of charge proposed—viz., 6d. per unit. By reference to the diagram of costs prepared on our last balance sheet, I find that the total cost to us at 1¼ hours per day, including all capital charges, etc., is very slightly over 6d. per unit, so that although we should not make any profit from the peak load supply to such a consumer, the day load drawn at the lower rate at 1d. per unit would yield a profit of ·17d. per unit, the cost of generating the day load supply being ·83d. per unit. Should the committee approve of this proposition for day load charges it would be possible for such firms as Shoolbred's, Maple's, Oetzmann's, and other large firms to provide a set of secondary batteries which could be charged during the hours of day load from our supply at the low rate, and these batteries could be utilised to maintain their lighting during the peak load. Such a customer would be a profitable one to our undertaking even at the low rate of 1d. per unit, because we should be in the position of being able to supply him with current without involving any capital charges whatever. I feel confident with such a low rate available that there are a number of ratepayers possessing their own generating plant who would find it a distinct advantage to draw current from us during the daytime rather than generate their own, and taking it on the whole I am sure that we should not only popularise the use of electricity, but that we should find it a distinct advantage financially to the undertaking in obtaining additional day load, which, as I have shown, would cost a very low rate to provide. There is a further possibility of long load in the development of electric signs, and again referring to the diagram, we see that even at 7.30 p.m. our load has commenced to fall, and since we could never contemplate a very large load due to these signs, I do not consider there would be any risk incurred if we allow these electric signs to go on at the 1d. rate between the hours of 7.30 in the evening and 4.30 the following afternoon: should it be found desirable to burn these electric signs during the prohibited hours, of course customers would be at liberty to do so through a separate meter at 6d. per unit. It may occur to some members of the committee that these suggestions do not wholly concur with the recommendations in the earlier part of this report, inasmuch as I have shortened the hours of prohibited load. I have done so to meet the views somewhat of customers having electric signs who have pointed out to me that unless they are in a position to display them at a fairly early hour in the evening, the advertisement obtained by catching the theatre traffic would be lost, and on making a study of our peak load diagram we see that it would be possible to strain a point in this case without it being a disadvantage to the undertaking, bearing in mind that the demand on our plant for electric signs can only become a small percentage of the total, and there is therefore little fear of their providing a peak load which would exceed that obtained by the lighting. In considering this report, I feel confident the committee will deal with the matter on broad lines, bearing in mind that the installation which we control is the property of the ratepayers generally, and this being so, it is desirable that they should be able to avail themselves of its use in every conceivable way, provided it does not increase the cost of operating the machinery to the detriment of the undertaking." The committee recommended the adoption of a system of day load supply for lighting purposes at the same rate as motive power—namely, 1d. per unit—under the following conditions: (1) the supply at this special rate is not to be used between the hours of 4.30 in the afternoon and 8 30 p.m., these being the hours approximately of peak load, any current drawn from the mains during these hours to be charged at the rate of 6d. per unit; (2) charges for all extra meters and switching-over gear, necessary to register the supply under the foregoing conditions, to be borne by every consumer availing himself of these specially low rates; (3) all customers receiving current under these special rates will be liable to be cut off at any time that circumstances may necessitate in a similar way to which is reserved the right in giving the special low motor rates now in force. In the thoroughfares where it is anticipated it will be some time before electric mains will be laid, it has been decided to substitute 500 incandescent gas lamps for the existing open-flame burners. The recommendations were agreed to.

## PROVISIONAL PATENTS, 1904.

DEC. 27.

**28329. An improvement in or connected with the working of telephonic systems.** Robert Lambert Murray and Frederick Thomas Jackson, 9, Regent-street, London. (Complete specification.)

**28336. Improvements in brush-holders for dynamo-electric machines and other uses.** Veritys, Limited, and Daniel Evan Rogers, 11, Burlington-chambers, New-street, Birmingham.

**28345. Improvements in regulating gear for use in connection with train-lighting and similar dynamos.** Charles Dixon Charlesworth and John Robert Charlesworth, 24, Temple-row, Birmingham.

**28349. Improvements in the generation and distribution of electricity.** Walter Dixon, 121, West George-street, Glasgow. (Complete specification.)

**28350. A new or improved attachment or appliance for use in connection with suspended electric lamps.** Edgar Augustus Joseph Hooper, 24, Temple-row, Birmingham. (Complete specification.)

**28369. Improvements in electric switches.** George Harrison, 11, Southampton-buildings, Chancery-lane, London. (Monroe Guett, United States.) (Complete specification.)

**28370. Improvements in electric switches.** George Harrison, 11, Southampton-buildings, Chancery-lane, London. (Monroe Guett, United States.) (Complete specification.)

**28375. Electric bipolar plates accumulator.** Gustavus Martin Zingel, 132, Hanley-road, London.

**28393. Improvements in or relating to electric current governors.** Alfred Julius Boult, 111, Hatton-garden, London. (Walter Joseph Richards, United States.) (Complete specification.)

**28409. Electric arc lamp.** Wallace Fairweather, 65, Chancery-lane, London. (The Marquette Electric Company, United States.) (Complete specification.)

**28416. Appliance for the commutation of current in armatures of dynamos.** Engelbert Arnold and Jens Lassen la Cour, 34, Castle-street, Liverpool. (Complete specification.)

**28453. Improved continuous-current electric motor.** Soc. Anon. pour le Travail Electrique des Métaux, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, May 10, 1904, being date of application in France.) (Complete specification.)

**28455. Improvements in central telephone station installations.** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

**28458. Incandescent electric lamp.** Franklin Wise Howorth, 46, Lincoln's-inn-fields, London. (John Henry Guest and Charles Isaac Hills, United States.)

**28467. Improvements in or relating to electric incandescence lamps.** William Phillips Thompson, 322, High Holborn, London. (Deutsche Gasglühlicht Act.-Ges. (Auer Ges.), Germany. (Complete specification.)

**28468. Improvements in systems of electrical conductors.** Béla Gáti, 322, High Holborn, London. (Complete specification.)

**28471. Combined starting and braking device for electric motors.** Arthur Hultqvist, 322, High Holborn, London. (Complete specification.)

**28495. Improvements in or relating to automatic electric switches.** Anton Firley, 18, Buckingham-street, Strand, London.

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DEC. 28.

**28522. Improvements in electric signalling on railways.** William John Mackenzie, 100, Wellington-street, Glasgow.

**28525. Improvements in trolley standards for electric tramcars and the like.** Montague Brown Mountain and Godfrey Marsden Gibson, 55, Market-street, Manchester.

**28546. Improvements in protected or armour-clad switch-fuses.** Herbert Henry Berry, Uplands House, Chase Ridings, Enfield.

**28554. Improvements in or relating to thermo-electric couples.** Alfred Julius Boult, 111, Hatton-garden, London. (William Hoskins, United States.) (Complete specification.)

**28601. Improvements in apparatus for electro-deposition of metals.** Willis Rinaldo King, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**28608. Improvements in and relating to "electric candle" lamps.** Charles Clare Regnart and the Hunter Electric Candle Lamp Company, Limited, 29, Anson-road, Cricklewood, London. (Complete specification.)

**28628. Improvements in or relating to arc lamps.** Joseph Rosemeyer, 322, High Holborn, London. (Complete specification.)

**28629. Improvements relating to drop-signals or annunciators for central telephone stations and so forth.** Isidore Bernard Birnbaum, 322, High Holborn, London. (Complete specification.)

DEC. 29.

**28677. Improved safety device for electric railways.** Frederick Owen, 6, Lord-street, Liverpool.

**28678. Improvements in or applicable to cranes and other lifting machinery driven by electric motors.** Frank William Reed and Craven Bros., Limited, 70, Deansgate, Manchester.

**28687. Improvements in means or apparatus for automatically starting, controlling, and stopping single or multi-phase alternating-current electric motors.** Oswald Carr and John Charters Birch, 50, Wellington-street, Leeds.

**28689. Globe or shade carrier for gasfittings, oil-lamps, electric light fittings, and the like.** Thomas William Maddox, 173, Bevington-road, Aston, Birmingham.

**28717. Improved operating gear for groups of electrical switches and rheostats.** Wolf Defries, 60, Queen Victoria-street, London.

**28722. Improvements in or relating to electric incandescent lighting devices.** Carl Schwabe, 6, Lord-street, Liverpool. (Complete specification.)

**28723. Improvements in electric incandescent lighting devices for shop windows, showcases, and the like.** Carl Schwabe, 6, Lord-street, Liverpool. (Complete specification.)

**28724. Improvements in electric incandescent lighting devices for billiard tables, exhibition tables, sale counters, and the like.** Carl Schwabe, 6, Lord-street, Liverpool. (Complete specification.)

**28741. Improvements in and relating to electric ignition devices for internal-combustion engines.** William Henry Astell, 70, Chancery-lane, London.

**28749. Improvements in or relating to telephones for the use more particularly of divers.** Edwin Charles Lacey and James Holman, 53, Chancery-lane, London.

**28787. Improvements in electrical switches.** George Benjamin Stern and Albert Cecil Greene, 14, Coleman-street, London.

**28791. Improvements in electric current distributors for luminous letters.** L. Snoeck, 46, Lincoln's-inn-fields, London.

**28804. Improvements in and relating to insulators for high-voltage electric lines.** Società Ceramica Richard-Ginori, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, June 22, 1904, being date of application in Italy.) (Complete specification.)

**28824. Improvements in electric igniting arrangements for internal-combustion engines.** Louis Renault, 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Feb. 2, 1904, being date of application in France.) (Complete specification.)

**28826. Improvements in or connected with space telegraphy.** John Stone Stone, Norfolk House, Norfolk-street, Strand. (Date applied for under Patents Act, 1901, Feb. 13, 1904, being date of application in United States.) (Complete specification.)

**28827. Improvements in or connected with bolometers and space telegraphy.** John Stone Stone, Norfolk House, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Feb. 15, 1904, being date of application in United States.) (Complete specification.)

DEC. 30.

**28845. Improvements in anti-vibration electric couplings.** Robert William Bill and Sidney Bill, 9, Headingley-road, Handsworth.

**28852. An improved conduit for containing electric cables and wires, and other wires, tubes, pipes, and the like.** Walter Hepworth-Collins, 17, Nicholas-street, Manchester. (Complete specification.)

**28858. An improved electric switch and circuit breaker.** John Arthur Hirst and Percy Smith Brook, Northgate Electrical Works, Chester.

**28860. A self-acting motor-starting rheostat.** John Arthur Hirst and Percy Smith Brook, Northgate Electrical Works, Chester.

**28875. Plug adapter for electric lamps.** William Frank Simmonds, 4, Newton-street, Holborn, London. (Complete specification.)

**28889. Improvements in or relating to electric control circuits with heat indicators.** Martin Arnold Abrahamson, 322, High Holborn, London.

**28895. Electric lamp for ovens.** William Emerson George Read, 486, Edgware-road, London.

**28899. Improvements in electric bell-pushes.** William Walker, jun., 7, Staple-inn, London.

**28962. Improvements in galvanometers.** Jules Richard, 11, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Feb. 3, 1904, being date of application in France.) (Complete specification.)

**28968. Improvements in series commutator motors for single-phase alternating current.** The Maschinenfabrik Oerlikon, 46, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Feb. 29, 1904, being date of application in Switzerland.) (Complete specification.)

**29001. Improvements in or relating to electric railway conduit systems.** Joseph van Aerschot, 111, Hatton-garden, London. (Complete specification.)

**29004. Improvements in or relating to electric railways and tramways.** Charles Mackintosh, 111, Hatton-garden, London.

**29014. Improvements in electric switches.** Robert Longden, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**29015. Improvements relating to the automatic control of overloads in electric circuits.** Siemens Bros. and Co., Limited, and Percy Gilbert Ledger, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**29054. Improvements in electric incandescent lighting devices for pictures, music desks, writing desks, pianofortes, and the like.** Carl Schwabe, 6, Lord-street, Liverpool. (Complete specification.)

**29057. Improvements in electric insulation.** Max Meirowsky, 6, Lord-street, Liverpool.

**29058. Improvements in terminals for electric conductors.** Louis Renault, 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, May 2, 1904, being date of application in France.) (Complete specification.)

**29059. Improvements in electric ignition plugs for internal-combustion engines.** Louis Renault, 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, May 2, 1904, being date of application in France.) (Complete specification.)

**29063. Improvements in or connected with insulators of overhead electric conductors.** Emile Giraud, 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, April 14, 1904, being date of application in France.) (Complete specification.)

**29064. Improvements in safety devices for overhead electric conductors.** Emile Giraud, 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, April 14, 1904, being date of application in France.) (Complete specification.)

**29074. Improvements in metal reflectors for use with electric lanterns.** Jean Alexander Rey, 24, Southampton-buildings, Chancery-lane, London.

**29079. Improvements in electric current measuring and recording apparatus.** George Gatton Melhuish Hardingham, Clun House, Surrey-street, Strand, London. (Vittorio Arcioni, Italy.)

**29092. Improvements in or relating to electrically-propelled automobile vehicles.** Pierre Marical, 18, Buckingham-street, Strand, London.

**29107. Improvements in telephones for diving and like purposes.** Robert Henry Davis and Alfred Graham, 4, South-street, Finsbury, London.

**29125. Improvements relating to switching devices for electric lamps, especially adapted for use in "flash" advertising.** Leonard Kingwill Job, 322, High Holborn, London.

**29129. Improvements in and relating to electromagnetic separators.** William Blackmore, 18, Southampton-buildings, Chancery-lane, London.

**29138. Improvements in electric dry batteries.** Charles Aubrey Day, 321, High Holborn, London. (Empire State Dry Battery Company, United States.)

**29142. Improvements in space telegraphy.** John Stone Stone, Norfolk House, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Feb. 23, 1904, being date of application in United States.) (Complete specification.)

**29143. Improvements in or connected with space telegraphic receiving systems.** John Stone Stone, Norfolk House, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Feb. 23, 1904, being date of application in United States.) (Complete specification.)

**29144. Improvements in space telegraph systems.** John Stone Stone, Norfolk House, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, April 11, 1904, being date of application in United States.) (Complete specification.

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**29145. Improvements in space telegraphy.** John Stone Stone, Norfolk House, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, April 11, 1904, being date of application in United States.) (Complete specification.)

**29146. A new or improved support for use in space telegraphy.** John Stone Stone, Norfolk House, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, May 3, 1904, being date of application in United States.) (Complete specificatton.)

**29165. Improvements in electric dry batteries.** Herbert William Butler, 47, Lincoln's-inn-fields, London.

DEC. 31.

**29180. An improved magnetic compass.** John Fisher Le Page, 8, King-street, Manchester.

**29187. Improvements in electric igniters for explosion motors.** Henri Guillou, 40, Chancery-lane, London. (Date applied for under Patents Act, 1901, Jan. 2, 1904, being date of application in France.) (Complete specification).

**29233. Improvements in or connected with low-tension electric ignition devices for internal-combustion motors.** Albion Motorcar Company, Limited, and Thomas Blackwood Murray, 121, West George-street, Glasgow. (Complete specification.)

**29259. Charging plug and leads for charging an accumulator from the lampholder on any direct-current electric lighting circuit.** Ernest Philip Melancthon Eldridge, 47, Gloucester-street, London.

**29281. Improvements in apparatus for opening and closing electric circuits at predetermined times.** John Gunning, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**29307. Improvements in or relating to switches for electric incandescent lamps.** Armand Frey, 111, Hatton-garden, London. (Complete specification.)

**29308. Improvements in or relating to the detection and recording of electrical impulses or oscillations and apparatus therefor.** George Finlay Anderson, 111, Hatton-garden, London.

**29310. Improvements in or relating to electrical dumb-bells and similar appliances for physical exercises.** Alfred Loebl, 111, Hatton-garden, London. (Complete specification.)

**29337. Method of and means for the protection of electrical apparatus branched on circuits which are traversed (accidentally or otherwise) by currents of high frequency.** Georges Eugène Gaiffe, 53, Chancery-lane, London.

**29343. Improvements in or connected with electrical gas-igniting and extinguishing apparatus.** Henry Langdon Down and Douglas Herbert Wiseman, 115, Cannon-street, London.

**29345. Improvements in or connected with electrical gas-igniting and extinguishing apparatus.** Henry Langdon Down and Douglas Herbert Wiseman, 115, Cannon-street, London.

**29346. Improvements in or connected with electrical gas-igniting and extinguishing apparatus.** Henry Langdon Down and Douglas Herbert Wiseman, 115, Cannon-street, London.

**29347. An improved electric transformer.** Gustav Stern, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published Jan. 19, 1905.*

1903.

**28062. Electric chain welding machines.** Helberger.

1904.

**716. Control and propulsion of vehicles propelled by electric motors.** Raworth.

**2152. Electrolytic cells.** Raschen, Clayton, and United Alkali Company, Limited.

**4676. Insulators for the conductors of electric railways.** Henry Percy Bradford, Frank Dietrich Ward, and Harry Crampton Furniss.

**4770. Automatic regulators for alternating-current motors.** British Thomson-Houston Company, Limited. (General Electric Company.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ⅞-⅞ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 15/32-9/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | – | 5-5¼ |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | – | 5⅛-5⅜ |
| —— 4½ per cent. Mortgage Debentures | 100 | – | 101-104 xd |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 101-103 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | – | 2⅜-2⅝ |
| —— 4 per cent. Mortgage Debenture Stock | 100 | – | 86-88 xd |
| Brush Electrical Engineering, Ordinary, Nos. 1-106,731 | 2 | – | ⅞-⅞ |
| —— Non. Cum., 6 per cent. Pref. | 2 | – | 1 5/16-1 9/16 |
| —— 4½ per cent. 1st Debenture Stock | 100 | – | 93-96 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | – | 73-76 xd |
| Callender's Cable, Debentures | 100 | – | 104-106 xd |
| —— Ordinary | 5 | – | 9¼-10 |
| —— 5 per cent. Pref. | 5 | – | 5-5¼ |
| Crompton and Co. | 5 | – | 2-2½ xd |
| —— 5 per cent. Debentures | 100 | – | 95-98 xd |
| Edison and Swan United, "A" Shares, 1-99,261 | 5 | – | ⅞-1 |
| —— "A" Shares, 01-017,139 | 5 | – | 1-1¼ |
| —— 5 per cent. Debentures | 100 | – | 79-84 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 77-82 xd |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | – | 1⅛-1½ |
| —— 7 per cent. Cumulative Pref. | 2 | – | 2⅛-2⅜ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | – | 98-100 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | – | 9¼-10 xd |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | – | 91-96 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | – | 10½-10⅝ |
| —— 5 per cent. Preference | 5 | – | 5⅛-5⅜ |
| —— 4½ per cent. Debentures | 100 | – | 110-112 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | – | 15 16 xd |
| —— 4 per cent. Debentures | 100 | – | 98-102 |
| Parker, Thos., Limited, Ordinary | 10 | – | 10-10¼ |
| Telegraph Construction and Maintenance | 12 | – | 38 40 |
| —— 5 per cent. Bonds | 100 | – | 101¼-102½ xd |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary | 10 | – | 12-12¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | – | 9¼-10 |
| —— 5 per cent. Cum. Second Pref., 15,001-22,500 | 10 | – | 11-12 |
| —— 4½ per cent. Debenture Stock. Red. | 100 | – | 103-106 xd |
| Bromley (Kent) Electric Light and Power Co. | 5 | .. | 5⅛-5⅜ |
| —— 4½ per cent. 1st Debenture Stock, Red. | 100 | – | 101-104 |
| Brompton and Kensington, Ordinary | 5 | – | 10¼-11 |
| —— 7 per cent. Preference | 5 | – | 10⅛-10⅜ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 | 5 | – | 8⅛ 8⅜ |
| —— Nos. 60,001-80,000 | 5 | – | 6⅛-6⅜ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | – | 12½-13⅛ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 105-108 |
| Charing Cross and Strand, Nos. 1-70,000 | 5 | – | 8⅛-8⅜ |
| —— 70,001-80,000 | 5 | .. | 8-8¼ |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5 9/16-5 13/16 |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 4⅛ 5 xd |
| —— 40,001-80,000 | 5 | .. | 4⅛-5 xd |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | – | 101-103 |
| Chelsea Electricity Supply | 5 | – | 6⅜ 7 |
| —— 4½ per cent. Debentures | 100 | – | 108 110 xd |
| City of London, Ordinary | 10 | – | 11-11⅛ |
| —— 6 per cent. Cumulative Pref. | 10 | – | 13⅛-14 |
| —— 5 per cent. Debenture Stock | 100 | – | 121-125 xd |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | – | 100 103 xd |
| County of London Electric Supply, Ordinary | 10 | – | 8 9⅛ |
| —— 6 per cent. Cum. Pref. | 10 | – | 12-12⅛ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 101-103 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. | 100 | .. | 106-109 xd |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | – | 6⅜ 6⅝ |
| —— 6 per cent. Cum. Pref. | 5 | – | 6-6¼ |
| —— 4½ per cent. First Mort. Deb. | 100 | – | 108-110 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 14-2⅛ |
| —— 5 per cent. Debenture Stock, Red. | 100 | – | 86-91 xd |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | – | 5⅛-6 |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | – | 102-105 |
| Havana Electricity, Limited, 1-15,000 | 10 | – | 9⅛-10⅛ |
| Howe Electric Lighting, Limited, Ord., 1-13,000 | 5 | – | 7⅛ 8 |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 100-102 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 | 1 | – | 9/16-11/16 |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | | 12⅛-13 |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red | 100 | – | 102-104 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅛-10⅛ |
| London Electric, Ordinary | 5 | – | 2⅛-2⅜ |
| —— 6 per cent. Pref. | 5 | – | 5 9/16 5 13/16 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | – | 95 97 |
| Metropolitan Ordinary | 10 | – | 18 18⅛ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | – | 110 115 |
| —— 4½ per cent. Cum. Pref. | 5 | .. | 5 7/16-5 9/16 xd |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | – | 86 88 xd |
| Midland Electric Power Dis., Ld., 4½ p c. 1st Mort. Deb. | 100 | – | 93-96 xd |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | – | 98-101 |
| —— Preference | 4 | – | 100-102 |
| Notting Hill Electric Lighting | 10 | . | 14⅛-15 |
| —— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.) | 100 | | 102-104 |
| Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,510 | 5 | – | 6⅛ 6⅜ |
| —— 4 per cent. Debenture Stock | 100 | – | 99-101 |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures | 100 | – | 100-102 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 | – | 2⅜-3⅛ |
| —— 4 per cent. Debenture Stock | 100 | – | 83-87 |
| South London, Ordinary | – | – | 4⅛ 4⅜ |
| South Metropolitan Electric Light and Power Co., Ord. | 1 | .. | 13/16-15/16 |
| —— 7 per cent. Cum. Pref. | 1 | .. | 1⅛-1 7/16 |
| —— 4½ per cent. 1st Mort. Deb. | 100 | .. | 107 110 |
| —— Ditto, June, 1904 | | .. | |
| St. James's and Pall Mall, Ordinary, 101-20,080 | 5 | – | 13⅛-14 |
| —— 7 per cent. Pref. | 5 | – | 8⅛-9 |
| —— 3½ per cent. Deb. | 100 | – | 98-100 xd |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | – | 5 5⅛ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5 1/16-5 3/16 |
| Westminster, Ordinary | 5 | – | 12⅜-13⅛ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | – | 6-6½ xd |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 | 5 | – | 5⅛-5⅜ xd |
| —— Ord. | 5 | .. | 2⅝-3⅛ |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | – | 140 143 xd |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 104-106 xd |
| Barcelona Tramways, Limited, Ord., 1-20,000 | 10 | .. | 12-12⅛ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 | 10 | .. | 9⅛-10 xd |
| —— 5 per cent. Deb., Red., 1-600 | 100 | .. | 99-102 |
| —— 4½ per cent. Red. Deb. Stock | 100 | .. | 96-100 |
| Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606 | 1 | .. | ⅜-⅝ |
| —— 5 per cent. Cum. Pref. Shares, 1-69,394 | 1 | .. | ¼-1 xd |
| Belfast Street Tramways, Ord., 1-26,600 | 10 | .. | 10-11 |
| Blackpool and Fleetwood Tramroad | 10 | – | 13⅜-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | – | 1⅛-2 |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | – | 3⅜-4⅛ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 91 93 xd |
| British Columbia Electric Railway Co., Ord. Def. | 100 | – | 100-103 |
| —— Ord Pref. | 100 | .. | 100-103 |
| —— Non. Cum. 5 per cent. Pref. | 10 | – | 10⅛-10⅜ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each | 40 | – | 102-104 p c |
| —— 4½ per cent. Vancouver Power Deb. | 100 | – | 98-101 |
| British Electric Traction Ord. 1-500,000 & 50,001-90,000 | 10 | – | 9⅜-10⅛ xd |
| —— 6 per cent. Cm. Pf., 30,001-50,000 | 10 | – | 11-11⅛ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | .. | 118-120 |
| —— 4½ per cent. 2nd Deb. Stock | 100 | | 97-90 |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 | 3¼-4 |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | 5⅝-5¾ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | 5⅛-5⅜ |
| —— 5 per cent. Deb. Stock, Red. | 100 | 105-107 xd |
| —— Prov. Cert., all paid | 100 | 101-104 xd |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | 94-97 xd |
| Calcutta Tramways, Limited, 1-102,268 | 5 | 8¼-8½ |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | 106-108 xd |
| Cape Electric Tramways, Nos. 1-480,000 | 1 | 1⅛-1⅛ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | 4¾-5⅛ |
| —— 4 per cent. 1st Mortgage Deb., 1-5,000 (1917) | 100 | 99-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | 101-104 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | 9¼-10 |
| —— 5 per cent. Cum. Pref. | 10 | 11-12 |
| —— 4 per cent. Debentures | 100 | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | 13-14 |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 | 15-16 |
| —— 3½ per cent. Mort. Debs., 1-3,000, Red. | 100 | 94-97 |
| Imperial Tramways Ordinary | all | 18-19 |
| —— 5 per cent. Cum. Pref. | all | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-50,000 | 5 | 3¼-4 |
| —— 4 per cent. Debenture Stock | 100 | 88-91 xd |
| Kidderminster and District Lighting and Traction, Pref. | 5 | 8-8¼ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | 10⅜-10⅝ xd |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | 101-103 xd |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 | 101-103 xd |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016. | 1 | ⅜-7/16 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | 15/16-1 |
| —— 4½ per cent. Deb. Stock, Red. | 100 | 103-105 xd |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000 | $1,000 | 108-113 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 | 100-103 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 | 103-105 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000 | 5 | ¼-1½ |

| Name. | Amount paid. | Last price |
|---|---|---|
| | £ | £ |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | ·12½ |
| —— 5 per cent. Cum. Pref. | 10 | 9⅜-9¾ |
| Perth Elec. Tramways (W. A.) 5 per cent. 1 Mrt. Deb. Stk. | 100 | 101-104 xd |
| Potteries Electric Traction, Ordinary 20,001-40,00 | 10 | 8-9 |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | 8¼-8¾ |
| —— 4½ per cent. Debenture Stock | 100 | 99-102 |
| South Lancashire Electric Traction and Power Company —— £250,000 Ordinary | 1 | 1 |
| —— £101,152 5 per cent. Preference | 1 | 1 |
| —— £528,093 4½ per cent. Debenture Stock | 100 p.c. | 100 p.c. |

## Electric Railways.—

| | | |
|---|---|---|
| Central London, Ordinary | 100 | 91-93 |
| —— 4 per cent. Pref. | 100 | 101-103 |
| —— " " deferred | 100 | 85-87 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid). | 100 | 108-110 |
| City and South London, Consolidated Ordinary | 100 | 46-47 |
| —— 4 per cent. Debenture Stock | 100 | 104-107 |
| —— 5 per cent. Pref. Stock '91 | 100 | 122-125 |
| —— " " " '96 | 100 | 117-120 |
| —— " " " '01 | 100 | 116-119 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | 10-10¼ |
| —— Ordinary, 1-50,000 | 10 | 3¾-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700. | — | 99-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | — | 97-98 |
| Waterloo and City, Ordinary | 100 | 90-92 |

## Telephones.—

| | | |
|---|---|---|
| National Telephone, Preferred | 100 | 108¼-109¼ |
| —— Deferred Stock | 100 | 107-109 |
| —— 6 per cent. Cum. First Pref. | 10 | 13-15 |
| —— 6 per cent. Cum. Second Pref. | 10 | 12-13 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | 5 5/16-5 7/16 |
| —— 3½ per cent. Deb. Stock, Red. | 100 | 96 98 xd |
| —— 4 per cent. Deb. Stock, Red. | 100 | 101-103 xd |
| —— 4 per cent. Prov. Cert. | — | 101-103 xd |
| Oriental Telephone and Electric Company | 1 | 1-1¼ |
| —— 6 per cent. Cum. Pref. | 1 | 1¼-1¾ |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905. | 1904. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Car mile. | Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Dec. 31 | 1,291 | 1,470 | − 179 | — h | 19¼ | 19¼ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | Jan. 7 | 245 | 189 | + 57 | + 522 | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 336,049 | 1·03 | 10·11 | 1,770 | 5·04 |
| Barking Corporation | ,, 7 | 62 | 41 | + 20 | + 132 | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 8 | 1,034 | 1,048 | + 35 | − 572 | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,349,701 | 1·158 | 9·98 | 2,383b | 6·1 |
| Birmingham Corporation | ,, 7 | 357 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | ,, 7 | 5,545 | 5,045 | + 497 | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | Dec. 16 | 765 | 723 | + 42 | + 3,353 | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10·94 | — | 4·59 |
| Blackpool Corporation | Jan. 5 | 336 | 287 | + 49 | + 5,995 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 7 | 180 | 183 | − 8 | − 70 | 16½ | 16½ | Dec. 31 | 32,021 | 2,258,984 | 600,757 | 3·34 | 12·75 | 2,001 | 7·05 |
| Bolton Corporation | ,, 8 | 2,151 | 1,666 | + 485 | — | 38 | 38 | March 31 | 94,161 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·89 |
| Bournemouth Corporation | ,, 4 | 973 | 857 | + 116 | + 2,158 | 10·15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | Dec. 17 | 3,729 | 3,366 | + 363 | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | Jan. 8 | 797 | 743 | + 54 | + 3,495h | 9 | 7½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 6 | 4,579 | 4,448 | + 131 | — | 51½ | 51½ | Dec. 31g | 253,150 | 44,391,439 | 6,033,528 | — | — | — | — |
| Burnley Corporation | ,, 7 | 1,090 | 816 | + 274 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 8 | 312 | 294 | + 18 | — | 8½ | — | March 31j | 11,574 | 2,556,134 | 282,378 | 1·08 | 9·84 | 1,570 | 7·57 |
| Cardiff Corporation | ,, 7 | 1,933 | 1,823 | + 116 | + 2,090 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 7 | 189 | 175 | + 14 | + 14 | — | — | Dec. 31g | 9,987 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 7 | 7,015 | 7,054 | − 39 | — h | 6 | 6 | ,, 31 | 362,471 | 44,953,988 | 1,292,674a | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 8 | 3,179 | 3,133 | + 46 | — h | 6½ | 6⅜ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Colchester Corporation | Dec. 28 | 255 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. T. and L. Company | Jan. 5 | 304 | 415 | − 111 | — | — | — | ,, 31g | 25,657 | 6,355,323 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | ,, 8 | 231 | 198 | + 33 | − 98 | 7·23 | 7·23 | March 31g | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 7 | 180 | 171 | + 9 | − 62 | 4½ | 4½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0·94 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | ,, 6 | 79 | 75 | + 4 | — h | 7 | 6½ | Dec. 31g | 6,234 | 888,905 | 107,164 | 3·88 | 14·09 | 952 | 7·39 |
| Dublin U. T., electric cars | ,, 6 | 3,248 | 3,135 | + 113 | — | 47 | 46 | ,, 31g | 134,648 | — | 3,429,356 | — | — | — | — h |
| Dublin S. District, Electric | ,, 6 | 667 | 598 | + 69 | | | | | | | | | | | |
| Dundee City Tramways | ,, 4 | 1,278 | 1,125 | + 82 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 7 | 628 | 584 | + 44 | + 1,564 | 10·77 | 10·75 | March 31 | 34,312 | 12,950,269 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 7 | 17,069 | 14,619 | +2,450 | +22,459h | 145 | 123 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Gloucester Corporation | ,, 4 | 242 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | Dec. 28 | 2,198 | 2,377 | + 121 | + 4,192 | 33 | 30½ | March 31 | 68,289 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,069 | 8·77 |
| Huddersfield Corporation | — | — | — | — | — | 35 | 35 | ,, 31 | 65,545 | 11,899,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | Jan. 7 | 2,180 | 2,037 | + 143 | +10,763 | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | ,, 7 | 358 | 321 | + 37 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | ,, 4 | 91 | 105 | − 14 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 4 | 374 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 7 | 5,293 | 4,795 | + 498 | +13,446 | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | ,, 7 | 1,752 | — | — | — | 7¼ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | Dec. 31 | 10 377 | 9,696 | + 681 | +16,477 | 103 | 103 | Dec. 31g | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | Jan. 8 | 1,505 | 1,598 | − 93 | — h | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — a |
| London County Council | Dec. 31 | 11,973 | 8,859 | +3,119 | — | 46½ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | Jan. 7 | 135 | 136 | — | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | ,, 5 | 95 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 7 | 11 996 | 10,749 | +1,247 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Metropolitan Elec. Tramways | Dec. 30 | 2,327 | 1,029 | +1,298 | +14,915h | 10 | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | Jan. 7 | 105 | 93 | + 12 | + 1,314 | 2¾ | — | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newcastle-on-Tyne Corptn. | ,, 7 | 3,745 | 3,472 | + 271 | — | 45 | 38½ | ,, 25 | 185,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111b | — |
| Newport (Mon.) Corporation | Dec. 31 | 619 | 420 | + 198 | + 472 | 15 | — | — | — | — | — | — | — | — | — |
| Oldham Corporation | Jan. 8 | 1,753 | 1,021 | + 332 | + 2,565 | 34¾ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 7 | 1,515 | 1,372 | + 143 | + 6,232 | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·16 | 12·39 | — | — |
| Rochdale Corporation | — | — | — | — | — | 4½ | 4½ | 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | — |
| Rotherham Corporation | ,, 5 | 423 | 383 | + 40 | — | — | — | ,, 31 | 20,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 7·66 |
| Salford Corporation | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 6·68 |
| Scarborough Tramways Co. | — | — | — | — | — | 7¾ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 8 | 4,557 | 4,037 | + 520 | + 4,690 | 34½ | — | ,, 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 5 | 859 | 845 | + 14 | − 2,302 | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | — | — | — | — | — | 6½ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 6 | 452 | 346 | + 106 | + 8,053 | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | Dec. 18 | 1,116 | 1,072 | + 44 | + 1 052 | 19·54 | 18·48 | ,, 31 | 62,506 | 14,848,958 | 1,433.463 | 1·01 | 10·46 | — | 6·08 |
| Swindon Corporation | — | — | — | — | — | 3¾ | — | — | — | — | — | — | — | — | — |
| Wallasey U.D.C. | Jan. 7 | 690 | 584 | + 106 | + 2,047 | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,100 | 7·60 |
| West Ham Corporation | ,, 5 | 1,076 | — | — | — | 8·62 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 4 | 732 | 437 | + 295 | — | 7½ | — | ,, 31g | 20,878 | 4,263,066 | 417,335 | — | 12·006 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. c Train mile.
b Per mile of single track. e Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1905. h Half-year's figures.
Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**Personal.**—The St. Petersburg Academy of Sciences has elected Sir Norman Lockyer a corresponding member. Dr. D. H. Scott has been re-elected president of the Royal Microscopical Society, with Mr. G. C. Karop, Sir Ford North, Mr. H. G. Plimmer, and Dr. H. Woodward as vice-presidents.

**Islington Electrical Exhibition.**—We learn that the electrical exhibition which the Islington Borough Council proposed to hold in February or March, as announced in our issue of the 6th inst., has been postponed until October or November. In the meantime the borough electrical engineer, Mr. Albert Gay, will be glad to receive any applications for space or for advertisements in the catalogue.

**Errata.**—We regret that in publishing the article last week on "Electricity in India and Burma" we made a mistake in the author's name. It should be Mr. E. C. Deefholts, and not "Deepholt." In the article itself "Sibpur" is mis-spelt Silepur. We regret this error in the name of the place, which is noted as the home of the civil engineering college which is doing such good work in the technical education of engineers in India.

**Electro-Harmonic Society.**—This society will hold its first concert of the present year to-night in the King's Hall of the Holborn Restaurant, commencing at 8 o'clock. The vocal artists will be Messrs. Jas. Davis and Harry Dearth, while the instrumental music will be in the familiar hands of Messrs. Izard and Gatehouse, with Mr. B. C. Goodhead. A delightful programme will be completed by miscellaneous features, contributed by Messrs. J. Warren, C. Gellett, and G. Robins.

**Engineering Standards Committee.**—We have received this committee's twelfth report, which deals with the standard specification for Portland cement. The sub-committee appointed to consider this branch held a dozen meetings in all. The report embraces sections on quality and preparation, sampling, specific gravity, chemical composition, mode of gauging, tests, soundness, etc. It is supplemented by diagrams which help to make the Standards Committee's methods invariable.

**Wireless Telegraphy.** — It is announced that Marconi's Wireless Telegraph Company, Limited, has entered into an agreement with the Oceanic Steam Navigation Company, Limited (the White Star Line) for the equipment of six of the White Star Line vessels—the "Oceanic," "Celtic," "Baltic," "Cedric," "Majestic," and "Teutonic"—with Marconi wireless apparatus. It is hoped that the first of these liners—the "Oceanic"—may be equipped in readiness for her voyage from Liverpool on Feb. 1. The remainder of the vessels will be fitted at short intervals after that date. When the boats mentioned have been equipped under the agreement referred to, practically all the Atlantic liners of the first-class shipping companies will be carrying Marconi apparatus.

**Novel Danger Signal.**—During a great gale in February, 1903, a mail train was blown over on Levens Viaduct, on the Furness line, and almost fell into the sea. The Furness Company, in order to prevent similar accidents, have now erected an ingenious instrument which will automatically warn the signalmen on duty when there is unusual wind pressure of sufficient force to be dangerous to trains crossing the viaduct. The apparatus consists of a combined wind pressure gauge and recorder, and is connected with an electrical device by means of which bells are set in motion at distant signal-cabins. These bells will continue to ring so long as the velocity of the wind on the viaduct is dangerous to passing trains, consequently all traffic will be stopped until the wind pressure falls below the point of danger.

**"Tube" Construction.**—The London County Council and the promoters of the Great Northern, Brompton, and Piccadilly Railway are at issue over the completion of the tube railways in the Metropolis, owing to the London Council having refused sanction for continuation of the work except under certain conditions. The Council's case is that under the Great Northern and Strand Company's Act of 1899, the company were restrained from working below the new Kingsway pending the completion of the Council's work thereon. There is also a clause of the same character in the Improvements Bill promoted by the Council in 1899. The Kingsway improvement is not yet completed, but the company require permission to waive the stipulation in the Bill, and at once to continue their work The Council are prepared to consent to this, but consider the public interest requires that some compensation shall be given. So far the company have declined to fall in with this view, with the result that a deadlock has occurred. The delay on the part of the Council in the completion of Kingsway seems a poor ground on which to base a claim for compensation.

**Municipalisation and Private Enterprise.**—A conference of London borough councils was held last week at the Shoreditch Town Hall to consider a scheme of combined municipal opposition to the companies promoting Bills in the next session of Parliament for the purpose of supplying electricity in competition with borough councils. The Mayor of Shoreditch presided, and representatives from 21 councils attended. It was resolved to appoint an executive committee to conduct the joint opposition. A proposal was then made by the Town Clerk of Shoreditch, that the committee should consider the advisability of formulating a municipal scheme for a large generating station or stations to supply electricity in bulk to the boroughs. His reason was that this would enable the councils to fight the companies on their own ground, and give a remarkably cheap supply of electrical energy. This proposal, however, met with a somewhat hostile reception, delegates from Poplar, Woolwich, and elsewhere contending that the present municipal electric generating stations in London were sufficiently large for the needs of the respective boroughs, and that the companies could be competed with quite successfully, if necessary, under present conditions. The resolution was consequently withdrawn.

**The Institution.** — At last week's meeting an impressive list of donations to the library was announced; in fact, it seemed as though Mr. Lloyd was going on till Doomsday, but at last he worked his way through to the end of the alphabet. The President expressed a hope that this good example would be followed by many more. In the course of the discussion on Mr. Adams's paper, "The Combination of Dust Destructors and Electricity Works Economically Considered," Mr. G. Watson deprecated the attitude of certain members who had adopted a somewhat adverse view of this system, remarking that there seemed to be a tendency to divide the Institution into two parties—viz, the enthusiasts, and those who threw cold water on enterprising projects. After Mr. Adams's reply, the President made a semi-humorous allusion to this subject, stating that he thought such conduct on the part of members ought to be encouraged, because they would then keep each other in order "just as the Conservatives and Liberals *used* to do"! The arrangements for the next three meetings are

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as follows: Jan. 26, discussion on Messrs. Booth and Kershaw's paper, "Fuel Economy in Steam Power Plants"; Feb. 9, Mr. G. L. Addenbrooke will read a paper on "The Value of Overhead Mains for Electric Distribution in the United Kingdom"; and Feb. 23, Mr. Donald Murray will read a paper on "Setting Type by Telegraphy."

**Cape-to-Cairo Telegraph.**—The Cape-to-Cairo telegraph has reached Udjidji, the capital and chief town of German East Africa, on the eastern shore of Lake Tanganyika. For the moment construction work is suspended while the route northwards is carefully surveyed and the sections of the line that have been erected are got into thorough working order. From the commercial point of view, the line is quite realising, if not exceeding, the expectations that were formed concerning it. When the work of construction is recommenced the route will probably be along the eastern shore of the Victoria Nyanza, and will then strike due north to the town of Rosares, which is the southernmost point of the Soudanese telegraph system. A junction will be effected here between the two lines, and the scheme for a Cape-to-Cairo telegraph will then be an accomplished fact. The engineers of the line are, however, faced with a difficulty in their preparations for carrying it forward from Udjidji, inasmuch as the country for a distance of nearly 100 miles through which the line would have to pass is very swampy, and quite unfit for the erection of a telegraph wire. It was at first thought that a wide detour would have to be made at this point in order to escape this region, but latterly other counsels have prevailed, and a more enterprising expedient is likely to be tried—the installation of the Marconi system of wireless telegraphy in order to bridge over this inhospitable belt of country. Owing to the reduced speed of signalling we shall be surprised if the wireless link is more than a temporary one.

**Rubber Cultivation.**—The report lately issued by Mr. W. H. Johnston, Director of Agriculture for the Gold Coast, shows how disastrous has been the ruthless tapping of rubber-producing trees by the natives of that part of Africa. The industry exported goods to the value of £555,731 five years ago, but in 1903 the figure had fallen to £196,500. Practically all the rubber trees from the coast to more than a week's journey inland have been exterminated, and the report devotes consideration to the best method of replanting the land so as to give a return on the expenditure initially incurred at as early a date as possible, and at the same time to yield the largest percentage of good rubber. Various objections attach to the Castilloa elastica, the Funtumia elastica, and the Glyphodes ocellata. Mr. Johnston, in conjunction with Mr. C. W. Smythe, a botanical expert, therefore recommends the Hevea brasiliensis, which, since its introduction into the colony, has been remarkably free from insect and fungus pests. The heavy rainfall and the rich soil are both favourable to this variety. As an example, four trees, 10 years old, tapped for the first time in 1903, yielded 67oz. of dry rubber without showing signs of having suffered in the slightest degree. It appears that unless Europeans take up the industry in earnest, it will speedily become extinct on the Gold Coast, as, having derived all the available gain from the plants, the natives manifest complete indifference, and will not trouble to cultivate plants offered them gratis. With the growing dearth of rubber, it would be unfortunate if such suitable territory were allowed to continue in a barren state.

**The Telephone Situation.**—Under the heading of "Preparing for Amalgamation," the *Daily News* indulges in a forecast of the future relations between the Post Office and the National Telephone Company. We give the gist of our contemporary's statement, so that readers may decide for themselves whether they belong to the category of "intelligent anticipations of events." A representative of that paper ascertained that "wholesale alterations have taken place in the company's system since Jan. 1, which would seem to indicate that the purchase agreement has been signed, and is only awaiting ratification by Parliament." The article proceeds to state that very extensive changes have been made in the company's organisation, which will render amalgamation with the Post Office much more easy when the time comes. Before Jan. 1 the London area was divided into six districts, each of which was in charge of a local manager, with a staff of clerks and other employés. The company has adopted the American system of telephone organisation, the watchword being centralisation of the strictest kind. The new exchange which will shortly be opened at London-wall is, states the *Daily News*, regarded as a decided step towards amalgamation with the Government system. Like the Post Office service, several central battery exchanges have been installed. The Post Office has adopted a similar system, which is looked upon as the one that will ultimately prevail throughout the kingdom. This exchange will contain about 3,500 direct telephone lines for subscribers, which will be worked by 90 operators, and several new electrical inventions which have been adopted by the Post Office will be used.

**American Patent Examination.**—We notice in the *Electrical Review* of New York the following description of a patent issued as recently as Dec. 13 last for an improved magnet coil. The interest in the patent to us lies in the fact that it describes a method of construction which has been used for many years in dynamo work, and is now the common practice among electrical manufacturers, in the United Kingdom at any rate. A great deal is made of the advantage of a search for prior patents, and we are quite sure that if the examiner who passed this patent had been referred to manufacturers of dynamos, the latter would promptly have recognised an old friend. As it is, the patent has been issued, and, were it not for the universal use of this method of winding, we presume that the owners of the original patent would attempt to claim royalties for the same. Apparently, the parties concerned imagine the patent to be valid, as the Keystone Electric and Manufacturing Company, of Pittsburg, have obtained an assignment of same from Mr. A. Schweitzer, the grantee. The abstract of the patent, as appearing in our contemporary, reads as follows: "The invention relates to improvements in electromagnet coils, such as solenoids, etc. The object is to provide a coil for these purposes which occupies a smaller space than coils as ordinarily wound, and which, nevertheless, has a larger current-carrying capacity and produces less heat and offers less resistance proportionately. Another object is to produce a coil which can be insulated in such a manner as to prevent the same being burned out or short-circuited, and which is simple, durable, and strong. The invention consists of a coil having a spiral conductor composed of a flat strip wound edgewise to form a plurality of convolutions, the flat faces of which lie in substantially parallel planes and are separated by discs of mica or other suitable insulating material slid in from one edge to the centre and arranged between the several convolutions of the coil."

**Patent Law Reform.**—The President of the Board of Trade has issued a report with reference to the resolution adopted, at the instance of the Manchester Chamber of Commerce, by the Association of Chambers of Commerce, at the recent meeting in Manchester, urging on the Board the necessity for a further amendment of the patent laws so as to secure the forfeiture of all British patents for inventions and registered industrial designs which are

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worked or made abroad, but not within the United Kingdom. The Board of Trade points out that the resolution is apparently at variance with Article 2 of the additional Act of Dec. 14, 1900, modifying the Industrial Property Convention of 1883 (adopted by this country as a party to the convention), which provides that a patent cannot be forfeited on account of failure to utilise it for three years after the deposit of the application, and only then when the patentee cannot show reasonable cause for his inaction. Under the Act of 1902, a patent may be revoked if the reasonable wants of the public cannot be satisfied by a grant of licenses, and the reasonable wants of the public are not met if the refusal of the patentee to work or grant licenses prejudices any existing industry or the establishment of a new one. Two applications under the Act of 1902 have already been referred to the Privy Council, but have not yet been decided, and the Government will not be prepared to propose further legislation until the provisions of the Act of 1902 have been proved to be ineffective. The Associated Chambers addressed a similar communication to the Premier, who replied: "The Government would not be prepared to propose a further amendment of the patent laws, relating to compulsory licenses until the provisions of the section of the new Act have been found by experience to be ineffective. At present Mr. Balfour has no evidence before him which leads him to believe that this will be the case." It will be of interest to observe the spirit in which the Privy Council treats the pending applications for revocation.

**The Motorcar Act.**—At the Automobile Club last week Mr. A. Moresby White read a paper on "The First Year's Working of the Motorcar Act," in which he complained that magistrates extended the application of the statute beyond the point contemplated by the Legislature. Another grievance of the motorist was that the Bench were prone to convict simply because the defendant's license had been once endorsed. Earl Russell, who presided, declared that the time was rapidly approaching when motorists should formulate the amendments which they wished to have introduced into the Act. The measure was not so bad as they had feared. It was true that in the first 20 miles of a drive they would probably commit about 10 serious offences, but in practice they were only convicted once in 100 times. The real difficulty was the objection in the minds of the public to speed as such. His lordship humorously referred to the "wilful credulity" of magistrates who believed any evidence against motorists, regarding them as persons of criminal instincts, though it was consoling to see that even bishops shared such treatment. Mr. Staplee Firth, who has appeared for the defence in numerous prosecutions for excessive speed, characterised the Act as the worst piece of legislation on the statute book. One police-sergeant always referred in court to "the vehicular traffic, the pedestrians, and the little children" who "might" have been present, and it was very effective in securing convictions, until at length the motorist's advocate began to prompt him when he came to this stage of each case, and would say, "What about the little children?" Even the Bench saw the point, and the sergeant dropped that part of his evidence. Mr. Firth made the important announcements that Mr. Horace Avory, K.C., had given his opinion that motorists could not be convicted of obstructing the police if they warned other automobilists of traps, and that it had been discovered that the 10-mile limit in the Royal parks, under which numbers of motorists had been convicted, without the slightest suggestion of danger to the public, was entirely illegal, as it had not been submitted for the sanction of Parliament.

**Tramways and Light Railways Association.**—A party of this institution assembled at the Oxford-circus Station of the Central London Railway on Monday for the purpose of inspecting the company's works. The company included Messrs. A. L. C. Fell (London County Council), J. W. Courtenay, C. H. Gadsby, P. Gadsby, W. H. Sayers, S. Sharp, and Ernest Benedict (secretary of the association). Mr. G. C. Cuningham, the general manager, and Mr. E. P. Grove, engineer, met the party at Oxford-circus, and accompanied them to Shepherd's Bush, where the visitors were shown over the splendid power station. As this is so well known, a brief description will suffice. The generating engines in the main house are six horizontal, cross-compound, condensing machines, made by Allis, of Milwaukee, U.S.A., running at 96 revolutions per minute. The electric generator is fixed directly on the flywheel shaft. Each is of 750 kw. capacity, or about 1,000 h.p. Not more than four engines are required at the time of greatest load, so that there is always an ample reserve of power. The boiler-house contains 16 Babcock and Wilcox water-tube boilers and four Lancashire boilers. Klein cooling towers are used to cool the condensing water, and the water supply is obtained from an artesian well on the premises. The amount of current amounts to about 50,000 units per diem. The grand total for the six months ended June 30 last was 8,981,878 units. The coal used is almost entirely smokeless Welsh washed peas. Current is generated at 5,000 volts alternating, which is converted into 550 volts direct at transformer stations at Notting Hill Gate, Marble Arch, Bond-street, and Post Office. Besides the power production directly from the generating station storage batteries are maintained to supply power for emergency lighting. These batteries are installed at Queen's-road, Bond-street, and Post Office Stations, and in the event of power going off from the main supply the current from these battery stations is immediately switched on, so as to keep up the lighting throughout the system. Car-sheds for the storage and overhaul of all trains are situated at the Shepherd's Bush Station, in addition to repair shops for the rolling-stock. It should be mentioned that the party also visited the Bond-street sub-station.

**Electrical Operation of Textile Factories.**—Before the Manchester Section of the Institution on Tuesday a paper on this subject was read by Mr. H. W. Wilson. After describing the advantages of electrical driving for large textile factories, the author dealt with the question of power costs. He found that in a modern spinning-mill of good size it may generally be taken that the generation costs by steam per indicated horse-power hour averages about $\frac{1}{12}$d., or about £1 per indicated horse-power year. Allowing for repairs, interest, and depreciation (interest and depreciation being taken at about 10 per cent.), the total cost per indicated horse-power year comes out at something of the order of £2. 5s. to £2. 10s. In the case of a weaving-shed, which is normally a smaller undertaking with less engine power, causing the proportion of standing charges per indicated horse-power to come out higher, the cost may be taken as between £2. 10s. and £3. 5s. per indicated horse-power year. The author considers these figures remarkably good, and in point of economy alone difficult to improve upon. In a cotton mill the working load factor is generally something considerably below the maximum, owing to a percentage of the machinery for sundry reasons standing idle at a given time; but some curves taken by the British Thomson-Houston Company show an average load factor of about 90 per cent. In this case, the mill being electrically driven, the transmission losses were small, but it has to be remembered that the greater the steady transmission losses the higher the apparent working

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load factor. The author calculates that a well-arranged electrical generating plant for a mill of fair size should be able to produce energy, after allowing 5 per cent. interest and 10 per cent. depreciation in the capital cost of the plant, at about 0·3d. to 0·35d. per unit. The centralisation of power was incidentally touched upon in the paper, and the author intimated that in a district like Bolton or Oldham and the surrounding townships, he thought it would be possible for a very large generating station to supply energy at a cheaper rate than mills could provide power themselves. As the mills are only running during the daytime, the resultant load factor would not by itself be very high, but if, by the offer of special terms, other manufacturers could be induced to take power when the mills were stopped, such a station should be able to produce power at extremely low rates.

**Telegraph Employes.**—The Postmaster-General, in company with the Chancellor of the Exchequer, the Financial Secretary of the Treasury, and other high officials, last week received a deputation representing telegraph servants and others. The object of the deputation was to urge the adoption of the recommendations submitted by the Bradford Committee, which comprised several measures for improving the conditions of service. The delegate of the Postal and Telegraph Clerks' Association stated that the employés had heard with dismay that the Postmaster-General was not prepared to accept these recommendations in their entirety, as the concessions named by the committee would largely allay the discontent. Lord Stanley stated, in reply, that the report of the committee had received careful consideration, not only by himself, but by the Government, since the last session of Parliament. He must, however, disclaim any suggestion that the deliberations of the committee were to be regarded in the light of an arbitration, as Mr. Chamberlain had simply appointed a committee "who will consent to examine the scale of wages now paid, and who will report for my advice and information as to whether they consider the wages adequate or not." One member of the deputation had stated that the Post Office made a profit of four or five million pounds because the employés did not receive adequate remuneration, and the same representative intimated that the whole, or, at any rate, the greater part, of this sum ought to go in improved remuneration. Few people will be surprised that Lord Stanley characterised this suggestion as "very alarming in the present state of our finances, or at any time." Although the Government were unable to accept the Bradford Committee's proceedings as an arbitration, his lordship stated that they had been largely guided by the valuable evidence contained in the report when formulating improved conditions of service. The new conditions have yet to receive the approval of Parliament, and Lord Stanley will introduce the subject in connection with the Estimates. A general outline, however, was given to the deputation concerning the reforms which the Government has in view. An "additional increase of pay at the age of 25" will be given to telegraphists, this being prompted by considerations of matrimony. The request by some employés that their wages should be paid weekly instead of monthly will be acceded to. For women telegraphists there will be a higher minimum rate of pay in London and the largest provincial towns, while in the smaller offices there will be a higher maximum. The whole question of the learners is under consideration. These concessions seem pretty substantial, but one of the delegates frankly stated that they were far from satisfactory to the deputation. Presumably a *plébiscite* of the employés will be taken, and in one or two cases has already been taken, dissatisfaction being expressed with the Postmaster-General's reply.

**The "Times" and Wireless Telegraphy.**—There was a large attendance at the Society of Arts on Wednesday evening, when, under the presidency of Sir William Preece, a paper was read by Captain Lionel James detailing his experiences in the Far East on behalf of the *Times* and wireless telegraphy. Captain James prefaced his remarks by the statement that he "knew nothing at all about wireless telegraphy." The paper, in fact, did not purport to deal with the scientific aspect of the subject, but comprised a history of the enterprise. As such it was highly interesting, though most of our readers are doubtless already acquainted with this, a long descriptive letter sent from the seat of war by Captain James having been reproduced in these columns by the courtesy of the editor of the *Times*. It was five years ago that Captain James commenced to take an interest in the results which were being attained by wireless telegraphy, as it seemed certain to him that, sooner or later, "occasion would arrive when it would be practicable to apply to journalistic enterprise this marvellous adjunct to the world's system of communication." It was the success of the de Forest system in the field of American Press rivalry during the yacht races of 1903 that caused Captain James to favour that system. The paper contained some interesting particulars of the obstacles encountered by the operating party in erecting the masts, materials and labour being very difficult to obtain owing to the outbreak of war. Dr. de Forest had stipulated for a shore station with 180ft. exposure and 120ft. on the moving station, but the causes just mentioned prevented more than 165ft. and 115ft. respectively being available. The Japanese treated the party with courtesy, but the Russians promised them a short shrift Whilst regretting that their operations should have been vetoed at such an interesting juncture, Captain James recognised that the course was dictated by vital political considerations. For the rest, the paper contained an entertaining, not to say thrilling, account of several incidents in the compaign, and a number of lantern views added to the interest of the occasion. Sir William Preece, in complimenting the author upon his paper, remarked that less importance was now attached to the altitude of the antennæ, the electrical equipment being the primary factor. Captain James had really performed his work in the Far East too well. If he had done it indifferently it would not have caused such a sensation, and would have escaped prohibition. At the same time "wireless" must necessarily be the auxiliary to, and not a substitute for, the cable. In answer to Mr. Cuthbert Hall (Marconi Company), Major-General Stirling, and other gentlemen, Captain James stated that he had selected the de Forest system because it was, practically speaking, impervious to interruption by other operators, and enabled messages to be transmitted much more rapidly.

**Montreal.**—Amongst the features contained in the report of Mr. S. E. Fedden, manager of the Sheffield Corporation electric supply department, on his recent Transatlantic tour, is a review of the electric lighting system of Montreal, the largest city in Canada. The energy is supplied from three water-driven turbine power-houses—viz., the Chambly, the Lachine, and the Shawinigan stations—which are situated 5, 17, and 85 miles respectively from the city, and in consequence of the long distance over which the power has to be transmitted the voltages are raised to 5,000, 25,000, and 50,000. Two of the stations—the Chambly and Lachine—are owned and worked by the Montreal Light, Heat, and Power Company, which company has the entire control of the electricity supply in Montreal. The number of consumers connected to their mains is 10,600 for lighting, 880 for power, etc., or, say,

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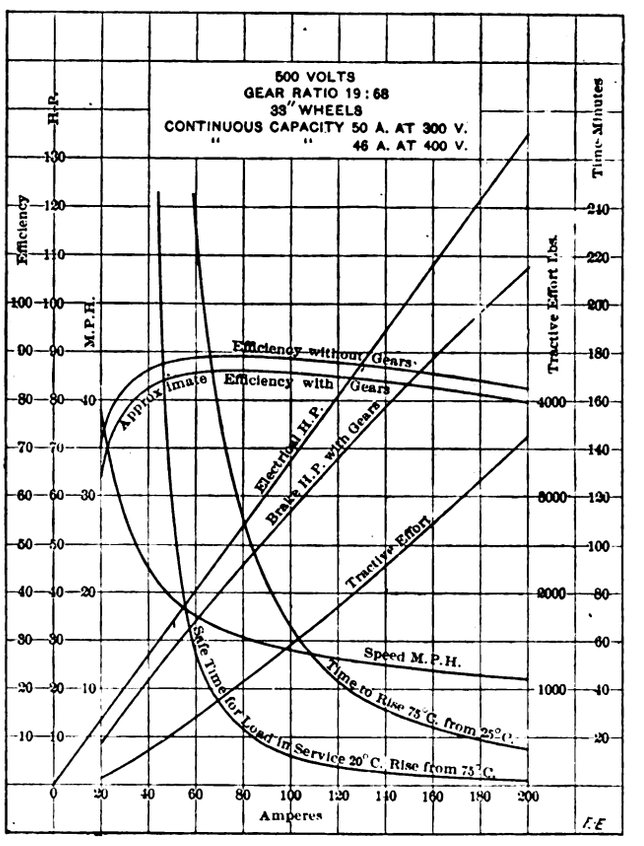
3·3 per cent. of the population, as against 0·8 per cent. in Sheffield, though such comparisons, of course, are very approximate. In addition a large supply of energy is taken for street-lighting purposes and tramways, some 85 million units being consumed per annum. The big motor load enables a very high load factor to be obtained, which averages 75 per cent. throughout the year. This is largely owing to the arrangement of charges, which are extremely low to very large customers, on condition that they take no current during the dark months between 4 and 7 p.m. This entails very simple changes in the working hours, quite possible to many trades, and, Mr. Fedden remarks, is worthy of more attention than it has yet received in this country as a means of reducing the overlapping of motor and lighting loads at the peak time, which does much to keep up the capital cost and price per unit. At the Chambly station, 17 miles distant, the plant capacity is 17,000 kw. Current is generated at 2,200 volts two-phase, and by the use of specially connected step-up transformers is converted to three-phase 25,000 volts for transmission by overhead wires to the various sub-stations in the city, and from there it is distributed to consumers' premises either two or three phase alternating or direct current and at varying voltages. The Lachine station, which is only five miles away from the city, has a total capacity of 6,000 kw. The current is dealt with in a similar manner as at the Chambly station, with the exception that as the distance for transmission is much less the pressure is only stepped up to 5,000 volts. The third station, which is situated 84 miles away, is owned by the Shawinigan Water and Power Company, who are under contract to deliver to the sub-stations of the Montreal Company a supply equal to 5,000 kw. To enable the owners of the power works to do this, special apparatus has had to be installed to bring the frequency into line with that used in Montreal. Three aluminium lines have been erected to transmit the current over this great distance at a pressure of 50,000 volts. In addition to the water-power plants the Montreal Company have several steam plants in the city which are kept in reserve in case of breakdown. These plants are capable of producing from 6,000 kw. to 7,000 kw. There are five sub-stations in Montreal, the three principal ones being tied together by means of a 2,200-volt tie line. At these three sub-stations the energy received from the generating station is transformed and converted to alternating current at 2,400 volts, 63 cycles, two or three phase. Besides the supply to Montreal the Shawinigan works deliver electrical energy to other towns and villages. A novel feature with regard to the heavy transformers which are in use is that they are placed on small trucks and wheeled to their position, thus obviating the necessity of a crane in the transformer-room, and leaving overhead clear for the carrying of the high-tension wires.

**New Tramway Motor.**—An account of the No. 93 Westinghouse tramway motor, which retains the successful features of the No. 56 type, but is designed to meet increasingly rigid traffic demands, appears in the *Street Railway Journal*. The motor has a continuous capacity of 50 amperes at 300 volts, or 46 amperes at 400 volts It will carry safely any loads within the range shown on the accompanying diagram, provided that the integrated heating effect does not exceed the heating effect caused by the continuous application of the above currents at the corresponding voltage. In a shop test at either of these loads the rise in temperature of the windings of the motor during an all-day run will not exceed 75deg. C., but it is calculated that in actual service the rise would not usually exceed 55deg., owing to the better ventilation. For short periods, such as the rush hours of service, the motor may be operated with loads in excess of its continuous capacity, and under these conditions a higher temperature will be reached, though still within safe limits. The poles have projecting tips which serve the double purpose of giving a proper distribution of magnetic field and retaining the field coils. The coils, which are formed of copper strap wound on the flat, are heavily taped, and repeatedly dipped and dried, and impregnated with special insulating compounds, rendering the entire coil moisture proof and practically indestructible. The armature core is made up of a soft-steel punchings, built up on a cast-iron spider. Air-ducts are provided between the punchings, which connect with ventilating spaces in the spider, this arrangement providing an excellent circulation of air. The commutator is of the straight-bar type, without neck. There are 135 bars of hard-drawn copper, specially insulated and built up and clamped on a cast-steel bushing. The commutator bushing is then forced on the




armature spider and securely keyed to it, preventing any vibration between the commutator and armature core. The brush-holders are of the sliding type, with shunts. Two cast-brass arms are fastened by insulated bolts to the upper frame. Each arm carries two spiral phosphor-bronze brush springs, each of which bears upon a brush. The two brushes are placed side by side in the slot, each extending half-way across the commutator. This arrangement reduces the inertia of each moving element, and allows it to follow the surface of the commutator very closely, avoiding any sparking due to "chattering." The armature may be swung down with the lower frame, or retained in the upper part, rendering the interior of the motor perfectly accessible. To give access to brushes and brush-holders there is a large opening in the upper casting over the commutator. This opening is closed by a dust-proof malleable iron lid, which may be removed when conditions permit, with better ventilation and consequent increase of capacity. The general performance of this motor, which has a nominal capacity of 50 h.p. at 500 volts for one hour, is illustrated by the accompanying diagram.

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## ARMATURE WINDINGS OF THE CLOSED-CIRCUIT TYPE.

BY WM. CRAMP.

SIMPLE OR SIMPLEX MULTIPLE-CIRCUIT WINDINGS.

**The Simple Gramme Ring.**

Without doubt one of the most beautifully simple inventions in connection with modern electro-mechanics was the idea of the ring winding, which is named after the great French pioneer: it forms a natural starting point for the discussion of other varieties of armature winding; and, therefore, we will first consider its action in some detail. Fig. 1 shows a diagram of such a winding as applied to a four-pole machine.

It consists of a series of spirals of wire, such as A, B, wound about an annular core, the last turn of the last spiral being connected to the first in regular order, so that the whole winding forms an endless helix. It is connected regularly to a series of commutator segments as shown in the figure, and because it is an endless helix it is called a "closed-circuit" winding, though this term

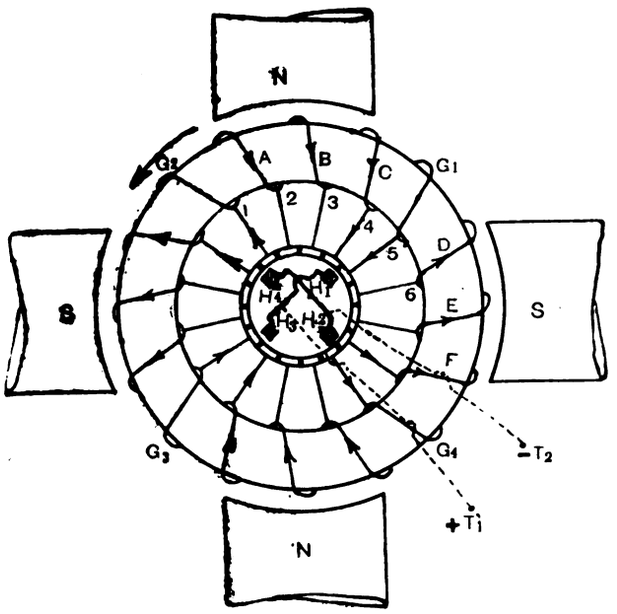


FIG. 1.

has no relation whatever with the external circuit connected to the brushes.

**Re-entrancy.**

Now all the windings which we are going to examine are similar in this respect, that they are endless, or (as it is sometimes expressed) they close upon themselves.

A winding which closes upon itself is called a re-entrant winding. I come, therefore, to the first definition:

*An armature winding is said to be re-entrant when it closes upon itself; or when, irrespective of core or commutator, it forms an endless band.*

This definition, simple though it is, is a sufficient interpretation of the word re-entrant. It evidently implies, in the case of a single winding, that if the core upon which such winding is placed and the commutator to which it is connected could both be dissolved out of, or removed from, the winding without otherwise disturbing it, and if the winding were then pulled, it would be found to consist of a single so-called endless band. Similarly, if a winding were "doubly re-entrant," and the same process were carried out with it, we should expect two separate and independent endless wire bands to be the result. On this we base the notation; which is used throughout in this work and in Parshall and Hobart, but which does not always agree with that found in other works. A singly re-entrant winding is denoted by a single band or circle, and a doubly re-entrant winding will therefore be denoted by two bands or circles. This system will be explained more fully presently, as well as *multiple re-entrancy*.

Since the windings which we shall discuss here are all *regular* windings—*i.e.*, consist of a number of conductors and connections quite regularly spaced around the armature—it follows that the closing of the winding upon itself must be such that it comes about *naturally*, not by some special connection inserted. There are cases where such special connections have been used, and with success, but they are to be avoided whenever possible as tending to destroy the symmetry, and so to set up the circulation of "parasitic"* currents in the windings themselves.

**Position of Collecting Points or Brushes.**

In the example which we are considering (Fig. 1)

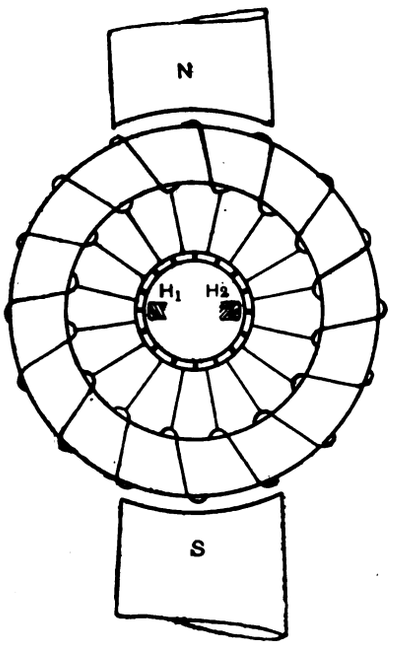


FIG. 2.

the winding passes sixteen times about its core before finally returning to the starting point. Calling such a section of the winding as that lying between A and B one spiral, we may say that there are sixteen spirals on the armature, and since there are four poles, we have four spirals per pole. Now let the direction of rotation of the armature and the polarity be as shown in the diagram. Then the induced electromotive forces are as shown by the small arrows where marked on the spirals, as at E, F, etc. In consequence at points $G_1$, $G_2$, etc., we have opposing and equal electromotive forces which are such that, if we arrange connections at these points, $G_1$ and $G_3$ will be positive with respect to $G_2$ and $G_4$. At points equally spaced around the winding then, such as 1, 2, 3, 4, etc., let connections be made to commutator sections as shown in the diagram; then, from what has already been stated, brushes must be placed at the four points $H_1$, $H_2$, $H_3$, $H_4$. $H_1$ and $H_3$ are positive brushes, $H_2$ and $H_4$ are negative brushes. We note that in passing certain points each spiral has the direction of its electromotive force reversed—that is, at each of these points two

* By "parasitic" current we mean a current not essential to the proper function of the machine: such currents usually flow round and round the windings themselves without passing through the external circuit, thereby causing a loss of energy and performing no useful work.

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series of opposing electromotive forces meet. And these are the positions for the brushes, as is clearly shown in the diagram above.

**Number of Circuits in the Armature.**

If brushes $H_1$ and $H_2$ were joined we should have a circuit ($H_1$, D, E, F, $H_2$) in which the electromotive force acting would be as shown by the arrows, this electromotive force being that due to the action of the three spirals D, E, F. Exactly the same reasoning applies to a consideration of any other adjacent pair of brushes, such as $H_2$ $H_3$ or $H_3$ $H_4$: hence in a section of the winding lying between adjacent brushes there is a definite electromotive force, and from the consideration of the direction of the electromotive forces thus spaced round the armature, it follows that alternate brushes may be connected together and gathered into one group, which in turn is connected to a positive terminal, the intermediate ones being similarly joined to a negative terminal as shown. In this way the winding with respect to these two terminals, $T_1$ and $T_2$, becomes a system of four circuits connected in parallel. This is not so readily seen from Fig. 1 as it is from

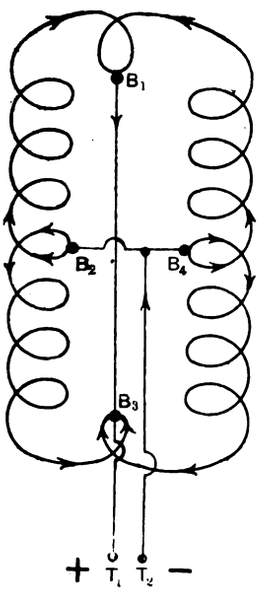


Fig. 3.

Fig. 3, where the armature winding is represented by the spirals and the brushes by the connections at $B_1$, $B_2$, $B_3$, $B_4$, $T_1$ and $T_2$ being again the terminals. By careful comparison Figs. 1 and 3 are seen to be similar, and Fig. 3 is exactly the same in effect as Fig. 4, which is clearly four parallel circuits of four spirals each. In practice, however, with a commutator, one spiral in each circuit is constantly short-circuited. Hence in Fig. 1 we only see three active spirals between any pair of brushes.

Another way of expressing this division of the armature into circuits is by saying that, since the armature in Fig. 1 revolves while the brushes remain stationary, there always exists an average of about four coils between adjacent brushes. If $T_1$ and $T_2$ are connected by some resistance, the electromotive forces in the armature will tend to set up a current: this current flowing, in the case of $H_1$, part from B towards $H_1$, and part from D towards $H_1$, so that each positive brush has two paths connected to it. Similarly with each negative brush; and there are two positive brushes and two negative brushes connected in parallel: therefore with respect to the external circuit connected to $T_1$ and $T_2$ there are four paths *through the armature* in parallel. Stress must be laid upon the above effect of having a plain Gramme ring placed in a four-pole field with four brushes, and it must be clearly understood from the very beginning that *no system of connection between brush and brush alone can result in placing two or more sections of the armature winding under different poles in series with one another with respect to the external circuit;* and, therefore, if it were possible to add to any existing bipolar ring dynamo another pair of poles with the same number of lines per pole and two extra brushes, by no possibility would the electromotive force of the machine be increased: only the current which might be safely taken from it would be doubled by reason of the fact that two extra parallel circuits had been added to the armature.

**Importance of Electrical Balance.**

From Fig. 1 we can also see that the omission of one or more brushes always renders the armature either out of electrical balance or partly useless. Moreover, if the brushes be not placed symmetrically about the commutator, a lack of balance follows. Thus, if we imagine $H_1$ moved sufficiently far toward D, we shall presently have the electromotive forces at C and D

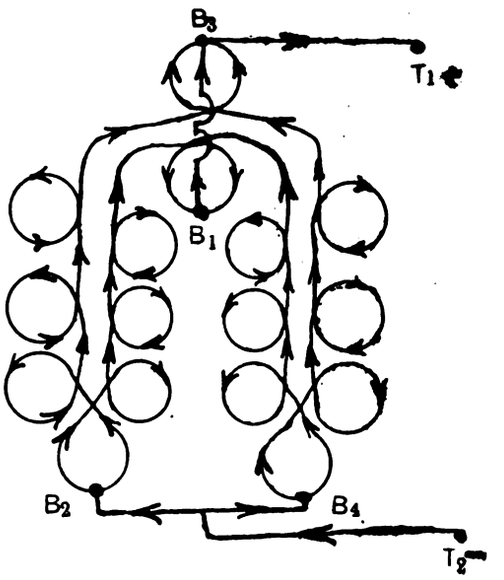


Fig. 4.

neutralising one another, the current from $H_1$ reduced, the spiral D carrying current in the wrong direction, resulting almost certainly in asymmetrically distributed armature reaction and parasitic currents flowing round and round the armature winding. Similar effects must ensue if the armature is eccentric to the field, so that in these armatures, central position in the bore and regular connections to the commutator with carefully adjusted brushes are of the greatest importance.

*(To be continued.)*

## DISTANCE-CONTROL SWITCHES AND THEIR LAY-OUT IN STATIONS.

BY W. E. WARRILOW, A.M.I.E.E.

(*Continued from page 51.*)

**Messrs Siemens Bros. and Co. make a rather interesting oil switch, illustrated in Fig. 11. This depicts a two-way type, but the configuration of the oil-bath for the single way can be seen by the dotted lines. The bridging piece in this case is a single swing lever depending from the oil-tank cover, and engaging with a fixed contact hanging down from a similar position. The terminal of the swing link is fixed into an insulator, and fitted with a rubbing contact clip which engages with a sector forming the half of the**

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clip casting of the swing link. A spindle passes through the box carrying the switch pieces for the three phases on an insulating sleeve, and a handle is fitted at the outside for direct operation, or a lever and links for distance control. A spring lever with a roller fitted ensures the switch remaining in either the on or off positions. An automatic release is provided if required.

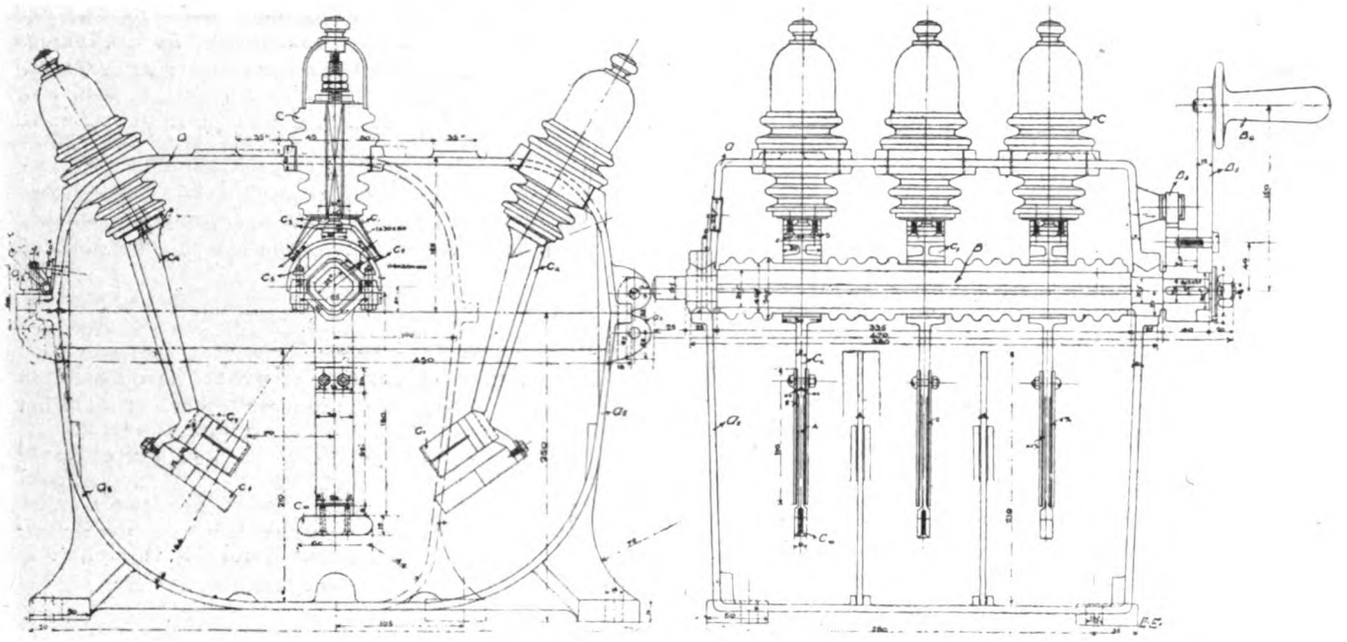

FIG. 11.—Box Oil Switch (Siemens Bros.).

Messrs. Cowan and Andrews, who have done so much for reverse-current devices for alternating and direct current circuits in this country, contend that electrical and pneumatic control introduces a risk of failure to be avoided if possible. They accordingly advocate direct mechanical control, and where this is not possible, electrical control at low voltage. Fig. 12 illustrates their lay-out for a high-tension switchgear, and from this it will be noticed that the operating panels are fixed upon a gallery and the high-potential fittings installed below, each section being enclosed by 4½in. brick walls, with substantial iron doors affording access to each cell. It is not essential that these fittings be placed below the operating board, as they can be arranged at the back, some distance from the board. Wherever the high-tension portion may be placed, however, the same principle of isolation is adhered to by placing a brick wall between the dangerous parts of the gear and the operator. In the figure the iron door is shown removed from the first cell, and the high-tension switch withdrawn for inspection.

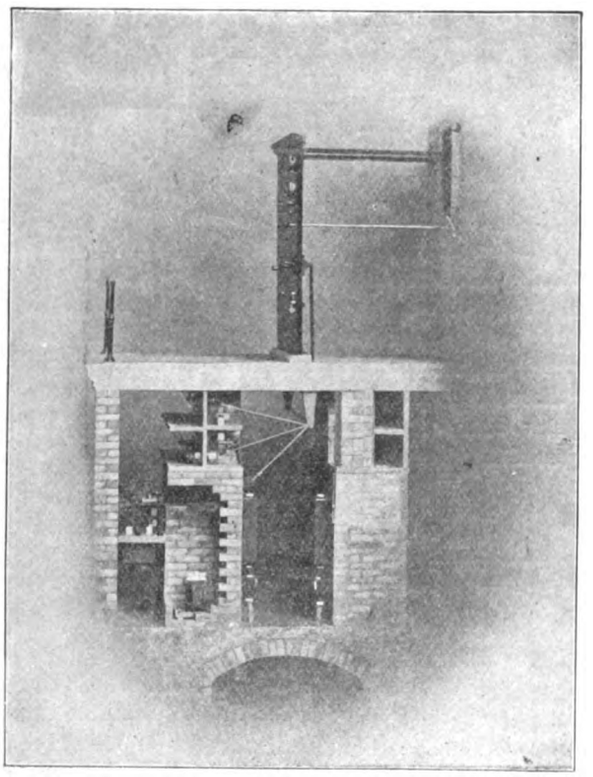

FIG. 12.—Distance Control Lever-Operated Gear (Cowan-Andrews).

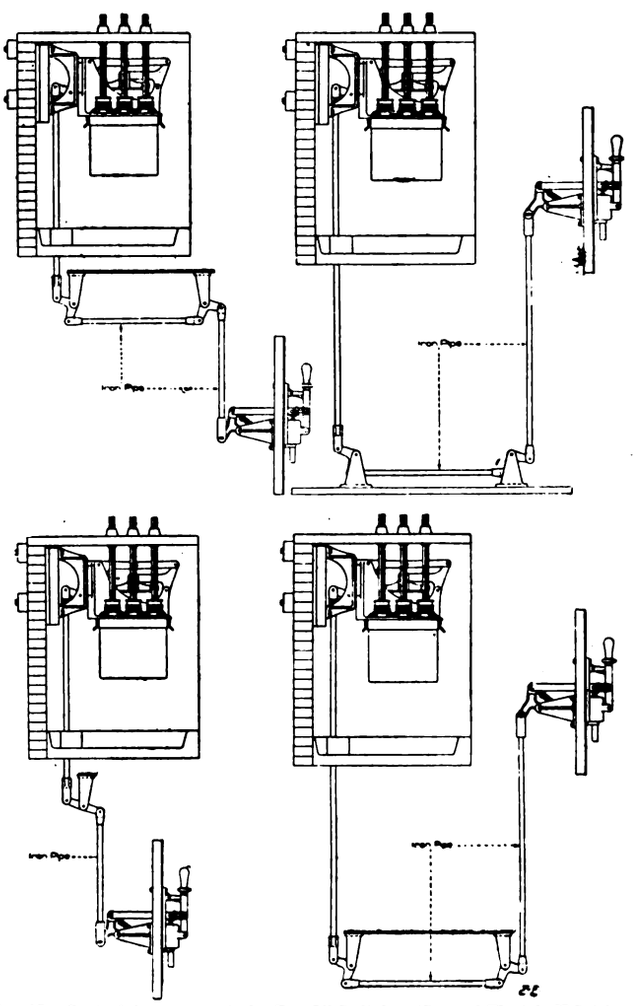

FIG. 13.—Control Arrangements for Box Oil Switches (General Electric N.S.A.)

Traversing rods are temporarily fitted for withdrawing the switch, but when in position the switch cannot be removed. On generator panels the synchronising transformer is placed immediately below the switch in the brick cell, and a ledge at the front side prevents the oil from spreading should it

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boil over for any reason. The bottom of the cell is filled with sand to absorb any escaping oil. The oil switches are operated by bell cranks and levers passing through the back wall of the cells, thence through the gallery floor to the back of the operating board. There are no fuses either on generators or feeders, the former being fitted with Andrews's reverse-current release and the latter with a maximum-current device. The reverse-current release may be described somewhat in detail as it operates on an entirely novel principle. The main current so deflects the magnetic induction in a small transformer, that if a normal current be flowing, a secondary coil on the same transformer is excited which in turn excites a coil tending to hold the circuit-breaker catch "closed." A reversal of the main current excites another coil which tends to release the catch, and in this way a positive pull, definite and strong, is obtained. By this device relay circuits, wiring, and small batteries are dispensed with. By putting red and green lamps into the circuits of the respective coils, the condition of the switching device is readily indicated beyond all chance of error on the part of the switchman. The relative brilliance of the lamps also serves to denote approximately the load on the particular unit. Referring again to Fig. 12, it will be noticed that there are two rows of cells placed back to back, a passage being left in which mechanical gearing can be inspected. The automatic release gear and current transformers, enclosed in iron cases, are fixed in this passage, while the cables are brought up into it from a ment being suitable for either generator or feeder circuits. The control board is mounted separately on a gallery, and directly behind the board is a wall completely dividing the operating gear from the high-pressure portions. In case of fire this wall isolates the operator and the control board, and it may be the engine-room wall or a division built up in the switch-house. The control board is merely a number of marble or slate slabs in an iron framing staged out from the wall, and accommodating on its back the exciter bars and field-breaking resistance. The field rheostat is mounted on the back of the dividing wall and geared through chains and spindle to the regulating handwheel. The only physical connections between the high-tension gear and the control board are the low-tension instrument and relay leads and the rod for operating the high-tension switch.

The high-tension gear comprises a wall with two working faces. On that facing the control board, starting from the bottom, are mounted the cable-dividing box, the instrument and relay transformers, and the oil switch. The latter is at the top, and divided from the transformers by a heavy stone slab, with insulated bushes for the connections. A heavy guard plate is fixed some distance above the oil switch, and the connections therefrom pass to an insulated connection fixed in and through the wall. From a corresponding position on the opposite face the connections descend to a section switch and thence to the 'bus bars. Where leads of opposite phase pass through the 'bus-bar

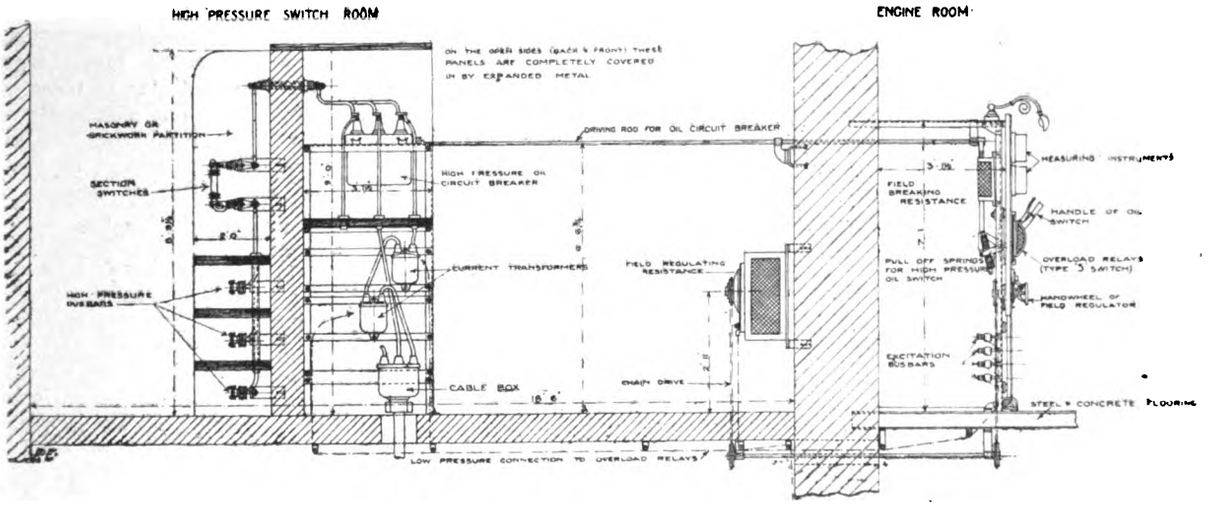


FIG. 14.—Lay-out for Box Oil Switches (Witting-Eborall).

conduit under the floor. Each conductor is passed through its own current transformer, and thence to its particular switch in its own individual cell. In the opposite passage to be seen on the left the 'bus bars are carried longitudinally in stone cells immediately above the oil-switch cells. They can be readily inspected from this passage, and section switches are fixed where required in the lengths of bar. These switches are placed each in a separate cell accessible from the same passage, and are worked mechanically from the main operating panels. The isolating of these switches precludes all possibility of any arc, started at switch opened in error, spreading to the 'bus bars. Rheostats and low-tension exciter gear are placed behind the operating panels, alternately upwards and downwards, to economise space. In designing this gear the makers have had in mind the destructive effect of breakdowns, and endeavoured to confine this to its source without fear of spreading to other apparatus.

### LAY-OUTS FOR MECHANICAL CONTROL.

In Fig. 13, methods of operating the oil-box switches previously mentioned are clearly shown, and each emphasises the flexibility of the system. In no case is the operating handle placed *above* the switch, though the reverse is done for obvious reasons. The switch can, of course, be placed below the operating board in a cellar or basement, but such a proceeding is not to be recommended.

A typical lay-out for the switches shown in Figs. 8 and 9 (Witting-Eborall) is depicted in Fig. 14, the arrange- chambers, they are enclosed in insulating tubes. Feeder connections from the same bars are brought back through the wall to a switch and cable box on the opposite side and in line with the generator switches. A lay-out similar to the foregoing is equal to a normal capacity of 2,500 kw. per panel.

*(To be continued.)*

## TRAMWAY OVERHEAD EQUIPMENT MATERIALS.*

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This audience is well aware of the general purposes to be fulfilled by a satisfactory overhead equipment, but to make an orderly study it is necessary to commence by a brief analysis of the mechanical and electrical conditions which must be satisfied in order that the structure may serve its purpose with the maximum economy and efficiency. The necessity of studying appearance should not be a serious addition to the primary engineering necessities, for the appropriate use of materials and obvious adaptations of means to ends satisfies the æsthetic as well as the practical sense, and where incongruity with architectural and natural beauties is the danger, unobtrusiveness will probably give better results than any elaborate attempts at ornament.

The first mechanical condition to be satisfied is evidently that of safe and stable support. The trolley wire has to resist, in addition to the stresses on a suspended wire, the

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repeated upward thrust of the trolley pole and the friction of the trolley wheel. The attachments are exposed to reversed stresses of the nature of blows in both vertical and horizontal directions, and the wires being necessarily carried at a distance of several feet from the poles, any unbalanced longitudinal stress produces considerable couples upon the supporting structure. The second mechanical condition is that imposed by the function of the trolley wire as a suspended guide or rail for the trolley wheel to run on. This condition resolves itself into a necessity to follow the general lines of the rail track in plan—with some maximum permissible lateral deviation, and some maximum permissible change of horizontal direction at points of support. The permissible limits in both directions depend upon factors outside the overhead structure, some of them being the type of trolley boom and wheel, the size and speed of the cars, the radii of the curves, and the lay-out of junctions or other special work The effects of wind and snow are of relatively small importance as regards trolley wires, but must be given full weight in the erection of guard wires. The electrical conditions to be met affect the mechanical structure in so far as they prescribe the size and weight of the trolley wire, the necessity for efficient insulation being constant.

Time will not permit of more than quite general references to questions of design and erection of the line, excepting as they may affect the choice of materials and design of parts. I therefore take the different items of material in an order which is intended to be logical and consequent. The trolley wire comes first, its support and proper position being the principal object of the whole work. The stresses on all the supporting structure are evidently functions of the size and weight of the wire used, and to keep down the size, weight, number, and expense of supports the wire should be chosen as small as will serve the designed purpose. It is easy to show that there is no electrical necessity for using any wire larger than No. 0 S.W.G. (·324in. diameter), where the trolley wire is fed as usual from underground feeders at half-mile intervals, unless the traffic is extremely heavy. But on suburban or inter-urban lines carrying an infrequent service it may be necessary to avoid the expense of underground feeders, and to employ heavier trolley wires, or, preferably, overhead feeders. Heavy traffic, especially over curves of short radius, may also afford a reason for the use of larger wire in order to increase the life, and remove the risk of breakage on account of heavy mechanical wear. The most economical size of trolley wire to employ in any particular case is thus mainly a question of its life as a mechanical wearing part, the cost of renewal and the loss by scrapping having to be put against the capital expenditure. But it must not be forgotten that a heavier wire involves heavier poles and other supports, the cost of which must be properly brought into the account. The conditions are too complex, and at present too little determined by experience, to admit of the formulation of any general rule, but it is probable that where the conditions are very severe it is better to employ one of the harder bronze alloys than a copper wire of larger size. One reason for this is that the wearing qualities of hard-drawn copper wire are not directly proportional to its weight, the hardness diminishing from circumference to centre. This is well shown by the fact that the Post Office specification for such sizes as Nos. 12 and 14 calls for a breaking strain of 28 tons per square inch, whilst the usual trolley wire specification is equal to 22 tons, over 20 per cent. less. The effective thickness of the hard skin varies with the details of the manufacturing process, and very little seems to be known about the subject by users; but, from the behaviour of trolley wire under long wear, it seems probable that the hardness diminishes gradually, and, up to such sizes as No. 0, a considerable thickness is appreciably hardened. It is also possible that the rolling of the trolley wheel has a further hardening effect, but where the wheel rubs or grinds, hard abrasion removes the hard exterior, and the softer metal inside is soon reached. On these facts it is clear that a material that is hard right through should be preferred. Very little experience with these bronze wires has been made public, and as some are brittle and some pit badly under arcing, they should not be extensively adopted without trial. They are all of higher electrical resistance than copper, and therefore require feeding at shorter intervals if the traffic is heavy. The mechanical and electrical qualities required in trolley wire are well known, easily verified by test, and readily complied with by a considerable number of makers. Very high tensile strength should be regarded with suspicion as probably indicative of brittleness, and bending and falling weight tests should be made in such cases.

The next point in order after the size of the wire is its position in relation to the track; the choice lies between side and central wires. There is sometimes a conflict here between the claims of good working and the supposed interests of appearance, but the prejudice against span wire construction is happily dying out, and it is unnecessary to enter into any elaborate argument before this audience to show why and how the centre wire gives the best working. Assuming that centre wiring is adopted, the approximate position of the wire is given at once by the centre lines of the tracks, as shown on the permanent-way plans, or as actualy laid. There are sometimes material differences between track plans and execution, and it is often wasted labour to plan out overhead work in full detail from construction plans. It is far better to let the permanent-way construction get a good long start of the overhead; then pole positions can be laid out from the actual track centres, and the overhead work can be carried through continuously, and with the certainty of correct position. As overhead work does not take more than a fifth of the time required for track construction, there need be no difficulty in arranging for practically simultaneous completion of the two. Although exact positions cannot be taken from permanent-way plans, the number and size of poles and the general arrangements can be got out sufficiently well to order all necessary materials in good time. The maximum distance apart of supports is settled by the Board of Trade regulations at 40 yards; on straight lengths there is no reason for diminishing this, and it *is*, therefore, taken as the standard. But at curves, junctions, and termini the positions of poles have to be carefully considered, and so arranged as to take the longitudinal pulls of the straight lengths or tangents as directly as possible, to hold the trolley wire closely and firmly to the required curves, and to hold "special work" to its correct place. There is often but a limited choice for pole positions, especially at junctions where streets cross, and in all such cases an accurate large scale survey should be made, the trolley wire and special work laid down on it, and the best arrangement of span and pull-off wires that will suit the possible pole positions worked out The labour of drawing several alternatives will be well repaid by the workmanlike and satisfying appearance of the completed work, and by the absence of working troubles.

One essential point at these places is to anchor the straight lengths as directly as possible to a heavy pole. If such a pole can be placed at the intersection of the tangents it can take both anchor wires. The ends of the curves should also be anchored in the usual way. This anchoring is very important, because it makes the straight lengths and the curve work mutually independent, the span wires are not distressfully pulled out of line, and the pull-off wires intended to shape the curve have not to take indefinite components of the pull of the straight lengths. Most important of all, if any accident happens to the overhead work on either the curve or one of the straight lengths, its effects will be stopped by the anchoring. Anchoring is also necessary at section insulators, and it is advisable to anchor every quarter of a mile, even on a perfectly straight line, in order to localise the effect of a trolley wire breaking. Termini, curves, and junctions are the keystones of the whole structure, and when the pole positions at these places have been worked out, the tangents between have only to be divided up into equal lengths of as near 40 yards as circumstances permit, but never exceeding that distance. Side poles with brackets can rarely be used to carry wires central to the track, as the bracket arms would be unduly long; the choice lies between span wires and central poles. Where there is room central poles have certain advantages, especially that of neat or even

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ornamental appearance, and their cost is somewhat less than that of span-wire construction. But as the clear way between the tracks has to be from 2ft. to 2ft. 6in. wider to give the regulation clearance between cars and standards, the total cost to the tramway undertaking is rather increased than diminished. They also have to be lighted sometimes at the tramway expense. To other traffic in a busy thoroughfare central poles are a nuisance and a danger, but where streets of magnificent width relatively to the traffic on them exist, the disadvantages may be inappreciable. On even slight curves centre poles are insufficient, as there is no means of "pulling-off" the outside wire, and if side poles are added for that purpose, they look very odd.

Feeding points have also to be reckoned with in laying out pole positions. The best way of cutting up the work into half-mile sections will depend upon many local conditions, but one constant consideration is to arrange that a fault on any section shall have a minimum effect upon the whole service, and, consequently, sections frequently terminate at junctions. Section insulators should be kept out of the junction special work, and, where this is complex or important, it is best to insulate it on all sides and feed it separately. Section insulators should not be put on curves, or on steep gradients. If the central wire has been decided upon, span-wire construction will be the prevailing type, excepting where central poles may be possible and preferred. It is just possible in some cases to carry a central wire from a side pole and bracket-arm. In the case of a double line these will be required on each side of the street, and it is hard to see what is gained in appearance by the substitution of two sets of bracket arms for one set of span wires. The bracket arms are much more conspicuous and the construction more expensive. Span-wire poles will be set out in pairs opposite each other on straight work, but on curves more and stronger poles are needed on the outside or convex side of the road than on the concave side, the pull of the trolley wire being centripetal. Bracket-arm poles should always be on the outside or convex side of the road.

Having arrived at the pole positions, the next point to determine is the strength of pole to be used in used in each. Generally speaking, three grades of strength will suffice. The Engineering Standards Committee has recently issued a standard specification for tubular tramway poles in which the three strengths are classed as light, medium, and heavy, and the strength defined by the loads needed to produce a temporary deflection of 6in. and a permanent set not exceeding ½in. under conditions fairly representing the working loads. The temporary deflection load may be regarded as the maximum safe working load, and the permanent set load as marking the commencement of danger by deformation. The loads are as follows :

| Class of pole. | Load for temporary deflection of 6in. | Load for permanent set not exceeding ½in. |
|---|---|---|
| Light | 750lb. | 1,000lb. |
| Medium | 1,250lb. | 1,750lb. |
| Heavy | 2,000lb. | 2,500lb. |

The light poles will naturally be chosen for straight line work, the medium serve for pull-offs on moderate curves and for feeder poles, and the heavy for anchor poles and for carrying heavy special or curve work which involves resistance to the direct longitudinal pull of trolley wires. Occasionally heavier poles than the standard "heavy" class may be needed, but these occasions are rare, and may often be avoided by dividing the load between two "heavy" poles. The choice as between sectional and taper poles is mainly one of taste and price. That the appearance of a pole of uniform taper is better than that of a pole built of three parallel sections is a general opinion. At present, for equivalent mechanical tests, taper poles to standard dimensions are dearer than sectional poles, and somewhat heavier. The absence of the swaged joints is put forward as a mechanical advantage, but it is very rarely found in practice that a sectional pole fails at the joints. If taper poles are used, it is desirable to have them solid rolled, as a lap weld the whole length of the pole may prove a line of weakness. Solid rolled tube is an improvement in sectional poles, but there is not a great risk of poor welds in these comparatively short lengths, and if the joints are set at 120deg. in plan, as they should be, the pole as a whole will show no line of weakness. Wooden poles have been very little used in this country, but are somewhat extensively employed in the United States and some Continental countries. They will rarely be tolerated in town work here. Wooden poles should be chosen to give the same temporary deflection as would be called for in steel poles. As this depends upon stiffness, it will generally be found that very thick timber is necessary, and the poles will have a stumpy and heavy appearance. The first cost will generally be lower than for steel poles, but the ultimate economy is somewhat doubtful, and should be considered with full knowledge of the special conditions, especially the probable life of the wooden pole in the local soil and climate. In any case the poles should be creosoted to the Post Office specification, and they should not be set in concrete. Lattice poles can be purchased and are sometimes used on the Continent. They are said to be cheaper than tubular poles of equal strength, but are very ugly, and it is probable that the painting necessary to preserve them from rapid corrosion in this climate will neutralise the initial saving.

The type, positions, and sizes of poles being settled, the intermediate supports between poles and wires claim attention. The choice lies between span wire and bracket arms, but it is frequently necessary to use both constructions in different parts of a tramway network. If the central wire has been chosen, span-wire work will generally predominate, but there are many exceptions, especially on systems which are mainly composed of single lines with turn-outs. Where bracket arms are employed it will be wise to use the short span-wire arrangement generally known as the "bowstring." The older construction, in which the hanger is clamped directly to the bracket arm, is probably obsolete. The rigidity of the attachment is a serious evil, imposing upon the hangers and the trolley boom a considerable blow, detrimental to every part, especially to the insulation of the hanger and clamp. It may further be said that it is not possible to provide a satisfactory permanent insulating sleeve for the clamp in this climate, all materials tried, so far, failing in a comparatively short time. The "bowstring" suspension is an improvement, but it is still far more rigid than the span wire, and, therefore, results in greater wear of wire and trolley wheels, and in deterioration of insulators, besides leading to de-wiring at speeds much lower than can be run with safety on span-wire work. This detrimental effect of rigid or semi-rigid attachments is sometimes overlooked, or the true cause is not recognised, although it is simple enough. The trolley wheel of a moving car presses the trolley wire upwards with a force which usually equals or exceeds half the weight of the span of wire. At the centre of a span it will therefore lift the wire considerably, possibly to the height of the points of support; from the centre onwards it is, however, depressed with increasing rapidity, as the stiffness of the wire comes into play, and will be below the level of the ear some distance before it arrives there. It, therefore, meets the rigid ear while rising rapidly, and delivers a blow the force of which is the product of the effective mass of the whole boom and head and the square of its upward velocity. At some speeds the rebound will take the wheel flanges clear of the ear and, if there is any side pressure, de-wiring results. The noise and the flash invariably seen on the passage of trolley wheels under bracket-supported hangers demonstrate the correctness of this explanation. After passing the ear the wheel at first descends, but soon commences to rise again up to about the middle of the next span. Its path is therefore a wavelike one with a high crest in the middle of each span and a small steep one at each ear. Besides the effect of the blow upon the ear, the insulating materials, and the trolley wheels and boom, the wire is worn by arcing and damaged by bending. It is, therefore, not extraordinary that failures of insulators and breakages of wire at ears are more common on bracket than on span-wire work. If bracket-arm construction is used, the bowstring should be made as long as practicable in order to get the maximum flexibility. The flexibility of a span-wire construction greatly reduces the blow upon the ears, as the span wire also rises to the trolley pressure, and the ear more readily

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aligns itself with the wire, but, at high speeds, the effect is quite perceptible, and, for railway speeds, the longitudinal suspending wire carrying the trolley wire by hangers at short distances and so approximating to a system with a constant vertical rigidity from point to point is essential.

Span, bowstring, and pull-off wires are generally of galvanised steel, but in many towns this material has but a short life on account of atmospheric pollution, and in such cases phosphor or silicon bronze wire should be used. This applies equally to guard wires and their supports; whichever is used the metal parts of the suspension fittings should be of similar metal. There is no means of preventing galvanic corrosion where dissimilar metals are in contact, and such contact should be avoided. The use of iron insulated bolts screwed into brass ears is almost universal, and frequent trouble results at this point. Gunmetal bolts would be better, but there is some difficulty in getting them made. The size of span wire should not be less than $^{7}/_{14}$ S.W.G. There seems no reason for using larger wire, but such use is quite common even up to the monstrosity of $^{19}/_{13}$. This wire should have a breaking point equal to from 35 to 40 tons per square inch after stranding; the galvanising should be carefully examined and tested in the manner prescribed by the Post Office. Galvanising that is originally defective, or that cracks and peels off in erecting, is useless; the wire will rust through at the unprotected points in a brief period. To secure the wire at the poles, it should be laid around a horse-collar thimble of size proportioned to the size of strand, and properly bound with galvanised charcoal wire—not twisted up. Better than the thimble is a shackle or reel of porcelain with a central hole to take the strap bolt. Porcelain is a far better, more durable, and cheaper insulator than any of the compounds used in turnbuckles, globe strains, etc. There is no need to provide any tension adjustment at the ends of span wires—insulated turnbuckles, Brooklyn strains, etc., are quite unnecessary, and represent wasted money. With a dynamometer on the drawvice, or by the measurement of the sag from the ground, span wires can be put up with the greatest uniformity, and the certainty that the trolley wires will be carried at their correct level. This level can be checked, if desired, by loading the span wires at the correct points with weights represent the working load, but this only needs to be done once for each width of street.

Bracket arms are generally made of 2in. steel steam tube either screwed or expanded into a socket on the pole clamp. These arms are often much too long for safety. A 2in. tube 12ft. 6in. long, fixed as a cantilever, and loaded with the weight of a span of trolley wire and the suspension fittings, is very near its breaking point. Longer arms are therefore entirely dependent upon tie-rods. The longer the arm the less efficient the tie-rod, owing to the more acute angle between the two members. As generally made, tie-rods are pulled up by a nut, so that their effective strength is the resistance of the threads to shear. Bracket arms 18ft. and 20ft. in length are therefore extremely unsafe, having practically no margin of safety. It is better to use eye-ended tie-rods and dispense with nuts, and no real difficulty arises in erection if the clamps are fixed at measured distances, so that the brackets and tie-rods make the correct calculated angle; but if adjustment is necessary it is best provided by a long, solid, right-and-left-threaded sleeve fitting the two parts of the rod like a rigging screw. Struts are usually inapplicable, but if the scrollwork can be made to give some support, so much the better. Bracket-arm pole clamps should be of substantial length and a good fit on the pole by internal fitting rings at top and bottom. The bolts should fit through long bored sockets in the planes of the fitting rings, and be kept close in to the poles. The socket receiving the arm should be of ample length and well thickened out to the body of the clamp. In fact, in designing bracket arms and their fittings the stresses and strains should be calculated out as for a loaded cantilever, ignoring the tie-rod, but adding 50 per cent. to the dead weight to allow for the rolling load and its hammering effects. Then the tie-rod and its fastenings should be designed to carry the same load safely. Malleable cast iron is the best material for pole and bracket-arm clamps and bowstring brackets. These last are often too short to give proper clearance, and are spaced too close on the bracket to give the elasticity so desirable. They should be pinned or otherwise secured so that they will not slide along the arm. Porcelain shackles should be used as the secondary insulation of bowstrings.

On straight work the "straight line" hanger is the best insulated fitting, but on curves, and wherever there is a probability of lateral pressure on the wire, the pull-off pattern must be used. The caps of these should be provided with some form of locking device, and a soft-leather washer should be placed between the head of the insulated bolt and the cap. The insulating material on the bolts is far from perfect. The compounds are trade "secrets," but very slight investigation shows that shellac is the insulating and consolidating element in nearly all. Mica, asbestos, and other mineral substances add some toughness to the mass, but its mechanical qualities are generally poor. Whilst new the insulating qualities are very good, but in a short time the atmosphere deposits dirt on the exposed surface, and sooner or later in damp weather a trifling leakage of current chars the surface and breakdown speedily follows. This should not happen if the secondary insulation remains good, and if porcelain is used, such breakdowns are very rare, because a porcelain surface does not char with a small creeping leak, it dries up, and the leakage ceases. A somewhat tough vulcanite has been introduced. Vulcanite has had extensive trials in telegraph practice and obtained a bad reputation. Tramway conditions are less favourable to its permanence. This matter is a really serious one, and the insulated bolt is probably the most unsatisfactory item of the whole overhead equipment. The cure may be found in redesigning the arrangement in such a way as to remove the insulator itself from so trying a position, but there are obvious difficulties. The usual practice of keeping the two trolley wires for up and down directions separately insulated and separately fed is highly advantageous. But at junctions this becomes very difficult. Insulated crossings are a variety best avoided, and, as above stated, the best course is to feed junction work separately; the next best thing is to feed it through one wire only of one of the junctioning lines, and to insulate the junction from all the other wires. In bowstring suspensions care should be taken to provide ample clearance above the cap of the hanger. Sometimes only a small fraction of an inch is left between the cap and the bracket-arm tube, with the result that at every passage of a trolley wheel the hanger strikes the arm, damage soon resulting.

The soldered ear is the best form of attachment for the trolley wire. Many patterns of mechanical ear have been devised and tried, but it is hard to see how any mechanical clip can give equal security without adding to the effective diameter of the wire on the arc in contact with the wheel. The use of wire of figure 8, or grooved section, makes the mechanical ear satisfactory, but such wire is at once more expensive and more troublesome to erect, so that the balance of advantage remains with the soldered ear. The metal used for ears should be a tough bronze or gunmetal, and careful inspection after machining is necessary to eliminate defective pieces, as the castings are somewhat apt to show blowholes and other weak places. The groove to receive the trolley wire should be milled to a hundredth of an inch larger diameter than the wire, and should come to a sharp edge. It is doubtful whether the small lugs, which it is usual to provide at the ends of the ears for hammering over the wire, serve any useful purpose. They sometimes hold up a wire that has not been properly soldered until traffic commences. Fifteen inches is the minimum length of ear for straight work. The tendency is to increase the length up to as much as 24in., but the advantage seems doubtful. On curves longer ears are necessary, and by bending them to a proper radius the change of direction of the trolley wheel is much smoothed. Unfortunately, curved ears tend to pull into angular shape with use. There seems no good reason why they should not be cast curved with lateral webs to impart stiffness. It would not be necessary to use many different radii, as the varying radii of the track curves should be met by the use of a larger or smaller number of pull-offs, with a standard deviation at each. Splicing ears should not be

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needed in building a new line, but are necessary for repair work. They are rarely well designed, the wire ends having to be bent too sharply, and some patterns are provided with foolish little steel set screws, that invariably set fast and break off. Anchor ears should be provided with stout eyes of rounded section, to which the anchor wire can be secured without bending to a dangerously small radius.

Section insulators present a combination of difficulties, and in selecting a pattern both mechanical and electrical considerations must be studied. The pull of the wires has necessarily to be transmitted through insulating material, and it ought to be so transmitted as a straight pull without any binding or twisting component. This is inconsistent with the necessity for allowing a straight level path for the trolley wheel. Hence the best designs are but compromises, and the worst may be guaranteed to break down within a few months. The terminating arrangements for the wire ends need the same easy curvature as in splicing ears. It is better to dispense with set screws for securing either the feeder cable or the trolley wires and to have tinned sockets or grooves into which they can be soldered. The air-gap pattern is probably better than that with a gap stick, but there should be two distinct air-gaps, and an insulated running piece between them to prevent an arc being drawn in the event of an earth on one wire. Gap sticks of lignum vitæ have been found to wear smoothly and give a regular life. Section insulators are very heavy, and saving of weight is a merit to be fully credited. Easy and rapid replacement is another virtue which will be appreciated when the line is at work. The sweating of the connections is not inimical to this, because, knowing that it has to be done, the fire-pot and bit will be ready, but a rusted-in set screw cannot be calculated for.

Junction special work fittings also require careful selection. For central wires and rigid trolley heads the frog makes a satisfactory facing point, provided that it is properly set with reference to the track points and the lengths of the cars and trolley booms. Even with swivelling trolley heads frogs will work fairly well if the wire is approximately central, but for sides wires, switches with movable tongues should always be used in the facing direction. Frogs will work on side wires in the trailing direction, but must have deep cheeks and grooves to take the wheel flanges, as there is a considerable centrifugal force tending to de-wiring, and automatic or spring switches are preferable. Crossings are apt to give more trouble than frogs or switches. The greatest care should be taken to get them of the correct angle to suit the track crossing, but as the angle is also affected by the lengths of car and trolley boom, the junction should be drawn to scale, a template of the car and trolley boom fitted to it in successive positions to ascertain the best angle and position for the crossing. Even with a central wire there must be a lateral pressure on the trolley wheel taking the junction curve, so that guidance by the flanges across the gap is necessary. A swivelling trolley head adds largely to trouble at crossing by its liability to turn while crossing the gap, and this liability is aggravated by any considerable side reach. At junctions on single lines it is best to use only a single trolley wire and thus avoid the use of crossings, especially if swivelling heads and side wires are used. It involves the use of three automatic switches, but these give much less trouble than one crossing. All these fittings should be so designed that the trolley wires need not be cut when fixing them, and so that they can be securely held by pull-off and span wires to their positions.

Feeding arrangements are usually classed with the overhead equipment, the feeder work terminating with the thimbles entering the 'bus-bar terminals. As regards the feeder pillars, the best advice is to make them as big as will be tolerated. Even at this they are pretty sure to be awkwardly cramped. Opinions and practice are divided between cylindrical and rectangular shapes. Perhaps it is largely a matter of taste. The cylindrical pattern gives the largest amount of useful space for the area covered and for the weight of the casting, and has the practical advantage that when opened the panel is somewhat more accessible. On the other hand, the fitting of the curved doors is not so good a job as with the flat-sided pillar, and when the doors are closed there is less clearance between them and the live parts. Provision should be made for ventilating the pillars without permitting the entrance of rain or snow; the bottoms should be filled in over the concrete with a thick layer of pitch or bitumen, and all leading-in pipes stoppered. The safest kind of panel is a cast-iron frame, into which are cemented porcelain insulators carrying the live metal-work, the frame being itself carried from the sides of the pillar by oil insulators. It should be easily removed for replacement by a new panel. All the cable connections should be made on one side of the panel, the switch fittings being on the other. Plain quick-break switches are frequently used and answer most purposes, but, where a number of feeder pillars are fed by one cable feeder, the use of switch fuses, such as the Bates pattern, will sometimes isolate a faulty length of trolley wire and avoid the stoppage of all the sections served by the feeder. As these switch fuses are not dearer than quick-break knife switches, and have no troubles of their own, they should be chosen, although in most cases the feeder circuit breaker will outstrip the fuse.

All cable ends should be terminated with corrugated porcelain stoppers suitably sealing the dielectric. A kicking coil and lightning arrester are necessary to protect the underground cables. Three or four kinds of arresters are in use, and there is not much to choose between them. I think the Garton is perhaps the best. They all get blown to pieces occasionally, either by a lightning discharge or the short set up by it. Telephone fittings are generally included in feeder pillars. They should not be fixed on the switch panel, but quite separately, and surrounded by an earthed metallic frame to protect them from leakage. The same treatment is best for the pilot wire terminals that may be provided. Telephones do not thrive in feeder pillars, and there is rarely any room for them. The provision of a socket box into which the cords of a portable set may be plugged is therefore the best arrangement. If fixed telephones are thought essential they should be placed in separate pillars, or in boxes secured to the poles. The side feed cables from the feeder pillars to the trolley wires are often troublesome; the trying conditions and their importance are such as to warrant careful design and erection. In many cases small holes are drilled through the pole underground and above the span-wire or bracket attachments, and the unfortunate cables threaded through these holes with the slight protection of a wooden or fibre bush. It is impossible to tell how sharply they may be bent, or how much they may have been strained in the process, but experience shows that they are frequently damaged, and have in consequence but a short life. Their replacement, in case of need, is a particularly tedious and exasperating job. The following has been found a good method of dealing with this matter. An oval hole about 3in. by 5in. is cut in one side of the pole about 1ft. below the ground level, and a special quarter bend of 3in. pipe passed into the pole and bolted through a flange which fits its periphery. This 3in. pipe finishes in the base of the feeder pillar, with a bellmouth providing a duct of ample diameter and easy curvature for the passage of the four cables. The pole is fitted with a special finial made in two parts. The lower part fits easily into the top of the pole supported by a narrow flange resting on the pole end, and expanding upwards and outwards to form the ornamental base collar of the finial. The portion inside the pole carries four screwed glands provided with rubber gaskets, and bored to pass the cable. Screwing up the glands secures the cables by compressing the rubber packing rings. Four holes are cored out in two opposite pairs through the bottom of the flared-out part, through which the cables descend outside the pole. This fitting is wired by passing the four cable lengths through the glands, and then, by an easy and regular curve, through the holes in the wide part. A hauling wire having been threaded down the pole and into the section pillar, the long ends are drawn through the pole, and the fitting rests on its place. The upper part of the finial is merely a cover shaped to match the other pole finials, and secured by two tap bolts. The outside cables are secured to the pole by a suitable clamp, and then taken by an easy curve to the span wire or bracket. This arrangement is safe for the cables, and, in case of need, their replacement is a very

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simple and speedy operation. It is almost essential to use indiarubber-insulated cable, as the dielectric must be waterproof and flexible. The Board of Trade calls for metallic sheathing, but objects to lead in this position. Flexible metallic tubing has been found very suitable. It adds little to the diameter and weight; it is very flexible up to a certain point, and then refuses to bend further, which is a safeguard to the cable. The metal sheathing of the cable should not touch the trolley span or bowstring wire, and should therefore be cut well back. On span-wire work it is best to carry the feeder cables on a separate span wire above the trolley wires. This should be insulated in the usual way, and the sheathing cut back from it. The cable ends then dip down very conveniently to the section insulators, and there is a long surface of cable covering free in air, over which very little leakage can occur. The cable terminals here should be made with corrugated porcelain stoppers as a further precaution. On bracket arms the cables should be secured by special collars fitted with ebonite bushes, and arranged to give the longest possible leakage path.

Guard wiring is a necessary evil in this country, as tramway undertakers can neither compel the owners of overhead wires to make alterations to them, or even prevent the erection of new wires over an existing trolley line. Galvanised steel wire, No. 8 standard gauge, satisfies the requirements. Solid wire is better than stranded, having a longer life. The same wire may be used for guard-wire spans. Guard wires should be run over the span wires and secured to them by binding wire sweated at the ends of the lappings. In some atmospheres it is necessary to use bronze instead of steel wire. On bracket-arm work a span wire from the pole to a standard clamped to the end of the bracket makes the best job, but a neat and good-looking arrangement is hard to find. Secure erection is often neglected for the sake of light or ornamental appearance, with sad results. Telephone and pilot wires are sometimes run on tramway poles; hard-drawn copper is the best material. Good telegraph practice should be followed in the design and attachment of the insulators, but a somewhat freer use of shackles is sometimes desirable. These wires are sometimes carried on the trolley or guard-wire span wires, but it is difficult to make a good job of this. No. 12 wire is usually large enough; smaller sizes are too weak. They should be carried at such levels and positions that they cannot blow across the trolley wires if broken in a gale. The speaking on these telephone lines would be improved if they were rotated after the manner of Post Office trunk lines. They generally suffer much from trolley wire induction. Overhead feeders have sometimes to be provided for. They have to be carried from suspender wires, and to be covered, best done by hard cotton or hemp braiding saturated with waterproof preservative compound. These conductors should be shackled off at every pole. If they are large, it will be necessary to increase the size and stiffness of the poles used. As regards appearance such feeders are very objectionable, and they complicate the overhead engineering considerably, especially at feeder poles. But the saving of underground work is ofttimes an important economy, and a perfectly good job can be made.

Time and space limit this discussion to matters of material. Much might be said on erection, but I have probably said quite enough for one time. There must be now a good deal of information available as to the normal life of various items of overhead equipment under various conditions of traffic and atmosphere, and also as to the nature and frequency of breakdowns. Mr. McElroy last year made a laudable attempt to collect some of this information, and I am considerably indebted to the paper which he prepared for the last conference of the Municipal Tramways Association. This, however, is only a beginning and only partial, because, for some reason not easy to understand, no information was given to Mr. McElroy by any tramway company's officials. It is by the collation and discussion of information from all sources that advance may be expected, and every little helps, so the continuation of Mr. McElroy's good start is highly desirable. The cost of overhead work seems to vary a good deal more than it should. Some authorities put it at £1,500 to £2,000 per mile of route, but I don't know how so much can be properly spent. Thoroughly good span-wire work for either double or single lines can be erected for £1,200 per route mile, with fair profit to the contractor. Bracket-arm work for single lines, where a single line of poles is generally sufficient, can be done for £1,000 per route mile, or even less under specially favourable conditions. These rates include average amounts of guard wiring and proportion of junctions, but very heavy and complex junctions, car-shed fanwork, and similar special requirements will involve some additional expense. A great deal of money can be spent on elaborate scrollwork and fancy painting, especially if a little gold-leaf is thought necessary to harmonise with the surroundings; but these are matters of taste rather than engineering, and those who like to pay for them will doubtless continue to do so. In some towns there certainly is the excuse that the overhead structure is the only thing visible in the streets that bears the slightest trace of design or grace, of which the most should, therefore, be made.

## THE DISTRIBUTION OF ELECTRICAL POWER IN CITIES.

At a meeting of the Aberdeen Association of Civil Engineers on the 10th inst., a paper entitled "The Distribution of Electrical Power in Cities" was read by Mr. A. H. McKay, mains superintendent of the Aberdeen Corporation electricity department. The chair was occupied by Mr. George Mann, A.M.I C.E.

In dealing with the subject, Mr. McKay first described the general principles involved in designing a direct-current low-tension system of electrical distribution, explaining the appropriate applications of both the "two-wire system" and "three-wire system," and the necessity for a methodical use of feeders from the generating station to the distributing mains to ensure that the pressure is kept constant throughout the system. On this, he stated, the success of an electrical distributing system largely depended. The success and economy attending the introduction of increased voltage was next explained, the lecturer stating that at one time electric lamps could only be got for a pressure of 100 volts, whereas to-day they could now be had for any pressure up to 250 volts. With regard to the mains themselves, Mr. McKay explained that some systems of bare copper strip were first used with a certain amount of success, but that with the introduction of higher pressures they proved defective owing to the difficulty of getting proper insulation. After explaining other methods in use, he stated that the most satisfactory system of mains was that in which the cables were laid solid in a wooden trough about 2ft. deep.

Mr. McKay next stated that on account of the great expense of opening up streets for additional cables and the annoyance caused to city traffic, the great demand for electrical energy led supply authorities to consider the advisability of constructing subways for carrying cables. In the city of Aberdeen two such subways have been constructed, in which the feeder cables for both tramways and lighting are carried. They are such that when filled with cables a person can walk through their entire length and have the whole of the cables completely in view for examination. Altogether 1,500 yards of subway have been constructed in Aberdeen.

This most interesting paper was concluded by some very valuable practical remarks on the faults met with in an electrical system, their causes, location, and elimination. The paper was thoroughly well illustrated by sheets of hand diagrams and a fine collection of electrical apparatus, pertaining to the points introduced in the lecture.

The discussion was opened by Mr. Bell, city electrical engineer, who congratulated the author on the manner in which he had presented the paper to the members, and referred to the abnormal advance of electricity in 20 years. The explosions in Aberdeen at electrical manholes, he said, were, through an interesting series of experiments, traced to the dissipation of electricity from the mains causing the air to expand, and produce the accident. The discussion was continued by Messrs. Milne, Cook, Moncur, Conway,

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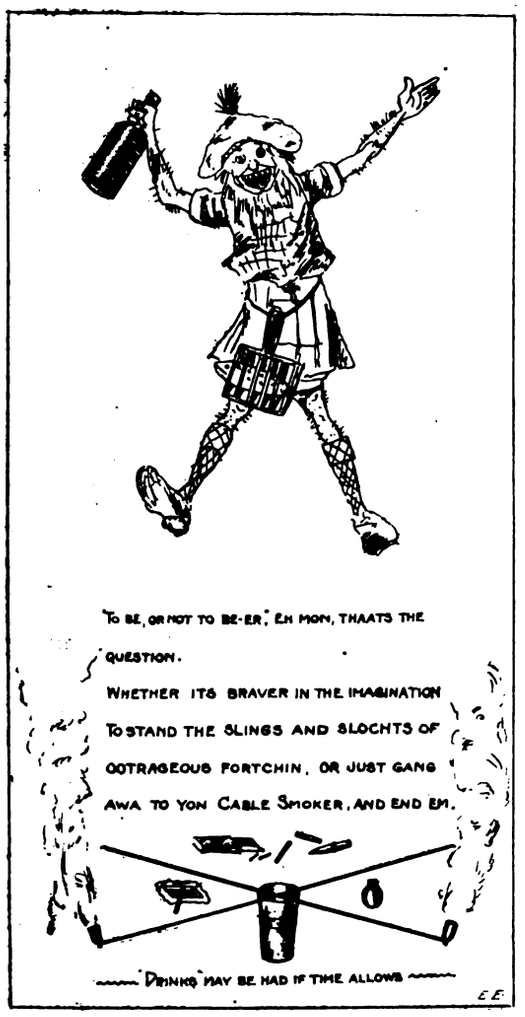
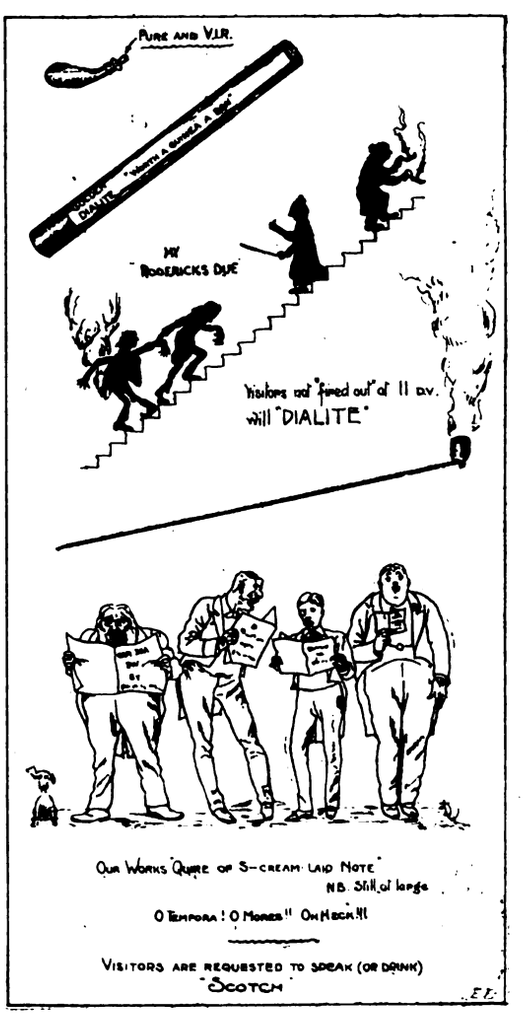
and Simpson, and, on the chairman's concluding remarks, a vote of thanks, proposed by Mr. Moncur, vice-president, and seconded by Mr. Conway, vice-president, was cordially awarded Mr. McKay for his most interesting paper.

## THE ST. HELENS CABLE COMPANY'S SMOKING CONCERT.

The first annual smoker of the staff of the St. Helens Cable Company was held on Friday at the Patten Arms Hotel. Mr. Kenyon was to have taken the chair, but was unfortunately prevented from doing so by indisposition. A most enjoyable programme of music was arranged, a good feature being that all the contributors were members of the St. Helens Cable Company's staff. The drawing office of this company was responsible for the invitation card, which is a work of high art. We reproduce herewith




two pages of this invitation card, which will show the extensive experience of the artist on other subjects than working drawings of cables and accessories. Due to the success of the first smoker, these functions are likely to become annual affairs.

## GLASGOW LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The monthly meeting of this section was held on Jan. 10, when Mr. H. B. Maxwell read a paper on "Street-Lighting by Electric Arc Lamps." Mr. Maxwell said that the objects of his paper were to show that street-lighting by electric arc lamps was not the expensive luxury it was generally imagined to be, and also to start a discussion which could not but be beneficial. The chief requirement of effective street-lighting was an illuminant which would efficiently illuminate the street without dazzling the eye, and at the same time give a maximum candle-power at an angle below the horizontal. The author contended that arc lamps met this requirement more fully than incandescent gas lanterns. In certain streets in Partick, six 3ft. incandescent burners had been displaced by each 12½-ampere arc. With the gas lamps, objects between lamps were indistinct at a distance of 100 yards from the point of light, while with the arc lamps similar objects were quite clear 300 yards distant in straight streets. The chief reasons why station engineers had not more arc lamps in circuit were: first, they failed to realise that street-lighting had a load factor of over 42 per cent., and consequently they did not charge low enough rates; and second, there was an inclination to cram too many lamps into the space available, instead of rather trying to place the lamps in the most suitable positions with a view to further extensions. The author thought the open type of arc lamp was to be preferred for street-lighting, as it was cheaper to maintain, and the colour of the light was better. Ten open-type lamps could be run in series as against five of the enclosed type. He preferred the use of large-sized lamps placed further apart to the adoption of smaller sized ones for the lighting of side streets. This meant that the lamps throughout were of a uniform size, and necessitated only one stock of carbons and stores being kept. He thought that the 10-ampere open-type arc lamp pendant from a swan-neck or bracket at a height of 20ft. would be found most satisfactory for all streets. In view of the fact that the cost of the lamp was only a small part of the total capital expenditure, it was advisable to get lamps of the best make, thus lessening the cost of maintenance and reducing the number of failures. In busy streets he would place the lamps 60 to 80 yards apart to suit the corners, and in less-frequented streets from 90 to 100 yards apart. A street lit with lamps staggered on alternate sides was better lit than with centre poles, and obstructed street traffic less. The use of tramway poles was not advisable, owing to the increased cost of maintenance as the result of vibration. With regard to ladders as against lowering gear for cleaning and trimming the lamps, the author was in favour of the former, for the reasons that the first cost was less, the maintenance cost of lowering gear was higher, a

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trimmer could attend to at least as many lamps with the one as the other, and the ladder was probably the safer of the two in windy weather. The author was strongly of opinion that it was most necessary to control the street arc circuits direct from the station. This brought the street-lighting under the direct observation of the station staff, it obviated interference with street-lighting in the event of failure through faults developing in a distributor, and the extra capital charges were very much the same in the one case as the extra cost of wages and current in the other.

Mr. Maxwell gave some interesting data with regard to the price of street-lighting. From a table of costs he showed that the charges on capital and for current form over 80 per cent. of the total cost of the lamp if 1d. per unit is charged for current. It was, therefore, in these two items that any reduction in price must be sought. The 7 per cent. allowed for interest, sinking fund, and depreciation would be found more than sufficient. It was advisable to trim full during the summer months, as then half the trimmers could be put to other work. He found that one trimmer could attend to 90 lamps in Partick, but this figure he believed could be exceeded in other towns where the lamps were not at such a height from the ground, and the use of the telescope ladder was not therefore necessary. Every £50 increase in the total wages bill on a 400-lamp installation meant an increase of cost amounting to 2s. 6d. per lamp per annum. With regard to the charge for current, the only items which should be included were the works costs, minus wages (not increased by street-lighting load) and interest, sinking fund, and depreciation on capital cost of extra station plant except switchboards, which, together with cables and feeders, had already been debited against street-lighting capital cost. The increased cost for station plant would therefore be amply covered at £40 per kilowatt demanded. This charge on 400 lamps burning 3,500 hours per annum makes the cost per unit generated ·25d. + works costs, which in 54 stations mentioned in an *Electrical Times'* record brought the total cost per unit out at from ·57d. to 1d. Comparing this with the figure of £6. 15s., which is the average cost per lamp per annum of incandescent gas lamps containing three 3½ft. to 4ft. burners giving 100 c.p. after 50 hours' use, leads Mr. Maxwell to conclude that a very large number of towns can light their streets with arc lamps as cheaply as with incandescent gas, and with a large increase of light.

The remainder of Mr. Maxwell's remarks consisted of a description of the street-lighting scheme which has been carried out in Partick. The lamps are of the 12½-ampere size, and are 290 in number. In several streets they are placed apart as far as 180 yards. The circuits are run with $^{7}/_{16}$ twin lead-covered wires laid solid, the two conductors being insulated with different coloured papers, so that they may be distinguished. Contiguous lamps are connected alternately on the red and white conductors. The circuits have been run in this manner as far as possible, so that every alternate lamp only is out when a fuse blows. The circuits are run from feeder pillars, each controlling four to six circuits, supplied from the station by independent feeders and from separate 'bus bars.

"The street-lighting is started on separate machines from the ordinary supply, and afterwards paralleled on to the main bars, thus obviating any irregularity in the ordinary lighting due to switching on several circuits at once. As the machines are separated out again at dawn and shut down on the load, the feeder switches are only operated in the case of emergency, which is a great saving to the switches, as the arc formed when opening arc circuits on 500 volts is excessive owing to induction. Also, if an arc circuit or feeder is earthed so that a fuse will not hold, all that is necessary is to open the paralleling switch and run with one pole earthed till the fault is remedied. If the earth is on a circuit, it can then be easily isolated by testing at each lamp to earth with a voltmeter."

Efficiency and economy are provided for by a system whereby each lamp is thoroughly cleaned once a week, and a substantial bonus is awarded to the trimmer who shows the lowest costs per lamp per annum. The revenue from current also for the 300 street arc lamps in Partick is about £3,000 per annum, while the money spent on the scheme for goods manufactured in this country has been £18,000.

The following is an abstract of the discussion which took place:

**Mr. F. A. Newington** (Edinburgh) said that for side streets they had not at present any electric lamp which could successfully compete with the gas mantle. Where he had displaced gas with electric street-lighting it had been at the rate of three gas lamps displaced by one arc, as against Mr. Maxwell's six gas lamps to one arc. He did not think it was advisable to have all the arcs of one size and type. Such a proceeding would block the march of improvement. He was of opinion that something still required to be done with regard to the density of the arc-lamp globe. The opalescent globe meant a loss of about 50 per cent. of the light. He was averse to the use of lowering gear in windy places, as breakages of globes were likely to be frequent in the lowering and raising of the lamps. Mr. Maxwell's contention for separate feeders, etc., would, of course, entail extra cost, and it was significant that the Partick cost was £60 per lamp, whereas the average elsewhere was £30 per lamp. He should like the kind of ladder Mr. Maxwell used, which could be managed by one man. He disagreed with the author in his omission of wages from the costs given in the paper. The costs for arc lighting in Edinburgh were £10. 16s. 1d. per lamp per annum.

**Mr. Andrew Jamieson** said that the extreme distance of 150 to 300 yards was too much between arc lamps even in quiet streets, and he also thought that 15 guineas would be nearer the proper charge per lamp per annum than the figure given in the paper.

**Mr. Hanson** said he believed in the use of smaller lamps in quiet streets rather than large lamps placed further apart. He thought that centre poles could be used with advantage in wide thoroughfares, as they helped to regulate rather than hinder the traffic.

**Mr. Burbridge** said that he used lowering gear in Kilmarnock, and it worked very well. They had had no breakages with it, although the weather had been very windy. The lamps sometimes stuck, however, when half lowered, and then the ladder had to be brought into use. One man could trim 50 lamps comfortably in five hours in that way.

**Mr. Robertson** had a word to say in defence of the enclosed arc, which he said in its improved form was to be preferred for the lighting of quiet streets. From a recent estimate which he got out, he was driven to the conclusion that for the lighting of outlying streets gas was the cheaper illuminant. He thought Mr. Maxwell was quite wrong in omitting the item of wages from his estimate. Additional load in any large quantity was bound to materially affect the wages bill of the generating station.

**Mr. Wilson**, manager of Glasgow gas department, was present by invitation, and delivered a long speech condemning Mr. Maxwell's figures as inaccurate and only meant for "home consumption." Arc lighting had lost favour in the eyes of nearly all local authorities, while incandescent gas was extending everywhere. He maintained that Mr. Maxwell was selling his current for street-lighting under cost. While he was inspecting the lighting of Brighton, the electrical engineer who was showing them round lost his way, and someone suggested lighting a match, as the street was so dark—a fact! The speaker expected there was a good trade done in Partick in the match business.

**Mr. W. W. Lackie** thought Mr. Maxwell's street arc lighting load factor of 42 per cent. was too high, and that 30 per cent. would be more like the average. The distance apart, and not the candle-power, should regulate the height of the arc from the ground. He did not agree that arc lamps suffered by being put on tramway poles. He agreed with the author that ladders were preferable to lowering gear, especially in the central district of a city. As the capital cost was one of the chief items in street-lighting, he thought that more consideration should be given by engineers to high-tension continuous current, the adoption of which would be bound to lower capital cost.

The discussion at this point was adjourned till next meeting.

## INSTITUTION OF ELECTRICAL ENGINEERS.

The following is a summary of the resumed discussion on Mr. W. P. Adams's paper, entitled "The Combination of Dust Destructors and Electricity Works Economically Considered," of which a summary appeared in our issue of the 23rd ult.:

**Mr. H. N. Leask** had expected the paper to deal more with the planning of combined stations, as this matter deserved most attention when one was to be put down. A point which was apt to be lost sight of was that few combined works employ forced draught, which would facilitate economy and render the value of the destructor more apparent. An example was afforded by Mansfield, a small station generating about 1,500 units per day, where the refuse destructor was almost entirely relied upon. At that station over 50 units per ton of refuse are obtained, and on the peak load the figure has reached 120.

**Mr. W. R. Cooper** remarked that in the preliminary part of his paper the author had given the advantages rather than the disadvantages of destructors. One difficulty in combined works arose from the fact that the destructor had a full load as soon as it was built, but the electricity works started with a very small load. The result was that, initially, perhaps the whole of the steam might be supplied by the destructor. This stage soon passed when the electricity works became larger and coal firing had to be resorted to for parts of the load. Finally came the stage when separate boilers had to be put down to meet the load. All works were liable to pass through these three stages and eventually to find themselves with two lots of boilers. As the population did not increase as rapidly as the lighting load, the proportion of

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steam supplied by the destructor became less, so that one had to consider how far it was worth while to complicate the system, and very possibly to use the coal to less advantage. The complication was apt to hamper extensions, and although there might be a gain in the first instance in the amount of ground required, this proportionate gain diminished as time went on. Moreover, the requirements of a station, as regards site, were generally incompatible with those of a destructor. A destructor should be placed well away from the best parts of a town, but if an electricity works was so placed there was likely to be a material loss in distribution. A chimney shaft might be saved to some extent by the combination, but it could be said that a whole chimney was so saved, because a destructor chimney was very large in proportion to the power which it represents. Mr. Cooper regretted that the author had taken for his basis *units* generated per ton. Since the efficiency from boiler to generator terminals varied very much from station to station, such a basis rendered any comparison of the different stations quite impossible, and there was no reason to hope that good results would be obtained at one station merely because they were obtained at another. The utilisation of the steam in the two cases might be quite different. The only true basis of comparison for destructors was the heat available from the destructor. This, however, was somewhat impracticable, and the next best basis was the quantity of steam raised per ton of refuse burnt. As to what was done with the steam afterwards, whether it was wasted or used to the best advantage, was a question of design and of the steam plant used. Referring to the various load curves, Mr. Cooper observed that these were generally complicated by the two quantities—coal and refuse; and in order to determine the effect of one of these quantities, the effect of the other had to be assumed. The curves in Figs. 20 and 24, however, which deal with refuse only, certainly gave valuable information. Fig. 20 refers to Hackney, and gives the high figure of 104·3 units per ton. This was accounted for by the economy of the station, and it had also to be borne in mind that stand-by losses with refuse did not exist, because the refuse was burnt whether required or not. Fig. 20 also gave a high figure—namely, 100 units per ton for part of the time—but in this case the calorific value of the refuse appeared to be unusually high. In the other curves the value of the refuse was apparently arrived at by taking an average value for the coal and calculating the value for the refuse by difference. The amount of fuel per hour was not directly proportional to the power, so that the figure for units due to coal should be increased, which meant that the figure for refuse should be lower. In any case, Mr. Cooper did not think that a comparison should be drawn between the effect of refuse and coal in a combined plant, because the coal was often burnt in such a station under disadvantageous circumstances. What was really important was the best that can be done with refuse as compared with coal under the best conditions. The author was inclined to look with scepticism upon calculations which depended upon refuse giving from 1lb. to 2lb. of steam per pound of refuse. The author would probably regard 1·5lb. as a high figure. Ordinary figures ranged from 1lb. to 1·5lb., and 1·25lb. per pound might, perhaps, be taken as an average figure. This is equivalent to 2,800lb. of steam per ton of refuse. If such a figure as 100 units per ton was to be obtained, it meant that the average steam consumption per unit generated for the whole station must be as low as 28lb., which was rarely found. The author's figures in regard to Fulham and Hackney seemed flattering to refuse, or did not do justice to coal. The criterion, however, must be the financial result. Unfortunately, it was always difficult to arrive at a sound conclusion from such tables as those given by the author, because the destructor and the electricity works were owned and worked by the same body. The combined undertaking was worked to benefit the destructor, not the electricity works, and the financial position was largely a matter of book-keeping. The only valid way of dealing with the matter was to consider the undertaking as a whole, and see whether the saving in fuel to the electricity works compensated the complication, with probably a lower efficiency, and a certain additional outlay for depreciation, etc.

**Mr. G. Watson** considered that managers of destructor works ought to be grateful to the author for his paper, though it was doubtless open to criticism upon matters of detail. He thought there was a danger of the Institution being formed into two rival camps—the enthusiasts, and those who threw cold water upon all these proposals. Mr. Highfield had spoken of refuse as though it consisted of nothing but malodorous fish and cabbage, but there were also cinders and the like, which rendered it a fairly good low-class fuel. It had also to be remembered that it was incumbent upon the local authority to dispose of the refuse in a sanitary manner, and this generally cost 2s. per ton where there was no destructor. Everybody agreed that the higher the temperature at which the refuse was burnt the more satisfactory the process, because you obtained more steam and better clinker. He thought that the modern destructor could be placed in the centre of any town, and the same considerations which prompted the placing of electricity stations in such positions applied to refuse destructors. He was not disposed to attach great weight to Mr. Cooper's point about the more rapid growth of the lighting load as compared with the population; when refuse destructors were designed, consideration should be given to future needs. Regarding the leakage of dust, some gentlemen seemed able to persuade themselves that dust would go through a 14in. wall. His experience was that if you put a wall between the power-house and the destructor, things would be all right. He agreed with Mr. Cooper's objection to the author's method of calculating the respective values of coal and refuse. Mr. Watson pointed out that the coal was burnt during a short period of high load, while for the rest of the 24 hours it was burnt in banked fires. A second lot of boilers might be obviated by using petroleum. Thermal storage had given good results at the Kensington and Knightsbridge works. No doubt as long as coal was plentiful, and electricity could command a reasonable price, low-class fuels would be neglected. He thought it would be found that the clinker which left the mechanical stokers in many large stations had calorific power to the extent of 5 to 7½ per cent., if not more, left in it. This would not only provide more fuel, but, if burned down, would reduce the clinker to a more convenient size. He thought these matters called for a more scientific attitude on the part of electrical engineers, who, however, could claim to be pioneers in the utilisation of refuse.

**Mr. J. H. Thwaite** regarded the total ultimate capacity of the Hackney plant—39,200 tons—as very low. He quite agreed with Mr. Watson's remarks concerning destructors generally, which were worked on a wrong principle in this country. They should be worked from an economical point of view, and if engineers would properly analyse the refuse they would obtain better results. The author was incorrect in saying that the only combined plant erected outside the United Kingdom was one in New Zealand. A station had been put up in Denmark, and gave results which surpassed expectations.

**Mr. L. Boot** recommended air-channel bars instead of ordinary solid bars for the grates, as he had found the former had a much longer life. Another point was the location of the economisers, which were sometimes placed in extraordinary positions. They should be put more in line with the flues. The dust problem was certainly an objection, as electrical engineers took a pride in their works. Mr. Watson's idea about a wall excluding dust took no account of skylights and other essential methods of ventilation. As to clinker disposal, it would be interesting to have particulars of the cost at Fulham for converting the clinker into bricks. The paper did not deal with the question, is it advisable to add destructors to existing electricity works? Mr. Boot did not think there would be much advantage where expense had to be incurred in putting down boilers, etc. He would like some figures in regard to the saving effected by thermal storage. There seemed to be a substantial discrepancy between the Hackney wages bill for the destructor and electricity works respectively, the former being heavily debited. With regard to accumulators, if manufacturers would bring out a suitable type, every engineer would no doubt use them, but at present he considered they were impracticable.

**Mr. Adams**, in reply, stated that the selection of refuse, which Mr. Highfield suggested was the reason for obtaining good results on the peak load, was out of the question in large works in London. He sympathised with engineers-in-charge in regard to the leakage of dust, but thought this trouble was overrated. In support of this he quoted from a paper read by Mr. Highfield before the Glasgow Section. He appealed to engineers to treat this branch of the subject from the point of view of utility, as the extra cost of repair to machinery was a negligible quantity compared with the value of the refuse. By "storage" he simply referred to the storage from day to day, as actually carried on in some works at the present time. He welcomed Mr. Russell's announcement that he was experimenting with a method of burning the fuel down to a lower point, as clinker-disposal was of the greatest importance. Mr. Adams had not any detailed figures to give in regard to the conversion of clinker into bricks at Fulham; but if the proceeds equalled the cost it represented a gain, the clinker being thus disposed of without expense. He hoped that the importance of keeping separate accounts would be recognised as it was at Hackney. Hitherto the electricity works had generally been favoured when apportioning the expenses. He thought the method he had adopted in calculating the capital charges was quite justified. In regard to the calculation of Prof. Forbes, to which reference was made in the paper, it only applied to private lighting. Mr. Russell objected to "units per ton" being taken as the criterion of the value of the destructor works, but where so many factors entered into the question it was impossible to devise a perfect method of calculation. Diagram 3 and Tables 7 and 9, however, furnished a considerable amount of supplementary information upon this point. A good deal of criticism had been directed against his estimate that 100 units per ton of refuse should be practicable, but this result was actually being obtained, notably at Woolwich. Test figures were not always representative of a plant's capabilities, as the furnaces were quite cold in the first instance, but after getting into working order better results might be secured. He thought the figures he had assumed for the peak values were quite fair. The figures given in the curves were necessarily approximate to some extent, but they were substantially correct. In regard to the values he had taken on the peak for coal, at Hackney the average value was the peak value, as banking did not enter into the question. The case of Fulham was not quite so simple, but, generally speaking, there was not much difference between the average and the peak value. Respecting the water consumption at Fulham, the figure of 59lb. given in the paper was that derived from a test, but no doubt better results could be obtained. It was a question of evaporation. In further support of his estimate, that 100 units per ton of refuse were obtainable, Mr. Adams quoted some recent figures from Partick.

A vote of thanks was unanimously accorded to the author.

## PERSONAL.

Mr. G. R. Pepper has been appointed to the position of head of the publicity department at Croydon works.

Mr. M. Farrar has resigned the position of chief assistant to the Twickenham and Teddington Electric Supply Company to take up the position of resident engineer to the Ramsgate and District Electric Supply Company.

Mr. H. H. Oxley, of Lincoln, has been appointed junior assistant at King's Lynn electricity works.

We are informed that Mr. Thomas Thomas, of Ogmore Vale, Glamorgan, has been appointed by the Bridgend Urban District Council as working electrician. In response to an advertisement in our columns, 325 persons applied for list of duties, and there were 143 applications for the position.

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THE
# ELECTRICAL ENGINEER.

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### TO CORRESPONDENTS.

*All Rights Reserved.* *Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

*All communications intended for the Editor should be addressed* C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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## SINKING FUND INSTALMENTS.

We should not have touched this topic at present had not our contemporary, the *Accountant*, incited our curiosity, and now we want badly to ask questions and receive enlightenment. The *Accountant* is expert in all that concerns accounts and the funniosities therein, but its dicta are often outside the comprehension of the non-expert. The misfortune is that these experts so often in their statements put in a saving word or clause, so that the interpretation is rendered more difficult. Here is one sentence taken from our contemporary which puzzles us: "It has been so frequently assumed that loans sanctioned by the Local Government Board for trading purposes are fixed for a period approximating closely with the estimated life of the assets that will be acquired, that it seems desirable to draw attention to the fallacy of any such assumption." Now, what does that mean? That there is no connection with the loan granted and the life of the work for which it is granted, or what? Is the fallacy in "approximating closely," or is "closely" merely the saving word? Does the Local Government Board toss up as to how many years a loan should run, or has it some system other than "life of work" about which the public knows nothing and evidently cares less. We seem to have heard that a short time ago the period for loans for wood paving was in certain cases shortened because experience showed that the paving did not last as long as it was expected to last. Was it wrong to assume, then, that life of assets had something to do with the period of such loans? However, we are anxious to learn, and shall be under a deep debt of obligation to our contemporary if it will give us a real insight into the procedure of the Local Government Board with regard to period of loans. Its example does not help us far, because it is merely a comparison between the procedure of the London County Council and the Local Government Board. For electricity expenditure the London County Council's equated term is forty-two years; for the country that is under the Local Government Board's *régime* it is twenty-five years. If we might assume anything, it would be that the Local Government Board, feeling a certain responsibility, wishes to be on the safe side, while the London County Council is willing to run close to the wind—or, rather, to the "life of the asset." We have a more or less vivid recollection that Mr. Snell, of Sunderland, a past-president of the Municipal Electrical Association, has made a special study of this "equated time," and that his views are corroborative of the London County Council's action. It may be that neither of these periods is settled with any regard to life of assets, yet it can hardly be settled by chance.

Another sentence in our contemporary is very funny. What it really means we know not; but, then, it takes a sledge-hammer or a ton of dynamite to drive a joke into a Scotchman's head or to explain to him a conundrum. Here is the trouble: "That unduly extended periods for loans are no real economy, even at the time, seems to be shown by the fact that the charge at Poplar in respect of interest was £6,331 (3·26 per cent.) against £4,327 (2·97 per cent.) at Eastbourne." What is the use of a head if you cannot understand? Does the *Accountant* assume that in these cases rate of interest is directly as length of life of loan—hence Poplar having the longer period pays the greater rate of interest? If not, what on earth does it mean? In our benighted sphere of operations we should never have thought of connecting interest so closely with period of loan, but should have wondered at the state of the money market when the various loans were floated. Really, we live and learn, and if our expert con-

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temporary can prove its case, that rate of interest varies directly with length of loan, the shorter the period the lower the rate of interest, it is a satisfactory argument for the Local Government Board in keeping its loan period short. We have always inclined to the opinion that "unduly extended periods" and unduly "contracted periods" for loans were equally bad. In the former there comes a time when, as in the case of wood paving, there are no assets against the outstanding portion of the loan, while in the latter case too great a burden is thrown upon the early users. Electrical engineers, so far as we have gathered their opinions, think too short a period, giving an unduly large sinking fund, accompanied, as it usually is, by biassed pressure for more depreciation and better upkeep, is in the nature of a calamity, putting far too great a strain upon an undertaking in its early years, mulcting too heavily its earlier users—all to the advantage of posterity, who have done nothing in the way of development, exploitation, and perfection. The old economic view of small profits and large returns is upset and progress retarded, for the profits must in the nature of the case be larger than if longer time was given for repayment. Our views are possibly absurd. We are open to conviction if our contemporary will assume we possess an open mind, and desire information easily to be digested or interpreted. The equated time of the Local Government Board may be—possibly is—too short, hence the weeping and wailing throughout the country and the jealousy of countrymen against the London County Council, whose time, on the other hand, may be too long, leading in the sweet by-and-by to many bad financial positions. The counsellors are multitudinous. When shall we obtain wisdom?

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### TELEPHONE RATES.

SIR,—I suppose that if it were argued in your columns that no hotel ought to charge more than 7s. 6d. a day for full board and lodging, and, therefore, that all hotels in Great Britain should be built, equipped, and run on the basis of such a maximum charge, the most casual reader would see the absurdity of the argument. Different people require different hotel accommodation, and pay accordingly. It is much the same with telephone service; different people take different classes and quantities of telephone service, and pay accordingly.

Mr. Alfred R. Bennett, in your issue of Jan. 6, says that the "business way" of dealing with the telephone service is to fix arbitrarily a flat rate of £5. 10s., and adjust the whole business to that. No more unbusinesslike way of attacking a telephone problem could possibly be imagined. It is more foolish even than putting the cart before the horse. It is picking out in advance a weedy animal to draw the cart without any regard to the style and size of the cart, the load to be carried, the road to be travelled, or the speed or length of the journey. It is precisely this haphazard and superficial manner of approaching the telephone business which has led the few British municipalities now engaged in telephony into the troubles they are now gradually realising.

The proper way to arrive at a commercial telephone tariff for any given city or area is to study in the greatest detail all the various conditions. Such a study is by no means a simple matter, as there are a great many factors to be considered. If proper consideration be not given to all the factors, trouble will inevitably arise. If a telephone scheme be launched without a thorough preliminary study, without due regard to modern telephone methods and on a narrow margin of possible profit, it will be a commercial failure before it is many years old.

The really important features of the telephone business are an efficient service and high development. An essential feature of any business is that it shall pay. Give the public an efficient service, develop it broadly so that it shall be generally useful, and the public will cheerfully meet the rates necessary to make it pay.

To seek to adjust the whole telephone business—a business in which the requirements of individual customers vary between wide limits—to a rate for a single class of service, and that rate arrived at by pure guesswork, is a proposal which is not only narrow-minded and unscientific, but is flatly at variance with practical experience.

The effort to work to such a proposal results in subordinating every consideration to that of cheapness. No more certain way of ensuring the ultimate failure of a technical business could be devised. The municipalities in this country which have so far engaged in telephony have proceeded on Mr. Bennett's plan of fixing arbitrarily a low flat rate for unlimited service, and then seeking to adjust the whole business to that one rate. The result has been that the municipalities have provided themselves with badly-designed and badly-found telephone plants, which represent in the main the practice of 12 or 15 years ago, and will all have to be rebuilt in a few years.

The existing municipal systems seem to have been dropped down without any thorough study of the various factors of the problem, without any regard to the existing state of the telephone art, and without any regard to systematic future development. The result is that we find the municipalities struggling with call-wire systems, push-button systems, and indicator systems of various kinds, sometimes with a mixture of several systems in the same town, and extending haphazard and piecemeal with a total absence of a settled technical policy.

What is the actual situation in the only municipal telephone system having a history of over three years? At Glasgow the Telephone Committee is face to face with the necessity of rebuilding a plant which, for the most part, has been in service less than three years. It has been found impossible to give a satisfactory service with the mixture of call-wire and indicator plant laid out in 1901. The Glasgow system has cost per working subscriber's line (the unit on which the estimates were based) practically double the estimated cost. To put the plant abreast of modern practice will cost from a third to half as much again, even assuming that the cable and distributing plant is in sound condition. Therefore, if the Glasgow Corporation undertake an effective reconstruction of their telephone plant, they will have spent by the time the work is done nearly three times the capital per working subscriber's line which, by the process of working backwards from an arbitrary rate, was originally forecast. What then becomes of the £5. 5s. flat rate?

No more striking object lesson in the folly of dealing with a great technical business in the superficial manner advocated by Mr. Bennett could possibly be desired than the telephonic muddle at Glasgow.—Yours, etc.,

HERBERT LAWS WEBB.

35, Old Queen-street, Westminster, S.W.

[What Mr. Webb writes is always interesting reading, but sometimes his advocacy leads him to do scant justice to his adversary. We certainly do not read Mr. Bennett's remarks in our issue of Jan. 6 last, or put the interpretation upon them that Mr. Webb does. Here is our interpretation:

1. Mr. Bennett is discussing purchase by the Government of the National Company's interests.
   As business men it is the duty of the National to get all it can, and of the Government to buy as low as it can.
2. Mr. Bennett says the Government is not good at making a bargain, and ought to be cautious, for
   It is shown by Continental and American practice that a rate of from £5 to £6 is remunerative, hence
3. In making such a purchase the Government ought to consider what maximum rate they can well ask from subscribers, and Mr. Bennett merely assumes £5. 10s. for argument's sake. He might have assumed £6. 10s. or £60. 10s, and his argument would have been unaltered.

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4. The Government ought not to pay a single penny more than necessary, because any such extra payment means increase of tariff; yes, an unwarranted increase of tariff.
5. Mr Bennett goes on to say much capital will have to be expended to bring the purchase up to date. Mr. Webb's letter is largely saying that Mr. Bennett's work is not up to date.

Beginning with the third paragraph, Mr. Webb is dealing with a subject not touched upon by Mr. Bennett, his argument being directed to show how we ought to construct a commercial tariff, and a gibe at Mr. Bennett's (to him) lack of up-to-dateness. As we have said before, these experts may discuss each other's up-to-dateness till all is blue for what we care. We are only concerned at misinterpretations, because our interpretations are then criticised.—ED., *E. E.*]

## THE METRIC FALLACY.

SIR,—The communication from Lord Belhaven in your issue of Dec. 23, indicates that he is labouring under a misapprehension regarding the metric agitation in this country. He asks: "Is it generally known that America has so far departed from the British system of weights and measures as to adopt the metre as the fundamental standard of length, the yard being derived from such standard metre? Is this a part of the metric fallacy?" It is not only a part of the metric fallacy, but probably the weakest part of that house of cards.

In one of the Government bureaus at Washington there are two bars of metal—one called a yard, the other called a metre. In 1893, one of the metric scientists in the employ of the Government persuaded the Secretary of the Treasury Carlisle to issue an order that the bar called a yard should be "verified" by the lines on the bar called a metre, and since then the metricites have been shouting themselves hoarse that the fundamental standards of the United States are on a metric basis. The grotesque pretence that an employé of the Government could, by a stroke of his pen, change the fundamental linear standards of 80,000,000 people would not deserve refutation were it not that it is spread broadcast by the metricites, and leads many, as it has led Lord Belhaven, to believe that it means something. This metric fallacy recently received a new impetus by a letter from our Bureau of Standards to the British Consul-General at New York.

Unfortunately, the metricites do not always confine themselves to the vague expression "fundamental standards," which has deceived his lordship, but use the pretence as a basis for statements that can best be described by an Anglo-Saxon word of three letters. Thus, the Bureau of the American Republics—another Government bureau temporarily under the control of the metricites—states once a month in its *Bulletin* that "the metric system has been adopted in the United States of America." This *Bulletin* is published in English, French, and Spanish, and 12 times a year it carries this metric "fallacy" to every country on the Western Hemisphere, and such methods are deemed necessary to support a system that is claimed to make its own way because of its merits, and to be the only scientific system of weights and measures on earth.

Our Government officials may verify their yard bar by the lines on their metre bar, or their metre bar by the lines on their yard bar; or they may alternate such methods of verification so that our "fundamental standards" may be metric in the forenoon and English in the afternoon; but whatever they do or leave undone, the people of this country will continue without interruption to do business on the basis of the English system of weights and measures, and if ever they find it necessary to verify their fundamental yard stick, it will be done by the yard stick in London and not the metre stick at Paris. Lord Belhaven refers to the American Chamber of Commerce at Paris. This is a pro-metric association, and last year formulated and presented to the Société des Ingenieurs civils de France, another pro-metric organisation, a series of 30 questions. Although they are entirely *ex parte*, these questions and answers contain admissions extremely damaging to the metric cause.

The metrological anarchy unearthed in the Philippines is a conclusive answer to Lord Belhaven's argument that "If the custom house in a metric-using country requires all invoices to be made out in the metric system, it matters very little for purposes of our export trade what weights and measures prevail in the far interior of that country." The metric system has been used very little in the Philippines outside of the Government bureaus. Take the hemp industry, for example, whose products form by valuation nearly three quarters of all the exports of the islands. Locally, on the plantations and in transactions between dealers, Philippine hemp is always bought and sold by the Spanish *picul* and *arroba*. When the fibre reaches the custom house the invoices are reduced to kilos, and again (as in the case of 93 per cent. of the exports), when it is shipped to the United States or England, the invoices are reduced to pounds. The use of the metric system in the custom house thus necessitates two useless conversions of the weights (in each case from one incommensurable standard to another), and is a wholly unnecessary impediment to business.

The extract Lord Belhaven makes from the report of the Secretary of the Treasury simply means that our metricite officials have been presenting their fallacies to his (the Secretary's) attention. Weights and measures are regulated in the United States by Congress, and not by the Secretary of the Treasury. At present a Metric Bill is before the Committee on Coinage, Weights, and Measures, and it is stated on excellent authority that it has only one friend there, although the same committee reported a similar Bill favourably three years ago with but two dissenting votes out of a total of 18. The change has been brought about by discussion, during which the following associations have officially declared against the metric system: National Association of Manufacturers, American Society of Mechanical Engineers, American Iron and Steel Association, National Association of Carriage Builders, National Association of Heating Engineers and Contractors, Engine Builders' Association of the United States, National Association of Builders, National Brick Manufacturers' Association, National Association of Machine Tool Builders, Furniture Association of America, National Metal Trades Association, Association of Railway Master Mechanics, Master Car Builders' Association, American Society of Heating and Ventilating Engineers, Providence Society of Mechanical Engineers, and Society of Naval Architects and Marine Engineers.

Important as is the official action of these associations, it is but a zephyr to the cyclone of protest that would be raised in the United States if any administration should attempt to force the people to abandon the English standards of weight and measure. The population of the United States presents 80,000,000 reasons, and 4,000 new ones every morning, why the uniformity of measures between them and Great Britain should not be disturbed.—Yours, etc,

SAMUEL S. DALE.

Boston, Mass., Jan. 10, 1905.

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SIR,—My attention has been drawn to the leader on "The Metric Fallacy" in your issue of Dec. 23, 1904, in which you remark, quoting from the British Weights and Measures Association pamphlet, "We are not aware of any single country in the world, not even France, that has made the metric system its textile standard."

As one of the members of the "Comité permanent des Congrès international de 1900 pour l'unification de numérotage des fils," I can safely say that the chief reason why the metric system in numbering yarns has not been universally adopted is that Great Britain has refused to agree. I myself, as representing the Leicester Chamber of Commerce at a meeting of the Associated Chambers of Commerce, proposed its adoption in Great Britain some years since, and met a considerable amount of support, but it was thought impracticable for this country until the metric system of weights and measures was the national system.

At the congress of 1900 held in the Paris Exhibition, the following countries unanimously supported the adoption of the metric numbering of yarns—namely, the number of thousand metres contained in a kilogramme: France, Belgium, Austria, Spain, Italy, Germany, United States, Sweden and Norway, Switzerland, Hungary, Luxembourg,

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Japan, Mexico, Russia, Turkey; Great Britain being the only dissentient.

The French textile manufacturer is quite right in saying they are in anarchy, but it is not the fault of the French nation.

One result of the congress of 1900 at Paris has been the adoption by users and makers of raw and thrown silks, *including the Silk Association of Great Britain and Ireland*, of the metric numbering of silk for international purposes.

You speak of the persistence of old units in France, but in all commercial transactions and all book-keeping the metric system is in use. The word "livre," or pound of 500 grammes, is being replaced even in retail shop windows by "half kilo," and though a seller may quote a price of cent sous, in his invoice he marks the article five francs.

As a member of the executive committee of the Decimal Association, I should like to finish my letter by saying that although we advocate the decimal system of weights and measures on account of its international importance, we do so quite as much in the interests of internal trade, and simplification of education. I may also say that those who use decimals throughout, as in the metric countries, have many ways of abbreviating their calculations, quite as much as we have by the use of practice, etc., and have thus all the advantages, without the disadvantages, of compound arithmetic, which does not exist in the metric system.—Yours, etc., W. T. ROWLETT.

Newarke-street, Leicester, Jan. 16, 1905.

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SIR,—Referring to Mr. Johnson's letter appearing in your issue of the 13th, he surely has a very poor opinion of British scientists and manufacturers when he states that it is impossible to reform our existing system by bringing about the inter-relation of the inch with the pound, which, he truly states, is the chief disadvantage our present system suffers from.

A man that has a defective machine does not throw it away if by a little alteration he can make it as effective—possibly superior—to some new machine which is recommended to him, especially if that machine has its own recognised defects; and this is what we should do, and what can be done, with our weights and measures. It is deplorable that Lord Kelvin and those who follow him should have so far agitated for the introduction of a new, expensive, yet imperfect, machine, instead of using their great abilities to perfect the existing one.

In view of the reintroduction of the obnoxious Metric Bill before Parliament in the coming session, it is of the greatest importance that the country give every possible support through its councils, corporations, societies, and individuals to this association in its efforts to bring about by easy and inexpensive means the results which are sought by the Decimal Association asking Parliament to impose upon us by most expensive, revolutionary, and compulsory methods.—Yours, etc., GEO. MOORES.

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## FIRE-ALARMS.

SIR,—Can any reader inform me of a recently-erected and efficient fire-alarm and telephone system in a large public institution or asylum?—Yours, etc, INTERESTED.

[Our correspondent should write to the May-Oatway Fire Appliances, Limited, who make a speciality of this class of work.—ED. *E.E.*]

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## CENTRAL STATIONS IN GERMANY.

The statistics for 1904 published in the *Elektrotechnische Zeitschrift* show good progress with central-station works in Germany during the year just passed. There are now 51 electricity works in the Fatherland, each having a plant capacity of 2,000 kw. and upwards. The aggregate output of these 51 stations, distributed among 33 towns, amounts to 290,693 kw. As regards individual stations, the Berliner Elektricitätswerke, Berlin, easily heads the list with a capacity of 85,136 kw., the six smaller works which help to serve the capital totalling another 83,185 kw. between them. Hamburg follows Berlin with six central plants, having a total capacity of 53,905 kw., of which 25,433 kw. is installed in one station. It is pointed out that there are at the present time 1,108 central electricity works in Germany, but of these only 1,028 are dealt with in the tables, since particulars relating to the remaining 80 were not forthcoming in time for publication. The 1,028 works included have a total output of 530,947 kw., accumulators representing 96,065 kw. of this, while the load consists of 5,687,382 50-watt incandescent lamps, 110,856 10-ampere arc lamps, and 263,036 h.p in motors—an aggregate of 576 529 kw. Compared with these figures we find that in 1894 there were 148 stations, with 493,801 50-watt incandescent lamps, 12,357 10-ampere arc lamps, and 5,635 h.p. in motors connected. As regards systems of supply, continuous-current plants working with accumulators largely predominate, numbering 803, with a total output of 245,220 kw. Mixed systems are installed in 79, polyphase in 63, alternating current (single and two phase) in 41, and continuous current without accumulators in 40 instances respectively. The large majority of the plants are driven either by steam or water power; but it is interesting to note that gas-engines are employed exclusively in 94 stations, having an aggregate output of 10,050 kw. The progress of the various power transmission schemes seems to have been fairly satisfactory. The Brühl station, opened in 1899, which supplies 66 townships and villages within a radius of 15 km. to 20 km. with current for lighting and power has plant aggregating 1,540 kw. installed, while the load connected consists of 22,272 50-watt incandescent lamps, 208 10-ampere arc lamps, and 1,975 h.p. in motors. It should be mentioned that the population within the area of supply is 66,000. Polyphase current having a frequency of 50 is generated at this station and transmitted at a pressure of 5,500 volts to the different centres of consumption, where it is transformed for distribution on the three-wire system at 115 or 230 volts. The two stations belonging to the Oberschl. Elektricitätswerke serve a population of 360,000. They have generating plant of 9,980 kw. total capacity installed, besides 622 kw. in accumulators. The load consists of 83,710 50-watt incandescent lamps, 2,516 10-ampere arc lamps, 5,217 h.p. in motors for industrial purposes, etc., and 5,797 kw. in tramway motors. Polyphase current having a frequency of 50 is generated and transmitted in this case at a pressure of 5,850 volts.

The better-known Rheinfelden station, wherein some 12,700 kw. of plant is installed, serves 46 townships and villages, the load connected consisting of 28,396 50-watt incandescent lamps, 164 10-ampere arc lamps, and 7,642 h.p. in motors. There are also a number of smaller transmission stations scattered about Germany. In sharp contrast with these are numerous small electricity works designed to supply current principally for power purposes locally, their erection being the outcome of co-operative efforts to stimulate home industry and benefit small users of power. The Anrath electricity works, near Crefeld, may be regarded as a typical illustration. All the motors receiving a supply from these works are of ¼ h.p. to ½ h.p. each. They are used in connection with the local ribbon industry, which is carried on largely in the homes of the workers.

In conclusion, reference may be made to a noteworthy change indicated by the returns published in the *Elektrotechnische Zeitschrift*. We allude to the rapid increase during the last few years in the consumption of current for general power purposes, and the comparative slackening in the increase of electric lighting. Thus, taking Berlin as an example we find that down to 1899 the kilowatt equivalent of the total lamps connected exceeded that of the motors installed, while last year a total equivalent of 36,195 kw. in lamps was connected as against 44,448 kw. in motors, exclusive of the tramways load. According to the returns there are now 12,933 electric motors installed in Berlin, apart from the tramways.

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## TRADE NOTICES AND NOVELTIES.

### G. E. C. Progress.

The Progress Sheet issued by the General Electric Company, Limited, for the current month includes particulars of the

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Angold automatic suspension gear and contact device. This apparatus consists primarily of a device for automatically holding the lamp and taking the strain of the steel wire; and, secondly, of an arrangement of contacts for conveying current to the lamp. It is suitable for any make of arc lamp. The accompanying illustration (Fig. 1) shows the apparatus with the clutch gear and contact plug out of the socket. The upper and larger portion is fastened to the lamp bracket or ceiling plate, while the inside plug is attached to the lamp top, being fitted with two spring-controlled catches, which are normally in a horizontal position. When the lamp is drawn up by the winch these catches first strike against the bell mouth of the socket, which depresses them inside the plug until the first increased diameter inside the socket is reached, when they open out and support the weight of the lamp. The suspension wire is now slack, and relieved of all strain. To lower the lamp, it is first pulled a little higher until the catches reach the second increased diameter of the socket, where they open out horizontally, and if the winch be released the lamp will come down and the catches will be thrown upwards as they pass the two steps in the socket, springing into the horizontal position, when they emerge from the well mouth.

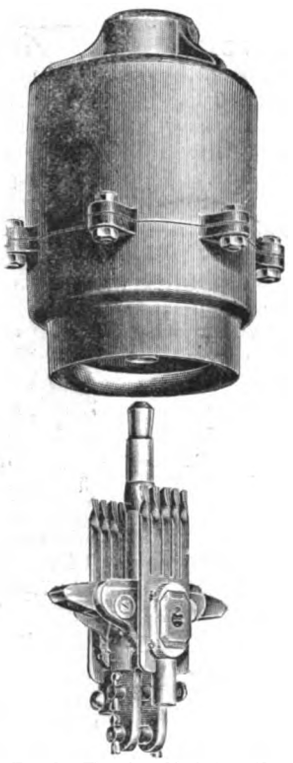

FIG. 1.—The Angold Automatic Suspension Gear and Contact Device.

Another item dealt with is the "Wigan" (patent) mining bell, which we are told has been specially designed by Lancashire mining experts to meet the requirements of the Government mining inspectors and colliery engineers. It is absolutely watertight and gas-proof. The whole of the electro-magnetic movement is enclosed in a cast-iron case. Either trembling or single stroke can be supplied, but on account of the quick action the trembling type is recommended for all ordinary installations. The coils of the trembling bell are wound to a resistance of 60 ohms, and those of the single-stroke bell to a resistance of 30 ohms. The accompanying diagram (Fig. 2) illustrates the essential features of this bell. The ordinary hammer, H, attached to the armature strikes against the subsidiary hammer, B, which is fixed immediately under the edge of the gong.

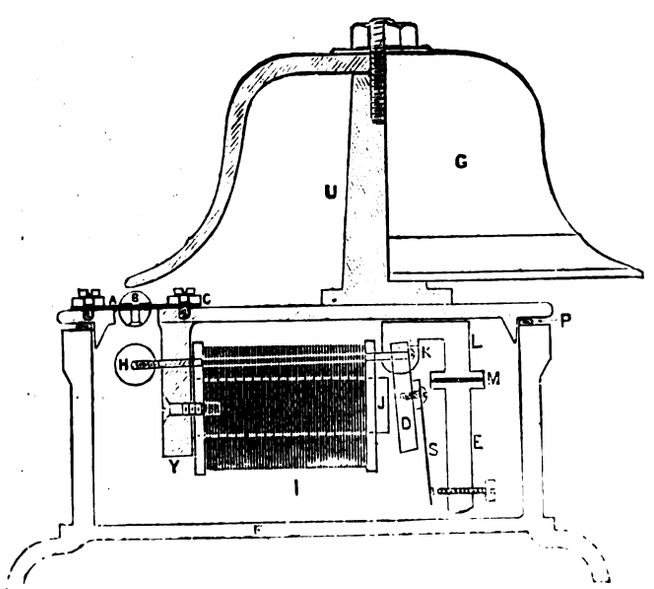


FIG. 2.—Diagram of the "Wigan" Mining Bell.

Alarm bells suitable for fire-alarms, factories, mines, and railways, etc., find place among the further contents of this sheet. These bells, we understand, are in considerable demand.

A separate circular gives particulars of the arrangements made by the company for the convenience of customers wishing to transact business by telephone. It seems they have provided their private branch telephone exchange with operators able to take down orders and messages in shorthand—a departure which will doubtless be widely appreciated.

## Simplex Price List, 1905.

In the seventh annual edition of the price-list issued by the Simplex Steel Conduit Company, Limited, of 80, Digbeth, Birmingham, and 20, Bucklersbury, London, E.C., there is much that merits praise. Thanks are expressed by the firm in the preface to those consulting and station engineers, architects, and electricians who have given them the benefit of their advice and experience in connection with the many improvements in Simplex fittings included in the catalogue. One of the secrets of the firm's great success is, no doubt, revealed by this action, since it proves their readiness to profit from the advice tendered by competent critics. Their policy is evidently to march with the times and to introduce improvements as the necessity arises or is suggested by practical experience. In this way the flexibility of their system has also been increased to meet new sets of conditions, until it may be said to satisfy all the requirements of to-day. So many interesting details are illustrated in the list that it is difficult to select for special notice the small number which limited space demands. However, we will do our best. The accompanying illustration (Fig. 1) shows an octagonal box. This box is supplied with an accurately fitting cast cover, with edges which overlap by $\frac{1}{8}$in., attached by three brass screws, and can be readily made watertight. It will take up to $\frac{7}{8}$in. screwed conduit fixed through clearing holes by lock-nuts, or $\frac{7}{8}$in. unscrewed conduit fixed by contact nipples. There are a variety of uses to which this box can be put—viz., as a bend, "T" piece, or inspection box of large capacity; for wiring down to lighting points through cement or patent floors with a centre hole for the down run, terminating in a bellmouth piece and block; as a X or Y inspection piece; or as a star box for lighting a number of points from a central position.

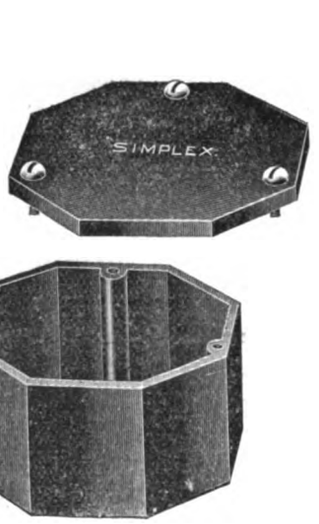


FIG. 1. Simplex Octagonal Box.

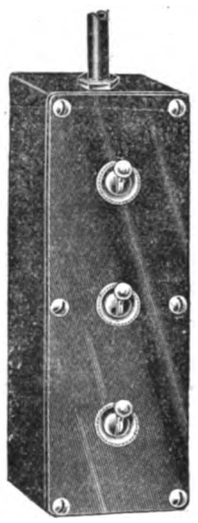

FIG. 2.—Simplex Multiple Switch Fitting.

It is often found necessary to group switches together. Our next illustration (Fig. 2) shows a convenient way of doing this in the case of three-way sunk switches. The switches may be mounted flush if preferred. The insulating cover of the light cast box is attached by brass screws, and can be readily removed for wiring or inspection purposes.

FIG. 3.—Simplex Insulating Bushes.

Conduit insulating bushes form one of the principal adjuncts to the Simplex system. These bushes are moulded under pressure to exact diameters in three patterns—namely, internal, external, and screwed—the first two of which are illustrated in Fig. 3 herewith. In all metal conduit systems the use of insulating bushes is necessary to protect the insulation of the wires and cables emerging from the free ends of the conduits.

Special attention is directed to the very substantial reduction in prices of all Simplex conduits and fittings, which is now rendered possible by the lowering of manufacturing costs, attained by the equipment of the company's works with the latest labour-saving machinery, coupled with their largely increased output.

For the rest, it remains to commend the convenient form of this list for the breast-pocket, its excellent binding and compilation.

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## FORTHCOMING EVENTS.

FRIDAY, JAN. 20.

**Institution of Mechanical Engineers.**—At 8 p.m., "Some Impressions of American Workshops," by Mr. A. J. Gimson; "Waterworks Pumping Engines in the United States and Canada," by Mr. John Barr; "Some Features in the Design and Construction of American Planing Machines," by Mr. A. Kenrick, jun.; "Engines at the Power Stations and at the St. Louis Exhibition," by Mr. Alfred Saxon.

**Royal Institution.**—At 9 p.m., "New Low-Temperature Phenomena," by Sir J. Dewar.

**North-East Coast Institution of Shipbuilders and Engineers.**—At Newcastle, general meeting.

**Electro-Harmonic Society.**—At 8 p.m., smoking concert.

SATURDAY, JAN. 21.

**Glasgow Technical College Scientific Society.**—At 7.30 p.m., "Notes on Tool-Room Organisation and Practice," by Mr. G. Blair.

TUESDAY, JAN. 24.

**Society of Arts.**—At 8 p.m., "British Commercial Prospects in the Far East," by Mr. B. Brenan.

**Institution of Engineers and Shipbuilders in Scotland.**—At 8 p.m., general meeting.

**Institution of Civil Engineers.**—At 8 p.m., "Notes on the Working of the Shone System of Sewerage at Karachi," by Mr. J. F. Brunton; and "The Sewerage of Douglas, Isle of Man," by Messrs. E. H. Stevenson and E. K. Burstal.

WEDNESDAY, JAN. 25.

**Institution of Electrical Engineers (Birmingham Local Section).** At 7.30 p.m., "The American Tour of the Institution of Electrical Engineers," by Mr. D. K. Morris.

**Society of Arts.**—At 8 p.m., "London Electric Railways," by the Hon. R. P. Porter.

THURSDAY, JAN. 26.

**Institution of Electrical Engineers.**—At 8 p.m., conclusion of discussion on "Fuel Economy in Steam-Power Plants," by Messrs W. H. Booth and J. B. C. Kershaw.

FRIDAY, JAN. 27.

**Municipal and County Club.**—House dinner.

**Physical Society.**—At 5 p.m., "Action of a Magnetic Field on the Discharge through a Gas," by Dr. R. S. Willows; "Action of Radium on the Electric Spark," by Dr. Willows and Mr. J. Peck; "The Slow Stretch in Indiarubber, Glass, and Metal Wires when subjected to a Constant Pull," by Mr. J. Phillips; "Determination of Young's Modulus for Glass," by Mr. C. A. Bell; and "Some Methods for Studying the Viscosity of Solids," by Dr. Boris Weinberg.

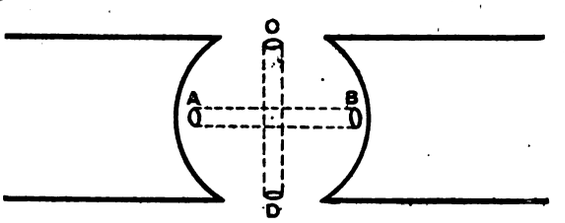
## DESCRIPTION OF SOME PLANT INSPECTED DURING A RECENT VISIT TO THE STATES.*

BY H. L. RISELEY.

In response to your committee's invitation to submit a paper to the local section on my general impressions during a recent trip over to the other side, it appears to me that so many papers are being read, and so much has already appeared in the technical Press as regards power stations, traction, and other kindred subjects, that it would be superfluous to present anything on similar lines. It occurred to me that it would be of more general interest if I were to give a description of such apparatus as appeared unique or different from our standard practice, and which came under my observation. By the great courtesy of the various manufacturers, I managed to gather a good deal of information as regards single-phase traction motors—a subject which I wish to deal with this evening.

*General Principles of the Single-Phase Railway Motor.*—Of course, it is well understood that if the current in both the field and armature of a direct-current series motor is reversed, the direction of rotation of the armature will remain unchanged. If the current was only reversed once an hour, or once a minute, we should not find any difference in the operation of the motor, and with more frequent reversals of the current the same principles should apply. With a direct current rapidly reversed an effect similar to that produced by an alternating current is obtained, and therefore it is only natural to expect that alternating current applied to a direct-current series motor should produce continuous rotation in its armature. However, there are certain phenomena peculiar to alternating currents which have made the operation of the single-phase motor a difficult problem. One of these is the loss which occurs in any solid iron core if the magnetism is rapidly changed in strength, or reversed in direction. This is greatly reduced if the iron core is made laminated. A more serious difficulty, due to the alternating magnetism, is the transformer action which occurs between armature and field.

Suppose C D be an armature coil in a two-pole machine at position of commutation. Owing to the passage of alternating magnetism from one pole to another, there will be a voltage induced in each of the armature coils by transformer action entirely independent of their speed of rotation. This voltage will be different in the different coils, depending on their position, and will be maximum in the coil C D, which is at right angles to the flux, and zero at A B. As each commutator bar passes under a




brush, an armature coil is momentarily short-circuited. The armature coils are thus short-circuited consecutively in the positions where the greatest E.M.F. due to transformer action is induced in them. The result is an excessive current in each coil at the moment it is commutated. Means to neutralise this effect is taken auxiliary field windings, arranged between the poles. Other things being constant, the value of the induced E.M.F. will be proportional to the frequency of the alternating current supplied, and therefore the alternating-current motor is most easily designed for low frequencies.

THE GENERAL ELECTRIC COMPANY'S COMPENSATED MOTOR EQUIPMENT.

This apparatus was in commercial use on the Ballston division of the Schenectady Railway, and the details of the equipment are as under: total length of line, 15·5 miles; inside city length of line, 3·9 miles; interurban portion of line, 11·6 miles; weight of rail (double T), 75lb.; maximum gradient, 1·8 per 100; maximum curvature, 4·25deg.; spacing between poles, 100ft.; size of trolley wire, alternating-current and direct-current, 000; alternating-current trolley suspended from ⅜in. steel catenary; voltage on trolley, 2,200 alternating current, 25 cycles; maximum speed, alternating-current and direct-current, 43 miles; wheel base of car, 6ft.; each motor 50 h.p., 200 volts alternating current, 300 volts direct current; motors connected permanently, two in series; trolleys per car (two alternating-current and two direct-current); average speed per hour (not including stops), 32 miles; volt-ampere hours per ton-mile, 4,350 direct current, 6,330 alternating current.

The purpose for which this apparatus has been designed is (as is well known) that with a direct-current voltage of 600 volts a suburban system is a commercial possibility, but when an extended and heavier service is needed the cost of copper required at 600 volts becomes a serious item, and the position from a commercial point of view assumes a different aspect; consequently there has been felt a need for a higher trolley voltage. The use of alternating current for the trolley would allow a higher voltage than is possible with direct current, as the voltage can be reduced on the car by a transformer to the potential required by the motors. The general practice of large power companies has been to generate at a high voltage and to transmit to sub-stations, and there to change the alternating current to direct current for use on railways by means of rotary converters or other similar commutating devices. Obviously it would be of great advantage if the railway motors could be operated from the high-voltage trolley, thus saving all the expensive intermediate transforming apparatus. The proposed scheme offers the double advantage that it can be operated on systems where direct current is already installed, and alternating current can be easily adopted for future extensions. The single-phase alternating-current motor offers several advantages over the three-phase motor, due to the limitations of the latter. The alternating-current single-phase commutator motor, with its inherent fitness for heavy traction work, has attracted the attention of engineers all over the world for some considerable time past.

*Motor.*—The motor has the general appearance of the usual direct-current traction motor. It has compensated field windings in order to neutralise the heavy reaction of the armature. Both the compensated motors and control are adapted for operation on the 2,000-volt alternating between cities and the standard 600-volt direct current inside the city line. The compensated motor is essentially a variable-speed motor, differing in this respect from the three-phase induction motor, whose constant speed features proved such a drawback to its successful adoption in railway work. The speed torque of the compensated motor is very similar to that of the direct-current series motor, while its commutating qualities and method of control are equally satisfactory. The alternating-current compensated motor consists of an annular laminated field with distributed windings similar to that of an induction motor, and an armature provided with a commutator similar in general construction to a direct-current railway motor armature. These motors are wound for 200 volts, and are connected permanently two in series, being fed from the 400 volts secondary of an 80-kw. air-

*Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, Jan. 16.

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blast transformer carried on the car. The distributed character of the field windings fully compensates for the armature reaction, so that the power factors are relatively high throughout the range of operation. A set of motor characteristics (Figs. 1, 2, 3, and 4) are shown in accompanying diagrams for both alternating-current and direct-current running. It will be noticed that the speed torque characteristics for alternating-current running are equal to direct-current in meeting the requirements of railway work. Unlike the three-phase induction motor, with its practically constant speed characteristic, the compensated alternating-current motor varies its speed with its load, and is better adapted to operate traffic over an irregular profile. The commutation is equally satisfactory whether running alternating current or direct current, and this good commutation has been obtained by careful design, without resort to high-resistance leads or other devices likely to give trouble in case of heavy and long-sustained overloads. The following

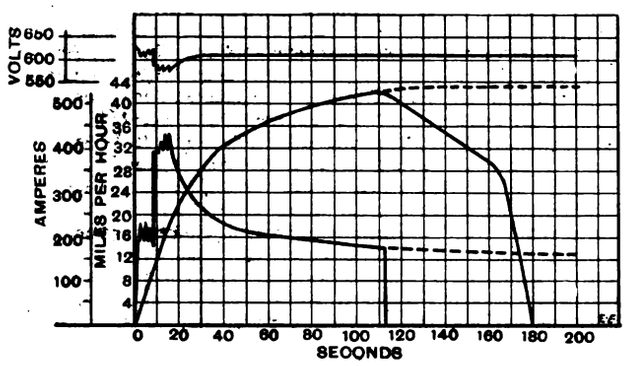


FIG. 1.—Speed Time Curve, D.C. Running. Four G E A 604 Compensated Railway Motors. Total weight of Car, 31·55 tons. Length of run, 1·6 miles. Gear ratio, 3·74. Diameter of wheels, 34in.

figures show the comparative alternating-current and direct-current resistance of trolley and track per mile :

| | D.C. resistance. | A.C. resistance. 25 cycles. | Ratio A.C./D.C. |
|---|---|---|---|
| Two trolleys in series ..... | ·318 ..... | ·417 ..... | 1·31 |
| One trolley and double track | ·167 ..... | ·259 ..... | 1·55 |
| Two trolleys and double track | ·088 ..... | ·155 ..... | 1·76 |
| Double track alone ..... | ·0174 ..... | ·114 ..... | 6·55 |

*Track and Line.*—The special features noticeable (as far as it was possible to observe) were that the alternating-current trolley wire was suspended from ⅜in. steel catenary, the wire being clipped to the catenary midway between poles, and the catenary in turn being hung over very heavy porcelain insulators on wooden cross-arms, the whole forming a construction of great flexibility, with the additional advantage of providing excellent insulation with standard porcelain insulators, and thus eliminating span wires

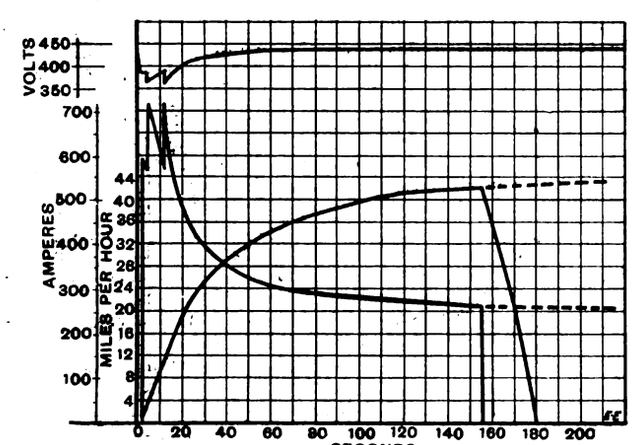


FIG. 2.—Speed Time Curve, A.C. Running. Four G E A 604 Compensated Railway Motors. Total weight of Car, 31·55 tons. Length of run, 1·6 miles. Gear ratio, 3·74. Diameter of wheels, 34in.

adjacent to the trolley wire, thereby preventing the pole catching in the event of the trolley jumping the wire. With alternating current using a track return there is an inductive drop in the wire and rails, with an additional loss in the latter due to eddy currents and hysteresis. Of course, the resistance of the alternating-current trolley wire is somewhat reduced by the steel catenary parallel with it. The track is cross bonded every 1,500ft.

*Sub-Station.*—The present sub-station operating the Ballston line is operated from the Hudson River Power Company's station, but owing to the fact that this company generates at 40 cycles, it became necessary to instal a frequency-changing device, an inverted converter being used, obtaining direct current straight from the direct-current 'bus bars of the sub-station. The sub-station feeds direct into trolley wire at 2,200 volts, with no outside transforming sub-stations. (The sub-station is shown in the attached diagram, both an intermediate and terminal sub-station feed from a single-phase source of power being indicated ; Figs. 6 and 7.) When it is desired to instal and make use of a three-phase generator to take care of the operation of rotary converters, induction motors, etc., the preferred arrangement to balance the load at each sub-station is to instal three-phase two-phase transformers connected two-phase on the secondary side, and feeding separate circuits from the two-phase. This is also shown in attached sketch. In the case of the Ballston line there was no difficulty in running the alternating equipments over the direct-current, this being accomplished by means of a standard direct-current series-parallel

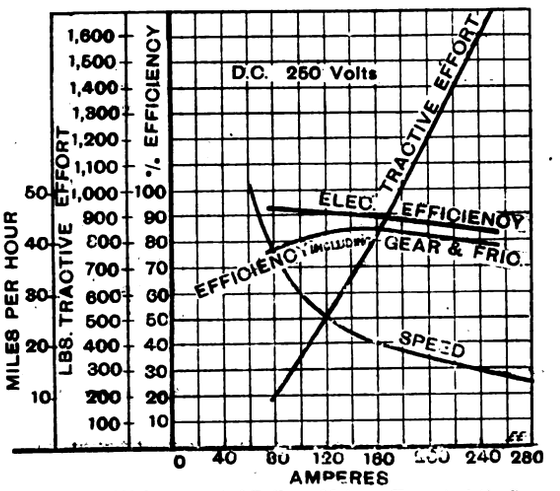


FIG. 3.—G E A 604 Compensated Railway Motor. Characteristic Curves. Gear ratio, 71 19=3·74. Diameter of wheels, 34in

controller used in connection with a commutating switch to change field connections, cut out step-down transformer, change line fuses, etc. The time required to operate the commutating switch is only a few seconds, and can be done while the car is travelling at full speed, as will be seen from the diagram (Fig. 5). The commutating switch is interlocked with two main oil switches, one being in the high-tension alternating current and the other in the direct-current, this interlocking being so arranged that only one switch can be closed at a time, and the commutating switch can only be thrown over when the oil switches are in the off position. Owing to the fact that the alternating-current trolley wire is off the centre while the direct-current is directly central, it has been necessary to provide a double set of poles, one for alternating current and the other for direct current, hence the necessity of interlocking the oil switches and commutating switch to prevent trouble in the case of both trolley poles being up at the same time.

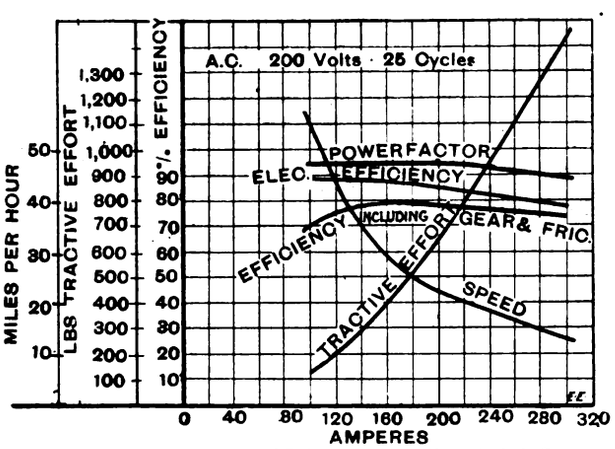


FIG. 4.—G E A 604 Compensated Railway Motor. Characteristic Curves. Gear ratio, 71/19=3·74. Diameter of wheels, 34in.

*Transformer.*—The 80-kw. transformer is air-cooled, forced draught being obtained by the motion of the car itself. The transformer is suspended below the car floor, and all primary leading-in wires are carried in brass tubes, which are well earthed. Car lighting and heating is effected from the direct-current trolley in the standard manner, and from the alternating-current trolley from the secondary of the transformer. The base of alternating-current trolley standard is treated with vacuum compound, and further insulated from the car body by composition insulators. The air-compressor for brakes and whistle is operated by a compensated motor, which operates from the alternating-current and direct-current trolley wires.

### WESTINGHOUSE SINGLE-PHASE RAILWAY MOTOR.

The Westinghouse motor does not differ materially in appearance from the G.E. motor, only the method of operating is

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entirely different, for, whereas the G.E. use a resistance for regulating, the Westinghouse use an auto-transformer. Even in direct-current railway equipment the method by which speed regulation is obtained on series-wound motors is clumsy and inefficient. With series-parallel control it possesses but two

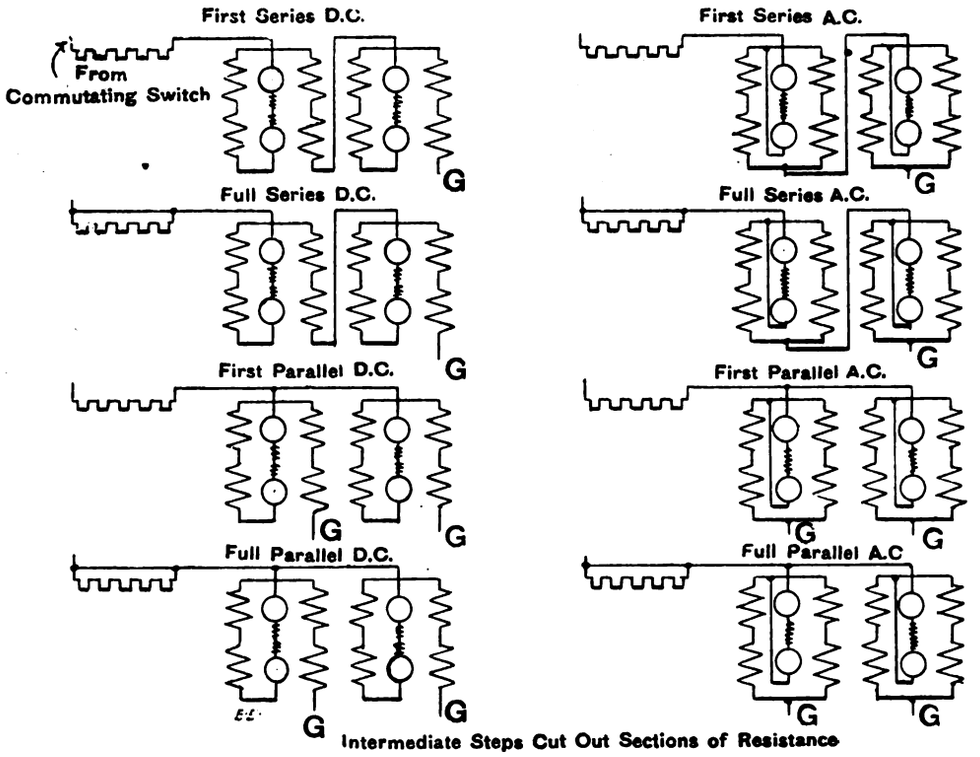


FIG. 5.

economical running speeds—*i.e.*, with motors in series and motors in parallel with no resistance in circuit. Any other speed of the car is only secured at an immense sacrifice of efficiency, involving a wasteful absorption of energy in the controlling resistance. At present there is no standard con-

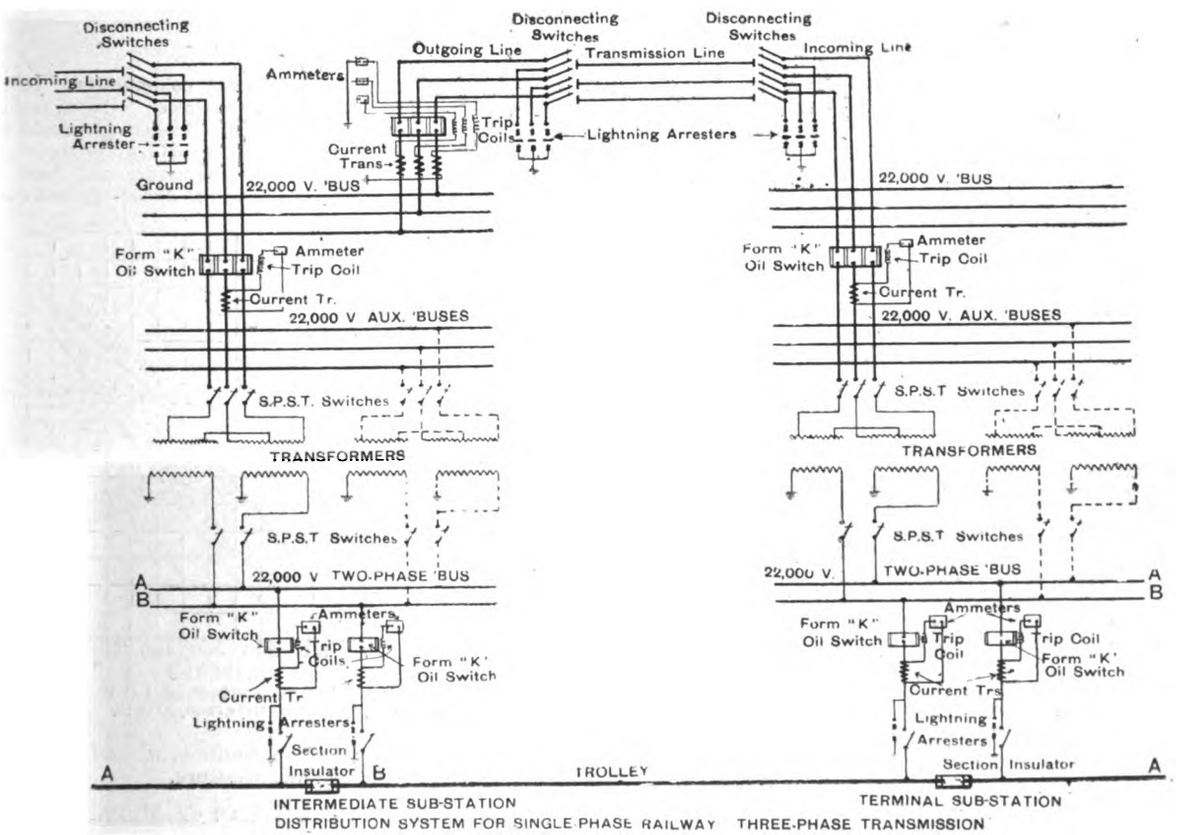


FIG. 6.

trolling device which will permit running on a resistance point any length of time, it being impossible to equip a car with sufficient resistance capacity for continuous operation. The Westinghouse alternating-current single-phase motor apparently overcomes all these difficulties. Its important points are described below.

*Field.*—A laminated core built up of circular punchings of soft steel bolted together is rigidly held within a cylindrical frame of cast steel. A large opening over the commutator and hand-holes in the end covers and bottom of frame provide easy access to the commutator and brushes, and permit inspection of the field and armature. The coils are wound with copper strip bent on edge and insulated. The field coils are connected permanently in series.

*Armature.*—A drum type core with open slots is wound with machine-formed coils of copper strip connected in multiple. The coils are held in place by a retaining wedge of hard fibre, which fits in grooves punched in the armature teeth. There are no band wires over the core. The motor is wound for 225 volts and a frequency of 25 cycles or less. At normal voltage and full load the speed is 700 revolutions per minute. Characteristic curves attached (Fig. 8).

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*Main Transformer.*—An auto-transformer is provided to reduce the trolley potential to that desired at the motors. It is of the shell type, with single coil, and of standard construction.

*Lighting Transformer.*—The lighting transformer is also of standard type, and may be of any suitable size. Current for car heaters may also be taken from the secondary of this transformer.

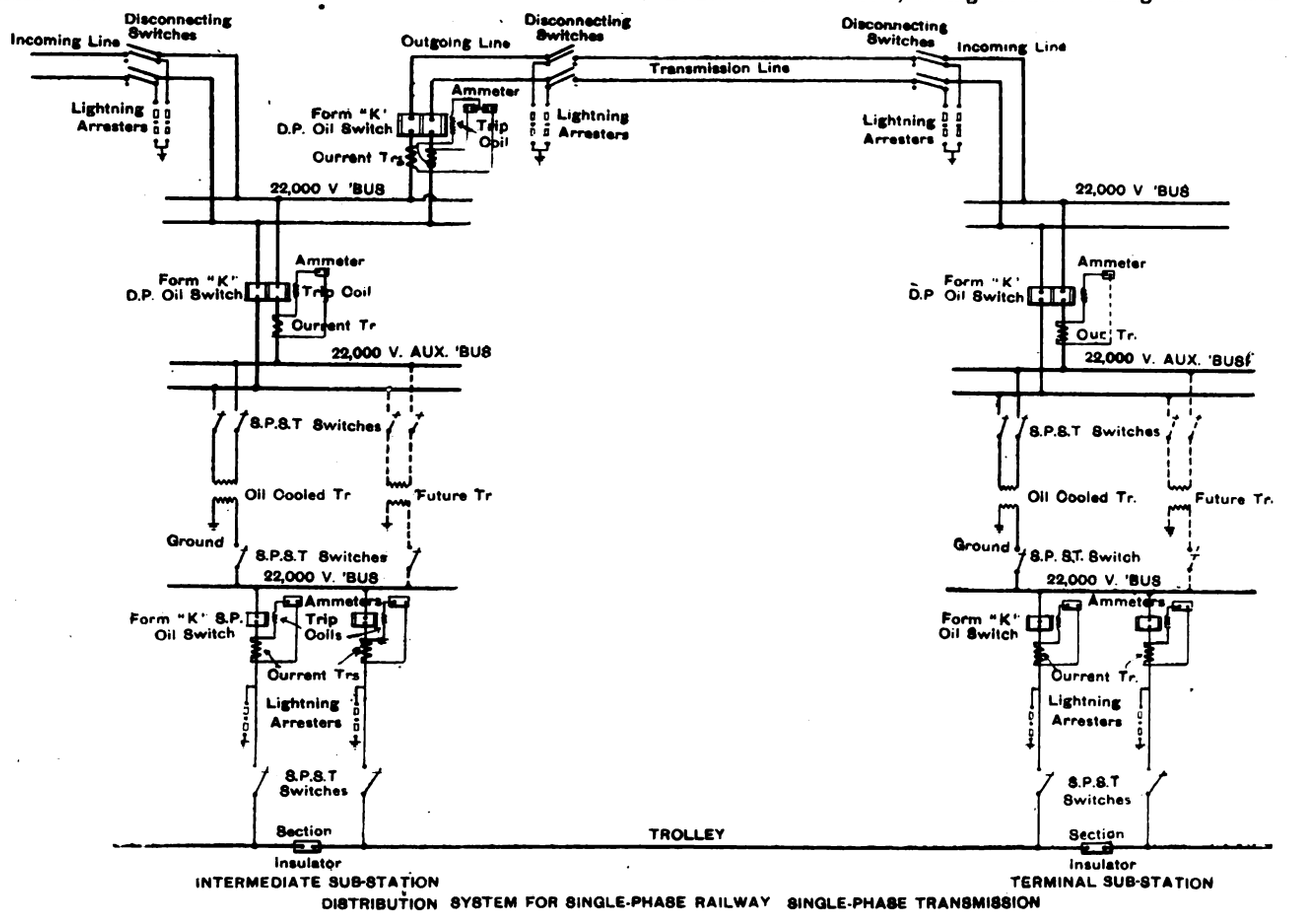


FIG. 7.

*Induction Regulator.*—Speed control is obtained by the induction regulator, without the interposition of any serious resistance. The regulator consists of two coils shown in diagram (Fig. 7) wound on two separate cores and so mounted that their relative angular position may be varied at will. The primary coil is connected between the trolley and the motors. One end of the secondary coil is connected to auto-transformer, A the other joins the primary at the motors. The voltage developed in the secondary coil varies with change of angular position, and may be either added to or subtracted from that of the auto-transformer. This method provides a voltage range of double that of the regulator, and consequently permits the use of a smaller size than would otherwise be possible. The regulator is operated by an air-motor connected to the shaft by a worm gear, and controlled by magnet valves.

*Switches.*—The main and reversing switches are of the drum type, operated by pneumatic cylinders, and controlled by magnet valves.

*Arrangement of Apparatus and Car Wiring.*—The induction regulator, main and reversing switches, and car circuit breaker are all operated by magnet valves, controlled from either of the master controllers. These magnet valves are actuated by a low-voltage current from a small battery. For the multiple control of a train, it is therefore only necessary to carry this low-voltage battery circuit from car to car. Seven-point plugs and sockets provide for making these connections. The four motors are arranged in pairs, each consisting of two armatures in series and two fields in series. The two pairs are connected in parallel. The equipment is designed for operation at a trolley potential from 1,000 to 1,200 volts, reduced by the auto-transformer on the car to 300 volts. The presence of the auto-transformer and induction regulator on the car offers a safeguard against damage to the motors by lightning or to other disturbances on the line. Motors of this type are operated on a direct-current line. This involves no change in the motors or line construction, but necessitates a modification of the controlling apparatus.

*General Remarks.*—The general resemblance of the alternating-current motor to the direct-current series motor, both in appearance and methods of operation, also in many details, is really surprising. The frame of the alternating-current railway motor, like that of the direct-current motor, is of cast steel, but the entire magnetic part of the field (poles and yoke) is laminated. This, of course, differs from the direct-current motor, where the poles alone are laminated, and the cast-steel frame also acts as the magnetic yoke. The poles of the alternating-current motor are shorter than those of the direct-current motor, and carry only a very few turns of heavy strip winding. The armature is in all essentials similar to that of the direct-current motor, having much the same general dimensions, and being fitted with the same commutator. Instead, however, of only two brush arms, the lower voltage, and consequently larger current motors of the alternating-current type, require one set of carbon brushes per pole in order to avoid excessive commutating current. The armature and field coils are connected in series precisely as in the direct-current motor,

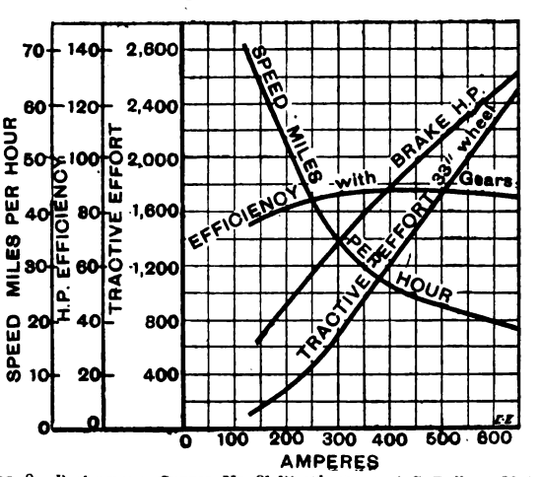


FIG. 8.—Performance Curves, No. 91 Westinghouse A.C. Railway Motor, 200 volts, 3,000 alts. Gear ratio, 20 to 62.

but there is an auxiliary field in addition, which is also placed in series with the main field and armature.

### WESTINGHOUSE UNIT SWITCH SYSTEM OF MULTIPLE CONTROL.

The above system consists of a controller operated by the motorman, with connecting leads to various air-switches on each motorcar. A unit switch-control equipment comprises: unit switch group, reverse switch, controllers, train line, diverters, limit and line relay switches, small storage battery, air connections. The storage battery is the independent source of current for the operation of air switches. Their control is secured by the movement of the controller, which completes

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the circuits to the various magnets' valves on each motorcar, which in turn secure the operation of corresponding air switches. The various resistance and motor changes are thus simply and positively attained. The air supply is common to the brake system, and its use so slight as to be negligible. A separate air reservoir is installed, thus obtaining a continuance of air supply for control operation in case of the failure of the air-breaker. The contacts are of peculiar construction, and are closed with a rocking and wiping motion, which keeps the surfaces smooth and bright. The magnet valves which control the several unit switches are so interconnected by simple mechanical interlock switches that the closing of one switch energises the magnet of the adjacent switch. The automatic progressive action thus provided is regulated by a "limit switch," so

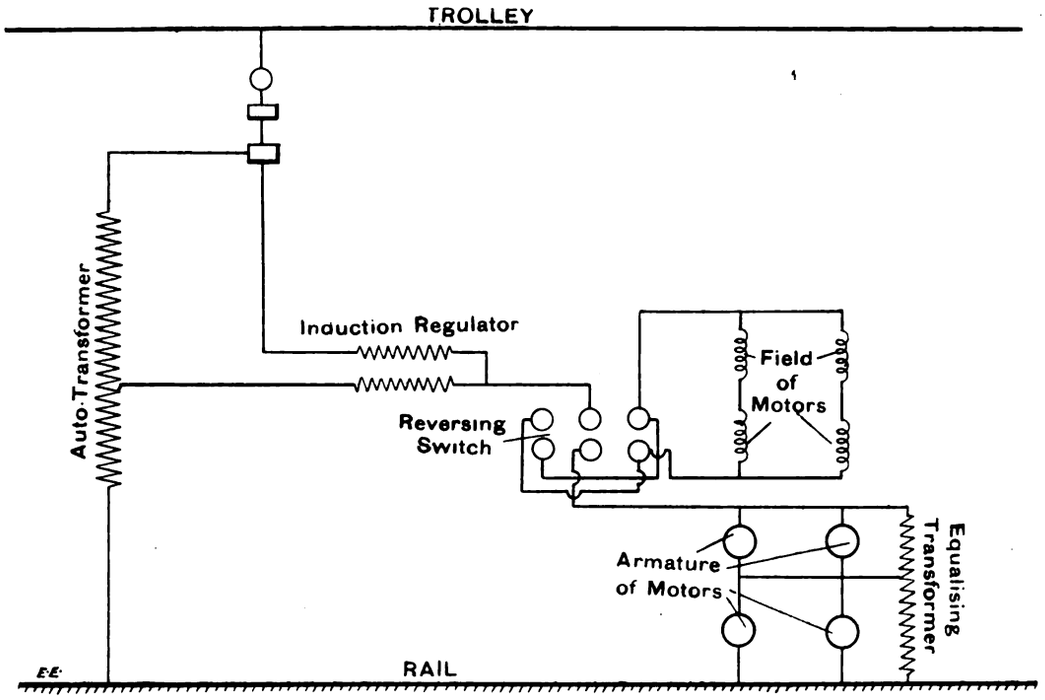


FIG. 9.

compressor. The certainty of positive contact, which is of such great importance in the continued handling of heavy currents, is obviously thus independent of a fluctuating line voltage. The expenditure of energy for the closing of switches, although small, continues only during their movement. The use of 14 volts for the control operating voltage secures the greatest

adjusted that the various switches are successively closed to afford uniform acceleration with a constant motor current. The rate of acceleration is determined by the adjustment of the limit switch, which consists of a small switch in the control circuit governing the progressive movement of the unit switches, and is actuated by an electromagnet in series

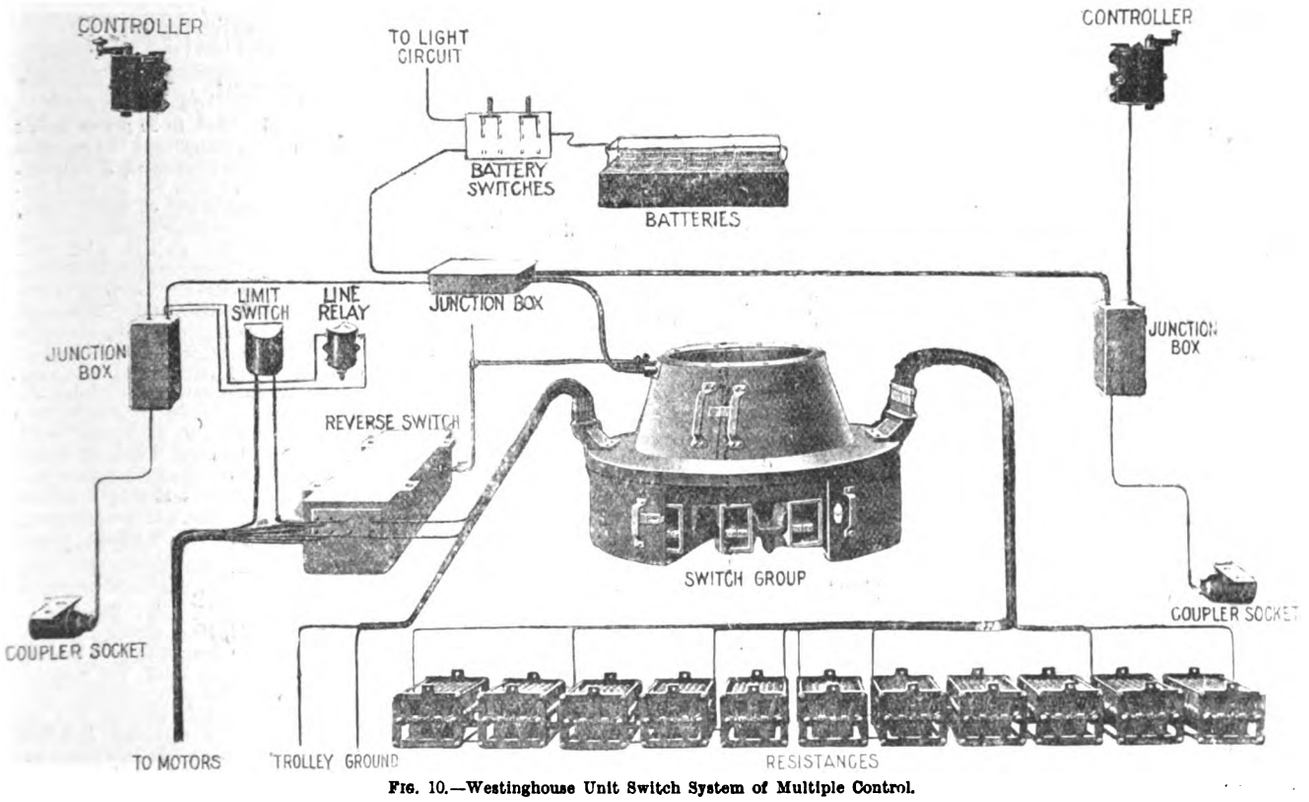


FIG. 10.—Westinghouse Unit Switch System of Multiple Control.

freedom from deteriorating contacts, short-circuits, and burn out of coils or wiring.

*Unit Switch Group.*—A number of independent switches are grouped together radially about a central air reservoir and operated by small pneumatic cylinders, the valves of which are controlled by electromagnets. This compact arrangement makes possible the use of a single magnetic blow-out coil for the entire group. Each switch, in fact, becomes a circuit

with the motor circuit, so that the switch is opened and the progressive action of the unit switches arrested whenever the motor current reaches a predetermined amount for which the limit switch has been adjusted. As soon as the motor current falls below this amount the switch closes, and the progressive action of the unit switches is continued. This arrangement ensures practically constant current per motor during the advance of the unit switches.

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*Line Relay.*—This apparatus is used to cut off the current from the line should the supply fail at any time, and is actuated by an electromagnet connected across in shunt across the supply circuit, so that the relay circuit is held closed unless the current supply is interrupted.

*General.*—The Westinghouse Company claims the following advantages for the above system: Freedom from failure due to crossed circuits or burn-outs; absence of trouble with control circuit contacts; simplicity of circuits to secure automatic current input; light weight and small space; ease of installation; ease of inspection; certainty of efficient contact on unit and reversing switches; great strength of blow-out; regularity of current input; economy of operation; absence of welding of contacts; great protection from abuse and neglect.

# LEGAL INTELLIGENCE.

## WEYBRIDGE ELECTRIC SUPPLY COMPANY.

In the Chancery Division on Friday last, before Mr. Justice Joyce, an application was made by the Weybridge Urban Electric Supply Company, who have a station at Weybridge, to stay so much of an order obtained against them as applied to the lighting of Walton from the generating station at Weybridge. The matter has been the subject of considerable litigation recently.

**Mr. Younger,** for the company, stated that the injunction obtained against the company on Sept. 22 had been suspended, so that the company might approach the Attorney-General.

**His Lordship:** I object to your saying this.

**Mr. Younger:** I will put it in any form you like. Proceeding, he said his company did approach the Attorney-General, but he was content to leave the matter in his lordship's hands. They had presented a Bill to Parliament authorising them to supply Walton from their Weybridge station. That Bill was now pending. The proposal he made to his lordship in the interests of the company, and of the consumers at Walton, was that part of the injunction which only related to the actual supply by means of the existing mains—leaving out of account the breaking-up of the roads or anything of that sort—should be suspended until the Bill which was now pending in Parliament had been disposed of either one way or the other. The actual supply at Weybridge had been going on for 18 months, and the company had erected in Walton a temporary station, which was completed.

**Mr. Hughes,** on behalf of the Urban Council, said at present there was a decision against the company, but what they were doing was contrary to the law—it was a clear breach of the law—and what the company said was, "allow us to go on committing a breach of the law until the law is altered."

The Judge granted a stay of the injunction previously made until any further order may have been made.

Mr. Hughes asked leave to appeal, which the Judge, after considerable hesitation, allowed.

## SOUTH LANCASHIRE ELECTRIC TRAMWAYS.

At the Chancery Court, Liverpool, last week, before Vice-Chancellor Sir S. Hall, K.C., the affairs of the South Lancashire Traction Company came up again for consideration in the form of two motions—one by Mr. Nicholas Earle, solicitor, Manchester, seeking to restrain the company from acting on resolutions passed at a meeting held on Dec. 30; and the other by Mr. Arthur Stanley, asking the Court to give effect to the resolutions. Both applicants were debenture holders in the company.

Counsel for Mr. Earle stated that some time ago a summons came before the Court asking it to sanction the terms of a Bill in Parliament and the raising of a sum of money for expenses, and that application failed. Nevertheless, a meeting was summoned for the purpose of considering and, if thought fit, of supporting the Bill of the South Lancashire Tramways, Limited, to extend the time for the compulsory purchase of lands and the rearrangement of capital in that company, and for the purchase of the undertaking of the electric traction company. The meeting was wholly irregular, and his client purposely refrained from attending, and the resolutions passed at it ought not to have any effect.

Counsel for two other debenture holders explained that in order to comply with the Standing Orders of Parliament notice had to be given in the local papers and meetings had to be called, and it was necessary to hold the meeting in question in order to be in time to present the Bill next session. If the compulsory powers held by the company were allowed to lapse it would seriously diminish the value of the shares held by the electric traction company, with a consequent loss to the debenture holders, and an enormous majority of the latter were in favour of the Bill.

**Mr. Maberly,** on behalf of Mr. Stanley, said that in such a case as this the Court could refuse an application at one time and grant it at another, according to its views of the circumstances. In this case the circumstances had changed, and the matter submitted to his Honour was not *res judicata*. It was anticipated that if the Bill were passed, a substantial value would be given to the shares held by the electric company.

It was stated in further argument that the holders of £502,000 out of £597,000 debenture stock were in favour of the Bill.

**His Honour** granted Mr. Stanley's motion, the costs to be paid by the trustees.

## MUTILATED TRAMCAR TICKETS.

At Sunderland on Friday last Andrew Bell was charged with wilfully obstructing a tramways inspector, and with refusing to produce his ticket when asked to do so.

**Mr. F. M. Bowey,** town clerk, stated that defendant and two other men boarded a car going from High-street to Grangetown. Defendant paid the three fares, and received three tickets properly punched from the conductor. A few minutes later Inspector Gray boarded the car to examine the tickets. When he asked defendant for his ticket, he produced three tickets all in pieces and massed together. The inspector could not ascertain the number, or whether the tickets were all there, the only thing he could see being that one ticket was complete though in pieces. He told defendant that he could not find the numbers of the other two tickets, and the defendant replied that it was the inspector's duty to look for the numbers and not his. He further stated that he had torn the tickets up intentionally in order to have a test case made of it. He gave his name and address when requested to do so. As soon as the inspector went upstairs the conductor of the car saw Bell stoop down and pick several pieces of tickets from the floor.

Corroborative evidence was given by the inspector and the conductor.

**Defendant** said the tickets were mutilated, but not destroyed, and the pieces—perhaps eight in all—were all together. The by-law stated that tickets must not be destroyed, and his were not destroyed.

**Mr. Bowey:** We are not charging him with destroying his ticket, but with obstruction.

**Harry Gordon,** a clerk, gave evidence in support of the defendant, and said the tickets were probably in 12 pieces. If the inspector had looked properly he could have found the other numbers. The tickets were mutilated, but not destroyed.

**Robert Wm. Haggie** also gave evidence, and said the tickets would be torn into 24 pieces, or probably less. The inspector could have found the numbers if he had liked.

The Bench said they found the case proved, and inflicted a fine of 20s., including costs.

## TRESPASS ON THE LANCS. AND YORKS RAILWAY.

A case of trespass on the electrified section of the Lancashire and Yorkshire Railway was heard before the Southport magistrates, the defendants being two men named Jones and Eannon.

A pointsman saw the defendants near the "live" rail. Eannon challenged Jones "to go and sit on the 'live' rail," but Jones did not accept. Both defendants were under the influence of drink, and the pointsman telephoned for assistance. Three porters were then sent up the line, and when they requested defendants to get away, Eannon again requested them to show him the "live" rail, stating that he was "prepared to meet his Maker." The defendants several times lurched into dangerous proximity to the "live" rail, but were eventually removed from the rails without mishap.

Both men were fined 20s. and costs.

# COMPANIES' MEETINGS AND REPORTS.

## EASTERN TELEGRAPH.

The report for the half-year ended Sept. 30, 1904, to be presented at an ordinary general meeting on the 25th inst., states that the revenue amounted to £589,386. 6s. 2d., from which are deducted £178,269. 13s. 7d. for the ordinary expenses and £41,847. 17s. 7d. for expenditure relating to maintenance of cables, depreciation of spare cable, sundry differences in exchange, and income tax payable abroad, leaving a balance of £369,268. 15s., to which is added £1,233. 13s. 10d. brought from the preceding half-year, making a total available balance of £370,502. 8s. 10d. After providing for income tax payable in England, interest on loan from Eastern and South African Telegraph Company, Limited, interest on mortgage debenture stock, and for two quarterly dividends on the preference stock, which in all absorb £97,870. 9s. 11d., there remains a balance of £272,631. 18s. 11d., out of which the directors have placed £12,000 to the reserve fund for maintenance ships, £125,000 to the general reserve fund, and allocated £100,000 to meet the two interim dividends of 1½ per cent. each on the ordinary stock, the balance of £35,631. 18s. 11d. being carried forward to the next account. Two of the directors, Lord Allerton and Sir Henry Charles Fischer, C.M.G., retire by rotation, but offer themselves for re-election, as also do the auditors, Messrs. Deloitte, Dever, Griffiths, and Co., and Messrs. Welton, Jones, and Co.

## DIRECT UNITED STATES CABLE.

The report for the half-year ended Dec. 31, 1904, states that the revenue, after deducting out-payments, amounted to £51,030, as compared with £47,815 for the corresponding period of 1903. The working and other expenses for the same period, including income tax, amounted to £22,108, leaving a balance of £28,921 as the net profit, making, with £2,168 brought forward, a total of £31,089. For the corresponding period of 1903 the working expenses and other payments amounted to £21,816. Interim dividends of 3s. per share for the quarter ended Sept. 30, 1904, and of 3s. per share for the quarter ended Dec. 31, 1904, amounting to £18,213, have been declared, and after setting aside £10,000 to the reserve fund account, the balance of £2,876 has been carried forward. The reserve fund account has been debited with £8,477 for cost of cable repairs, and after being credited with interest on the investments and amount set aside from revenue, now amounts to £472,964, taking the investments at cost price. The directors recommend a pension scheme for the staff of the company, to take the place of the existing system of endowment assurances.

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## NEW COMPANIES REGISTERED.

**General Electric de France, Limited.**—Capital, £10 000. Object: to acquire and carry on the business of Messrs. L. Espir and N. Gunz as dealers in electrical apparatus and appliances at 11bis, Rue de Maubeuge, Paris. Registered office: 67, Queen Victoria-street, E.C.

### Liens Registered.

**Minehead Electric Supply Company, Limited.**—Discharge registered Jan. 2 of debenture and mortgage as collateral security, dated April 24, 1903, for £700.

**Sir Henry S. Maxim Captive Flying Machine Company, Limited, Westminster.**—Lien registered Dec. 29 for £4,000 7 per cent. debentures, and, as collateral security, an assignment by way of mortgage for securing a like sum. Holder: Sir H. S. Maxim; the debentures being secured on all the property, present and future, the undertaking, goodwill, business, and uncalled capital for the time being, and the assignment on all moneys payable under agreements with the London Exhibitions, Limited, and the Crystal Palace Company.

## APPOINTMENTS VACANT.

**Switchboard Attendant**, Devonport electricity works. Wages, 30s. per week. Applications to the Borough Electrical Engineer. See advertisement in last issue.

**Manager**, London Motor Omnibus Company, Limited. Applications to the Secretary, 794, Salisbury House, London, E.C.

**Switchboard Attendant**, Stockton-on-Tees. Wages, 27s. 6d. per week advancing to 35s. per week. Applications to Mr. J. J. Smith, borough electrical engineer. See advertisement.

**Electrical Engineer**, Ashton-under-Lyne Union. Particulars from Mr. G. H. Parrington, clerk to the Guardians. See advertisement.

**Chief Assistant Electrical Engineer**, Battersea. Salary, £175 per annum.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Keighley.**—The Corporation invite tenders for tramcars. Tenders by Jan. 30.

**Halifax.**—The Corporation invite tenders for coal conveyors. Tenders by Jan. 31.

**Tourney.**—Tenders are required for the electric lighting of the waterworks. Tenders by Jan. 20.

**Saragossa (Spain).**—Tenders are invited for 32 candelabra for the municipal theatre. Tenders by Jan. 30.

**Oporto.**—The Municipal Authorities require tenders for lease of their electric tramways. Tenders by March 15.

**West Hartlepool.**—The Corporation require tenders for additional 250-kw. set, with the necessary switchboard, panel, etc.

**Ghent.**—The Municipality require tenders for 15 electric cranes for the harbour works. Provisional estimate, £1,200. Tenders by Feb. 20.

**Bucharest.**—The Government require tenders for the annual supplies to the Regie for lighting materials and accessories. Tenders by Feb. 7.

**Stockport.**—The Gas and Electricity Committee invite tenders for the supply of 10 complete feeder pillar boxes, with bases. Tenders by Feb. 1. See advertisement.

**Kirkcaldy.**—The Town Council invite tenders for the extension of about 500ft. in length of the present East Pier. Tenders to the Town Clerk by Feb. 4. See advertisement.

**Liria.**—The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

**Vienna.**—Tenders are required for telegraph and telephone materials. Particulars may be obtained from the K. K. Post Oeconomie-Verwaltung, Vienna. Tenders by Jan. 31.

**Grimsby.**—The Corporation invite tenders for (No. 30) motors; (31) water-purifying plant; and (32) 12 months' supply of stores. Tenders for 30 and 31 by Jan. 23, those for 32 by Feb. 1.

**Madrid.**—The Department of Agriculture, etc., invite tenders for installation and working for 60 years of an extension of the electric tramways in the north of the town. Tenders by Feb. 25.

**Stockport.**—The Tramways Committee invite tenders for the overhead equipment of about four miles of electric tramway, and also for copper rail bonds. Tenders by Feb. 6. See advertisement.

**Caen (France).**—The Prefect requires tenders for concession of a tramway from Ryes to Caen *via* Creully for goods and passengers. Particulars from the Prefect of Calvedos, Caen. Tenders by Feb. 1.

**Brussels.**—Tenders are required for erection of an electric station at the goods railway station at the port. Specification No. 391 is obtainable from the Belgian Government Railways. Tenders by Feb. 8.

**West Ham.**—The Council invite tenders for the supply of engine-room stores, cables, integrating wattmeters, double-pole house cut-out boxes, transformers, incandescent lamps, and coal. Tenders by Feb. 6. See advertisement.

**Pudsey.**—The Corporation invite tenders for underground electric mains, switchboard, etc. Specifications, etc., may be obtained on application to Messrs. Shepherd and Watney, consulting engineers, Greek-street-chambers, Leeds. Tenders to the Town Clerk by Jan. 20.

**Swindon.**—The Corporation invite tenders for the supply and erection of one 30ft. by 8ft. Lancashire boiler with down-take superheater, steam, exhaust, and feed piping, etc. Tenders to be delivered before 10 a.m. on Tuesday, Jan. 24, 1905, to Mr. Robt. Hilton, town clerk.

**London, N.**—The Metropolitan Asylums Board invite tenders for installation of fire-alarms at Northern Hospital, Winchmore Hill, N., in accordance with plan and specification prepared by Mr. W. T. Hatch, M.I.C.E., M.I.M.E., engineer-in-chief. Tenders by 10 a.m. on Jan. 24.

**Switzerland.**—M. R. Vontobel, of Winterthour, and M. Charles Probst, of Lucerne, have obtained a concession for the construction of a narrow-gauge electric railway from Meiringen to Gletsch. The total cost of the enterprise is estimated at £241,600; £19,600 is to be expended on rolling-stock.

**Drax (near Selby).**—Tenders are invited for electric light installation, also electric pump, etc., capable of delivering 500 gallons per hour, at Read's Grammar School. Apply to the headmaster, Mr. W. St. G. Drennan, at the School, who will supply all necessary particulars. Tenders to be delivered to Messrs. E. and T. Clark, solicitors, Snaith, R.S.O., clerk to the Governors, by noon on 28th inst.

**Johannesburg.**—The Council invite tenders for Vignoles rails, fishplates, angle steel guard-rails, bolts, nuts, coach screws, and dog-spikes. General conditions, specifications, and forms of tender may be seen at the offices of the Council's consulting engineers, Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster, S.W., and may be obtained on payment of five guineas. Tenders by Jan. 26.

**Shanghai.**—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Pook and Co., 63, Leadenhall-street, E.C. Tenders by March 31, 1905.

**Placencia.**—Tenders are required for the concession for 10 years of the lighting by electricity of the town. Adjudication of tenders will take place on Jan. 28, and tenderers, if not appearing in person, must be represented by a duly authorised agent. The conditions of concession are set out in the notice in the *Gaceta*, which may be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C., any day between the hours of 10 a.m. and 5 p.m. (Saturdays, 10 a.m. to 1 p.m.).

**Tredegar (Mon.).**—The Guardians of Bedwellty Union invite tenders for a complete electric light installation at their workhouse, Tredegar: (Section 1) steam dynamos, booster, battery, switchboard, and motors; (section 2) cables and wiring. The plans, specifications, and forms of tender will be issued shortly. Firms desiring to submit tenders are requested to apply in writing on or before 25th inst. to the consulting engineers to Guardians, Messrs. Herbert Lewis and Fletcher, Prudential-buildings, Cardiff. Mr. J. A. Shepard, clerk, Town Hall, Tredegar.

**Handsworth (near Birmingham).**—The Urban District Council invite tenders for the supply and delivery of the following in connection with the electric lighting undertaking: (Contract No. 10) power and lighting circuits and fittings in generating station; (11) pipework, feed pumps, economiser, etc.; (12) electricity meters. Tenders will only be considered for the whole of the work covered by each specification, and not for any part thereof. Copies of the specification, with the conditions of contract, etc., can be obtained from Mr. H. Ward, clerk. Tenders to the Clerk before noon on Feb. 2.

**Melbourne.**—Tenders will be received at the office of the Deputy Postmaster-General until noon on Feb. 7 for the supply and delivery of (1) 3,500 trunk-line multiple jacks, in strips of 20; (2) 1,320 yards of 64-wire wool-insulated switchboard cable. Specifications may be seen at the General Post Offices at Melbourne, Sydney, Brisbane, and Adelaide. Tenders, endorsed "Tender for ——," as the case may be, addressed to the Deputy Postmaster-General, Melbourne, may be deposited in the tender-box at the General Post Office, Melbourne, or, if sent by post, must be prepaid and registered. The deposit to be enclosed with the tender is 5 per cent. on the total amount.

**Johannesburg.**—The Municipal Council are prepared to receive tenders for 100 electric tramcars, two electric water-cars, one five-ton travelling crane, one electric car traverser, and various workshop tools, including erection at Johannesburg, to Specification No. 10 of their consulting engineers, Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W. Copies of the specification may be seen on and after Jan. 7 at the Council Offices, Johannesburg, and at the Consulting Engineers' Offices in London, and may be obtained on payment of five guineas, which will be returned on receipt of a bona fide tender. Duplicate copies of the specification may be bought for 10s. each (not returnable). Tenders must be addressed to Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W., and must be received by them not later than March 6. The Council will not be responsible for any expenses incurred in tendering.

**South Shields.**—The Corporation invite tenders for the execution of the works and the supply of plant in connection with the laying of proposed electric overhead tramways in the streets of the borough: (Part 1) permanent way and construction of track; (2) copper rail bonds, bonding of tramrails; (3) conduits, cables, and overhead equipment. Specification, etc., can be obtained from Mr. J. Moore Hayton, town clerk, on payment of £5. 5s. for each of Parts (1) and (3), and £2. 2s. for Part (2), which sum will be returned on receipt of a bona fide tender for each part. General and detailed plans of the proposed works can be seen as regards Part (1) at the office of Mr. S. E. Burgess,

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M.I.C.E., borough engineer, Chapter-row, and as regards Parts (2) and (3) at the office of Mr. J. H. Cawthra, M.I.E.E., the borough electrical engineer, West Holborn, South Shields. Tenders to the Town Clerk, Court-buildings, South Shields, by Feb. 20.

### RESULTS OF TENDERS.

**Norwich.**—The Town Council have accepted the tender of C. A. Parsons and Co., of Newcastle, at £6,400, for a 1,000-kw. steam turbine generator.

**Fulham.**—The Borough Council have accepted the tender of the General Electric Company, Queen Victoria-street, E.C., at £6,718, for the 1,000-kw. alternator.

**Leith.**—The Council at their meeting on Monday, after considerable debate, decided to place half of the order for the tramcars and equipment with the British Thomson-Houston Company and half with the Brush Company.

**Stockport.**—The Corporation Tramways Committee have accepted the tender of Walter Scott and Co., Leeds Steelworks, for rails, fishplates, and tiebars at nearly £7,000, for the reconstruction of the Hazel Grove and Edgeley tramway routes.

**Perth.**—The following tenders have been accepted by the Electricity Committee in connection with the reconstruction of the tramway system: for the engine and dynamo, the British Electric Plant Company, Alloa, at about £3,000; Cowan and Co., Salford, Manchester, for the switchboard, at about £1,100.

**Hull.**—The Public Libraries Committee have received the following tenders for the necessary electric light installation and fittings required at the Carnegie Library, West Park, Anlaby-road:

| | | | |
|---|---|---|---|
| W. L. Harrison, George-street, Hull (accepted) | £38 | 15 | 0 |
| Lancashire Electrical Engineering Company, Ashton-under-Lyne | 43 | 0 | 0 |
| Northern Electric Company, Grimsby | 49 | 0 | 0 |
| King and Co., South Church Side, Hull | 54 | 0 | 0 |
| H. Hyde, Spring Bank, Hull | 65 | 0 | 0 |
| Cox Walker, Darlington | 108 | 11 | 8 |

Note.—The price for fittings was not accepted.

## BUSINESS NOTES.

### TRACTION.

**Rothesay.**—It is reported that the extension of the tramway to Ettrick Bay is to be proceeded with immediately.

**Croydon.**—A confirmatory resolution in reference to the tramway extensions was adopted at last week's meeting of the Corporation.

**Colchester.**—At the special meeting called for the 11th inst. the Corporation approved the extension described in our last week's issue.

**Portsmouth.**—The Gosport Urban District Council have given their approval to the Portsmouth Street Tramways Company's Bill for additional lines.

**Newcastle.**—The city engineer has been instructed to prepare plans for the extensions to Sandyford Estate and Scotswood. Two top-covered cars are to be tried.

**Dalkeith.**—A syndicate project the construction of an electric tramway from Dalkeith to Lasswade, a distance of seven miles, if the local authorities are favourably disposed.

**Tranent (Scotland).**—At a public meeting it was unanimously decided to approve the proposal of the National Electric Construction Company to bring their Levenhall trams on to Tranent.

**Stockport.**—A meeting of the Tramways Committee was held to consider the tenders for the reconstruction of the Hazel Grove and Edgeley routes. Particulars appear in another column.

**Rawmarsh.**—The Urban District Council have agreed that if the promoters start construction by March 31, a reduction shall be made in the rent and consent will be given to an extension of time for completing the works.

**London County Council.**—The City Corporation have received resolutions from the Farringdon Within and Bread-street wardmotes in favour of bringing the cars over Blackfriars Bridge, and one from the wardmote of Walbrook against the proposal.

**Douglas.**—The Town Council considered on Wednesday a proposition to introduce 1d. fares all the year round in lieu of the 2d. fares now charged in the summer season. Ultimately it was decided to instruct the Tramways Committee to report on the advisability of introducing 1d. stages.

**Rhondda.**—A public meeting in connection with the omnibus Bill (including tramways) to be promoted in Parliament during the next session by the Urban District Council was held last week. After considerable discussion, in which a good deal of opposition was offered, the meeting was adjourned for a fortnight.

**Southampton.**—The proposal to appoint a general manager of the tramways has been referred to a joint conference of the Tramways and Electricity Committees, the opinion being expressed that if Mr. Street, the borough electrical engineer, were given an opportunity, he would discharge the additional duties of manager admirably.

**Coatbridge.**—At the monthly meeting of the Town Council a conversation took place with the British Electric Traction Company, as represented by Mr. Garcke, who stated that he would recommend the company to proceed with the construction of the tramway from Kirkwood-street to Woodside-street at an early date, though an extension of time for its completion will be necessary.

**Liverpool.**—The returns for the year ending Dec. 31 are as follows: car miles, 12,166,419; passengers carried, 116,642,663; receipts, £540,916; increase in traffic receipts, £16,407. The increase of receipts of 1903 over 1902 was £17,883, whilst 1902 over 1901 was £38,243. The biggest increase since the commencement of the electric system in one year was that of £57,645 in 1900 over 1899.

**Grimsby Light Railway.**—A special meeting of the Town Council was held on Monday to consider the plans of the proposed light railway which the Great Central Railway propose to lay down in connection with their Immingham Dock scheme. The application for sanction will come before the Light Railway Commissioners on Feb. 6. After considerable discussion it was decided to refer the matter to the Parliamentary Committee, which will meet at an early date.

**Electric Traction in Germany.**—According to the *Vossische Zeitung* numerous schemes are in contemplation for the construction of electric railways in Germany. These include lines Berlin Hamburg, Frankfort-Wiesbaden, Cologne-Dusseldorf, and Leipsic-Halle. Schemes for even longer distances are talked of, and it is claimed by the *Vossische Zeitung* that Germany will show herself to be the pioneer in electric railway construction apart from underground lines.—*Daily Telegraph.*

**Rochdale.**—A meeting of the Tramways Committee was held on Monday evening, when the chief item of interest was the question of Heywood running on the Corporation's lines with their steam trams from the borough boundary to Sudden. Heywood have struck out of the draft agreement certain clauses, the chief being that Heywood shall pay all rates and charges on the lines during the time they work them, and that they shall not at any time apply for running powers over this portion. It was decided by the committee not to agree to any of the alterations.

**Motor Tramcars.**—The *Morning Post* suggests that petrol motor tramcars should be run on existing tramlines where there are difficulties in the way of electrification. In view of the cost of electrification and the consequent opening of the streets, the London County Council is to be asked by the Shoreditch Borough Council to consider the possibility of adopting a system of automobile tramcars driven by petrol engines on the present lines north of the Thames, and to arrange with the North Metropolitan Tramway Company for the trial of an experimental motor tramcar.

**Leith.**—A requisition having been presented by four members of the Town Council to call a meeting to consider the action of the Tramways Committee in accepting an offer by the Brush Electrical Company for the supply of cars for the new electric system of tramways at £19,228, when a lower offer had been tendered, a special meeting was held on Monday. After various motions had been proposed and rejected, it was agreed to divide the order between the Brush Company and the British Thomson-Houston Company. Particulars will be found among our "Results of Tenders."

**New Tube Railways.**—The time for depositing in the Private Bill Office memorials alleging non-compliance with the Standing Orders of Parliament has expired. Memorials have been presented by the Marquis of Salisbury and Sir Walter Phillimore against the Great Northern, Piccadilly, and Brompton Railway (No. 2) Bill; and by Messrs. Pilkington Bros., Limited, Mr. Sydney Charles Lambert Messrs. George Wright and Co., Limited, and the Great Northern Piccadilly, and Brompton Railway Company against the Hammersmith City, and North-East London Railway Bill.

**North-Eastern Railway.**—At a meeting of the committee of the guarantors of the North-Eastern Passengers' Association held in Newcastle on Monday it was intimated that Sir George Gibb had written stating that the directors would be pleased to receive a deputation on 27th inst., and suggesting that the association should join with the corporate authorities and make one deputation. After some discussion it was resolved to adopt the suggestion, and several gentlemen were appointed to represent the different districts. Trials have been made of a new electric locomotive for goods traffic, and the results have been fairly satisfactory.

**North Metropolitan Tramways Co.**—Since the court of arbitration heard the evidence arising out of the claim for £105,000 by the North Metropolitan Tramways Company against the West Ham Corporation for the compulsory acquirement of the Swan-yard and Martin-street depôts, an arrangement has been come to between the parties on the following basis: no award to be made by the arbitrator, the Corporation to pay the tramways company £63,000 for the two depôts, the company to release the Corporation from all liability under the agreement dated Feb. 10, 1903, with regard to the Bow granaries, and immediate possession to be given of Swan-yard.

**Keighley.**—At the monthly meeting of the Town Council a councillor asked whether the Tramways and Electricity Committee intended to take the Council into their confidence and inform them as to how many passengers travelled on the cars month by month. In reply, it was stated that the information desired would be supplied regularly. Two new cars are being obtained, the manager having reported that it was practically impossible to work the whole system without them. All the existing cars are being used for the present service, and the two additional cars will be reserved for the new section, which will be opened in about a month. It is probable that the car-shed will have to be enlarged in the near future.

**Yarmouth.**—Negotiations with the Gorleston Tramway Company having failed, the Corporation have decided to apply to the Board of Trade for the appointment of an arbitrator. The December return shows an increase in receipts of £55 compared with last year. The aggregate report from April 1 shows an increase in receipts of £690. There have been 172 831 more passengers. The daily average receipts have increased by £2. 14s. 4d. The electrical engineer reported, after investigation, that the explanation of the excessive current consumed from the mains during the past five months by the trams was owing to the main meter reading off 10 per cent. too fast. The tramway accounts will be corrected accordingly.

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**Timber Market.**—In their annual timber report Messrs. Denny, Mott, and Dickson, Limited, remark that, despite high prices and depression in the shipbuilding trade, a leading feature has been that the consumption exceeded the exports, the result being that the stocks of teak in consumers' hands have become exhausted, and shippers have consequently made their increased scale of prices effective. The result of this is to encourage the substitution of other woods or of steel for teak in rolling-stock construction. The imports of teak to Europe last year were 30 per cent. lower than the unusually small import of 1903, and as the consumption was some 20 per cent. in excess of the import, the stocks available are limited.

**Johannesburg.**—The Corporation are proceeding actively with the realisation of their tramway scheme, and Messrs. Mordey and Dawbarn, 82, Victoria-street, S.W., the consulting engineers, are now inviting tenders for the permanent-way material, as also for rolling-stock, machine tools, etc. Those for the permanent-way material, deliverable by the 26th inst., include Vignoles rails, fishplates, angle-steel guard rails, bolts, nuts, coach screws, and dog spikes. The tenders for rolling-stock and machine tools, to be forwarded not later than March 8, comprise 100 electric cars and two electric water-cars, likewise a five-ton travelling crane, one electric car traverser, and various workshop tools—erection at Johannesburg being included in the contracts.—*British and South African Export Gazette.*

**Walsall.**—The following are particulars respecting the working of the tramways: Five weeks ending Dec. 3, 1904: Number of passengers, 400,754; receipts, £2,215. 4s. 6d.; car miles run, 57,558; receipts per car mile run, 9·23d. Four weeks ending Dec. 21, 1904: Number of passengers, 341,861; receipts, £1,900. 12s. 1½d.; car miles run, 44,707; receipts per car mile run, 10·20d. The town clerk has been instructed to confer with the borough accountant and manager as to the audit of the accounts, so as to facilitate the preparation of the balance-sheet. The electrical adviser to the Board of Trade has inspected the electrical equipment of the old lines, and has reported that the work is satisfactory. The Board of Trade have instructed Lieutenant-Colonel Yorke to inspect the permanent way.

**Leeds.**—Several important matters in connection with the fares were considered by the Tramways Committee on Monday. In the first place, it was resolved to recommend that all the 1d. stages throughout the city should be two miles in length. With regard to ½d. fares it was decided that an experiment should be made on about two-thirds of a mile of track on a route to be selected. Upon the result of this test will depend whether the system of ½d. fares shall be carried out all over the city. It was agreed to rearrange the working hours of the men engaged in cleaning and repairing the cars. At present they are on duty each night for eight hours, and under the new conditions they will work nine hours each night six times a week. In connection with the scheme of high-tension generation to supply current for the outlying districts of Horsforth, Rodley, etc., it was decided to advertise for tenders.

**London United Tramways Co.**—It was reported at last week's meeting of the Thames Ditton District Council that the construction of tramways in Long Ditton was about to be commenced. The Surbiton Urban District Council have referred back to committee the question of street widenings. It is stated that the line through Surbiton is not likely to be commenced before May. The Hampton Wick Urban District Council have passed the following resolution: "That an expression of opinion be sent from this Council to the Board of Trade to the effect that the construction of tramway lines over Kingston Bridge is at present impossible owing to the amount of traffic and the narrowness of the carriageway; and that the formation of the lines should be deferred until the bridge is widened." The Richmond Town Council have decided to oppose the company's application for an extension of time to construct the line from Kew Green to Richmond.

**Metropolitan Railway.**—The memorial which has been presented to the Examiner of Private Bills in both Houses by the Willesden Urban District Council against the Metropolitan Railway Bill is directed against Clause 35 of that Bill. This clause provides that "the company may enter into and carry into effect agreements with any railway or other company for the supply of electricity for traction, lighting, or other purposes." The District Council contends that this clause proposes to repeal, without proper notice, the proviso to Clause 31 of the Metropolitan Railway Act, 1902, which provides that the company shall not use or supply for use in the parish of Willesden electricity or electrical power except for the purpose of its own undertaking. Any proposed alteration or repeal of this proviso ought, it is contended, to have been served upon the Council, and the failure of the company to do so is, it is alleged, a non-compliance with Standing Orders.

**Heywood.**—At last week's meeting of the Corporation an agreement with the Corporation of Rochdale with respect to the running of the steam-cars to Sudden within the Rochdale boundary was approved. The Chairman of the Tramways Committee stated that he had met a deputation from the Rochdale Committee, and he thought they had beaten the matter out until there would be no difficulty in settlement. It was not convenient for Rochdale to work the tramways in Bolton-road, and as the Heywood Corporation had applied for permission to work them, it would seem that there could be no difficulty in arranging the matter; but Heywood were required to put the road in repair, keep the track in repair to the satisfaction of the Rochdale borough engineer, and be responsible for any damage that might be incurred. With a little alteration in the agreement he thought they would be able to come to terms with Rochdale. More communications have passed between the two towns, and the prospect of a settlement appears to be somewhat more hopeful.

**Jarrow.**—At the monthly meeting of the Town Council a communication was received from the Board of Trade enclosing copy of a letter from the solicitors to the promoters of the Jarrow and District Light Railway Order, 1901, regarding the proposed extension of time for completing the work. It was stated that the company had already spent more than £10 000 on the scheme, and in addition to purchasing property had completed both abutments of the proposed bridge over the River Don, having obtained delivery on the spot of the girders, and had practically completed the railway on either side of the bridge. But for the appearance of a crack in one of the abutments the construction of the bridge would before this have been actually completed. The company, therefore, thought they had shown sufficient ground to justify their requests for an extension of time for the completion of the railway and works, as they were not likely to allow the capital embarked in the scheme to lie idle longer than was necessary. In the circumstances the Board of Trade had sanctioned an extension for 12 months. Replying to a question, the Mayor said he did not think the Council could do anything further at present in the way of inducing the company to proceed with the laying of the lines.

**Mansfield.**—It is reported that a start is now to be made with the carrying out of the Mansfield and District Light Railways. During the week there has been a great deal of activity. The contract has been placed in the hands of Messrs. J. G. White and Co. The syndicate has abandoned the proposed site for car-sheds in Dallas-street, off Stockwell-gate, but terms for a lease of another site have been agreed upon. It is probable that work will be commenced at the extreme limits of the lines in the borough, leaving the laying of lines in the market place until the longer days in order to minimise interference with business. With regard to the completion of the work, the contractors are hopeful that May, when the extension of the order will expire under ordinary circumstances, will see the work in the borough practically completed. The design of car which has been submitted is on the Nottingham pattern, with accommodation for 22 passengers inside and 36 on the top. The question of providing the power has been under the consideration of the Electricity Committee, and it is proposed that the company shall pay a minimum price per quarter from May 1, whether the cars are then running or not. The enquiry by the Light Railway Commissioners into the application for sanction to make extensions is expected to be held at an early date, and a conference of the local authorities has been summoned to consider the proposals.

**Bradford.**—Arising out of the discussion which took place at last week's meeting of the City Council with regard to the discretionary powers of the general manager of the tramways department to suspend or discharge employés, and the question which was then raised as to the possibility of an appeal to the committee, the matter came up for consideration at Monday's meeting of the Tramways Committee. Special reference was paid to the interpretation of Rule 9 of the tramway regulations, which deals with the manner in which employés may be dealt with. Eventually the committee decided to allow the principle of appeal to the committee in cases of dismissal, and a sub-committee, including the chairman and deputy-chairman, was appointed to formulate rules under which appeals may be entertained by the committee. A proposal having been made that instead of each department of the Corporation in the town hall being connected separately with the National Telephone Company's system in Bradford it would be more economical if a central bureau were established in the town hall and the various departments of the Corporation connected with this bureau, a sub-committee considered this proposal and conferred with Mr. Spencer, the manager of the tramways, who had recently established a telephone system over the Bradford tramways, with a central office. Eventually the matter was adjourned for Mr. Spencer to present a report on the project. The town clerk and city treasurer have been instructed to prepare a scheme for the equitable distribution of administrative charges among the various departments.

**Wellingborough.**—The British Electric Traction Company's scheme for tramways in Wellingborough and the vicinity was again before the Irthlingborough District Council the other day. The clerk reported that in reply to his communications he had heard from the Higham Ferrers Council that that body had decided to support the Tramways Bill and withhold consent to the provisional order asked for on behalf of Mr. C. P. Harvey. From Rushden the reply was that the Council had not yet finally decided, but did not consider a conference necessary. The Council decided, that if the company would extend the tramlines to their district, they would support the scheme. At the meeting of the Raunds Urban District Council Mr. Paris, of the British Electric Traction Company, Limited, was introduced. Mr. Paris stated that the reason the company had not proceeded with the Tramways Bill of 1900 was because of the depression which set in about two years ago, and the difficulty experienced in getting the capital for the carrying out of a scheme that required £300,000 or £400 000. The company therefore decided to cut the scheme down by excluding Finedon and Irthlingborough so as to reduce the expense to manageable limits. These towns might be added in the extension of the present scheme later on. With regard to Raunds, the provisions of this Bill were the same as in the previous Bill. In reply to a question, Mr. Paris said the tramlines would be laid as far as Irthlingborough Station. The company had no power to supply electric light, but would provide power in bulk. On the retirement of Mr. Paris, the Council briefly discussed the matter and decided not to oppose the Bill.

**Swansea.**—The statutory public meeting of ratepayers for the purpose of considering the proposed Corporation Bill was held at the Guildhall last week, and the result of nearly three hours' debate was the approval of the Bill, with the exception of the sections relating to the proposed acquisition of powers to compulsorily acquire the existing tramways system within the borough. A demand was made for a poll. Dealing with the tramways clauses, the town clerk referred to the unsuccessful High Court action of February last for a declaration as regarded certain sections in the Swansea Improvements and Tramways Act, 1882, the result of which was that the Corporation now had

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no power to acquire the whole of the existing tramways till pretty well the end of the present century, notwithstanding that Section 43 of the General Tramways Act, 1870, provided for the purchase of the tramways company undertaking after a period of 21 years. Purchase in that case meant the cost of construction less depreciation. There was no question of goodwill. As a matter of fact, the question of improvements was not involved in any shape or form. The present Bill provided that in the event of purchase the Corporation must grant a lease to the company for 21 years, the lease to be agreed between the Corporation and the company, or, failing agreement, the terms to be decided by the Board of Trade. He deemed it his duty to point out that now was the time for a decision to be arrived at regarding purchase. Several speakers joined in the discussion, the chief objection to the tramways apparently being that the undertaking was a speculative one. A satisfactory trial run has been made on the new section from the old terminus at Morriston through Woodfield-street and Clydach-road up to the end of the new route near Ynisfrigan.

## LIGHTING AND GENERAL.

**Windsor.**—The Town Council have decided to oppose the application for an order for an extension to Clewer.

**Batley.**—On Sunday the electric light installation in Zion Church and schools was used for the first time. The cost of the installation amounted to £240.

**Kirkcaldy.**—It is reported that the Town Council have received sanction to borrow £30,000 for works connected with the electric supply undertaking.

**Norwich.**—Application is to be made for loans of £30,000 for the purposes of the electricity undertaking to Sept. 30, 1907, including £6,400 for a turbine engine.

**General Nogi's Report.**—Amongst the spoil at Port Arthur we find enumerated the following: searchlights, 14; telegraph apparatus, 15; telephone apparatus, 134; signalling apparatus, 5.

**Bedwellty.**—The Guardians have adopted the specification and estimate of Messrs Herbert, Lewis, and Fletcher, Cardiff, for the proposed installation of electric light at the workhouse.

**St. Andrews.**—Further consideration of the street-lighting by electricity has been postponed until the report has been received of a deputation about to proceed to Edinburgh and Dalkeith.

**Industrial Storage Battery Syndicate, Limited.**—The liquidator is prepared to sell by tender the whole of the assets and undertaking of the syndicate in one lot. Particulars appear in another column.

**Woking.**—The clerk reported that the electric supply company have given notice of their intention to apply to the Board of Trade for power to extend the area of their supply to the urban and rural districts of Chertsey.

**South London Electric Supply Co.**—The company reports having sold during the quarter ended Christmas last 2,546,868 units, realising £21 760. The figures for the corresponding quarter in 1903 were 2,009,230 units, realising £18,230.

**Croydon.**—The County Council intend to oppose the Bills being promoted by the Administrative County of London and District Electric Power Company, the County of London Electric Supply Company, Limited, and the South Suburban and Croydon Gas Companies.

**Ashton.**—The Guardians have authorised their Electricity Committee to consult an electrical engineer with a view to an estimate being prepared showing the probable cost of engines, dynamos, etc., required to generate electricity for lighting purposes at the workhouse.

**Holyhead.**—Sanction has been received to the borrowing of £1,000 for the purpose of extending the electric lighting scheme into the outskirts of Holyhead. The Holyhead Urban Council have already borrowed £12,700 for the electric lighting scheme and £3,300 for the refuse destructor.

**Telephone Posts on Commons.**—The Postmaster-General is to receive a deputation on the 26th *re* the disfigurement of many commons and open spaces in the Home Counties by the erection of unsightly posts and wires in connection with the telephone system of the General Post Office.

**Bedlington.**—The Northern Electric Supply Company have decided to proceed to lay their mains in the district as soon as favourable weather commences. The area to be covered by the company includes the large districts of Cambois, Sleekburn, Choppington, Guide Post, Barrington, and Bedlington Town.

**Private Bills.**—The Examiners of Private Bills have passed the following London Bills, to which there was no opposition at this stage: Administrative County of London and District Electric Power Company Bill, Charing Cross and Strand Electricity Supply Corporation (Power Supply), L.C.C. Tramways, and L.C.C. Building Acts.

**Electric Plant, etc.**—Messrs. Foot and Milne, Limited, Prince's-mansions, 66, Victoria-street, S.W., report the following recent contracts—viz., for electric lighting of Pembroke Dockyard, Netley Hospital, King Edward VII 's Sanatorium, and for the central stations and complete equipment of the towns of Saffron Walden and Newquay.

**Farnham.**—The Urban District Council have agreed to Messrs. Roberts and Co.'s application for a provisional order, on condition that the Council have power to purchase the undertaking, if desired, in 21 years, and that if the electricity is generated by power gas the chimney shaft be erected at such a height that it will not be a nuisance to the town.

**Brighton Telephones.**—The General Purposes Committee have refused to grant the National Telephone Company permission to place their wires underground. The application before the committee was intermingled with a proposal for the relief of the unemployed, but the committee had no difficulty in seeing an old question under this new guise.

**Isle of Wight.**—The Shanklin Urban District Council have given the Isle of Wight Electric Light and Power Company, Limited, another three years' contract for the public lighting, the original contract having expired December, 1904. The Parish Council of Bonchurch have also extended the agreement for another five years from last summer.

**Marconi Wireless Telegrams.**—The Marconi Company have entered into an agreement with the Oceanic Steam Navigation Company, Limited (White Star Line), for the equipment of six of the White Star Line vessels with Marconi wireless apparatus. The names of the vessels to be fitted are "Oceanic," "Celtic," "Baltic," "Cedric," "Majestic," and "Teutonic."

**Barmouth.**—At the next monthly meeting of the Urban District Council, a vote will be taken on the question of adopting or rejecting the electric light scheme. At present the town is called upon to provide the money, and an electric lighting company undertakes to carry the project through and to maintain the same, subject to the option of transfer on certain terms.

**Kensington.**—Notices from the undermentioned electric lighting companies relative to proposed extensions of their mains in the borough have been agreed to: Kensington and Knightsbridge Electric Lighting Company, Limited, Kensington-square; Notting Hill Electric Lighting Company, Limited, Lansdowne-crescent; Brompton and Kensington Electricity Supply Company, Limited, Hollywood-road.

**Westhoughton (Lancashire).**—The Urban District Council have signed an agreement with the Lancashire Electric Power Company for supply of electrical energy in bulk for all purposes. It is expected that the supply will be forthcoming in about four months, and that a very considerable demand will arise for electrical energy for power purposes in this important coal-mining and manufacturing district.

**Stock Exchange.**—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the Cape Electric Tramways' further issue of 11,222 shares of £1 each, fully paid, Nos. 480 001 to 491,222; and to allow the Commercial Cable Company's further issue of £289 000 sterling 500-year 4 per cent. debenture stock (redeemable) to be quoted in the official list.

**Electrical Engineers' Ball.**—The dance of last year having proved so great a success, it has been decided to hold the next one on Friday, Jan. 27, at the Hotel Cecil. The following gentlemen form the executive committee: Messrs. J. E. Kinsbury, R. J. Wallis-Jones, W. Geipel, M. F. Roberts, and Percy Swan. Mr. R. Hammond is the hon. treasurer, and Messrs. A. M. Sillar and H. Alabaster will act as hon. secretaries.

**Surbiton.**—The District Council have sealed an application to the Board of Trade for a provisional order to put in force the Electric Lighting Acts, 1882 and 1888 and the Electric Lighting (Clauses) Act, 1899, and to extend the limits of supply for electricity for all public and private purposes to that part of the urban district of Surbiton which is not included in the area of supply as defined by the Surbiton Electric Lighting Order, 1891.

**Luton.**—In his last report Mr. Cook, the electrical engineer, states that during the last month 31,333 units were generated, an equivalent of 326 8-c.p. lamps and seven motors of 54 h.p. connected, making a total of 228 consumers with 13 855 lamps and 70 motors of 256½ h.p., and that the units generated showed an increase of 51 per cent. over the number generated during the corresponding period of last year, and that at the present time applications were in for 500 additional lamps and motors of 200 h.p.

**Manchester.**—At the last meeting of the Parliamentary Committee of the City Council the city surveyor reported on the plans deposited in connection with an application for a provisional order to authorise the Lancashire Electric Power Company to supply electricity for public and private purposes within the rural district of Barton-on-Irwell. Power is sought to construct works, acquire land, make charges, lay electric lines, and for other purposes. We understand that the committee will recommend the City Council to oppose the order.

**Johannesburg.**—The whole of the overhead telephone cables are to be laid underground. The town has been mapped out in telephonic areas, and early in the year the reconstruction will commence. The cables will contain from 612 to 104 paper-insulated wires, the whole cable being contained in a lead tube laid in earthenware ducts of 3½in. diameter. The length of single ducts is approximately 50 miles, forming a conduit measuring about seven miles. The length of cables is 13 miles, containing some 5,300 miles of single copper wire.

**Measuring Instruments and Switchgear.**—The Union Electric Company, Limited, 151, Queen Victoria-street, E.C., have taken over the electrical department of the firm of Messrs. Moul and Co., of 76 8, York-street, Westminster. This department specialises in the best qualities of (*a*) measuring instruments, both for technical and scientific purposes, constructed by the world-famous firm of Hartmann and Braun; (*b*) automatic and hand switches, and cut-outs, lightning arresters, etc., for every class of current, and for voltages up to 40,000. Mr. H. E. Moul has joined the staff of this company as its technical manager.

**Coventry.**—We regret to note that the Town Council on Tuesday last referred back to the Electric Light Committee a proposal to increase the salary of Mr. J. A. Jeckell, the borough electrical engineer. It was admitted that he had converted a failure into a commercial success, and yet the councillors quibbled about the amount of the proposed increase and the length of Mr. Jeckell's service. Such quibbling over the remuneration of capable employés who have proved their worth brings great discredit on municipal management. We trust that at an early date the Electric Light Committee will bring forward and carry an exactly similar motion.

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**London Gazette.**—The partnership between Bernard Sherman, Francis Heron Rogers, and Dallas Henry Muston, carrying on business as electrical engineers and telephone specialists at 16 and 17, Devonshire-square, Bishopsgate-street Without, London, has been dissolved by mutual consent. A public examination will be held at Swansea on Feb. 8, 1905, *re* Henry Coles, electrical engineer, 10, York-street, Swansea. A first and final dividend of 1s. 5½d. in the £ has been declared in the estate of William Wenham, electrical engineer, 5, Century-buildings, London-road, Croydon, Surrey.

**Lichfield.**—The City Council have sealed an agreement with Messrs. Foote and Milne, Limited, of Princes-mansions, 66, Victoria-street, who are applying for a provisional order for the district. The maximum price is fixed at 7d. per unit, but a clause is inserted to the effect that until purchase and transfer to the Corporation as provided in the agreement the maximum price to be charged for energy under the new order shall not, except with the consent of the Corporation, in writing, exceed the following—viz.: to the Corporation for lighting, 5d.; to the Corporation for power, 2½d.; to ordinary consumers for lighting, 6d.; and to ordinary consumers for power, 3d. per Board of Trade unit.

**City Trade Branch.**—The Canadian Government have opened a City branch office at 73, Basinghall-street for the special convenience of business men. This office is well supplied with Canadian books of reference, directories, reports, and other sources of information, which will be kept up to date, and in due course it is proposed to instal a small display of the leading Canadian products and resources. Information will be supplied regarding Canadian trade, the products and resources of the Dominion, and other matters relating to Canada, to any persons who may wish to make use of the facilities possessed there, and personal interviews can be arranged by appointment when desired.

**King's Lynn.**—Mr. F. W. Savage having resigned the chairmanship of the Electricity Committee, Mr. Gemmell has been appointed in his stead. The engineer's last report states that since the last meeting applications have been received for 366 additional lamps of 8 c.p. (or equivalent), making a total of 20,334 from private consumers and that there are now 502 private consumers, being an addition of 17, the additions including one motor of 5 h.p. The following figures are added: Unit generated, November, 1904 57,081 (1903, 53,031); total units sold to private consumers (light and power), 28,295 (22,627); units sold at power rates, 10 228 (6,790); cost of fuel, stores, repairs, and wages at station, £141 (£132. 16s. 10d.); cost per unit generated, 0·5928d. (0·6012d.); wages of lamp-lighters and outside staff, £21. 3s. 5d. (£23. 13s. 10d.). One of the switchboard attendants has resigned, and the engineer has been authorised to fill up the vacancy.

**Derby.**—The returns for the tenth year of the Corporation's electricity undertaking show substantial progress. The increased demand for electricity and the gradual reduction of cost during the past three years are illustrated by the following: Year 1901-2—consumers 870, lamps 75,972, number of units sold 1,081,487, total cost per unit 2·07d.; 1902-3—consumers 1,002, lamps 87,502, number of units sold 1,287,619, total cost per unit 1·56d.; 1903-4—number of consumers 1,240, lamps 106,790, number of units sold 1,490,611, total cost per unit 1·45d. The amount of loan sanctioned was £196,048. Of this, £159,369 has been borrowed at the rate of 3 per cent. The amount repaid is £28,836. The capital expenditure at the ends of the ninth and tenth year was respectively £159,657 and £180,386; revenue from electricity supply, £17,137 and £18,950; revenue from meter rents and other sources, £1,319 and £1,504; total revenue, 1902-3, £18,456; 1903-4, £20,454; total costs, £8,389 and £8,986; gross profit, £10,067 and £11,468; percentage of gross profits to average capital, 6·50 and 6·57 per cent.; interest on loans, less interest receivable, £4,430 and £4,937; sinking fund, £5,040 and £4,814; percentage of ditto to average capital, 3·25 and 2·76 per cent.; financial result after providing for interest and sinking fund (surplus), 1902-3, £597; 1903-4, £1,717.

**Borough Theatre, Stratford.**—As already noted, some 12 months ago an entirely new electrical installation was put into this theatre and considerable improvement in the general lighting has since taken place. Consequently advantage has been taken by the management for the introduction of some novel electrical effects during the performance of the successful pantomime now running—"The Forty Thieves"—which admirably lends itself to this purpose. Perhaps the best effect is produced in the "Interior of the Cave" scene, in the centre of which a large fire is seen burning upon the altar to the god of Avarice. The appearance of fire is effected by the use of strips of red and yellow silk kept in upright motion by means of a motor fan situated in the altar beneath, while the rays of two powerful red arc lamps placed below the fan are projected on the moving silk strips. From the roof of the cave are suspended a number of swinging red 5-c.p. incandescent lamps. These are kept in a continuous state of "twinkling" by means of a break switch, and give the unique appearance of a swarm of fire flies floating about the stage. The change in this scene when the cave is opened, disclosing a beautiful green landscape in the distance, is particularly well executed. In the last grand tableau the scene is lighted by 12 powerful arc lamps mounted on the stage and two 50-light candelabra placed at the foot of the great staircase. To those of our readers who take an interest in electrical effects and theatre lighting generally we recommend a visit to this popular house of entertainment during the run of the present pantomime.

**Harwich.**—The report of the Lighting Committee dealing with a proposed scheme of electric lighting for Harwich was again discussed at the last Town Council meeting. It stated that the committee had considered the question of utilising the Harwich electric lighting order granted to the Corporation in 1892, as the Board of Trade had threatened to cancel it unless its provisions were put into effect. The advice of Messrs. Medhurst and Lloyd, electrical engineers, of Westminster, was obtained, and the report dealt with the provision of a refuse destructor in connection with the electric lighting scheme. The recommendation of the Lighting Committee was to the effect that tenders should be invited from responsible contractors, who would be prepared to enter into an agreement with the Corporation to carry out the scheme, and thereafter to take a lease of the undertaking for a term of 25 years, at a rental equal to £6 per cent. upon the total cost thereof, the contractors being responsible for the maintenance of the works and plant during the above period, and the Corporation having power to determine the lease at the end of seven, ten, or fourteen years. Under such lease the contractors would not be allowed to charge more than 6d. per unit for lighting and 3d. per unit for motor. The committee further recommended that, provided the town clerk was satisfied that the interests of the borough could be secured, and that no outlay for electric lighting would be requisite from the current rates, either for interest upon the money borrowed or for the repayment of capital, the Board of Trade be asked to consent to the proposed scheme, and authorise the Corporation to borrow £22 000 for electric lighting, and a further sum of £3,000 for the refuse destructor. After discussion it was decided that the Board of Trade be asked to extend the time for utilising the Harwich electric lighting order until the fate of the Dock Bill was known.

## PROVISIONAL PATENTS, 1904-5.

DEC. 31.

**29353. Improvements in rotary converters for electric currents.** Louis John Hunt and the Sandycroft Foundry Company, Limited, 6, Lord-street, Liverpool.

**29354. Improvements in apparatus for transmitting electric signals or impulses.** Gustav Grabosch, 6, Lord-street, Liverpool.

**29363. Improvements in and relating to electrical measuring instruments.** Henry Harris Lake, 7, Southampton-buildings, Chancery lane, London. (Vittorio Arcioni, Italy.) (Complete specification.)

**29368. Improvements in and connected with induction coils.** Herbert Watson Sullivan, 23, Southampton-buildings, Chancery-lane, London.

**29369. Improvements in and connected with electric relays and recorders.** Herbert Watson Sullivan, 23, Southampton-buildings, Chancery-lane, London.

**29377. Improvements in fuses for electrical circuits.** Michael Birt Field and Ferranti Limited, 18, Southampton-buildings, Chancery-lane, London.

**29386. Improvements relating to electrical generators having double T-shaped armatures.** Franz Gutzmann, 322, High Holborn, London. (Complete specification.)

**29397. Improvements in and relating to pendant electric fixtures.** Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (Walter Lincoln Bradshaw, Augustus Keough, Martin Keough, and James Keough, United States.) (Complete specification.)

**29401. Improvements in and relating to pendant electric fixtures.** Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (Walter Lincoln Bradshaw, Augustus Keough, Martin Keough, and James Keough, United States.) (Complete specification).

**29408. Improvements in current distributors for the electric ignition devices of internal-combustion engines.** Louis Renault, 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Sept. 23, 1904, being date of application in France.) (Complete specification.)

**29417. Electromagnetic machinery.** David Cook, 165, Queen Victoria-street, London.

**29422. Improvements relating to electrical apparatus for transmitting and receiving signals.** Arthur Trevor Dawson and George Thomas Buckham, 7, Southampton-buildings, Chancery-lane, London.

**29435. Improvements in alternating-current collector motors.** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens-Schuckertwerke, Germany.)

**29436. Improvements in alternating-current collector motors.** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (The Siemens-Schuckertwerke, Germany.)

**29437. Improvements in electrical ignition devices for internal-combustion engines and other purposes.** John Arthur Torrens, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**29438. Improvements in electrical measuring instruments.** James Hunter Gray, 58, Comeragh-road, West Kensington, London.

**29448. Improvements in and relating to arc lamps.** Oskar Konitzer, 27, Chancery-lane, London.

**29466. Apparatus or appliance for supporting a telephonic receiver and transmitter or analogous instrument.** William Henry Danson, 21, Cole-street, Borough, London.

**29487. Improvements in or relating to space telegraphy and apparatus therefor.** George Finlay Anderson, 111, Hatton-garden, London.

**29529. Improvements in telephone systems.** Felton Vollmer, Fife House, Kingston-on-Thames.

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29504. **Improvements in and relating to galvanic elements.** Nicolaas Arnoldus Smits, 1, Broad-street-buildings, Liverpool-street, London.

29516. **A new or improved automatic circuit breaker or cut-out for overhead tramway systems.** Henry Gordon Turnell, 9, Regent-street, London.

29531. **Improvements in electrical signalling apparatus.** Franklin S. Holmes, Fife House, Kingston-on-Thames. (Date applied for under Patents Act, 1901, March 25, 1904, being date of application in United States.) (Complete specification.)

29532. **Improvements in electrical signalling apparatus.** Franklin S. Holmes, Fife House, Kingston-on-Thames. (Date applied for under Patents Act, 1901, March 19, 1904, being date of application in United States.) (Complete specification.)

29533. **An improved electric circuit closer for fire-alarms.** John Elmer Bemiller and Emery C. Weisensale, Fife House, Kingston-on-Thames. (Date applied for under Patents Act, 1901, May 7, 1904, being date of application in United States.) (Complete specification.)

29607. **Improvements in liquid resistances for controlling the current in electrometers and the like.** Bruce Peebles and Co., Limited, and Arthur Charlesworth Peebles, 34, Castle-street, Liverpool.

29613. **Improvements in electrolytic meters.** George Hookham, 18, Southampton-buildings, Chancery-lane, London.

29627. **Improvements in electrical fire-alarm or other call apparatus.** Charles Shore and Charles Heap, 6, Bank-street, Manchester.

JAN. 2.

40. **Improved plough for use on the electric conduit for tramways or light railways.** James Jonas Attridge, 43, Lincoln-avenue, Bournemouth.

66. **Improvements in electric switches.** Charles Smith, 33, Chancery-lane, London.

98. **Improvements in electric arc lamps.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

JAN. 3.

123. **Improvements in apparatus for and process of electric welding and other metal-working operations.** William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Thomson Electric Welding Company, United States.) (Complete specification.)

136. **Improvements in transformers.** Frank Conrad, The Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Jan. 20, 1904, being date of application in United States.) (Complete specification.)

JAN. 4.

167. **Improvements in the insulation of wires conducting electricity.** Herbert George Longford, Woodcote, Weather-oak-road, Sparkhill, near Birmingham.

171. **Improvements in or relating to electromagnets used with cranes for lifting rails, ingots, or the like.** Steel, Peech, and Tozer, Limited, and Henry Edward Bowen, Bank-buildings, George-street, Sheffield.

177. **A device for notifying to an individual when an electric circuit fails, and especially for notifying the driver of a motorcar when the rear electric light fails.** Ernest Hardy Pickford, Moorgate, Rotherham.

184. **Compensated single-phase alternating-current commutater motor.** Engelbert Arnold and Jens Lassen la Cour, 34, Castle-street, Liverpool. (Date applied for under Patents Act, 1901, Jan. 4, 1904, being date of application in Germany.) (Complete specification.)

185. **Arrangement for leading in and taking off the armature current of compensated single-phase commutator motors.** Engelbert Arnold and Jens Lassen la Cour, 34, Castle-street, Liverpool. (Complete specification.)

191. **Improvements in adjustable flexible connections for gas-pendants, fluids, steam, or electrical conductors.** Samuel Quincey and Charles Harrison, 136, Kentish Town-road, London.

209. **Improvements in electromagnetically controlled fluid-pressure motors.** Ernest de Merindol Malan, The Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London.

210. **Improvements in electric arc lamps.** William Reginald Ridings, Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London.

211. **Improvements relating to electric arc lamps.** La Société Leperche et Cie., 40, Chancery-lane, London. (Date applied for under Patents Act, 1901, May 2, 1904, being date of application in France.) (Complete specification.)

JAN. 5.

256. **An improved solution for the formation of accumulator plates.** Max Lorenz and Henry Crane, 81, High Holborn, London.

254. **Improvements in electric lighting.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

255. **Improvements in electric resistance units.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

256. **Improvements in magnetic separators.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

257. **Improvements in electric arc lamp electrodes.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.) (Complete specification.)

JAN. 6.

311. **Improvements in apparatus for testing electrical resistances.** John Bernard West, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

313. **An improved device for attaching electric conductors to terminals.** Alexander Miller, 4, South-street, Finsbury, London.

315. **Improvements in or relating to plates for secondary batteries.** William Phillips Thompson, 322, High Holborn, London. (Pflüger Accumulatoren-Werke Act.-Ges., Germany.) (Complete specification.)

329. **Improvements in and relating to electric power-transmitting mechanism.** The British Thomson-Houston Company, Limited, and Bernard Hopps, 83, Cannon-street, London.

JAN. 7.

343. **Improvements in apparatus for converting multiphase current into continuous current.** Bruce Peebles and Co., Limited, and Jens Lassen la Cour, 34, Castle-street, Liverpool. (Complete specification.)

352. **Protective apparatus for alternating-current circuits.** Harry Phillips Davis and Frank Conrad, The Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Jan. 20, 1904, being date of application in the United States.) (Complete specification.)

354. **Improvements in electrical measuring instruments.** Evershed and Vignoles, Limited, and Sydney Evershed, 1, Queen Victoria-street, London.

368. **Improvements in vapour electric apparatus.** The British Thomson-Houston Company, Limited, and John Gray, 83, Cannon-street, London.

369. **Improvements in vapour electric apparatus.** Alexander McLeod Jackson, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Jan. 9, 1904, being date of application in United States.) (Complete specification.)

370. **Improvements in vapour electric apparatus.** Osias Otto Kruh, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Jan. 9, 1904, being date of application in United States.) (Complete specification.)

374. **Improvements in electrometers for single-phase current.** Akt.-Ges. Brown, Boveri, und Co., 46, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Jan. 8, 1904, being date of application in Switzerland.) (Complete specification.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published Jan. 19, 1905.*

1904.

4075. **Construction of electric switch.** Markt.

4925. **Electric bell-pushes.** Ross.

4944. **Arc lamps and carbons therefor.** Russo.

5164. **Electric arc lamps.** Crompton and Co., Limited, and Hodgson.

15691. **Advertising by means of electric lamps.** Mead.

24399. **Electric tools.** Schiemann.

25112. **Electric light systems.** Lake. (Gould.)

25592. **Electric switches.** Hunter.

26043. **Submarine telegraphy.** Kitsee.

26097. **Magnetic clutches.** Eastwood. (Date applied for under International Convention, April 1, 1904.)

*To be published Jan. 26, 1905.*

1904.

131. **Regulation of electric currents.** La Cour. (Date applied for under International Convention, Jan 5, 1903.)

552. **Microphones for telephonic apparatus.** Bassompierre and Dardeau. (Date applied for under International Convention, Jan. 15, 1903.)

2063. **Static electrical machines for lighting gas, ether, and the like.** Nehmer.

2456. **Machines for treating filaments for electric lamps.** British Thomson-Houston Company, Limited. (General Electric Company)

4234. **Electrical measuring and indicating instruments.** Elphinstone.

4376. **Electricity meters.** Tourtel and Tourtel Manufacturing Company, Limited.

4771. **Controlling alternating-current electric motors.** British Thomson-Houston Company, Limited. (General Electric Company.)

5118. **Electrical radiators.** Dowsing.

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**5664. Base or wall block to facilitate the erection of electric light fixtures and provide better insulation at their bases.** Ewart.

**7267. Electrical switches.** Bornand.

**9306. Apparatus for the automatic regulation of electric currents for charging storage batteries.** Akt.-Ges. Brown, Boveri, und Co. (Date applied for under International Convention, April 23, 1903.)

**19589. Electric meters.** Duncan. (Date applied for under International Convention, Dec. 29, 1903.)

**21894. Regenerative dry batteries.** Gregory.

**24200. Electric switches.** Clark.

**26157. Electric arc lamps.** Nusch. (Cotis.)

**26260. Electric arc lamps.** Sipe.

**26367. System of wireless telegraphy.** Thompson. (Ges. für drahtlose Telegraphie.)

**26449. Insulators for electric wires.** Flynt and Maiden.

*To be published Feb. 2.*

1903.

**24516. Receiving or detecting and recording apparatus for telegraphic and other electrical purposes.** Armstrong and Orling.

1904.

**618. Electric railway systems.** British Thomson-Houston Company, Limited, Sporborg, Carter, and Cubitt.

**1081. Telephone adapted for use by partially deaf persons.** Nathan and Newland.

**1484. Controlling electric motors.** British Thomson-Houston Company, Limited. (General Electric Company.)

**1513. Shade carrier holder for bayonet or screw electric glow lampholders.** Escaré.

**3147. Electric switches for the igniting circuits of multiple-cylinder explosion motors.** Talbot and Mobley.

**5308. Electric contact devices such as resonance relays for telephone systems.** Pedersen.

**5360. Electric lampholder.** Hirst and Collings.

**6039. Controlling valves for use in connection with pneumatic brake systems.** British Thomson-Houston Company, Limited. (General Electric Company.)

**6067. Adjustment of magnetic compasses.** Gruby.

**6425. Electric candle fittings.** Banks.

**8262. Telephones for use in dictating correspondence for exchange call-room, for personal use, and for other like uses.** Port.

**9831. Means for the regulation of electric circuits for the production of constant current or constant potential or of both.** James. (Northern Electric Company.)

**11274. Telephone selecting systems.** Watkins.

**21796. Controllers for electric motors.** Churchward. (Date applied for under International Convention, Oct. 10, 1903.)

**23797. Temperature compensating devices for electrical measuring instruments.** Bristol.

**25295. Electric accumulators.** Jungner.

**25165. Device for distinguishing between the poles of an electric circuit.** Prested.

**25911. Couplings for the driving and driven members of dynamos, turbines, hydro-extractors, and other high-speed machinery.** Jebsen.

**26538. Electrical fuse-boxes, ceiling roses, wall plugs, and the like.** Herbert.

**26696. Apparatus for wireless telegraphy or telephony.** Eisenstein.

**26757. Signalling bells worked by electrically-controlled compressed air or other gas.** Siemens Bros. and Co., Limited. (Siemens und Halske Act.-Ges.)

**26820. Electrical switches and cut-outs.** Dorman, Smith, and Baggs.

**26920. Arc light electrodes and methods of making the same.** Lindsay. (Date applied for under International Convention, Dec 10, 1903.)

**27010 Alternating electric current frequency changers.** Kruh. (Date applied for under International Convention, Dec. 12, 1903.)

**27095. Electric telephony.** Adams-Randall.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ⅞-1 |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 15/32 9/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | – | 5-5¼ |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | – | 5¼-5⅜ |
| —— 4½ per cent. Mortgage Debentures | 100 | – | 101-104 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 101-103 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | – | 2⅝-2¾ |
| —— 4 per cent. Mortgage Debenture Stock | 100 | – | 86-88 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 | 2 | – | ⅞-1 |
| —— Non. Cum., 6 per cent. Pref. | 2 | – | 1 5/16 1 9/16 |
| —— 4½ per cent. 1st Debenture Stock | 100 | – | 93-96 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | – | 74-77 xd |
| Callender's Cable, Debentures | 100 | – | 104-106 |
| —— Ordinary | 5 | – | 9⅛-10 |
| —— 5 per cent. Pref. | 5 | – | 5-5¼ |
| Crompton and Co. | 5 | – | 2-2¼ |
| —— 5 per cent. Debentures | 100 | – | 95-98 |
| Edison and Swan United, "A" Shares, 1-99,251 | 5 | – | ⅞-1 |
| —— "A" Shares, 01-017,139 | 5 | – | 1-1⅛ |
| —— 5 per cent. Debentures | 100 | – | 79-84 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 77-82 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | – | 1⅛-1¼ |
| —— 7 per cent. Cumulative Pref. | 2 | – | 2⅛-2¼ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | – | 97-99 xd |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | .. | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 | – | 9⅛-10 |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | – | 91-96 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | .. | 10¼-10⅜ |
| —— 4½ per cent. Preference | 5 | .. | 5⅛-5⅜ |
| —— 4½ per cent. Debentures | 100 | – | 110-112 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | – | 15-16 |
| —— 4 per cent. Debentures | 100 | – | 99-102 |
| Parker, Thos., Limited, Ordinary | 10 | – | 10-10¼ |
| Telegraph Construction and Maintenance | 12 | – | 38-40 |
| —— 5 per cent. Bonds | 100 | – | 101½-103½ |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary | 10 | – | 12-12½ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | – | 9⅛-10 |
| —— 5 per cent. Cum. Second Pref., 15,001-22,500 | 10 | – | 11-12 |
| —— 4½ per cent. Debenture Stock. Red. | 100 | – | 103-105 |
| Bromley (Kent) Electric Light and Power Co. | 5 | .. | 5⅛-5⅜ |
| —— 4½ per cent. 1st Debenture Stock, Red. | 100 | – | 101-104 |
| Brompton and Kensington, Ordinary | 5 | – | 10⅛-11 |
| —— 7 per cent. Preference | 5 | – | 10⅛-10⅜ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 | 5 | – | 8⅛-8⅜ |
| —— Nos. 60,001-80,000 | 5 | – | 6⅛-6⅜ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | – | 12⅛-12⅜ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 105-108 |
| Charing Cross and Strand, Nos. 1-70,000 | 5 | – | 8⅛-8⅜ |
| —— 70,001-80,000 | 5 | – | 8-8⅛ |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5⅛-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 4⅞-5 |
| —— 40,001-80,000 | 5 | .. | 4⅞-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | – | 101-103 |
| Chelsea Electricity Supply | 5 | – | 6⅜-7 |
| —— 4½ per cent. Debentures | 100 | – | 108-110 |
| City of London, Ordinary | 10 | – | 11-11⅛ |
| —— 6 per cent. Cumulative Pref. | 10 | – | 13⅛-14 |
| —— 5 per cent. Debenture Stock | 100 | – | 121-125 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | – | 100-103 |
| County of London Electric Supply, Ordinary | 10 | – | 9-9⅛ |
| —— 6 per cent. Cum. Pref. | 10 | – | 12-12½ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 101-103 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. | 100 | .. | 107-110 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | – | 6⅛-6½ xd |
| —— 6 per cent. Cum. Pref. | 5 | – | 6-6⅛ |
| —— 4½ per cent. First Mort. Deb. | 100 | – | 106-108 xd |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-50,000 | 5 | – | 1⅛-2⅛ |
| —— 5 per cent. Debenture Stock, Red. | 100 | – | 86-91 xd |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | – | 5⅛-6 |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | – | 102-105 |
| Havana Electricity, Limited, 1-15,000 | 10 | – | 9⅛-10⅛ |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | – | 7⅛-8 |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 100-102 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 | 1 | – | 9/16-11/16 |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | | 12⅛-13 |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red | 100 | – | 102-104 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅜-10⅛ |
| London Electric, Ordinary | 5 | – | 2⅛-2⅜ |
| —— 6 per cent. Pref. | 5 | – | 5 9/16 5 13/16 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | – | 96-98 |
| Metropolitan Ordinary | 10 | – | 18-18⅛ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | – | 110-115 |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5 7/16-5 9/16 |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | – | 86-98 |
| Midland Electric Power Dis., Ld., 4½ p c. 1st Mort. Deb. | 100 | – | 92-96 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | – | 98-101 |
| —— Preference | 4 | – | 100-102 |
| Notting Hill Electric Lighting | 10 | – | 14⅛-15 |
| —— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.) | 100 | | 102-104 |
| Oxford Electric, Ordinary, 1-96 and 1,[illegible]-14,510 | 5 | – | 6⅛-6⅜ |
| —— 4 per cent. Debenture Stock | 100 | – | 98-100 xd |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures | 100 | – | 100-102 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 | – | 2⅜-3⅛ |
| —— 4 per cent. Debenture Stock | 100 | – | 83-87 |
| South London, Ordinary | | – | 4⅛-4⅜ |
| South Metropolitan Electric Light and Power Co., Ord. | 1 | .. | 13/16-15/16 |
| —— 7 per cent. Cum. Pref. | 1 | .. | 1⅛-1 7/16 |
| —— 4½ per cent. 1st Mort. Deb. | 100 | .. | 107-110 |
| —— Ditto, June, 1904 | | .. | |
| St. James's and Pall Mall, Ordinary, 101-20,080 | 5 | – | 13⅛-14 |
| —— 7 per cent. Pref. | 5 | – | 8⅛-9 |
| —— 3½ per cent. Deb. | 100 | – | 98-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | – | 5-5⅛ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5 1/16-5 3/16 |
| Westminster, Ordinary | 5 | – | 13-13⅛ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | – | 6¼-6⅜ |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 | 5 | – | 5⅛-5⅜ |
| —— Ord. | 5 | .. | 8⅛-8⅜ |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | – | 140-143 |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 104-105 |
| Barcelona Tramways, Limited, Ord., 1-20,000 | 10 | .. | 12-12½ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 | 10 | .. | 9-10 xd |
| —— 5 per cent. Deb., Red., 1-600 | 100 | .. | 99-102 |
| —— 4½ per cent. Red. Deb. Stock | 100 | .. | 96-100 |
| Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606 | 1 | .. | ⅜-½ |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 | 1 | .. | ¾-1 |
| Belfast Street Tramways, Ord., 1-26,600 | 10 | .. | 10-11 |
| Blackpool and Fleetwood Tramroad | 10 | – | 13⅛-13⅜ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | – | 1⅛-2 |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | – | 3⅞-4⅛ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 91-98 |
| British Columbia Electric Railway Co., Ord. Def. | 100 | – | 100-103 |
| —— Ord Pref. | 100 | – | 100-103 |
| —— Non. Cum. 5 per cent. Pref. | 10 | – | 10-10⅛ xd |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each | 40 | – | 102-104 p e |
| —— 4½ per cent. Vancouver Power Deb. | 100 | – | 97-100 xd |
| British Electric Traction Ord. 1-500,000 & 60,001-90,000 | 10 | – | 9⅜-10⅛ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | – | 11-11⅛ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | .. | 118-120 |
| —— 4½ per cent. 2nd Deb. Stock | 100 | | 97-99 |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Buenos Ayres and Belgrano Tram., Ord., 1-100,000 | 5 | 4¼-4⅜ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | 6⅜ 6 |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | 5½-5⅝ |
| —— 5 per cent. Deb. Stock, Red. | 100 | 105-107 |
| —— Prov. Cert., all paid | 100 | 101-104 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | 94-97 |
| Calcutta Tramways, Limited, 1-102,268 | 5 | 8⅜-8⅝ |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | 106-108 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 | 1⅜ 1⅝ xd |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | 4⅞-5⅛ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | 99-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1s Mortgage Debenture Stock, Red. | 100 | 102-104 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | 9½-10 |
| —— 5 per cent. Cum. Pref. | 10 | 11-12 |
| —— 4 per cent. Debentures | 100 | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | 13-14 |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 | 15-16 |
| —— 5½ per cent. Mort. Debs., 1-3,000, Red. | 100 | 94-97 |
| Imperial Tramways Ordinary | all | 18-19 |
| —— 6 per cent. Cum. Pref. | all | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-50,000 | 5 | 3¼-4 |
| —— 4 per cent. Debenture Stock | 100 | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | 8-8¼ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | 10½-10⅝ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | 103-105 |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016. | 1 | ⅞ 7/16 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | 31/32-1 1/32 |
| —— 4½ per cent. Deb. Stock, Red. | 100 | 103-105 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000 | $1,000 | 106-110 xd |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 | 100-103 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 | 103-105 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000 | 5 | ¼-1¼ |

| Name. | Amount paid. | Last price |
|---|---|---|
| | £ | £ |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | -12½ |
| —— 5 per cent. Cum. Pref. | 10 | 9⅜-9¾ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk. | 100 | 101-104 |
| Potteries Electric Traction, Ordinary 20,001-40,00 | 10 | 8-9 |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | 8¼-8¾ |
| —— 4½ per cent. Debenture Stock | 100 | 99-102 |
| South Lancashire Electric Traction and Power Company | | |
| —— £250,000 Ordinary | 1 | 1 |
| —— £101,132 6 per cent. Preference | 1 | 1 |
| —— £528,093 4½ per cent. Debenture Stock | 100 p.c. | 100 p.c. |
| **Electric Railways.—** | | |
| Central London, Ordinary | 100 | 91-93 |
| —— 4 per cent. Pref. | 100 | 101-103 |
| —— ,, ,, deferred | 100 | 85-87 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid). | 100 | 107-109 xd |
| City and South London, Consolidated Ordinary | 100 | 45¼-46¼ |
| —— 4 per cent. Debenture Stock | 100 | 104-107 |
| —— 5 per cent. Pref. Stock '91 | 100 | 122-125 |
| —— ,, ,, ,, '96 | 100 | 118-121 |
| —— ,, ,, ,, '01 | 100 | 117-120 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | 10-10¼ |
| —— Ordinary, 1-50,000 | 10 | 3¾-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700. | — | 99-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | — | 97¼-98¼ |
| Waterloo and City, Ordinary | 100 | 90-92 |
| **Telephones.—** | | |
| National Telephone, Preferred | 100 | 108½-108¾ |
| —— Deferred Stock | 100 | 106-108 |
| —— 6 per cent. Cum. First Pref. | 10 | 13-15 |
| —— 6 per cent. Cum. Second Pref. | 10 | 12-13 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | 5⅜-5½ |
| —— 5½ per cent. Deb. Stock, Red. | 100 | 96 98 |
| —— 4 per cent. Deb. Stock, Red. | 100 | 101-103 |
| —— 4 per cent. Prov. Cert. | — | 101-103 |
| Oriental Telephone and Electric Company | 7 | 1-1½ |
| —— 6 per cent. Cum. Pref. | 1 | 1⅛-1¼ |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905. | 1904. | Week. | Current year. | 1904. | 1903 | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Car mile. | Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Dec. 31 | 1,291 | 1,470 | − 179 | — h | 19¼ | 19¼ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | Jan. 7 | 245 | 189 | + 57 | + 522 | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 336,049 | 1·03 | 10·11 | 1,770 | 5·04 |
| Barking Corporation | ,, 14 | 57 | 43 | + 14 | + 145 | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 15 | 984 | 1,003 | − 49 | − 608 | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,319,701 | 1·158 | 9·98 | 2,383b | 6·1 |
| Birmingham Corporation | ,, 14 | 334 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | ,, 13 | 5,590 | 5,023 | + 567 | — | 6¼ | 6¼ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | Dec. 16 | 765 | 723 | + 42 | + 3,353 | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10·94 | — | 4·59 |
| Blackpool Corporation | Jan. 12 | 330 | 268 | + 62 | + 6,055 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 14 | 167 | 159 | + 8 | — | 16½ | 16½ | Dec. 31 | 32,021 | 2,253,984 | 600,757 | 3·34 | 12·75 | 2,001 | 7·05 |
| Bolton Corporation | ,, 15 | 1,591 | 1,628 | − 37 | + 411 | 38 | 38 | March 31 | 94,161 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·89 |
| Bournemouth Corporation | ,, 11 | 906 | 887 | + 19 | + 2,177 | 10·15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | Dec. 17 | 3,729 | 3,366 | + 363 | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | Jan. 15 | 753 | 741 | + 12 | + 3,503h | 9 | 7½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 13 | 4,661 | 4,547 | + 114 | — | 51½ | 51½ | Dec. 31g | 253,150 | 44,391,439 | 6,033,528 | — | — | — | — |
| Burnley Corporation | ,, 14 | 994 | 777 | + 217 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 8 | 312 | 294 | + 18 | — | 8¼ | — | March 31i | 11,574 | 2,556,134 | 282,378 | 1·08 | 9·84 | 1,570 | 7·57 |
| Cardiff Corporation | ,, 7 | 1,939 | 1,823 | + 116 | + 2,090 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 14 | 152 | 169 | − 17 | — | — | — | Dec. 31g | 9,987 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 14 | 7,362 | 7,057 | + 305 | — h | 6 | 6 | ,, 31 | 362,471 | 44,953,938 | 1,292,674a | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 15 | 3,062 | 3,159 | − 97 | − 102h | 6¼ | 6⅜ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Colchester Corporation | Dec. 23 | 235 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. T. and L. Company | Jan. 12 | 409 | 396 | + 13 | — | — | — | ,, 31g | 25,657 | 6,353,323 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | ,, 13 | 199 | 195 | + 4 | − 66 | 7·23 | 7·23 | March 31a | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 14 | 170 | 170 | — | — | 4½ | 4½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0·94 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | ,, 13 | 106 | 92 | + 14 | — h | 7 | 6⅔ | Dec. 31g | 6,234 | 588,905 | 107,164 | 3·88 | 14·09 | 952 | 7·39 |
| Dublin U. T., electric cars | ,, 13 | 3,738 | 3,676 | + 62 | } — | 47 | 46 | ,, 31g | 134,643 | — | 3,429,356 | — | — | — | — h |
| Dublin S. District, Electric | ,, 13 | 769 | 716 | + 53 | | | | | | | | | | | |
| Dundee City Tramways | ,, 11 | 835 | 781 | + 54 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 14 | 612 | 5·5 | + 27 | + 1,591 | 10·77 | 10·75 | March 31 | 34,312 | 12,950,259 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 14 | 13,728 | 12,656 | + 672 | — h | 143 | 123 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Gloucester Corporation | ,, 11 | 228 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 11 | 2,497 | 2,173 | + 324 | + 4,516 | 33 | 30½ | March 31 | 68,283 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,069 | 8·77 |
| Huddersfield Corporation | — | — | — | — | — | 35 | 35 | ,, 31 | 65,545 | 11,899,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | ,, 14 | 2,066 | 1,957 | + 103 | +10,871 | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | ,, 14 | 355 | 323 | + 32 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | ,, 11 | 102 | 114 | − 12 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 11 | 213 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 14 | 5,247 | 4,877 | + 370 | +13,743 | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | ,, 14 | 1,707 | — | — | — | 7¼ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | ,, 7 | 10,272 | 9,622 | + 650 | + 2,414 | 103 | 103 | Dec. 31g | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | ,, 15 | 1,480 | 1,569 | − 89 | − 312h | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — e |
| London County Council | ,, 7 | 12,134 | 9,376 | +2,758 | — | 46¼ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 16 | 136 | 136 | — | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | ,, 12 | 95 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 14 | 11,558 | 10,531 | +1,027 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Metropolitan Elec. Tramways | Dec. 30 | 2,327 | 1,029 | +1,298 | +14,915h | 10 | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | Jan. 14 | 105 | 93 | + 12 | + 1,326 | 2¾ | — | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newcastle-on-Tyne Corptn. | ,, 14 | 3,395 | 3,416 | − 53 | — | 45 | 38½ | ,, 25 | 135,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111b | — |
| Newport (Mon.) Corporation | ,, 14 | 521 | 424 | + 97 | + 1,101 | 15 | — | — | — | — | — | — | — | — | — |
| Oldham Corporation | ,, 15 | 1,163 | 1,058 | + 304 | + 2,870 | 34½ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 14 | 1,465 | 1,355 | + 109 | + 6,341 | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·16 | 12·39 | — | — |
| Rochdale Corporation | — | — | — | — | — | 4½ | 4½ | 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 12 | 365 | 377 | − 12 | — | — | — | ,, 31 | 23,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·68 |
| Salford Corporation | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | — | — | — | — | — | 7¾ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 15 | 4,349 | 4,148 | + 201 | + 4,891 | 34¼ | — | ,, 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 12 | 853 | 855 | − 2 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | — | — | — | — | — | 6¼ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 13 | 412 | 329 | + 83 | + 8,146 | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 15 | 1,088 | 1,013 | + 75 | + 1 387 | 19 54 | 18·48 | ,, 31 | 62,506 | 14,848,958 | 1,433,463 | 1·01 | 10·46 | — | 6·08 |
| Swindon Corporation | — | — | — | — | — | 3¾ | — | — | — | — | — | — | — | — | — |
| Wallasey U.D.C. | ,, 14 | 653 | 534 | + 58 | + 2,106 | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·60 |
| West Ham Corporation | ,, 12 | 1,110 | — | — | — | 8·62 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 11 | 702 | 392 | + 310 | — | 7½ | — | ,, 31g | 20,878 | 4,263,066 | 417,335 | — | 12·006 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. e Train mile.
b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.
i Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**The Engineering Standards Committee.**—It is announced that Mr. James C. Inglis, general manager of the Great Western Railway, has been nominated by the council of the Institution of Civil Engineers as one of their representatives on the Engineering Standards Committee, in the place of the late Mr. John Allen McDonald, engineer-in-chief of the Midland Railway.

**Conduit Slot.**—As briefly noted in a recent issue, the Board of Trade has acceded to the application of the London County Council for an alteration in the width of the conduit slot for their tramways. In the report presented to the Council on Tuesday the Highways Committee state the Board has sanctioned a slot having a width of 1in. instead of $\frac{3}{4}$in. for the St. John-street and Rosebery-avenue route, thus introducing the new type of slot on the Council's northern system.

**Brighton Corporation Telephone Department.**—To celebrate the first year of its existence, this department held a successful conversazione at the Old Ship Assembly Rooms on the 13th inst., under the auspices of the Mayor (Alderman F. Blaker). The staff and their numerous friends were entertained to a capital programme, including vocal and instrumental music, dancing, etc. Naturally, the telephone undertaking itself was brought into requisition in adding to the attractions of the evening, as, by permission of Mr. Councillor Beryl, the proprietor of the Theatre Royal and a member of the Telephone Committee, the music of "The Girl from Kay's" could be heard on the electrophone, and was greatly appreciated. Mr. D. J. Barnes, the popular manager of the department, with Mrs. Barnes, ably did the honours of the evening.

**Wireless Telegraphy in the Navy.**—It is reported that previous to the Atlantic fleet leaving for its first cruise, each of the battleships will be provided with an installation of wireless telegraphy apparatus, the Admiralty having decided to take this step as the result of the improved reliability of wireless telegraphy in the British fleet. Owing to the improved apparatus, it is expected that ships on detached service will be able to keep in touch with the flagships of their respective squadrons at a much greater distance than was possible a year ago, thus considerably increasing the tactical area of the fleet's movements. It is also stated that the Admiralty intend to instal the system on several cruisers, thus enabling them to make reports direct to their flagships while maintaining their position in the "scouting line," which can then be far out of the present visual signalling range.

**New Publications.**—Messrs. Whittaker and Co. will shortly publish a new book entitled "The Insulation of Electric Machines," by H. W. Turner and H. M. Hobart. This work is the result of several years' practical experience with insulating materials and of careful study of their insulating properties.—"The Colliery Manager's Pocket-Book for 1905," by R. A. S. Redmayne. (London: "Colliery Guardian" Company, Limited. 2s., 3s., and 4s. 6d.) In addition to the usual almanac and diary features, this publication contains special articles upon "Deep Mining," "Coal-Cutting by Machinery," "The Coalfields of the United Kingdom," and a review of the chief events of the year, besides a quantity of statistics.—"Second Stage Magnetism and Electricity," by R. W. Stewart. (London: University Tutorial Press, Limited. 3s. 6d.) This treatise has been brought up to date, and covers all the requirements of the Board of Education's advanced examination.

**Railway Electrification.**—After having virtually decided upon the electrification of the Springs-Randfontein section of the Central South African Railways, it appears that the Inter-Colonial Council have shelved the project, some of their number being apprehensive about its success. This is rather surprising after the scheme which had been evolved by the authorities in consultation with Messrs. Mordey and Dawbarn, and particularly as a large firm of contractors was prepared to undertake the work and accept payment by instalments out of the profits. This arrangement, it is estimated, would have repaid the cost of conversion in little more than eight years without any capital being raised. Railway affairs in South Africa have become somewhat involved of late, judging by reports in the daily Press, but it is to be hoped that the electrification of the line in question will not be long delayed, as the figures reported in our issue of the 16th ult. indicate that the scheme is a promising one.

**Southern Nigeria.**—It is reported that Captain J. P. Moir, D.S.O., R.E., who has been appointed by the Colonial Office to take charge of the telegraph construction in Southern Nigeria, is about to depart for Lagos. He will be followed in a fortnight by a party of non-commissioned officers, who will superintend the working parties on the line of construction. After conferring with the commissioner at Lagos, Captain Moir will make a survey of the line to be followed. The actual work of construction will begin in March with the lines on the delta of the Niger, so that this portion of the work in the swampy country can be got well in hand before the rains commence. The work involves the erection of some 400 miles of telegraphs, and will occupy a year. When completed, Calabar and Lagos will be connected by land wires independent of the cables. From a point on the line between Calabar and Bonny the line will be carried to Onitsha, on the Niger, and thence to Benin, Warri, and Lagos, where it will effect a junction with the telegraph to Kano and Sokoto.

**Wireless Telegraphy.**—In replying to the brief discussion on his interesting paper, "Wireless Telegraphy and War Correspondence," read before the Society of Arts on the 18th inst., Captain Lionel James intimated that one of the reasons which prompted him to select the De Forest system was that communication was more rapid by that than any other. He stated the figures as 30 or more words per minute, as against the 10 or 12 of the other systems he had investigated. As an avowedly non-technical man, Captain James did not discuss the distinction between receiving messages by sound-reading instruments and recording instruments, but Mr. Cuthbert Hall, the managing director of Marconi's Wireless Telegraph Company, remarks in a communication to the *Times* that it is misleading to compare sound-reading instruments with recording instruments. He also states that the speed of his company's recording instruments is very much more than 10 or 12 words per minute, and that the speed of their sound-reading instruments is only limited by the capacity of the operator at the receiving station to read by sound. If, says Mr. Hall, an operator capable of reading by sound at the rate of, for example, 100 words per minute were available, there would be no difficulty in communicating at that speed by the Marconi system over 10 times the distance covered in the Far East operations described by Captain James.

**Telegraphic Achievement.**—The Washington and Sydney Observatories, with the telegraph administrations concerned, co-operated in the dispatch of time signals on New Year's Eve between the two observatories. An official of the Sydney institution now reports as follows: "The first set of signals were received satisfactorily, the 3 p.m. contacts being recorded here at 3 hours and 3·57 seconds. Of the second set only 30 signals were received altogether, the 4 p.m. signal reaching here at 4 hours and 3·66 seconds.

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The third set was satisfactory, the 5 p.m. signal reaching here at 5 hours 2·76 seconds. The fourth set was satisfactory, the 6 p.m. signal reaching here at 6 hours 2·55 seconds. The final mean was 3·14 seconds. Cutting out the second set, the mean gives 2·90 seconds. This concludes the arrangements at present existing, and the rapid time in sending the great distance separating Sydney and Washington, over 12,000 miles, is a triumph to the electrical departments of the States concerned. With many thanks and every good wish for the New Year." The general manager of the Pacific Cable Board, in communicating this information, adds that the signals through the Vancouver-Fanning cable, the longest cable span in the world (3,457·76 nautical miles), were sent by automatic apparatus, and were recorded as they passed at the Vancouver station on an instrument placed in the artificial line which balances the cable for the purpose of duplex working.

**The Orling-Armstrong Electro-Capillary Recorder.**—At the Royal Institution on Friday last the Orling-Armstrong recorder as adapted for use on submarine cables was exhibited. In order to obtain high speeds in such working, it is imperative that the recorder used should readily respond to small changes in potential difference. In this respect the Orling-Armstrong recorder working on the electro-capillary principle has several distinct advantages. It is free from self-induction faults, and, owing to the small mass of the moving parts, the mechanical inertia is very slight. With the recorder shown the full range of movement in the mercury thread was only ·5mm. The distortion of signals due to the weight of the siphon recorder coil can easily be traced by comparing the records produced by such instruments. For instance, the space between the two letters "U" and "V" is well defined on the capillary slip, whilst that between the same letters on the siphon recorder slip can only be observed by a trained eye, and that only from the general character of the line extending from the dash of "U" to the last dot of "V." The same instrument working on the electro-capillary principle is also useful for land lines in preventing to a large extent the interference caused by leakage. This leakage increases with the E.M.F. used on the lines, and with the Orling-Armstrong recorder the E.M.F. is very small. Sample records were shown, and it was claimed that with these recorders impulses at the rate of 1,000 per second could be received when the actuating potential difference was no more than one millivolt.

**Leeds Section.**—A paper on "Condensing Arrangements in Central Stations" was read last week before the Leeds Local Section by Mr. J. D. Bailie. The first part of the paper was of an elementary character, the reason of this being that the author considered that sufficient attention was not always given to the question of the most suitable type of condensing plant, or the general arrangement of the condenser itself and its accessories. Mr. Bailie emphasised the importance of the water supply as a primary consideration in the selection of the type of condenser. For example, if cooling towers were used, the surrounding atmosphere should be taken into account, as, the same water being used again and again, it might collect impurities from the atmosphere. He quoted an instance of some steelworks at Sheffield, where the chemical action resulting from this cause had converted the water into a corrosive medium. Generally, he found that, wherever practicable, condensing should be resorted to, and in many instances he thought it would pay to pump cooling water from considerable distances. Accessibility to the various parts of the condensing plant was another important factor. Examination should be systematic. Gauges should be fitted wherever desirable. Thermometer pockets and thermometers should be permanently fitted to the circulating suction and discharge connections and to the air-pump discharge. Logs should be kept of the quantity of circulating water passing, also of the several temperatures, and a look-out kept for leakage. In fact, tests of every principal part and function should be regularly made and studied, so that defects might be promptly detected and remedied.

**New Low-Temperature Phenomena.**—A lecture on this subject was delivered at the Royal Institution last week by Sir James Dewar. Having liquefied and then solidified hydrogen, Sir James directed his attention to helium, which is the only element that now resists the extreme forms of cold, and intimated a possible advance towards its ultimate subjugation. By means of Sir William Crookes's radiometer the lecturer then demonstrated the remarkable power of charcoal to absorb gases. Taking a radiometer with the bulb containing air, and connecting it with charcoal, reduced to the temperature of liquid air—minus 185deg. C.—the bulb immediately became a high vacuum, and the vanes revolved at a rapid rate. In another experiment phosphorus was placed in a small bulb above another filled with oxygen, both substances being quite dry. In this condition the phosphorus will not ignite. Then the oxygen was connected with charcoal chilled by liquid air. The bulk of it was absorbed by the charcoal; the phosphorus became gaseous and combined with the oxygen, and made the bulb luminous, showing that at the temperature of liquid air substances will combine chemically, even without moisture. Finally, the professor took a radiometer filled with helium, and on this charcoal cooled by liquid air had no effect. He then plunged the carbon into liquid hydrogen at the temperature of 20deg. C. absolute, representing about 456deg. of frost. Immediately the helium began to be absorbed by the charcoal, a vacuum was formed, and the vanes of the radiometer revolved. This suggests a further field of research, and a new means of separating from the air the rare gases recently discovered—argon, helium, neon, xenon, and krypton.

**Overhead Telegraph Wires.**—In the course of his recent paper before the Tramways and Light Railways Association, Mr. H. M. Sayers made the cogent statement that in the streets of some towns the only picturesque object visible is a neatly-constructed overhead equipment, and it certainly must be said that the æsthetes often call out with inadequate cause. At the same time one can appreciate the objections to the extensive use of overhead telegraph or telephone wires on open spaces. Early in last session the Postmaster-General sought power to dispense with the consent of the Conservators of Commons and Open Spaces, but, in consequence of the opposition evoked, the Bill was withdrawn. The General Post Office has, it is stated, since been active in endeavouring to attain the same end by obtaining the consent of the various highway authorities to the erection of overhead wires, with the result that the disfigurement of commons and places of unique attraction is proceeding at an increased rate, much to the alarm of those who are interested in preserving the natural aspect of open spaces and the amenities of picturesque districts. At the instance of the Commons and Footpaths Preservation Society, the Postmaster-General consented to receive a deputation yesterday, when representatives of the various open space societies and of numerous local authorities were expected to urge upon him that rural districts of special interest or beauty, and especially commons and open spaces, should be treated as sacred. It is proposed that in such cases alternative routes should be adopted, or the wires laid underground. Where no substantial addition to the cost is involved, these

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suggestions are deserving of consideration; but we live in a commercial age, and sentiment has perforce often to be subordinated to utility.

**Royal Meteorological Society.**—The annual general meeting of this society was held last week, Captain D. Wilson-Barker, F.R.S.E., the president, being in the chair. The council in their report referred to the fact that during the summer the Admiralty had placed at the disposal of the Kite Committee H.M.S. "Seahorse" for the purpose of carrying on the kite observations off Crinan. The average height attained was about one mile. Mr. Richard Bentley, F.L.S., was elected president for the ensuing year. Captain Wilson-Barker delivered an address on "The Connection of Meteorology with other Sciences." He said that meteorology and astronomy were doubtless the first of the sciences to attract the attention of man. Which of the two exerts most influence on the well-being of humanity was a matter dependent on the position of the globe. In many regions people are but slightly affected by the weather, while the heavenly bodies—particularly the sun—exert an enormous influence on human life. Everywhere in Nature we find the effects of meteorological agencies. After speaking upon the effects of evaporation—winds, rain, ice, snow—and pointing out the influence of weather on animal life, vegetation, health, etc., he said that meteorology was a science deserving more attention than it received. He thought it ought to be recognised as a preliminary to the studies of geography, geology, and kindred subjects, and he considered that meteorological observatories might very well be fitted up in schools, and pupils taught to observe. This could be done at a small cost of time or money. The tendency at present was to particularise in all scientific work, but the true path to progress laid in keeping a comprehensive outlook on the whole field of investigation. The United States have devoted much attention to meteorology with most satisfactory results. He regretted that official help and encouragement were so deficient in this country. The difficult nature of meteorological problems should but serve as an incentive to their elucidation. The persistent observer gains much, not only in knowledge of the subject, but in the habits of close and accurate investigation which he insensibly acquires, and all workers in the field learn to appreciate the difficulties which confront their fellow-labourers, and to recognise the value of what has been done by the meteorological organisations of the world.

**Accidental Electrocution.**—The *Lancet* reports a discussion by the members of the London Clinical Society upon a case of accidental electrocution which caused gangrene of all the extremities. The deceased, a healthy lad aged 15½ years, was employed at the London Electric Supply Corporation's station in Blackfriars-road. The current is received at this station from Deptford at high pressure, the maximum being 10,000 volts. Transformers are located on both sides of the station, and those on either side are "alive" in turn. The lad mounted one of the "dead" transformers to dust some slabs of slate above, and in descending the iron plates on the soles of his boots caused him to slip on the iron of the transformer, and, overbalancing, his right hand came in contact with the main cable carrying the 10,000 volts. The current, it is imagined, passed through him for about 30 seconds, when a man, attracted by the flash of the escaping current, rushed over to the boy, who was rigid and apparently lifeless. Artificial respiration restored consciousness. When taken to the hospital he showed signs of shock, and all his limbs were gangrenous. His socks and boots were extensively burnt, and the latter were burnt through. On the third day his right arm was amputated at the shoulder joint. On the sixth day it was evident that the gangrene of the legs was spreading, and the patient's temperature was rising, so both legs were amputated. Two days later, however, symptoms of toxic infection appeared, and on the ninth day from the accident the boy died. The remarks made during the discussion by Mr. F. Aspinall, electrical engineer, suggested a new explanation of the cause of death. He stated that when an arc was formed, metals became volatilised, and he suggested that the inhalation of these vapours might prove fatal. It was stated in the course of the discussion that when an accident is accompanied by burning of the skin, the shock is usually less severe. Allusion was also made to the now well-recognised fact that the effect of a shock is dependent more upon the nature of the contact than the voltage. Dr. S. Jellinck (Vienna) recommended that in framing rules for the prevention of accidents in establishments where electricity is employed regard should be had not only to the tension of the current, but to the dielectric condition of the ground.

**The Franklin Institute.**—We have received a copy of this Philadelphian society's *Journal* for January, which contains papers on "The Telegraphone," by Dr. Z. B. Babbitt; "The United States Patent Laws: Historically Considered," by Mr. C. N. Anderson; "Physical Characteristics of Certain Bronzes for Steam Uses," by Mr. S. L. Kneass; "Saltmaking in the Far West," by Mr. E. Goldsmith; "The Bacterial Disposal of Sewage," by Mr. G. E. Hill; and other matters. Dr. Babbitt, after tracing the development of Poulsen's telegraphone, which has already been described in our columns, asks what influence it is destined to exert upon the social system, and himself answers the question in these notable terms: "The reproductions are true to the human voice either conversational or in song, and the day will come when every family will have records made at frequent intervals—from the child's first efforts at speech through an entire life; and families will prize these records as they do photographs; national bureaus will be established for the preservation of records of speeches of our public men and women; correspondence will be carried on by the use of the disc machine in preference to the present methods. Many business transactions are carried on daily over the telephone, and the day is at hand when telegraphone records will be made of each and every transaction and filed away for reference. The telegraphone is destined to take the place largely of the present stenographer, and no business or professional man will think of writing his business letters, lectures, or sermons. The loud-speaking device, which is nearly ready for the market, reproduces sufficiently loud to fill a lecture hall, and makes it not only possible, but probable, that the telegraphone will play an important part in the entertainment field." The author incidentally mentions that on the occasion of their recent visit to Copenhagen, King Edward and Queen Alexandra manifested a deep interest in this invention. The *résumé* by Mr. Anderson, a barrister, of the United States patent laws is interesting from the historical standpoint. The author recalls the fact that the American patent system was based upon a statute of James I. The first patent law of the United States was enacted in 1790, and in 1836 a code was framed which forms the substance of the present system. The author calculates that something like 80 per cent. of American manufactures are the subject of patented inventions.

**Mercury Lamps in Practice.**—The Cooper Hewitt mercury lamps have recently been installed in the new building of the New York *Times*. This building consists of a large block 476ft. high, and all the machinery in it is to be electrically driven. The equipment of the building involves some 21 miles of conduit and 74 miles of wire,

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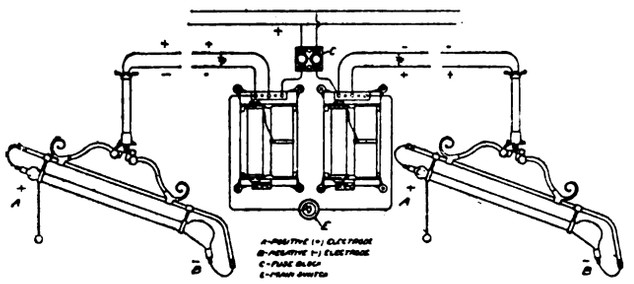
and it is said that it will use over 1,000 units daily from the public mains. Apart from the motor equipment, on which we do not propose to touch, the interesting feature is that the lighting, both in the machine rooms and in the compositors' rooms, is carried out by means of the Cooper Hewitt mercury tubes. The colour of the lighting advertises the building from any point of the city. From the description of this installation which appears in the *Electrical World* of New York, we gather that in the press and stereotype rooms alone 26 of these lamps are used, and that these replace no less than 132 incandescent lamps and 14 arcs, although consuming only one-third of the current. These lamps light four large presses and a floor space of 17,000 square feet. The departments are 21ft. high. The diffused light obtained from these long tubes has entirely obviated the necessity of carrying wires all round the presses. In the whole building there are 42 lamps of the H-6 type, which are operated, two in series, off the 118-volt supply mains. The connections are shown in the



accompanying diagram, each pair of lamps taking 3½ amperes. In making out the original estimate for the lighting of the building, 15 kw. were required for the arcs and incandescent lamps. The Cooper Hewitt outfit actually takes 5·46 kw. Quite apart from this there has been a considerable saving in the wiring, owing to the smaller number of wiring points. The actual length of the tube used is 27¼in., but the light-giving portion is only 20¾in. The diameter of the tube is 1in. The lamps are placed within 15in. of the ceiling, which gives a good diffused light. Our contemporary states that in the type-setting department this is particularly advantageous, as there are no reflections to contend with.

**Electric Railway Progress.**—Dr. Louis Bell, in the *Electrical Review* of New York for Jan. 14, is responsible for a most interesting *résumé* on the developments in electric railways during the past year. We know of no one more able to fairly weigh up progress than Dr. Bell, and the following opinion from him as to alternating-current commutating motors is of great value. He says that "the greatest novelty of the year has been the steady heralding of a new era in which alternating current series motors shall reign magnificent. The preliminary tuning up and the premonitory blasts came last year. All this year we who wait have been hearing the fanfare echoing among the distant hills, but the head of the procession is not yet in sight. It has been announced repeatedly, but seems to be still marking time somewhere in the about-to-be To those who, like the writer, have been eagerly awaiting an alternating traction system, the delay is a keen disappointment. The conviction is growing in the engineering profession that Dr. Finzi's announcement forced the hands of the American manufacturers to a very embarrassing degree, and that while from a purely engineering standpoint some very admirable results have been reached, a policy has been inaugurated of sidestepping the issue whenever possible. There is little use speculating on the cause of this attitude, which may result from some trivial 'bugs' which still have to be exterminated, from sharp differences of opinion in the engineering staff, or merely from the desire to avoid the undeniable difficulties of badly-mixed production. The fact, however, remains that while alternating railway motors are apparently all ready for the market and are cordially recommended in cases suited to their use, such cases seem suddenly to have become most extraordinarily scarce. Why, we shall soon know, for the situation is too absurd to persist for any considerable length of time." Elsewhere in the *résumé* attention is drawn to the large locomotive for the New York Central system which has recently been tested. In this locomotive the motors are direct acting, there being no gearing between the motor armature and the axle. As the author points out, the escape from the usual dilemma between gearing and the difficulties of direct driving is very cleverly contrived. By making the truck frame part of the magnetic circuit and getting the necessary mechanical play in the pole-gaps, the weight carried dead upon the axles is actually brought below that necessary in a steam locomotive of equal power, with the advantage of the abolition of hammering due to reciprocating parts. This method also avoids the hammering due to the heavy un-spring-borne weight on the axles if the motor fields are directly supported on the same, as was the case in the original locomotives on the Central London Railway.

**Personal.**—The Society columns have been active lately with Mr. Marconi's name. Last week it was stated that he had become engaged to the Princess Giacinta Ruspoli, a daughter of one of the old Italian nobility. Later reports are to the effect that he is to contract an alliance with a compatriot of his mother. The lady named is the Hon Beatrice O'Brien, fifth daughter of the late Lord Inchiquin, and it is stated that the wedding will take place during the second week in March. The bride is of Royal descent, and the genealogists have been busy in tracing her ancestry back to Brian Boroihme, who reigned as King of Munster in the eleventh century. In 1543, however, his successor swore allegiance to Henry VIII., by whom he was created Earl of Thomond and Baron Inchiquin. Unfortunately, all these reports concerning Mr. Marconi's matrimonial affairs cannot be correct, but, as the *Express* is "authorised to announce" his betrothal to Miss O'Brien, we avail ourselves of this opportunity to tender our congratulations to the distinguished inventor.—Mr. E. Kilburn Scott, who, as already noted, is about to quit the Northampton Institute for Sydney University, delivers a valedictory address to his students in the institute's *Gazette*. He echoes the views of Prof. Perry and Mr. C. E. L. Brown that an engineer should also be something of an artist, and he also recommends the students to liberally avail themselves of the institute's fine library. He considers that they would even be justified in deleting one engineering class to attend the art department. Evidently Mr. Scott participates to some extent in the views lately expressed by Mr. Charles Hawksley, the past-president of the Institution of Civil Engineers, upon the æsthetic phase of engineering. Mr. Scott considers that engineers as a class are too "narrow," and that their conversation is too "shoppy," the result being that they are often exploited by some City financial man. The implied advice to look after the commercial as well as the technical side is doubtless good, though we scarcely think the modern engineer is so verdant as Mr. Scott suggests. Another point he emphasises is the importance of a good address, to attain which he tenders the excellent advice that students should join the Electrical Engineers Volunteer Corps. In conclusion, he alludes to Dr. Walmsley's aspiration that

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the institute shall reach the highest rank, as represented by Charlottenburg, etc.; in fact, he says, "I have mistaken Dr. Walmsley's temper if the Northampton Institute does not attain very near to this ideal." As we are going to press we hear that Mr. H. M. Hobart has been appointed lecturer in electrical engineering design in succession to Mr. Scott. Mr. M. Holroyd Smith has been appointed chief assistant in the mechanical engineering department of the institute, in succession to Mr. W. E. Curnock, who has been appointed head of the mechanical engineering department of the Technical College, Huddersfield.

**Portable Wattmeter Calibrators.** — The Fort Wayne Electric Company have developed forms of a portable wattmeter calibrator, which they designate the "ringing" calibrator and the "registering" calibrator respectively. A description of these instruments, which are designed for use without removing the meters from service, appears in the *Western Electrician* of Chicago. In the ringing calibrator a standard wattmeter of suitable capacity, voltage, and frequency, but without registering mechanism, is mounted on the inside of a wooden carrying case. The case is provided with levelling screws, and a small spirit level is set into the base. A double-pole double-throw switch, by means of which the series coils of the standard can be connected either in multiple or in series for double or normal rated current, is also located in the case.

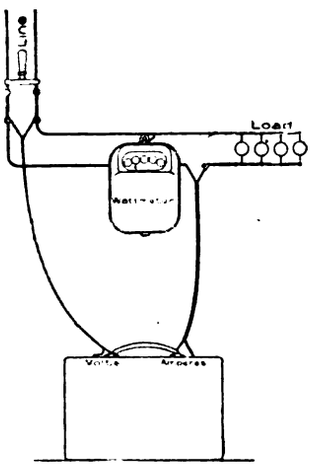



FIG. 1.

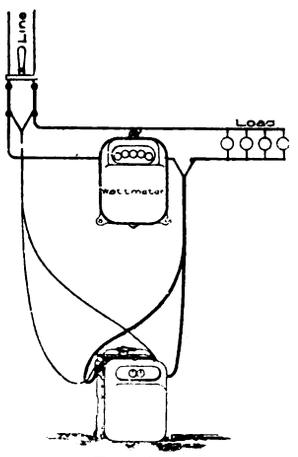
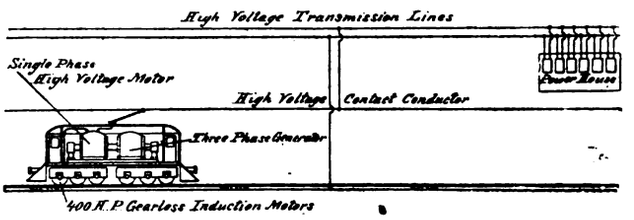



FIG. 2

For normal calibration of five-ampere meters with switch down the coils are in series; for double this current the switch is thrown up. This prepares the calibrator for use with five and ten ampere meters by direct comparisons without a speed constant, the change in connections making no change in total ampere-turns or speed. The scope of the calibrator is magnified by using a speed constant of two for testing 15, 20, or 25 ampere meters, the series coils of the calibrator being connected in multiple by throwing the switch up. For comparing the speeds of the two meters a bell circuit is connected with the standard through a two-segment commutator on its armature shaft in place of the registering train. At every revolution of the standard armature the bell circuit is closed through a dry cell battery mounted on the left side of the case, thus ringing the bell. This bell circuit may be permanently opened when not in use by a two-point switch to prevent leakage of battery current, should the armature come to rest with the commutator closed. Fig. 1 represents a diagram of connections With a heavy load the meter should be adjusted in step with the standard by means of its permanent magnet, so that the spot on the meter-cup will always come to a certain point every time the standard bell rings for 5 or 10 ampere meters, or every other time for 15, 20, or 25 ampere meters. The registering calibrator has the usual registering train replaced by a double-reduction train, and has two dials instead of five. The dials register revolutions instead of kilowatts. Fig. 2 illustrates the connections, which are similar to those in the ringing calibrator. This device is simpler than the ringing calibrator, but its adaptability is more restricted.

**Alternating-Current Railway System.**—Mr. J. H. Hallberg contributes to the *Electrical World* of New York an interesting comparison between various alternating-current systems of working main-line railways. He lays down 12 different points which should be observed in the design of such systems, amongst which is one that the driving motors should not have commutators or brushes. In support of this he claims that the efficiency of the series commutator type of motor is low, and that this fault is exaggerated when it has to be geared to the driving axle. The author describes various systems which have been tried for driving locomotives by means of induction motors, and gives due credit to Continental pioneers in this field. He describes finally his own system, of which considerable detail is given. In it the high-voltage transmission line is connected directly to the contact conductor suspended over the track. The high-voltage transmission would be by single-phase currents at any voltage up to 15,000, with a frequency of about 25 cycles. In consequence of the connections there would be no sub-stations, but the locomotive would carry its own transforming apparatus. He proposes to use on the locomotive one large motor-generator. The motor would, of course, be of the single-phase synchronous or induction type, but later on Mr. Hallberg refers only to the synchronous type. This would drive mechanically a




three-phase generator. Owing to the absence of any commutating apparatus, the very high speed of 1,500 revolutions is suggested, which would enable a 2,500-h.p. set to be carried. The three-phase generator would be a four-pole machine provided with special connections, so that the polarity of one set of poles could be reversed. In this way it could be operated either as a 50 or a 25 cycle machine, which gives a speed variation on the motors of 50 per cent. In addition to the speed variation obtainable by frequency, the author proposes to regulate the field current on the three-phase generator so as to make a proportionate change in the current delivered to the driving motors. These would be of the standard three-phase induction type, wound for a frequency of 50 cycles and a voltage of 1,000. The author claims that the system has several advantages, amongst which is one that power could be returned to the line when the speed of the train had to be reduced. The approximate weight of a 3,000-h.p. locomotive of this type, including the motor-generator set, would not, it is stated, exceed 175 tons, and an overload up to as much as 4,000 h.p. is said to be possible. At the end of the article some figures of comparative efficiencies are given, which need to be carefully considered. With the use of induction motors there is a considerable economy in the introduction of pole-changing devices for speed regulation, and in consequence the Hallberg system has a higher over-all efficiency than some of the others described. It remains to be seen, however, whether the complications introduced by the pole-changing and by the high-speed motor-generator carried on the locomotive will be acceptable to railway engineers.

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## ARMATURE WINDINGS OF THE CLOSED-CIRCUIT TYPE.

BY WM. CRAMP.

(*Continued from page 79.*)

**Comparison of Bipolar and Multipolar Machines.**

The electromotive force existing between the positive and negative terminals will be that due to the number of active spirals existing between the brush and its neighbour (in this case three); and it is, therefore, independent of the number of pairs of poles and equal to the electromotive force generated by a bipolar machine with the same total number of spirals as this winding, and the same number of lines per pole, and running at the same number of revolutions per second as shown in Fig. 2; because in the two cases the product of spirals multiplied by lines cut per second will be the same. The arrangement of circuits of Fig. 1 as depicted in Fig. 3 may be compared with the corresponding diagram for Fig. 2 shown in Fig. 5. This comparison clearly demonstrates the fact that the two extra poles which Fig. 1 possesses above Fig. 2 simply results in placing two extra circuits in parallel with the original two, with the use of two extra brushes.

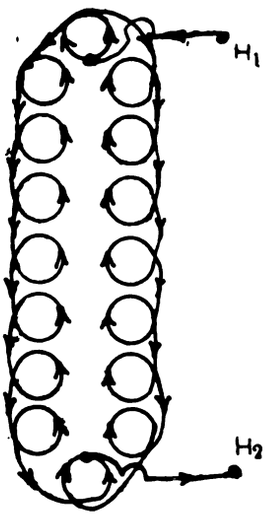


FIG. 5.

To contrast these two cases more clearly we may place them side by side as below:

| | Fig. 1. | Fig. 2. |
|---|---|---|
| Number of poles | 4 | 2 |
| Lines per pole | N | N |
| Total lines cut by one inductor per revolution | 4 N | 2 N |
| Total number of spirals on armature | 16 | 16 |
| Spirals per circuit | 4 | 8 |
| Electromotive force per circuit = product spirals per circuit × lines per revolution | 4 × 4 N | 8 × 2 N |
| Number of circuits in parallel in armature | 4 | 2 |
| Number of brushes | 4 | 2 |
| If the wire is the same in the two cases and its safe current is A amperes, then current from $T_1$, $T_2$ | 4 A | 2 A |
| Kilowatts output | 64 N A | 32 N A |

From the above analysis it is clear that the temperature rise in Fig. 1 would be very much higher than in Fig. 2, since both have the same cooling surface. It is, of course, assumed that the speed and pole-arc are the same in both cases.

It should be noticed that any one of the spirals in Figs. 1 and 2 might have been made up of several complete turns about the core, resulting in proportionately increased electromotive force; or, instead of having a total of sixteen spirals, there might have been any number, odd or even. The limiting conditions are (1) the space available on the armature, (2) the fact that the number of turns must be a multiple of the number of commutator sections, and (3) the number of turns per section consistent with sparkless commutation (a subject which we must omit). In any case, whatever number of spirals may be decided upon, the following general deductions remain unchanged:

(1) The winding requires as many brushes as poles.

(2) The winding is grouped by the connection of the brushes into as many parallel circuits as there are poles.

(3) The addition of another pair of poles with the same number of lines per pole simply adds another pair of circuits in parallel with the original number; thus the voltage given by the machine is not necessarily increased by the additional pair of poles, but the current which may be taken from it *with the same voltage drop due to armature resistance* is increased (approximately doubled).

(4) There may be any number of spirals on the armature, but this number must be equal to or a multiple of the number of commutator segments.

Such windings as these are designated by Parshall and Hobart *multiple-circuit windings because the minimum number of circuits possible is equal to the number of poles.*

**Cause of Re-entrancy.**

We have said that the winding in Fig. 1 is a *re-entrant* winding because it closes upon itself, and it is necessary now to enquire *why* it closes upon itself. A glance at the diagram shows that it is because the distance A B is an exact fraction of the armature circumference. In this particular case with sixteen spirals the distance A B (the pitch of the screw, we might call it) is one-sixteenth of the circumferential length of the armature. Hence: (5) A multiple-circuit winding will be re-entrant if the distance from spiral to spiral in the order of connection is $\frac{1}{S}$ of the total armature circumference, where S is the number of spirals.

**Pitch.**

Now we shall have occasion frequently to refer to this *distance* from spiral to spiral. There are two methods by which it may be expressed. The first is by speaking of it as a definite fraction of the armature circumference; thus, if a ring armature has sixteen spirals connected in series, we should call this distance one-sixteenth of the armature circumference. In this method of expressing the distance or *pitch* (for it clearly corresponds to the pitch of a screw) we shall speak of the *distance-pitch*, in order to obviate confusion between it and the second method. The latter consists in numbering the spirals (or inductors) in order around the armature, and then (since they are always regularly placed) speaking of the pitch as the difference between the number given to one spiral and that given to the one to which it is connected. This pitch we shall call the *number-pitch*, and it corresponds to that which Parshall and Hobart call, simply, *the pitch.*

Thus in Fig. 1 the distance-pitch is $\frac{1}{16}$, but the number-pitch is 1, because if we number the spirals

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in order as they lie on the armature the difference between the number of any spiral and the one to which it is immediately connected is 1.

It is common to calculate the electromotive force given by a machine from the number of *conductors* which lie upon the outside of the armature—"The number of *active conductors* (or *inductors*)," as it is commonly called. It is also convenient to consider a spiral as being made up of that part which lies upon the outside of the armature and cuts the lines of the field, and another part which simply forms the connection between it and the active part of the next spiral. The part which lies upon the outside of the armature and cuts through the lines of the field is termed the *inductor*; and it will naturally possess, to complete the spiral, a connection at each end. Thus, a spiral becomes an inductor with two end connections, and is, therefore, for a ring armature, in shape like a distorted and inverted U sprung on to an iron core. In a ring winding all the wires which pass within the armature are *inactive—i.e.*, generate no electromotive force—so that the number of active inductors in a ring winding is equal to the number of spirals. If the axial length of the armature is great compared to its diameter, the waste of energy caused by the resistance of the long internal connection may be very large. Not only this, but a ring armature is slow to wind, for the wire must be passed by hand through the interior of the ring, which, in the case of high-voltage armatures having many hundreds of spirals, becomes a slow and tedious process. For these and other reasons drum windings have been very largely used.

**Drum Windings.**

The distinction between a drum winding and a ring winding simply lies in the fact that all the interior wires, such as those which pass through the armature at 1, 2, 3 in Fig. 1, are taken and placed on the outside of the core. In doing this, we must remember:

Firstly (since corresponding to each inductor there is one of these inner wires), the total number of inductors on the armature surface will become twice what it was in the original ring winding, so that no matter whether you wind the ring with an odd or even number of spirals, *the total number of inductors upon the surface of the corresponding drum armature must be an even number.*

Secondly, that in any spiral, such as that lying between A and B, the fact that the inner wire at 3 passes *back* through the armature, causes the current in 3 to be apparently opposite in direction to that carried by the inductor upon the surface at A. In Fig. 1, the current in the inductor, which lies on the outside of the ring at A, is supposed to come out of the plane of the paper towards the observer, and, therefore, in the wire which goes through the ring at 3 it must be passing from the observer back towards the plane of the paper, if it is to be collected at $G_1$. Therefore, if the wire represented by 3 is to be placed upon the outside of the armature, to become useful, and if it is to be directly connected to the inductor A, it must lie in a field of opposite polarity to that in which A lies. For, imagine for a moment the wire 3 placed anywhere upon the outside of the armature between A and $G_1$. It is obvious that 3, while forming the return for B, lies nearly always under the same pole as B, thereby counteracting any electromotive force generated by B, and rendering it practically non-inductive. An armature so connected would generate no average electromotive force whatever.

In Fig. 6 we have taken a six-pole machine with a ring winding of twelve spirals, and have numbered these spirals consecutively; then one of the inner wires marked C has been taken and placed upon the outside of the armature at $C^1$, where it becomes an inductor, lying under a south pole while inductor No. 1 lies under a north pole. But since the only condition determining the position of $C^1$ is that it shall lie under a south pole, we might have placed it just as well between

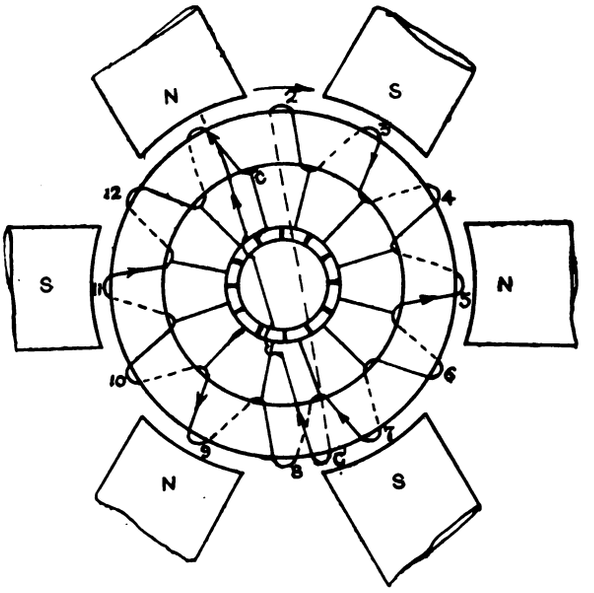


Fig. 6.

spirals 3 and 4 or 10 and 11. Obviously, it will be an advantage to place $C^1$ so that the connections between 1 and $C^1$ are as short as possible. If we remove every internal wire in the same way on to the outside of the armature, we shall get between each one of those outer inductors (which are numbered), and its neighbour, a second unnumbered inductor, such as $C^1$.

In Fig. 7 we have redrawn Fig. 6, placing in these extra unnumbered inductors. The rule for connecting

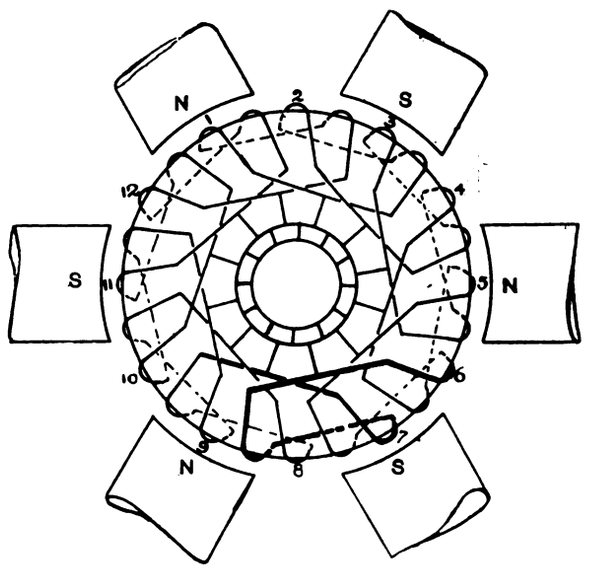


Fig. 7.

this winding is then simply this: Start from No. 1, go to an unnumbered inductor underneath the next pole, returning to No. 2, and so on. The winding may be completed as shown in the diagram. It will be noticed in Fig. 6 that we have cut through the connection C 2, but in doing so have left the connection from C to the commutator. It is clear that the connection might be made to the commutator from any part of the end connection 1 $C^1$ instead of leaving the

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connection at C. The outcome of this is the arrangement of commutator connections seen in Fig. 7.

The dotted lines in Fig. 7 represent connections at that end of the armature remote from the commutator; and one element of the winding has been accentuated so as to show clearly the fact that inductors under poles of unlike polarity are regularly connected together.

Fig. 7 is in every way the exact counterpart of the ring winding depicted in Fig. 6, having the same number of commutator segments, of poles, and of spirals upon the armature, and yet *twice the number of active conductors* (or *inductors*). It will therefore need the same number of brushes upon the commutator, and with the same field at the same speed will yield twice the electromotive force generated by such a machine as Fig. 6. The number of brushes required for the winding in Fig. 6 is, from the rules already given for multiple-circuit windings, obviously six, and this will be the number required for Fig. 7. Their position upon the commutator may be determined exactly as was done before, and the circuits through the armature might again be represented by diagrams such as Fig. 3.

(*To be continued.*)

## DISTANCE-CONTROL SWITCHES AND THEIR LAY-OUT IN STATIONS.

BY W. E. WARRILOW, A.M.I.E.E.

(*Continued from page 81.*)

In Fig. 15 another lay-out for the same design of switch is shown, but in this case the arrangement is compressed within narrower limits. The instrument and relay

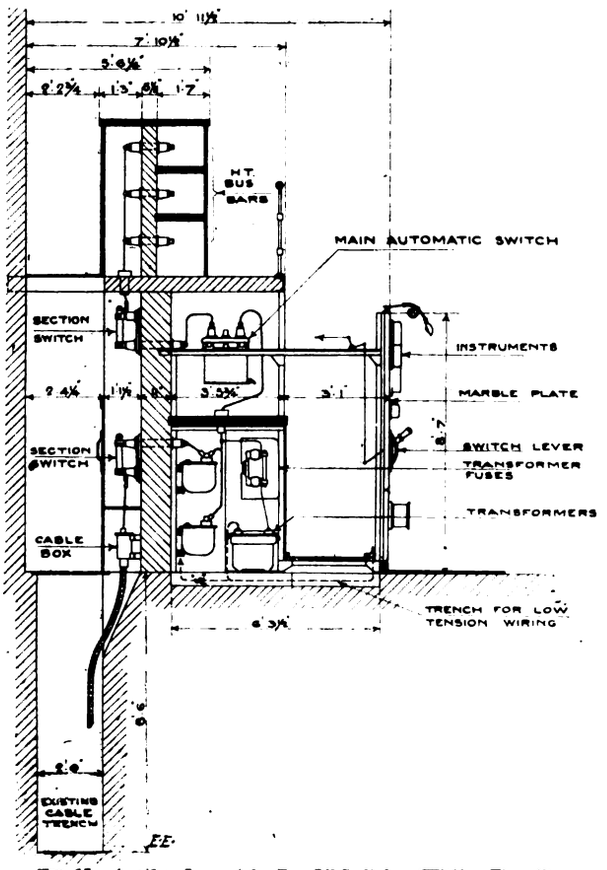


FIG. 15.—Another Lay-out for Box Oil Switches (Witting-Eborall).

transformers and oil switch are in the same position, the 'bus bars being, however, moved above the gear instead of below it. The connections to the bars can be more readily separated in this case, seeing that they pass *through* the wall to their respective bars instead of being on the same face with them. A design of this description is capable of controlling up to 1,000 kw. per panel, and is Witting-Eborall's standard for sub-station work. For generator and feeder circuits up to 1,500 kw. per panel the same firm make up an arrangement similar to that shown in Fig. 16.

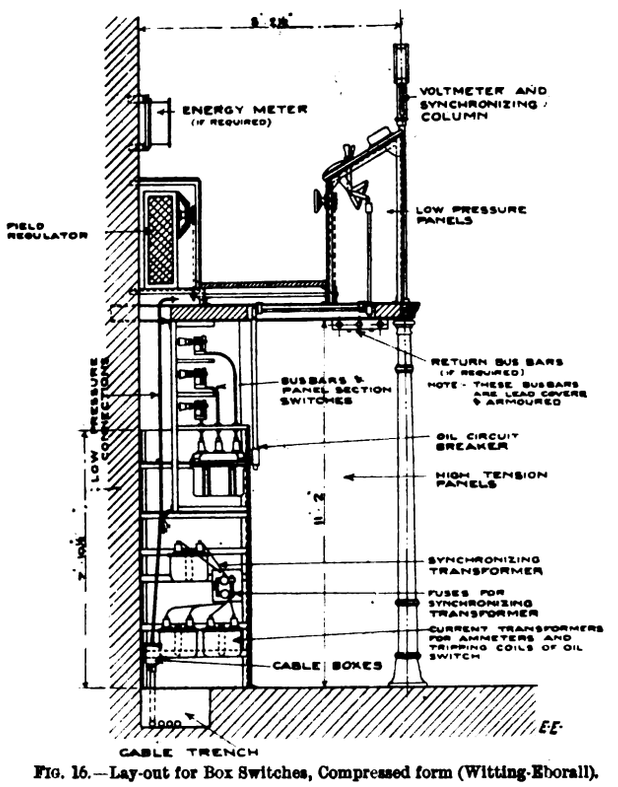


FIG. 16.—Lay-out for Box Switches, Compressed form (Witting-Eborall).

Here a complete tier is made of small transformers, oil switches, 'bus bars, and control board, the latter surmounting the whole. This gear is still more compressed, and might be employed where space is limited, as might be the case when such a gear was used to replace another type of board.

The method of operating the switch shown in Fig. 10 from a distance is illustrated in Fig. 17, but this needs little or no explanation. In Fig. 18 the cable connections are shown slung into position on insulators and clips. The

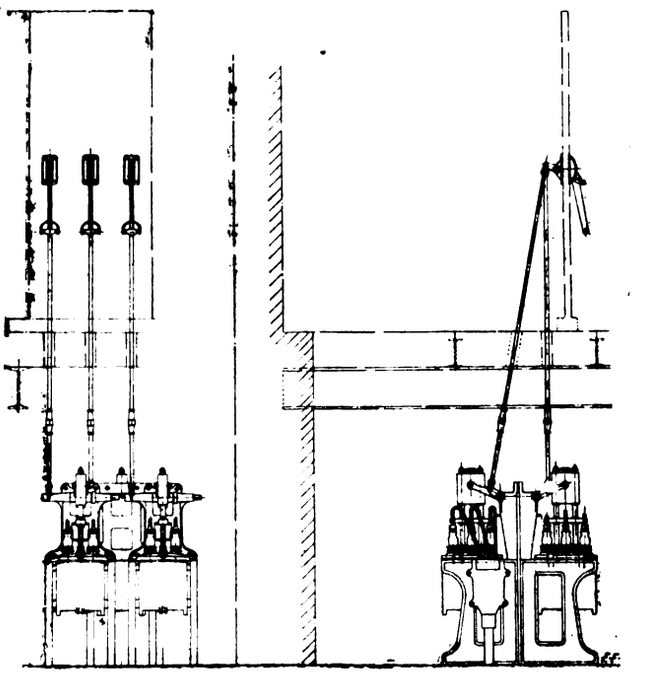

FIG. 17.—Lay-out for Oil Tank Switches (Dick-Kerr).

leads above the switches connect up to the different portions of the board, while the underground cables enter a dividing box, from which flexible tails are turned into the switch terminals. The method of thus slinging cables above the oil switches might appear risky should a fire

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ensue, but as there would seem to be no possibility of this under even exceptional conditions the risk is somewhat exaggerated.

### Electrical Control.

The electrically-controlled switch hails from America; at any rate, in so far as the application of electricity to large power switches is concerned. Phenomenal developments in power plants, with accompanying rise in the transmission voltage, practically compelled the introduction of such a switch, and as since its employment it has been a complete success, its general adoption followed as a natural consequence. It is the generally recognised thing now to provide a separate direct-current source for operating such switches, which may in turn be classified into two distinct types—(1) the motor-operated switch, (2) the magnetically-operated switch. Opinion is fairly well divided as to the relative advantages of these, though among the more recent types there is a decided bias in favour of pull magnets.

It is not difficult to apply electromagnets to almost any switch, and reference to Fig. 19 will bear out this statement. Here an ordinary box oil switch is fitted with powerful pull magnets, in place of the handle, on the front of the marble panel behind which the switch is mounted. Two magnets provide for the "on and off" pulls respectively, the plungers being coupled by a chain passing over a pulley carrying a pin for the attachment of the operating lever. This latter is connected to the oil switch in a similar manner to that employed for hand operation. In this case the switch capacity is about 3,000 kw. at 15,000 volts, and the type is the product of the General Incandescent and Arc Light Company, New

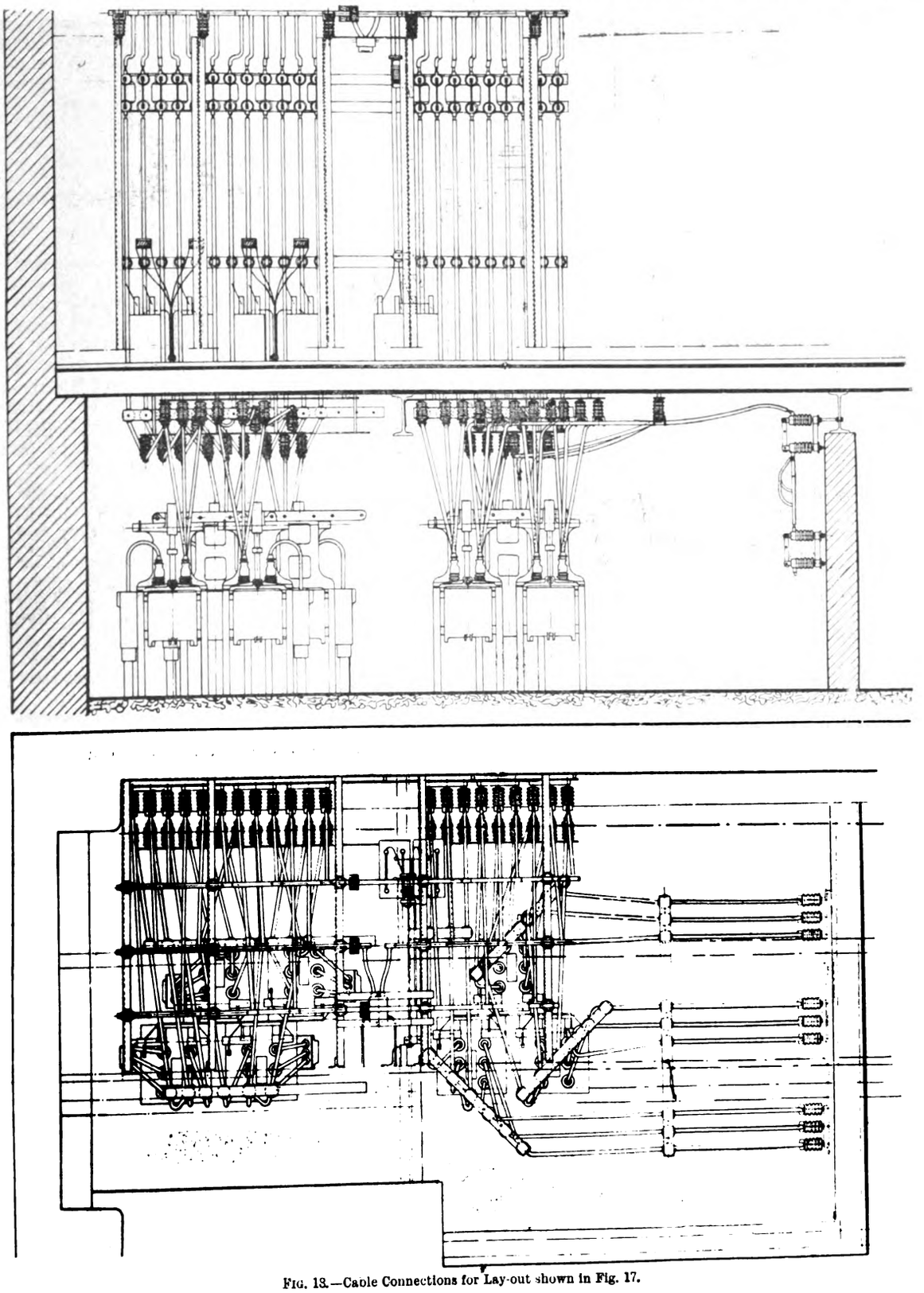

Fig. 18.—Cable Connections for Lay-out shown in Fig. 17.

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York. The same firm manufacture a larger switch on similar operating lines, but with the switches proper mounted in separate compartments for mounting in brickwork. Fig. 20 shows front and side views of this type. The pull magnets are mounted above the switch cells on

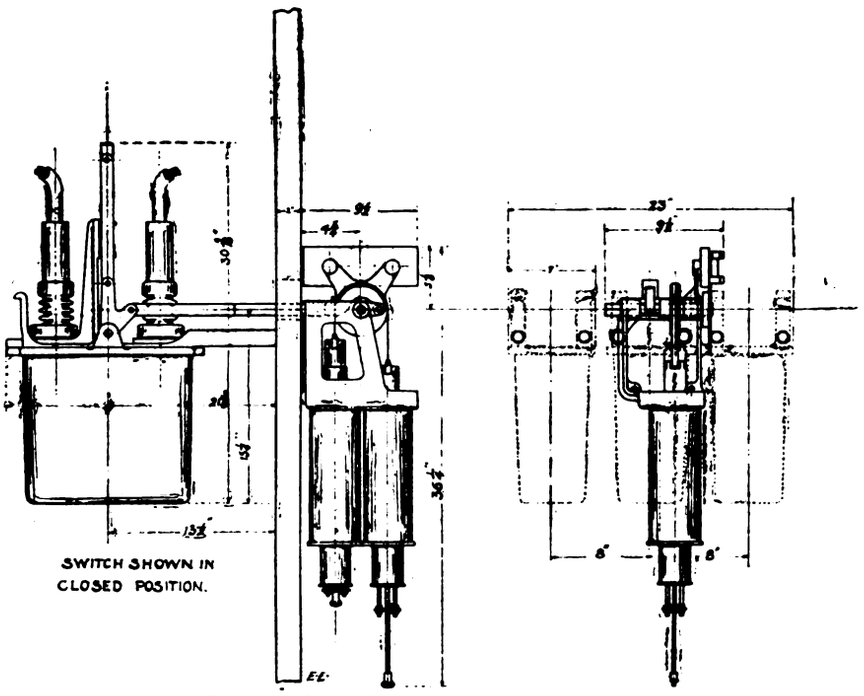


FIG. 19.—Electrically-Operated Box Switch (General Incandescent Co.).

a substantial cast-iron support, and serve to actuate the switch bar through suitable links and levers, in connection with which is a powerful spring. A small switch at the top of the device places either the "on" or the "off" magnet in circuit according to the position of the switch, though the actual closing of the magnet circuit is effected from

of the rods are fitted the bridging contacts to which the plungers are attached. There are two separate oil chambers, or tubes, per pole, each set in insulators in a small iron base, the top of the tubes being fitted with similar insulators for the passage of the switch rods. The cables enter below the switch at the two bottom contacts. Each set of oil-tubes is separated from its neighbour by brick, slate, or soapstone divisions, to confine any arcing which may arise to that particular panel. The upper and lower supports are distanced by tie-rods, which permit of adjustments in the throw being made. Switches of this character

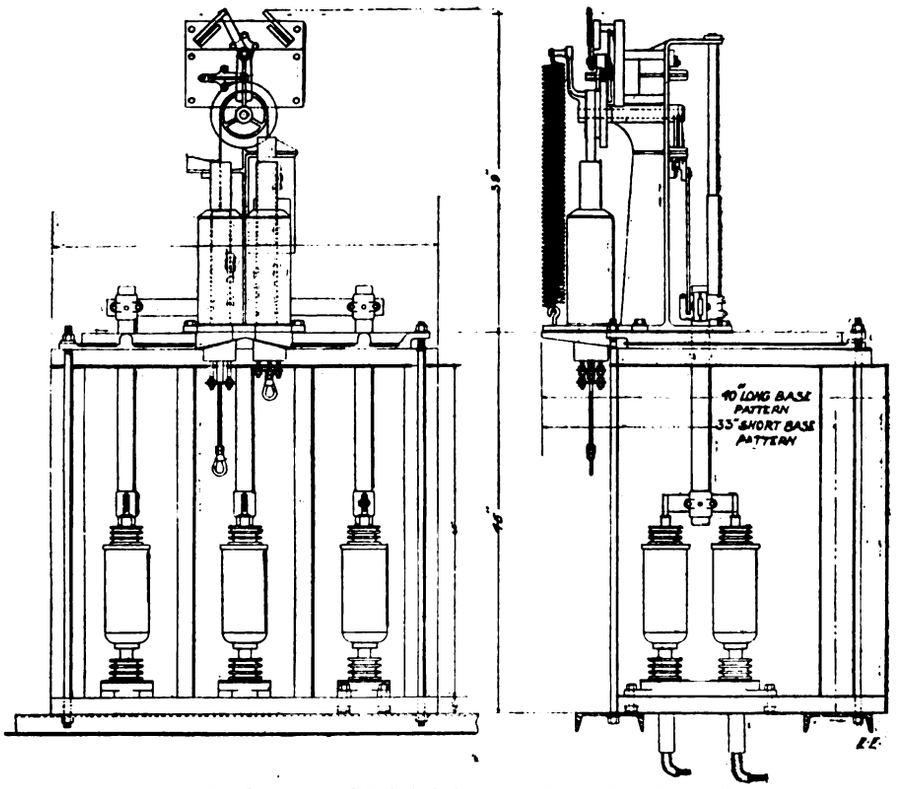


FIG. 20.—Magnet Pull Switch, large type (General Incandescent Co.

the distance control board. In closing the switch the spring is automatically wound up, and remains in a dead centre position, ready to be knocked over this centre by the pulling-off magnet directly this rises. A tripping coil to the right of the magnets in the side elevation (Fig. 20) also performs a similar function. A substantial casting couples the switch rods together above the main support, and at the other end will successfully cope with loads of 300 amperes at 15,000 volts, and they are extensively used in America on large power boards.

The foregoing type of switch requires brick compartments and special building arrangements for its fixing, and if a new switch were required at short notice, some little time would elapse before a new one could be inserted to replace

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the damaged apparatus. To ensure the complete protection of the circuit, there are cases in which two switches are placed in series and one or other utilised under normal conditions to keep all parts in working order. Should one switch fail the other is immediately opened, reliance being placed on this to open the circuit. This practice is not now adopted, but when distance-controlled switches were first used this costly precaution was perhaps expedient. The brick chamber switch has now considerable vogue, and although there are types now constructed in which the complete circuit breaker is self-contained, requiring no brick partitions except for high pressures. The brick cell arrangement, however, is deemed advisable on grounds of absolute isolation.

*(To be continued.)*

## THE FAYET-CHAMONIX ELECTRIC RAILWAY.

BY DR. ALFRED GRADENWITZ.

The railway line connecting the above towns was included in the concession obtained in 1886 by the Paris-Lyons Mediterranean Railway Company for a normal-gauge line from Cluses to Chamonix The construction of the first section of this railway from Cluses to Fayet was not particularly difficult from an engineering point of view. There was, however, a difference of level between the two terminal stations of the final section of the line (Fayet-Chamonix) of about 1,500ft. The very high gradients involved therefore necessitated an alteration in the original concession. The company was accordingly authorised in 1893 to use a track of 1m. gauge, and to employ a rack rail wherever this should prove desirable. The scheme ultimately adopted was, however, such that these rack rails were dispensed with, and electric traction used throughout the section in question. The supply of the whole electric outfit of the railway was placed in the hands of the Alioth Electric Company, of Munchenstein, Switzerland.

The length of this section of railway is about 12 miles, and there are intermediate stations at Cheddes-Servoz, Les Houches, and Les Bassons. The line is to be continued later on as far as the Swiss frontier, and from thence on to Martigny. The track follows the valley of the River Arve, and in consequence of the frequent crossings a number of iron bridges and a large masonry viaduct have had to be constructed. There are also three tunnels, the longest one of which is 415ft. long. In consequence of the great difference in level between Chamonix and Fayet, two steep gradients occur on the line. On the first of these there is a 9 per cent. rise for a distance of 2,360 yards. The other has an inclination of 8 per cent., and is 1,520 yards long.

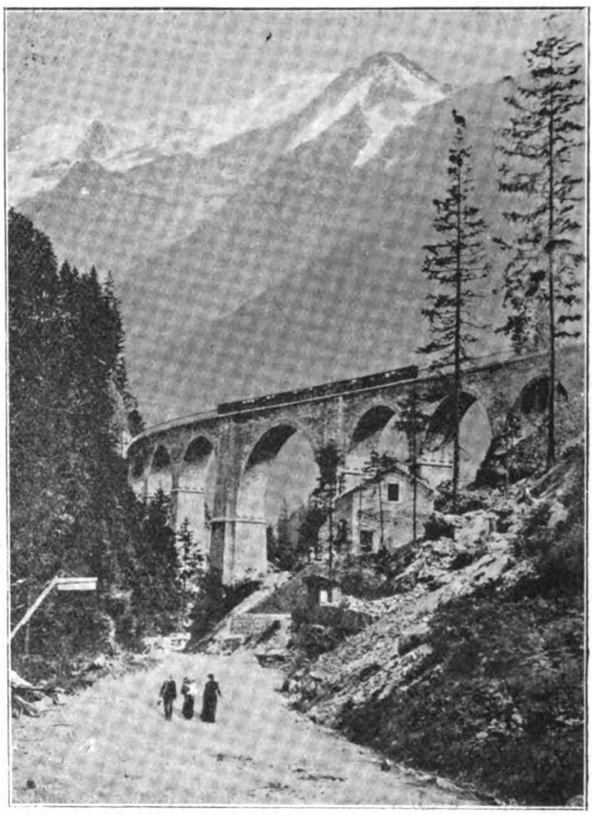

FIG. 1.—St. Marie Viaduct on the Fayet-Chamonix Electric Railway.

The remaining gradients nowhere exceed 3 per cent. The electrical energy required for operating the railway is obtained as 550-volt continuous current from two power stations, which have been erected at Servoz and Chavants respectively. In each case the water power of the River Arve is utilised. In the first central station there is a flow of about 425 cubic feet of water per second in the summer, with a head of 46ft. In winter the volume of the water available is about one-half. At the other power station at Chavants there is a head of

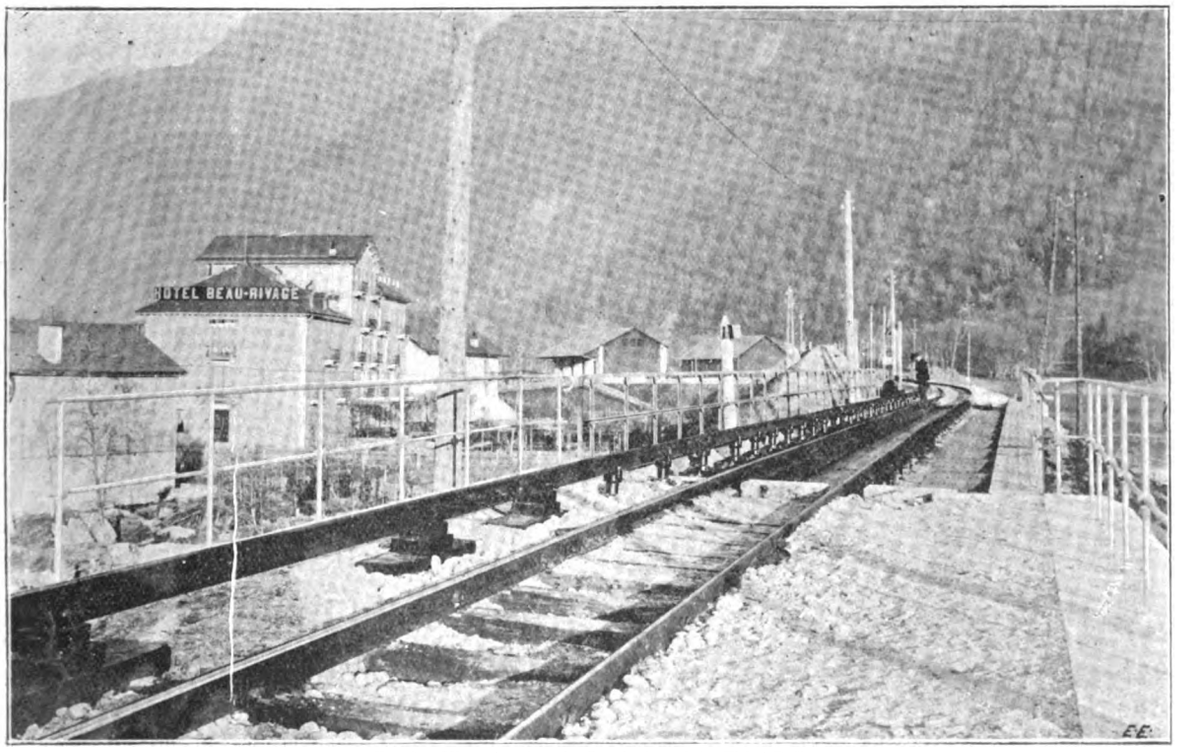


FIG. 2.—View showing the Insulation of the Third Rail.

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310ft., and the volume of water is only slightly less. The machinery in each of these central stations includes four continuous-current dynamos, with an output of 200 kw. each, which are coupled by means of elastic couplings to horizontal turbines. There are also two 40-kw. dynamos, directly coupled to horizontal turbines, for exciting the above machines. In each station three generators and one exciter are used for normal working, while the other generator and exciter act as spares.

The permanent way is constructed with Vignoles rails, 39ft. long and weighing about 63lb. per yard run. The gauge, as mentioned above, is 1m. Energy is supplied to to the motors on the train by means of a third insulated rail placed alongside the track. This conductor rail is also of the Vignoles section of the same weight as the running rails. The centre line of this third rail is placed slightly over a metre distant from the centre of the track. This is about 23in. from the inner surface of the running rail. The upper surface of the third rail is placed 9in. above the upper surface of the running rails. The position of the third rail on one side or other of the track is varied, so that the trains are equipped with two collector shoes on each side of the motor carriages. This arrangement ensures that the connection with the third rail is always maintained in spite of interruptions in the same due to level crossings, or to changing the third rail from one side of the track to the other. At crossings the third rail may be interrupted for a distance of nearly 50ft. As shown in the illustration (Fig. 4), the third rail is protected by wood when passing stations, or at level crossings, where some 30ft. on each side of the crossing is guarded in this way. The whole of the permanent way is fenced in for further protection, and the crossing places have been reduced to a minimum. The third rail is insulated by wood blocks which have been saturated in paraffin; these insulating blocks are supported on wood bearers, which are secured on to the ends of two consecutive sleepers. This insulation is said to have given satisfaction, the leakage current

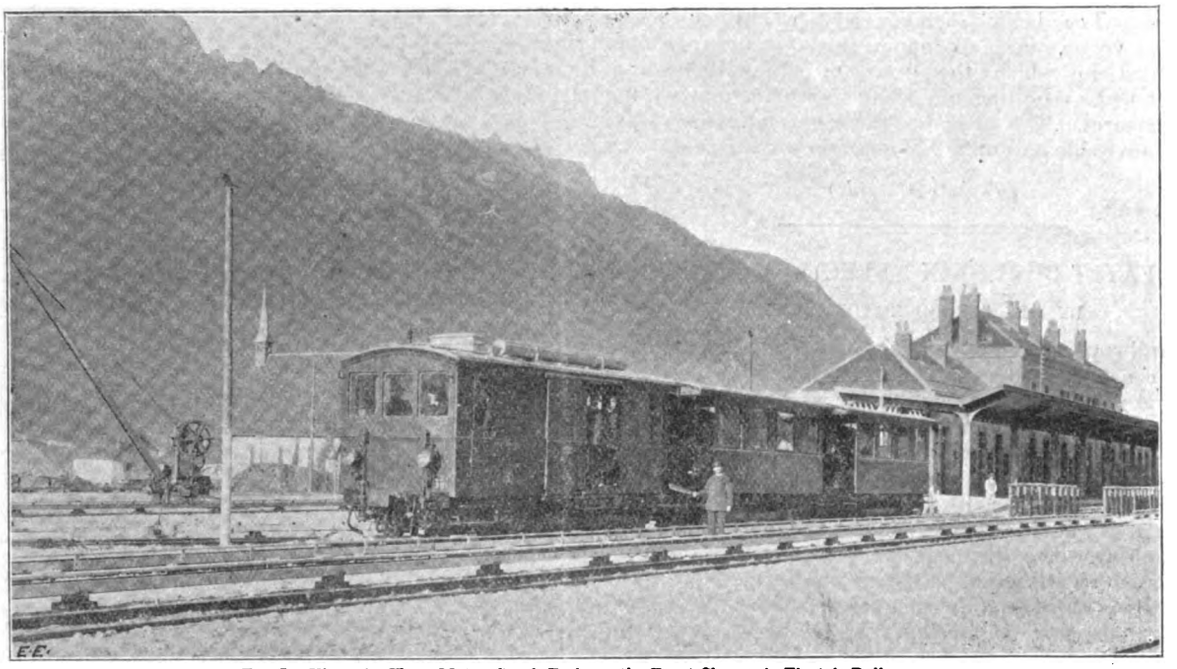

FIG. 3.—View of a Three-Motor Coach Train on the Fayet-Chamonix Electric Railway.

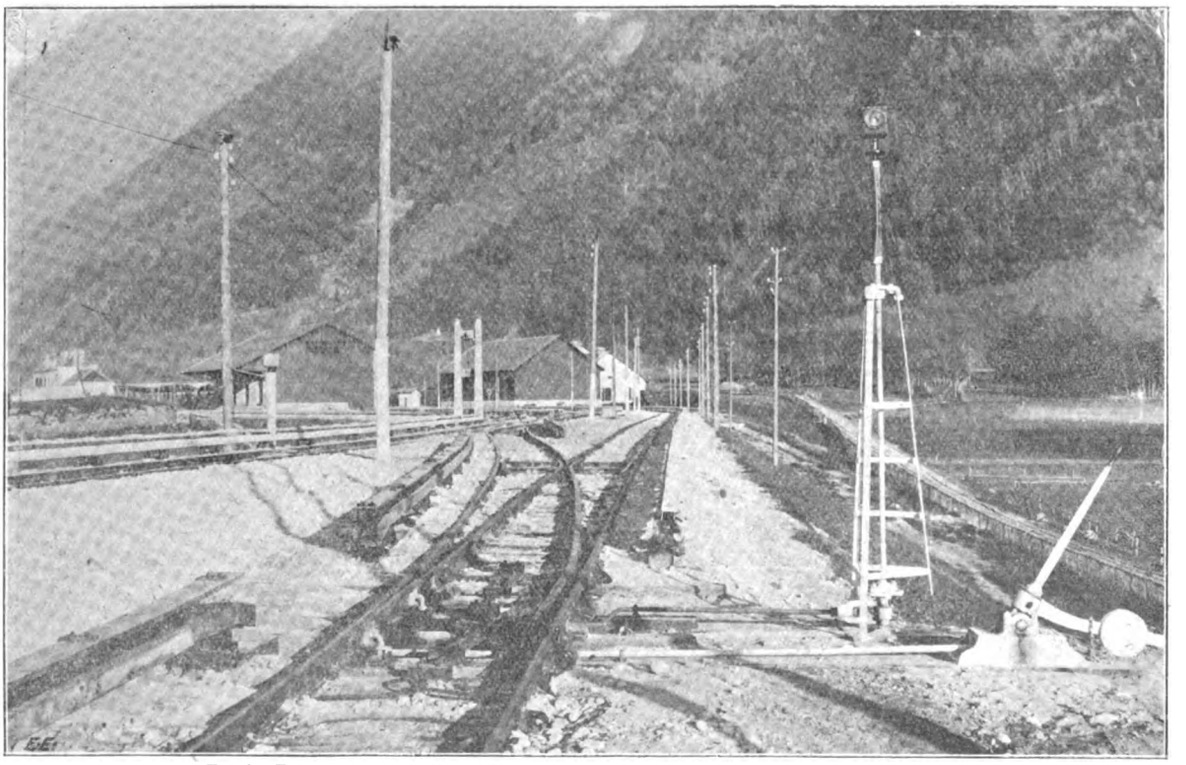

FIG. 4.—Entrance to the Station of Chamonix, showing the method of Guarding the Third Rail.

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per mile being less than 1½ amperes. It is a curious fact that this leakage should actually decrease during rain or snow. The reason for this is that the rain which falls in the Chamonix district is practically free from all chemical impurities, and thus possesses almost as low a conductivity as distilled water. This rain removes dust from the supports of the third rail, and hence increases the insulation resistance. On the heavy gradients a central rail of the same type is placed between the running rails with its upper surface 2½in. above the same. This is used in braking when the trains are descending the grades, being acted upon by slipper brakes.

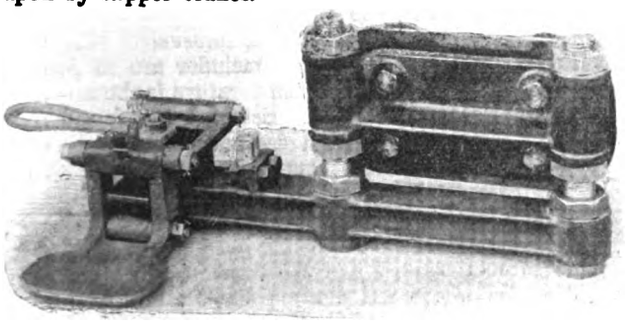

FIG. 5.—The Current Collector.

The rolling-stock was supplied by the Société Nouvelle des Etablissements de l'Horme et de la Buire of Lyons, but the Alioth Company supplied all the electrical equipment. The first order was for 80 motorcars, and further orders have recently been placed. There are also a number of trailers, each seating 40 passengers. The ordinary train will consist of between five and seven motorcars and a few trailers. It is quite possible, however, for the motorcars to be run singly, and they are in that case operated by one man. The control of the train is effected on a system due to the chief engineer of the Paris-Lyon Mediterranean Company (Mr. Auvert). The front car of every train is equipped with a master controller worked with compressed air. By means of two conductors the controllers on each of the motorcars are then controlled by means of compressed air. The actual movement of the controllers is effected by a rack working a toothed wheel on the controller shaft. Eighteen of these leading carriages are provided with air-compressor and master controllers. There are 36 passenger motorcars equipped with first and second class accommodation, which weigh when empty 19½ tons. Besides these there are 28 motorcars for goods traffic, some of which are completely closed and other half open. These goods cars are designed for the maximum load of 10 tons. Both the slipper brakes acting on the fourth rail on the heavy grades and the ordinary brakes on the running wheel are actuated by compressed air. The contact shoes are of the Alioth type, made of cast steel, as illustrated in Fig. 5, and designed so that protecting wood casings can be placed over the third rail in the stations. At points where the third rail is discontinued the last section is given a gradual slope, so as to prevent mechanical shock when a contact shoe approaches. Both the slipper brake and the brakes on the wheels can be operated by hand if need be. The trucks, of

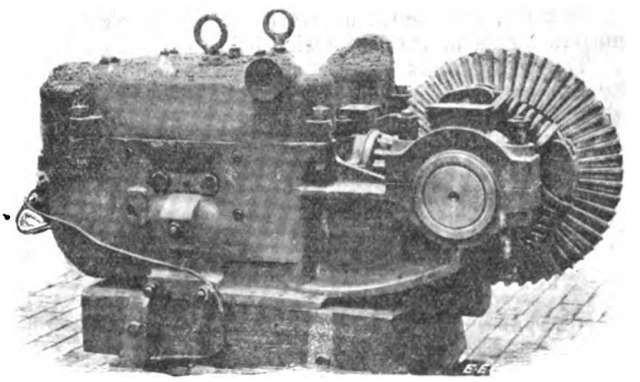

FIG. 6.—General View of Motor and Gearing, showing Spring Drive.

which there are two for each motorcar, have each two axles, one of which is motor driven. The design of the motors was rendered somewhat difficult by the gauge, which is only 1m., and by the fact that the two motors in each carriage had to be capable of taking the same up the long grades of 8 and 9 per cent. The problem was solved by placing the axles of the motor at right angles to the axle of the carriage. The motor transmits the power to the carriage axle by means of bevel gearing with a ratio of 1 to 4. The pinion on the motor shaft gears into the bevelled wheel, which is carried on a sleeve on the carriage axle and drives the same through springs, as shown in the illustration (Fig. 6). The gearing is completely enclosed, so that lubrication can be more easily effected. The use of the elastic coupling between the motor and the carriage axle is advantageous, as it reduces shock at the moment of starting. It was felt, however, that there was some danger in the adoption of the bevelled gearing. It has been found by experience, however, that the wear and tear in this gearing is very small, which is largely due to the same having been carefully cut by special machinery. The motors used are of the four-pole type, the magnets and casing being of cast steel. They are formed in two halves, which when bolted together completely enclose all the collecting gear. The field coils are wound on

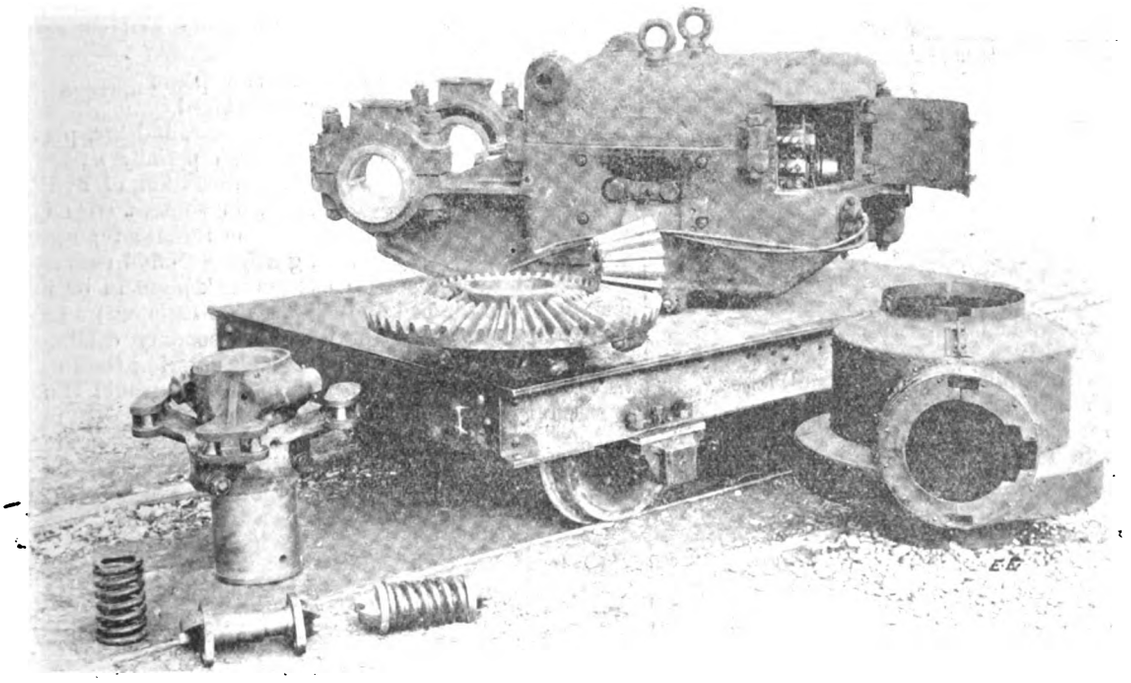

FIG. 7.—Motor Parts Dismantled, showing the Driving Sleeve, Springs, Gear Wheels, etc.

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metallic bobbins, which are easily replaceable. Copper strip 1mm. thick and 48mm. wide is used for the field magnet. The armature is of the toothed-core drum type, with 113 commutator sections. The motor can give an effective output of 65 h.p. for two hours at 550 volts with a speed of 275 revolutions per minute without any part of the magnets or armature rising more than 60deg. C. above the surrounding temperature. If, on the other hand, the motors have at the start a temperature of 40deg. C., they can be worked at 120 h.p. for 10 minutes without the temperature rise being such as to damage any part of the insulation. The brushes have a fixed lead for either direction of rotation, and the motors work without sparking at any output. This allows the trains being braked electrically. The two motors are always connected in parallel, and by reversing the direction of the current in the armature the trains can be quickly slowed up, even on the 9 per cent. grade. The fact that the wheels continue to rotate at a very low speed but are not locked gives a much better result than other systems of braking, which are apt to lock the wheels, causing the train to slide with a considerable diminution of adherence.

As regards the regulation of the motors, all the cars in a train are operated simultaneously by the driver in the front van by means of the compressed-air relays. The controllers of the cars have, therefore, to be made as simple as possible. On the other hand, on account of the considerable grades, there was a danger of slipping taking place if the motors were started in series. An extremely simple controller was, therefore, adopted with five forward and five backward positions, which allowed only for the coupling of the motors in parallel. The first four speeds in either direction are

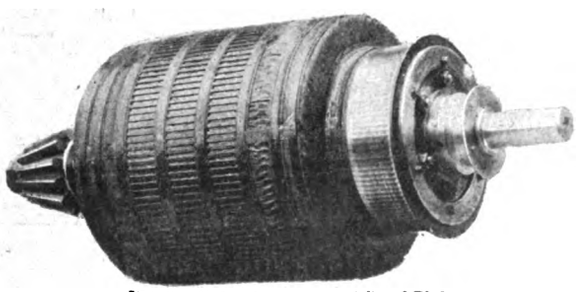

Fig. 5.—Motor Armature and Bevel Pinion.

obtained by inserting suitable resistances in the motor circuit. The fifth speed is obtained by shunting the series winding on the field magnets. The controller thus becomes a very simple one, which, in the event of a single car being required, can be worked by hand.

The regulating resistances are of a very simple type, consisting of high-resistance ribbons wound spirally with asbestos in between the adjacent layers. Each car is lighted by means of 10 incandescent lamps, connected in two parallel circuits with five lamps in series. The signal lamps are, however, of the oil type, so that the signalling may be independent of the continuity of the electric supply. In order to maintain a uniform lighting in the carriages, in spite of variation in the voltage on the line, an automatic regulator is used in the lamp circuit, which has been patented by the Alioth Company. The apparatus and equipment is so designed that the full candle-power can be obtained from the lamps on the lowest voltage likely to be met with when ascending the heavy grades. A voltage regulator then operates relays which automatically switch into circuit one or more resistances as the line voltage rises, so that the voltage across the terminals of the lamps remains approximately constant. The voltage regulator which actuates these relays is constructed on the moving-coil principle. The working of the apparatus is said to be very satisfactory, and such a device is needed on long lines where good voltage regulation cannot be economically obtained. The heating of the cars is also carried out electrically by means of electric radiators, which are controlled by means of a three-way switch. This gives three different temperatures on the radiator, so that the heating of the cars can be easily regulated.

My thanks are due to the Alioth Company for the photograph reproduced herewith, and for the information from which the above article was prepared.

## REFUSE DESTRUCTORS.

The following is a report on tests carried out on Jan. 13 and 14, 1903, by the Manchester Steam Users' Association, under the supervision of Mr. C. E. Stromeyer, their chief engineer, at the destructor works, Nelson.

The destructor was designed and erected by Messrs. Meldrum Bros., Limited, of the Engineering Works, Timperley, near Manchester, and is of their front-feed regenerative Simplex type. It has one continuous grate, 20ft. by 5ft., in a furnace chamber 22ft. by 6ft., having four separated and closed ashpits separately supplied with hot air under pressure. There are four feeding and clinkering doors through which the refuse is charged and the clinker withdrawn in rotation at regular intervals. When any one fire is being clinkered the remainder are in full work, so that a comparatively even temperature is obtained, never falling below incandescence. Between the furnace proper and the boiler is placed a secondary combustion chamber, where the maximum temperature is obtained, and where the oxidation of the gases is completed and the major proportion of the dust deposited.

The boiler is of the Lancashire type, 30ft. by 8ft., for a working pressure of 150lb., and with the usual modern setting. The combustion gases, after leaving the boiler, pass through a regenerator, where the air supplied to the ashpits under pressure by means of steam jet blowers is preheated to about 350deg. F. The gases entered the chimney at an average temperature of 645deg. F., which would easily allow of the addition of an economiser, by means of which the evaporation from and at 212deg. F. would be brought up to fully 2lb. per pound of refuse.

THE MANCHESTER STEAM USERS' ASSOCIATION.

Office, 9, Mount-street, Manchester.
July 23, 1903.

Messrs. Meldrum Bros., Limited, Timperley.

Gentlemen,—In accordance with your instructions we carried out a two days' economic test on the refuse destructor and boiler at the Nelson Corporation destructor works, Nelson. A special feature of this plant is that the air which is blown into the furnaces is hot, and the furnace temperature is naturally higher than if cold air had been used, and the chance of noxious vapours passing away unconsumed is thus materially diminished.

Steam jets are used under the firebars, and are, perhaps, an essential feature of the system, especially as regards keeping the firebars cool, but the liberation of hydrogen which takes place when steam is in contact with incandescent fuel, must tend to lower the furnace temperature somewhat. It was, therefore, gratfying to find that recombination of hydrogen with oxygen took place in or immediately above the bed of fuel, and that little or no air had to be admitted above the fires for secondary combustion, the damper being closed and little air entering the furnaces when the floors were open. The refuse would thus be exposed to the maximum temperature attainable in the furnace instead of being first partly volatilised and then consumed as gas.

Doubtless, when charging a furnace, of which there were four, the top layer of fuel will for a time give off gases, but the brick combustion chamber having a very large capacity, and being at a very high temperature, caused these gases to be at once consumed. The estimated mean temperature on the two days were 2,634deg. and 3,326deg. F., and the nickel, melting at 2,640deg. F., was fused when held in the flame.

A costly electric platinum wire resistance pyrometer was lowered into the end of the combustion chamber where the hot gases entered the boiler, and was destroyed.

The refuse consumed at Nelson was taken from exposed ashpits, and consisted principally of cinders and kitchen refuse; offal from the slaughter-houses was also burnt in this destructor, but in view of the nature of this fuel being totally different from that burnt during the rest of the time, it was considered advisable not to complicate matters by burning this offal during the test. It may here be mentioned that refuse of this nature is shot into the extreme end of the combustion chamber, so that noxious

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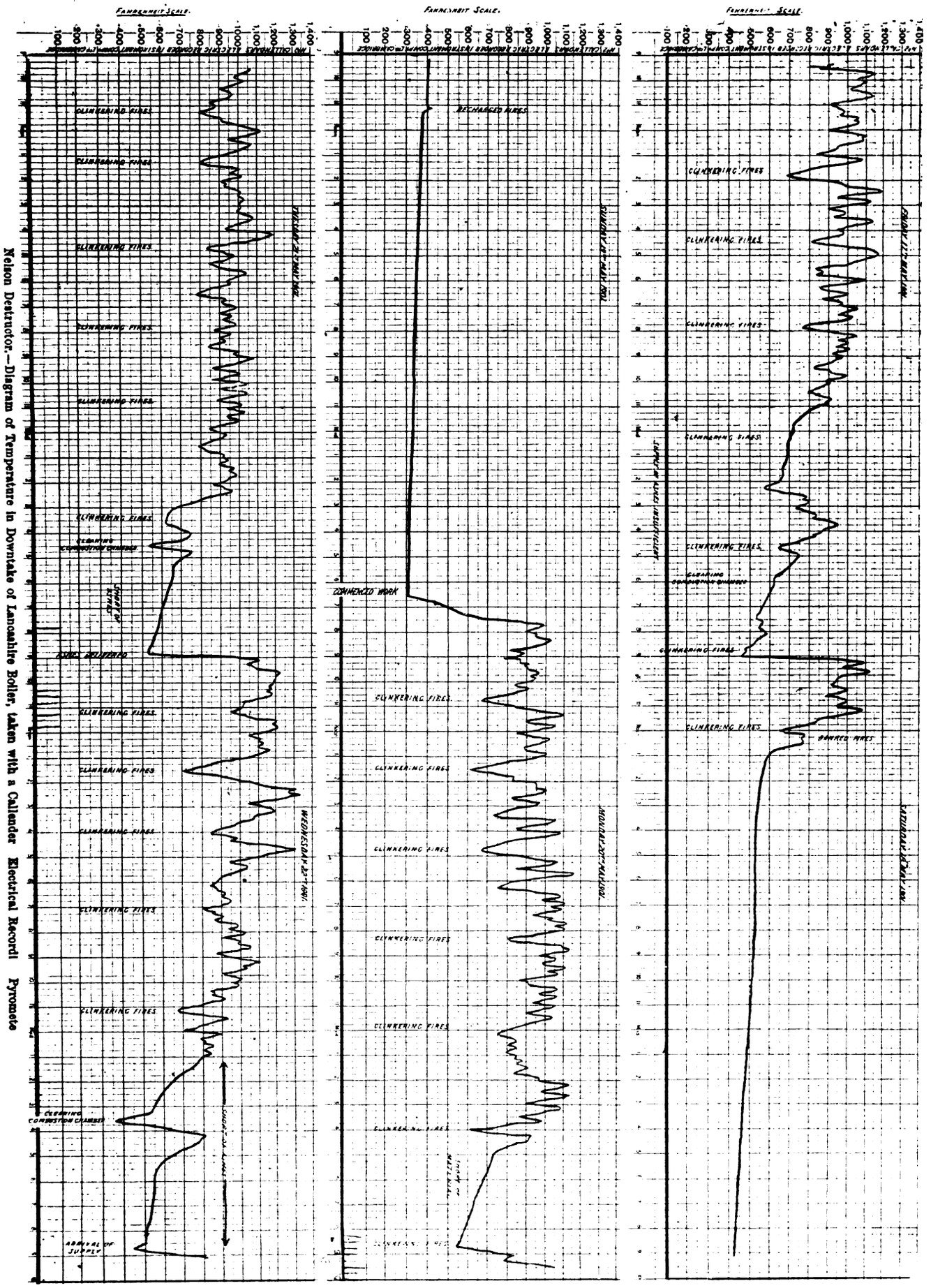
gases which would be generated have to pass over four furnaces, whose fuel is on such occasions purposely well burnt through.

the next lot was tipped. The two days' trial, therefore, consisted of a series of six short ones, which could be compared amongst themselves. The ashes drawn from the




Nelson Destructor.—Diagram of Temperature in Downtake of Lancashire Boiler, taken with a Callender Electrical Recordi Pyrometer

The trials were carried out on Tuesday and Wednesday, Jan. 13 and 14, 1903. The refuse was weighed on entering the premises. A sufficient quantity to last for nearly three hours' run was tipped into the bin, and was burnt up before furnaces were placed in the yard to cool, and were subsequently weighed, sampled, and analysed.

The feed water was carefully measured by means of three tanks. The temperatures were taken of the feed

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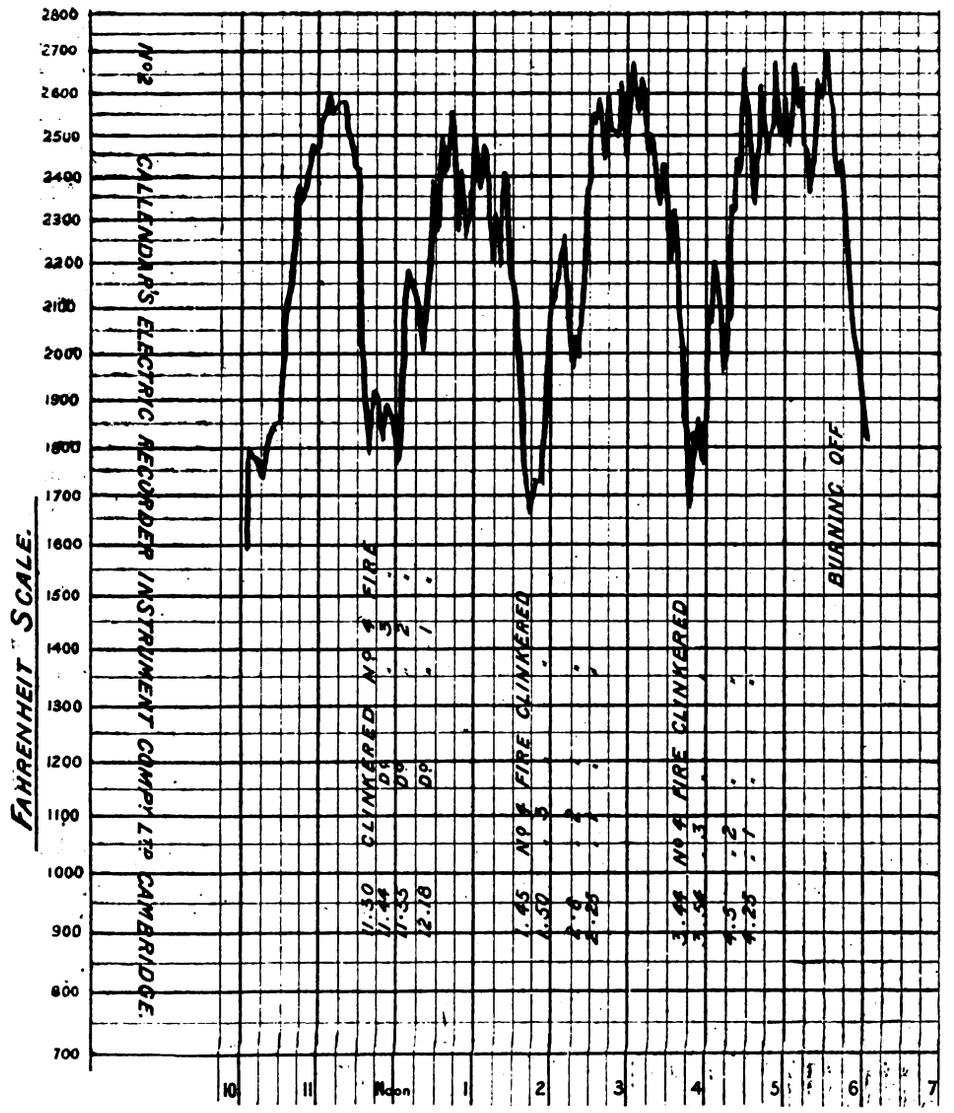
water, of the air (dry and wet bulb), of waste gases in the side flues before entering the air heater and after leaving it; also of the air supply to the furnaces both before and after heating.

Continuous gas samples were collected and analysed at once in an Orsat apparatus, and continuous gas samples were taken from the same suction pipe and passed through calcium chloride and potash tubes to determine both the moisture and the carbonic acid. This is an important and distinctive feature of this trial.

The Callender electric pyrometer, referred to previously as having been destroyed on the second day in the combustion chamber, was used for giving a record of the downtake temperature during the first day's trial.

One of the mercury nitrogen pyrometers in the end flues burst on account of the temperature exceeding 1,000deg. F. by making continuous and complete gas analysis, including the moisture in the waste gases. With the help of the information thus obtained, it was possible to calculate the chemical composition of the fuel (it contained on an average 31·4 per cent. carbon and 0·5 per cent. hydrogen), its calorific value (4 6 evaporative units), and the weight of waste products per pound of refuse (5·61b.) were then calculated. These additional details enable one to strike a balance-sheet of the heat expenditure.

It will be seen that the heat utilised in the production of steam (exclusive of the blowers) amounted to 36 per cent., which must be considered a high duty when it is seen that the carbon and the heat in the ashes account for a loss of 20 per cent. With ordinary fuel containing only a few per cent. of mineral matter this loss would have been only about 2 to 3 per cent., and then the efficiency would




Nelson Destructor.—Eight Hours' Test.—Diagram of Temperature in Combustion Chamber, taken with a Callender's Electrical Recording Pyrometer.

It was replaced by a Thalpotassimeter, a pyrometer in which the temperature in indicated by the pressure of mercury vapour.

High-temperature thermometers, either mercurial or electric, do not give reliable results, the zero point shifting very considerably, and in this trial there is a distinct disagreement between the readings of the temperature of the waste gases and of the incoming air. Probably the most correct readings are those of the thermometer in the main flue leading to the chimney, and these have been utilised in the compilation of the balance-sheet.

Table I. gives a brief summary of those details of the two days' trial, which is usually the only information that has been obtained from destructor trials; and it will be seen that the evaporation from and at 212deg.F. is 1·7881b. of water per pound of refuse.

Table II. contains details which were only obtainable have been 45 per cent. The heat carried up the chimney amounts to an average of 19·3 per cent., which is reasonably low. It would, of course, have been much lower if the refuse had contained less moisture—32·7 per cent.

There is a considerable difference between the estimated radiations on the two days. It amounts to 9·4 per cent. on Tuesday and 30·6 per cent. on Wednesday. The estimated flame temperature was certainly hotter on the second day, and increased radiation may account for part of the difference. Possibly this difference may be due to unavoidable errors of observation. Thus, if the weight of steam blown under the firebars was more or less than stated, or, if the fine dust, which is taken at 5 per cent. of the refuse, differed on the two days, or if the moisture in the waste gases, which was on an average 0·75 on Tuesday and 0·55 on Wednesday, varied considerably on each day, the mean values deduced from the average gas analysis may not be

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BALANCE SHEET OF HEAT EXPENDITURE.

| — | Tuesday | | | | Wednesday | | | |
|---|---|---|---|---|---|---|---|---|
| | B.Th.U. | B.Th.U. | Per cent. | Per cent. | B.Th.U. | B.Th.U. | Per cent. | Per cent. |
| Steam (useful) | — | 1,479 | — | 42·57 | — | 1,593 | — | 29·45 |
| Steam blast | 190 | — | 5·53 | — | 220 | — | 4·07 | — |
| Lost heating to 358deg. F. | 23 | — | ·67 | — | 26 | — | 0·48 | — |
| | 167 | — | 4·86 | — | 194 | — | 3·59 | — |
| Warming waste products, including steam and moisture from atmospheric temperature | 722 | — | 20·73 | — | 965 | — | 18·19 | — |
| Heat carried up chimney | 889 | 889 | 25·59 | 25·59 | 1,179 | 1,179 | 21·78 | 21·78 |
| Heat in ashes | 172 | — | 5·1 | — | 147 | — | 2·72 | — |
| Unconsumed carbon | 606 | — | 17·40 | — | 628 | — | 15·30 | — |
| Lost with ashes | 778 | 778 | 22·41 | 22·41 | 975 | 975 | 18·02 | 18·02 |
| Radiation and losses unaccounted for | — | 327 | — | 9 43 | — | 1,664 | — | 30·75 |
| | — | 3,473 | — | 100·00 | — | 5,411 | — | 100·00 |

the true mean, and comparatively slight alterations in all these quantities could easily affect the balance-sheet by a few per cent.

The mean radiation is 20 per cent., or 5,959 evaporative units per hour. The boiler and air heater expose a surface of about 1,300 square feet, and would radiate about 350 evaporative units, and the combustion chamber with a surface of about 1 300ft. and an internal temperature approaching 3,000deg. F., may be credited with a radiation of 2,500 evaporative units. This leaves 2,200 evaporative units unaccounted for, or about 9 per cent. In view of the difficulties of making these various determinations this quantity must be considered reasonably small. If we deduct it from the total, then the efficiency of the installation is raised from 35 per cent. to 40 per cent., which is just under the value obtained on the first day, and must be considered to be an exceedingly good result.—Yours faithfully,

(Signed) C. E. STROMEYER, Chief Engineer.

TABLE I.

| | | |
|---|---|---|
| Dates of trial | 13/1/05 | 14/1/05 |
| Time of trials | 10-5.45 | 9.35 6.31 |
| Duration of trials (hours) | 7·75 | 9·00 |
| Boiler pressure, mean (lbs.) | 135·1 | 134·2 |
| Corresponding temperature (deg. F.) | 358·2 | 357·8 |
| Refuse burnt during trial (lbs.) | 45 416 | 43 400 |
| Refuse burnt per hour (lbs.) | 5 837 | 4,822 |
| Feed-water supply during trial (lbs.) | 63 723 | 67,485 |
| ,, ,, per hour (lbs.) | 8,191 | 7,498 |
| ,, ,, per lb. of fuel (lbs.) | 1·419 | 1·555 |
| Moisture in steam (per cent.) | 1·07 | 1·034 |
| Temperature of feed (deg. F.) | 37·3 | 35·3 |
| Evaporation per lb. of fuel from and at 212deg. F., including steam jets (lbs.) | 1·698 | 1·877 |

TABLE II.

*Mean Corrected Gas Analysis (Volumetric).*

| | Atmosphere. Per cent. | Tuesday. Per cent. | Wednesday. Per cent. |
|---|---|---|---|
| Nitrogen, $N_2$ | 79·080 | 79·525 | 79·388 |
| Oxygen, $O_2$ | 20·880 | 8·140 | 5 836 |
| Carbonic acid, $CO_2$ | ·040 | 12·205 | 14·233 |
| Carbon monoxide, CO | — | ·130 | ·043 |
| Total | 100·000 | 100·000 | 100·000 |

*Other Analyses.*

| | Per cent. | Per cent. |
|---|---|---|
| Carbon in ashes, etc. | 11·44 | 17·69 |
| Mean ratio of moisture to $CO_2$ in waste gases | ·7549 | ·5479 |
| Estimated steam (jets) per pound of refuse | 16·22 | 18·70 |

*Composition of Fuel as calculated from above Data.*

| | Per cent. | Per cent. |
|---|---|---|
| Carbon (burnt | 21·33 | 31·58 |
| Carbon (in ashes) | 4·17 | 5·70 |
| Total carbon in fuel | 25·50 | 37·28 |
| Moisture | 35·00 | 30·53 |
| Mineral matter | 39·18 | 31·50 |
| Total refuse | 100·00 | 100·00 |
| Additional steam by jets | 16·22 | 18·70 |
| Air (including moisture) | 422 73 | 542 46 |
| Total | 538 95 | 661·16 |
| Less ashes, etc., in furnace and flues | 43·35 | 37·16 |
| Difference, being weight of waste products per 100 refuse | 495·60 | 624·00 |

*Estimated Calorific Value of Fuel.*

| | | |
|---|---|---|
| Calorific value of total fuel, B.Th.U. | 3,473 | 5.411 |
| Calorific value of total fuel, evap. units | 3·595 | 5·601 |
| Ditto less unburnt carbon, B.Th.U. | 2 867 | 4 582 |

*Furnace Temperatures.*

| | | |
|---|---|---|
| Heat supply—Combustion of fuel, B.Th.U. | 2,867 | 4,585 |
| Hot air | 271 | 436 |
| Steam blast | 23 | 26 |
| Total heat supply (B.Th.U.) | 3.161 | 5 045 |
| Heat capacity of gases, per lb. fuel | 1·3059 | 1·6058 |
| Furnace temperature, degrees F. | 2,478 | 3,208 |

If we assume the specific heat of steam to be 0·6 instead of 0·48, as assumed above, the furnace temperatures are respectively 2,370deg. and 3,100deg. F.

Copper melted (1,980deg. F.) easily. Nickel melted (2,640deg. F.) slowly.

| | Deg. F. | Deg. F. |
|---|---|---|
| Downtake temperature (electric pyrometer) | 1.388 | — |
| Waste gases entering air heater | 909·0 | 917·0 |
| Waste gases leaving air heater | 610·2 | 680·0 |
| Mean fall of temperature | 298·8 | 236·9 |
| Air entering air heater | 57·3 | 65·4 |
| Air leaving air heater | 315·7 | 336·9 |
| Mean rise of temperature | 258·4 | 271·5 |
| Wet-bulb thermometer | 47·6 | 51·2 |
| Estimated moisture in air | 0·419 | 0·383 |

## PERSONAL.

Mr. M. H. Volk, who has just resigned his position as works engineer to the Brighton Corporation tramways department, is about to take up an appointment as engineer and manager to the Brighton Beach electric railway. Last week, the tramways engineer and general manager, Mr. T. B. Holliday, presented Mr. Volk with a case of drawing instruments and a book on railway working, and a walking stick on behalf of the office and works staffs.

The Huddersfield Corporation have decided to increase the salary of Mr. J. C. Whiteley, chief assistant in the tramways department, from £150 to £160 per year.

The Electric Lighting Committee of the Wakefield City Council have decided to recommend the appointment of Mr. Harry Anderton Neville, first assistant electrical engineer at the Corporation works, as electrical engineer from April 1, at a commencing salary of £300 per annum, rising by annual increments of £25 to £400 per annum.

## APPOINTMENTS VACANT.

**Assistant Electrical Engineer**, West Bromwich. Commencing salary, £120 per annum. Applications to the Borough Electrical Engineer and Manager by Feb. 4. See advertisement.

**Clerks**, St. Marylebone Borough Council. Ledger clerk, at a commencing salary of £100 per annum, and a junior clerk, at a commencing salary of £50 per annum. Applications by Feb. 4. See advertisement.

**Draughtsman**, South Shields electricity works. Salary, £3 per week.

**Construction Superintendent**, Leith Corporation tramways. Salary, £3 per week. Applications by Feb. 1.

**St. James and Pall Mall Electric Light Company.**—The directors recommend a dividend for the half-year ending Dec. 31 of 7s. 6d., together with a bonus of 2s. per share, on the ordinary shares, making, with the interim dividend paid on Aug. 1 last, a total distribution of 14½ per cent. for the year.

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THE
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### TO CORRESPONDENTS.

*All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

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## ALTERNATING-CURRENT TRACTION.

The use of the alternate-current induction motor for traction purposes is by no means new. It was first tried on a commercial scale by Mr. C E L. Brown, who equipped in Switzerland first tramways and later some full-gauge railways on the three-phase system. The lines so equipped have done and are still doing good work, but there are certain objections to the three-phase induction motor as applied to traction which limit the extension of the system in its simplest form. The first of these is that the maximum speed of the train propelled by the ordinary three-phase induction motor is fixed once and for all by the frequency of the supply current. This is so much the case that it is a distinct advantage on the heavy grades of railways running through mountainous districts. When descending these grades the three phase motors act as generators, and return energy to the line immediately their speed exceeds by a few per cent. that corresponding to synchronism with the alternators in the generating station. Coupled with this rigid limit in the maximum speed, the induction motor also suffers from the fact that its efficiency is very low at any speeds considerably below the maximum. On lines where the energy is obtained from water power this inefficiency is not so material, but it becomes a most serious factor on lines which are dependent on coal for their source of power. Again, while the advantages of the three-phase induction motor are considerable on lines where long non-stop runs are required, a service requiring frequent stops and high mean speeds exaggerates their inefficiency. As a result of these considerations, engineers on the Continent, in England, and in the States have for some years been working on improved forms of alternate-current motors for traction purposes. Of these the Ganz system was brought strongly to the front when it was proposed for use on the Underground Railway in London. By working two alternate-current motors in cascade, and using the rotor of the first motor to supply the stator of the second, a vast improvement was made in the economy of speed variation. In fact, it was claimed and supported by actual figures that the Ganz system would be as efficient as the direct-current one, which gained the verdict of the arbitrator. With the Ganz improvement, however, there were still required two insulated conductors, as against one with the direct-current system. While this is not an insuperable difficulty, it is a distinct disadvantage, which has been overcome by the recent improvements made in single-phase motors. The workers in this field have been numerous, and while the several motors have yet to be tried on a commercial scale, others have already given most successful results on experimental lines. Those who wish for full particulars on this subject would do well to read thoroughly Mr. H. L. Rissley's paper presented recently to the Newcastle Local Section of the Institution of Electrical Engineers. In this he describes some of the plant he inspected, during a recent visit to the United States, at the works of the General Electric Company and those of the Westinghouse Company. In each case experimental lines have been equipped for single-phase working, and in the case of the first company's system the experimental line is some sixteen and a half miles long. The trial in this case proves how adaptable the new compensated motor of the General Electric Company is. For instance, the railway runs through a town for nearly four miles, and the equipment is so designed that the motors are worked as single-phase machines in the inter-urban portion of the route, and as direct-current motors within the town. The voltage in the town is six hundred, and outside no less than two thousand volts are applied. This high alternating-current voltage is reduced by trans-

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formers on the train to four hundred volts for use in two motors connected in series. Mr. Riseley gives the characteristic curves for the motor working, first with direct current and, secondly, with alternating current. These curves are remarkably alike, which shows that a motor when working under the latter conditions has all the advantages of a direct-current series motor from the acceleration point of view. Again, the apparatus being used by the Westinghouse Company on their trial line has also produced results which are eminently satisfactory. This firm employ an auto-transformer for regulating purposes, which is much more efficient than any method of introducing resistances into the motor circuit. Here, again, a high voltage is used on the trolley wire, which is reduced to about two hundred and twenty-five volts at the motor. The success of these trials and of other experiments which have been made on the Continent with motors of the single-phase type with commutators seem to point to the ultimate solution of long-distance electric traction being with the single-phase system. The advantages gained are most numerous, including a single high-voltage trolley wire, the abolition of the sub-station and its moving machinery, which would be replaced by static transformers on the train, etc. The economy in first costs would be very great. The uncertain features, such as the cost of maintenance for the new types of motor equipments, can only be ascertained after extended trials under regular working schedules. Such trials are to be made on the London, Brighton, and South Coast Railway, under the advice of Mr. Philip Dawson. The fact that such motors will work either with direct or alternating currents allows railway engineers to await the results of these trials with little anxiety, as their adoption would not necessitate the abandonment of machinery now being put in elsewhere

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### THE METRIC FALLACY.

SIR,—With regard to the article on the "Metric Fallacy" in your issue of 23rd ult., I was surprised to see quoted that of the 25 important shipyards in Germany two still use the British system of measurements. In this country, the Institution of Engineers and Shipbuilders in Scotland, with a membership of over 1,400, petitioned the Lords in favour of the metric system of weights and measures. Shipbuilders and engineers in this country would reap an advantage from the introduction of a decimal system in facilitating, as it undoubtedly would, the many calculations they have to make, and as the metric system is decimal, and is already in use by Continental nations and physicists here, it is the most suitable one.

As our people became more accustomed to the use of this metric system they would be better able to assimilate the valuable information published in Continental technical journals, and they would not be handicapped in competing for Continental and other orders as they are at present — Yours, etc. CHARLES STUART DOUGLAS.

### BALANCING CHOKING COIL.

SIR,—"Superheat," criticising the answers to Question No. 745 in your issue of Jan. 20, states "the out-of-balance current divides equally between the two halves of the choking coil, and is continuous in each." The answers he refers to are to a certain extent correct, quite as much so as the explanation given by "Superheat." Under certain conditions the out-of-balance current does not oscillate and become an alternating current in the choking coil. There are three main cases that can be considered.

1. When the out-of-balance current dealt with is less than twice the magnetising current of the choking coil. In this case the slip-rings supply a portion of the magnetising current; the other portion is supplied by the continuous out-of-balance current, which becomes an alternating current when it enters the choking coil, flowing first through one half, and then through the other in synchronism with the slip-ring current.

2. When the out-of-balance current is equal to about twice the magnetising current of the coil it supplies the whole of this current, and alternates in the two halves of the coil. At any instant when the current is in one limb of the coil it produces a back E M F. in the other half, which prevents current from the corresponding slip-ring entering this other half. Thus the out-of-balance current returns to the armature first through one slip-ring and then through the other in synchronism with the cycles of the armature.

3. When the out-of-balance current is greater than about twice the magnetising current, a portion of it flows continuously through both limbs of the choking coil. The remainder alternates first in one limb of the coil and then the other (as in Case 2), supplying the power to magnetise the coil and make up the $C^2R$ losses due to the whole current in the coil.—Yours, etc., CHOKER.

### TELEPHONE RATES.

SIR,—Your "interpretations" attached to my letter published in the *Electrical Engineer* of Jan. 20 naturally provoke a few further comments:

1. That when two persons are making a bargain one is trying to sell dear and the other to buy cheap is such an obvious proposition that it hardly needs for its demonstration a four-column article with "interpretations" by the editor.
2. Continental and American rates have little bearing on British conditions.
3. Mr. Bennett did *not* "merely assume £5. 10s. for argument's sake"; £5. 10s. was the pivot of his argument.
4. No comments.
5. Mr. Bennett says £5. 10s. as a flat rate ought to be fixed in advance and everything else made to fit. I say that this method of approaching the telephone problem is unsound, and that in the case of the municipal telephone systems, notably that of Glasgow, its unsoundness is proved by the results arrived at within three years of practical experience.

Finally, I must express my surprise that the editor of an engineering periodical should display such indifference as to what is or what is not up-to-date practice in an important branch of electrical engineering —Yours, etc.,

HERBERT LAWS WEBB.

[In replying to a reply, we have to state:

1. An editor has to interpret all articles, whether four columns or one, else he would be in queer street in a week.
2. Any rates, Continental or American, have a bearing, provided the differing conditions are considered.
3. What Mr. Bennett did say will be found on p. 26 of our issue of Jan. 6 last, but these words are important: ". . . seem that is admissible *on the basis of, say, a* £5. 10*s. rate.*" The argument being Continental, American, British corporations, *and the National Telephone Company* (the latter in certain cases) have found a flat rate of from £5 to £6 a paying one; hence if the Government is going to buy the National, its price should be largely determined by these figures and the further expenditure necessary to bring the system up to date.
4. Thanks for the smallest agreement.
5. Taking out the fixed amount, £5 10s, as not applicable to the general question, we agree that it is a debatable matter whether a flat rate or other form of payment should form the basis of calculation.

Mr. Webb is a little ingenuous in his final remark. From whence does he gather our indifference to what is up-to-date practice? We have devoted more attention to telephonic matters than all the other English technical papers

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combined. Mr. Webb thinks to little purpose—but that is a mere detail.—ED, *E. E.*]

## MUNICIPAL TELEPHONES.

Mr. Bennett writes: "Mr. Webb's letter in your issue of the 20th inst. amuses me very much. Your readers will be better able to estimate the degree of importance which should be attached to it when they are informed that Mr. Webb is employed by the National Telephone Company as contract manager in all those towns in which municipal competition exists. His principal, if not sole, duty would appear to be to villify and misrepresent the municipal systems. Hence this effusion and many others, signed and unsigned."

[We have also received a telegram from the Glasgow telephone department advising us of the dispatch of a letter denying the accuracy of Mr. Webb's statements regarding the change of system in Glasgow. This letter has not come to hand in time to appear in this week's issue—ED. *E. E.*]

## ALUMINIUM.*

BY W. SMITH.

As our time is limited, without further preamble, except expressing the hope that you may be as interested in *listening* to the paper as I have been in *preparing* it, we will at once take up the subject for this evening—aluminium.

What is aluminium? Where do we find it? Aluminium is a metal having a colour very similar to that of silver. Pure aluminium, when burnished or frosted, if viewed from a little distance might easily pass for silver, but would, however, certainly be found wanting if placed in the balance. Its most characteristic property is its extreme lightness. The specific gravity of aluminium is 2·5-2·7—*i.e.*, it is only that number of times heavier than an equal volume of water. If iron and aluminium were taken in equal volumes, the iron would weigh rather more than three times as much as the aluminium.

Like so many other of our words, aluminium comes from the Latin; *alumen*, from *alas*, salt. In answer to, Where do we find it? one might almost say everywhere. Although never found in a metallic state in nature, in combination with other substances it is, perhaps, more widely distributed than any of the other metals. Common clay, which is silicate of alumina, contains about 18 per cent. It does, at first sight, appear strange that with such vast stores of aluminium around us it should be so difficult to obtain; it seems a case of water, water everywhere, and not a drop to drink. With all the opportunities plants have of taking up alumina, it has only been found in the ashes of Lycopodia-club mosses. It is even said that only two of these, Lycopodium chamœcyparissus and Lycopodium clavatum, contain alumina. Specimens of these two plants are on the table for your inspection. We cannot obtain aluminium from alumina (oxide of aluminium) by means of an ordinary furnace; a greater temperature is required, and it was the electric furnace which brought aluminium from being a laboratory curiosity at a very high price to a metal cheap enough for everyday use.

Aluminium was discovered by Wöhler in 1827, but it was Deville in 1854 who first produced the metal in an almost pure state. Deville's chemical process was as follows: Ground bauxite was mixed with soda ash (containing $Na_2CO_3 + NaHo$) heated in a reverberatory furnace. The sodium combines with silicon and alumina to form silicate of soda and aluminate of soda, $CO_2$ being expelled as gas. The mass is then washed, dissolving out the aluminate of soda. This solution is mixed with hydrochloric acid to remove the soda, the alumina then separating out as a gelatinous mass. This is aluminate hydroxide. This hydroxide is mixed with NaCl and charcoal powder to a stiff paste. The paste is made up into balls 3in. in diameter, heated, dried, and then heated in a current of chlorine gas. The salt is added to form a double chloride of aluminium and sodium ($Al_2Cl_6 2NaCl$). This double chloride is distilled and condensed. Ten parts of this salt, two parts of sodium, and five parts of cryolite, or fluorspar, are mixed together and thrown on the hearth of a reverberatory furnace. The furnace is then closed to exclude the air. The sodium acts violently on aluminium, which collects in the metallic state beneath a layer of slag containing the sodium chloride and the cryolite. Metal made by this process contains much silica and iron. Samples of bauxite and cryolite, also prepared sections and photographs, are shown on the table.

For cooking utensils and for table use aluminium is very suitable, a great point in its favour being due to the fact that its salts are not poisonous. It seems a pity that its use in these capacities is not more general.

In considering the advisability of employing aluminium in place of the generally-used copper as a conductor for electrical energy, we may ask ourselves two questions: Is it possible? Is it practicable? As to its possibility there can be no doubt whatever; it conducts electricity to a degree of from about 55 to 62 per cent. that of copper. With regard to the practicability, it is more a commercial than an electrical question. As a heavily-insulated conductor it is out of court, but for many positions as an overhead bare conductor, or a lightly-insulated cable laid on the solid system, there appears to be many points in favour of aluminium. This is at the present price of about 2s. per pound. Who knows but that future improvements may result in such a further drop in price that copper may have to face a very formidable rival indeed. The electrical conductivity of aluminium wire appears to vary very considerably. Some wire purchased in the open market had a conductivity only 55 per cent. that of copper. Some special wire, very much higher in price, was 62 per cent. that of copper. If costs be carefully worked out, it appears that we can afford to pay rather more than twice the price per pound for aluminium than for copper.

Although the relatively larger diameter of aluminium is against its use for overhead work, perhaps the greatest drawback is the trouble found in jointing. There does not appear to be a reliable solder. This statement may appear to you somewhat paradoxical, seeing that on the table here are a number of soldered joints. All these joints have been prepared for the paper this evening, and I must say that very little difficulty has been encountered in making them. It is said, however, that soldered joints only last about three months; these have been made about six weeks. They do not, however, appear to have deteriorated, and we will presently examine some enlarged views of these joints on the screen. Burgess gives the following as a good solder for aluminium:

| | | |
|---|---|---|
| Zn | 21 | } 100. |
| Sn | 76 | |
| Al | 3 | |

Electrical welding appears to require special apparatus; time has not enabled me to make more than a few experiments in this direction. The Cowles was the first electrical furnace for production of aluminium, but was more fitted for producing alloys than the pure metal. The two methods, which are practically identical, now in use for separating aluminium are the Heroult and the Hall processes. Heroult is a Frenchman, Hall an American. Aluminium after being taken from the furnace may be cast, rolled, drawn, pressed, etc., as desired. It is rolled into leaf fine enough to rival silver for decorative purposes. Photographers use its powder for the "flashlight." You will see on the table some slips for the microscope made from aluminium sheet. The cell, and seating on which to fix the cover glass, together with the slip itself, are all stamped and pressed from one piece. They are frosted by immersion in a hot solution composed of the following ingredients:

| | |
|---|---|
| $H_2O$ | 87 |
| NaHo | 10 |
| NaCl | 3 |

After being in this solution about half a minute they are taken out and rinsed under the tap. They are then placed in strong nitric acid for a few minutes, rinsed under the tap, and dried in warm sawdust. Some of them have been roughened first with powdered pumice, others by means of the sand blast.

[The author then took advantage of the aid offered by

* Paper read before the Birmingham Electric Club on Jan. 14, 1905.

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photography to illustrate his remarks. Owing to difficulties in reproduction for printing, we are only able to give a limited number of these illustrations, and have selected those which are mostly original.]

FIG. 1.—This is a section of bauxite × 20. It does not make a particularly good object, partly owing to its colour and partly owing to its friability. It is a difficult object to prepare. It is found in Ireland, France, and the United States. It is rather variable in its composition, but generally contains about 56 per cent. of alumina. In appearance

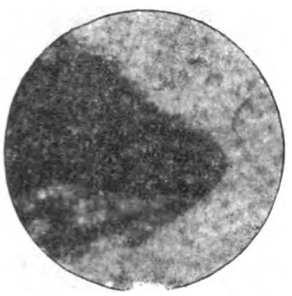

FIG. 1.

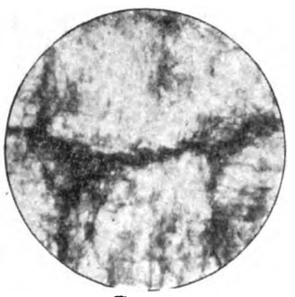

FIG. 2.

it is just like baked clay. In the Heroult method, bauxite is mixed with sufficient carbon to reduce all the impurities to the form of metals—silica to silicon, titanic acid to titanium, etc. Mixture is then melted in an electric furnace using a carbon pole, the material itself being fed into the arc, the melted alumina forming the other pole. An alternating current of low potential is used. Impurities collect as metallic alloys. The alumina is pure and above the alloys.

FIG. 2.—Section of cryolite × 20. Cryolite is a double fluoride of aluminium and sodium ($6NaFAl_2F_6$). It is mainly obtained from Arksut Fiord, Greenland. Used for electrolyte in Heroult's process for making aluminium. Melts at 800deg. C.; it is then transparent and dissolves alumina.

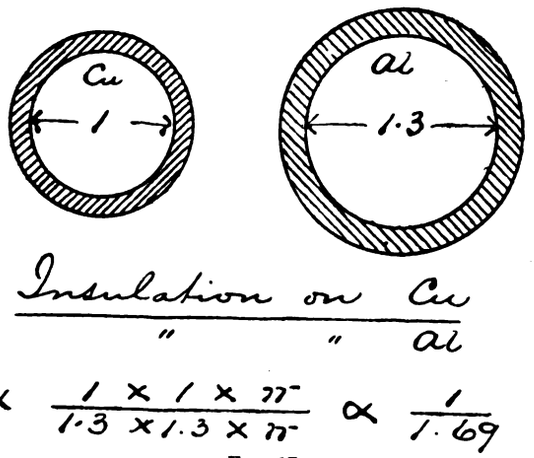


FIG. 13.

FIG. 13.—On the supposition that the aluminium has a conductivity 60 per cent. that of copper, we have:

$$\frac{\text{area of copper}}{\text{area of aluminium}} \propto \frac{60}{100} \propto \frac{3}{5}.$$

$$\therefore \frac{\text{diameter of copper}}{\text{diameter of aluminium}} \propto \frac{\sqrt{\frac{\pi}{4 \times 3}}}{\sqrt{\frac{\pi}{4 \times 5}}}.$$

$\therefore$ if diameter of copper = 1,

$$\text{diameter of aluminium} = \frac{\sqrt{5}}{\sqrt{3}} = 1{\cdot}3 \text{ (approximately)}.$$

Now, for equal insulation to leakage, as the leakage area is greater, the insulating material must also be thicker in a like ratio.

$$\therefore \frac{\text{insulation on Cu}}{\text{insulation on Al}} \propto \frac{1}{1{\cdot}69},$$

FIG. 14.—For equal losses, diameters of copper, aluminium, and iron are in the ratio 1 : 1·3 : 2·5. Taking 50lb. as maximum pressure per square foot due to wind, and taking an effective force of 30lb. in allowing for rounded surface of wire, with copper 1in. in diameter and aluminium and iron in their proportions, the thick lines will give an idea of the several resultant pressures.

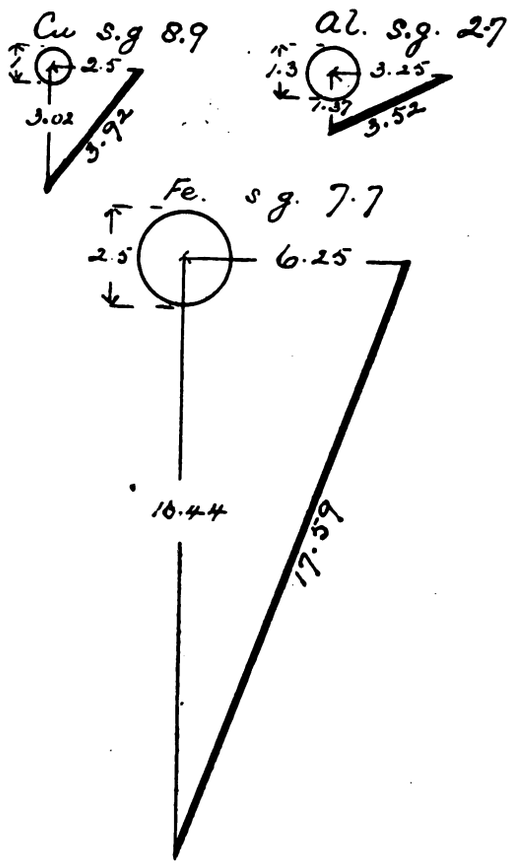


FIG. 14.

FIG. 15.—(I.) Wire is pulled through the slot, riveted, and then let back. Pull is taken up by the riveted head on wire. (II.) Two parts, male and female screws, make up the coupling; wire is bent over as shown, coupling screwed up, and a pin driven through to prevent untwisting.

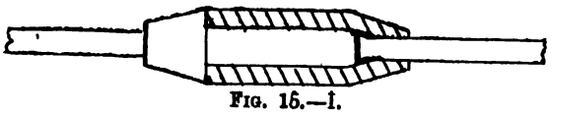

FIG. 15.—I.

FIG. 15.—II.

FIG. 16.—(I.) Grub screws in the coupling or sleeve hold the stranded conductor. (II.) Nuts screw down the taper and firmly grip the conductor. The fitting is in halves, with fitting pieces to keep in alignment. (III.) Tapered conical wedges, fitting over the middle, single, or seven strands, when driven home splay out the outer wires. Thus the conductor is held tighter as pull increases.

FIG. 16.—I.

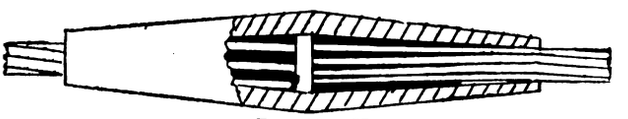

FIG. 16.—II.

FIG. 16.—III.

FIG. 17.—This joint, unless particularly well made, pulls out at much less than the breaking strain of the wire.

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FIG. 18.—Round wire is flattened and riveted. Rivets must be aluminium or aluminium bronze to prevent electrolytic action.

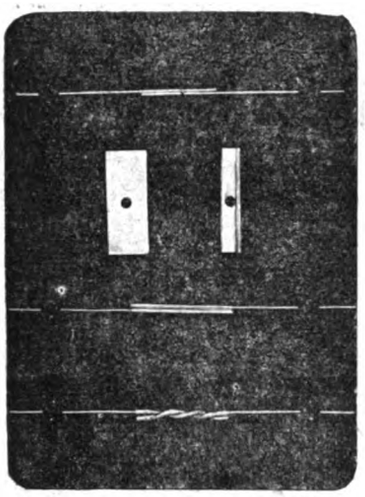

FIG. 17.

FIG. 20.—This is a joint—Neild's patent—made in overhead wires. Wires are placed in a sleeve; the sleeve has a recess, and is filled in with solder. Somewhat similar in style to the well-known Britannia joint.

FIG. 18.

FIG. 21.—Section through one of these joints (20). × 40. This is cut off at nearly the largest diameter of the cone. Polished. Etched with dilute HCl. The microscope aids our eyes and enables us to follow the finer details that otherwise would be invisible. Although at

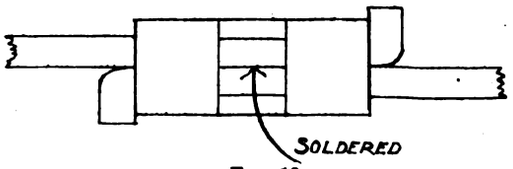


FIG. 19.

present one cannot claim an exact diagnosis by means of microscopical examination, there is no doubt that it is a wonderful aid to our knowledge of metals and their alloys. Many of us have seen a blacksmith look with critical eye at a fractured piece of iron or steel, and heard the grunt,

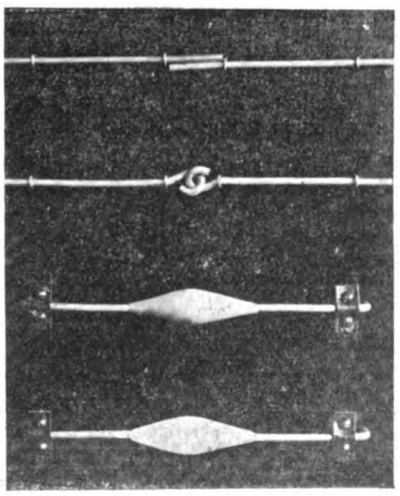

FIG. 20.

either of approval or disapproval. A tool that has been broken on the lathe will often show unmistakable signs of having been "burned." The microscope enables us to carry on our investigations with greater discrimination. To prepare metals for the microscope they must first be polished. Now there is polishing and polishing. In an engineering workshop one often hears the remark about a job that "it is highly polished and deeply scratched." This sort of thing would be useless to the microscopist. Under a medium power it would look something like a sheet of corrugated iron roofing. To be suitable for the microscope all scratches must be eliminated, and this is by no means an easy matter. When working

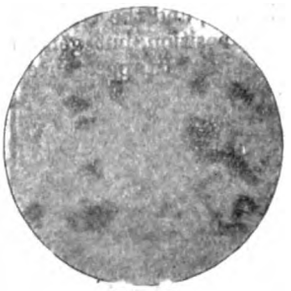

FIG. 21.

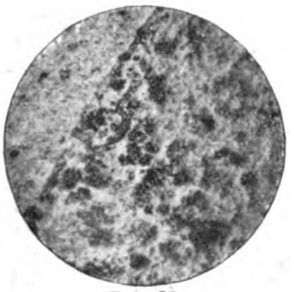

FIG. 22.

at the bench we say that the rough file should have nothing to do except remove the chisel marks, the smooth file remove the cuts of the rough file, and after draw-filing the emery cloth should simply have to polish. To prepare metallic surfaces for the microscope, we only begin to polish where the fitter leaves off. See that the surface is as good as can be obtained with No. 1 emery cloth; then use finer grades down to 0000 cloth or paper. In using these grades of cloth it is as well to make sure before using a finer one that there are no scratches but those due to the paper you are using. The polishing must then be done on stretched washleather with jewellers' rouge. Finally, take the object in the left hand, and holding a soft clean pad of washleather in the right hand, polish with a little precipitated calcium sulphate.

FIG. 22.—Same as Fig. 21, but × 60.

FIG. 23.—Same as Fig. 21, but × 80.

FIG. 23.

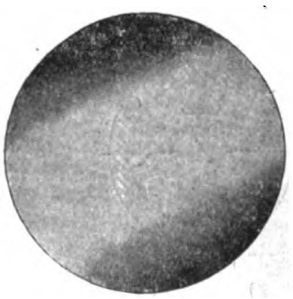

FIG. 24.

FIG. 24.—Soldered joint in aluminium wire not etched. × 8. To solder aluminium the metal must be as hot as possible when joint is just being finished. The main difficulty lies in well covering the surfaces that are to be soldered. A scratch brush will do, but personally I prefer to scrape the surfaces that are to be joined with a knife while they are covered with melted solder. If the joint, solder, and knife be well cleaned in a little benzol the surfaces will tin satisfactorily. As soon as possible, while the parts are well heated, press firmly together.

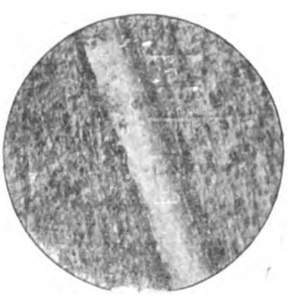

FIG. 25.

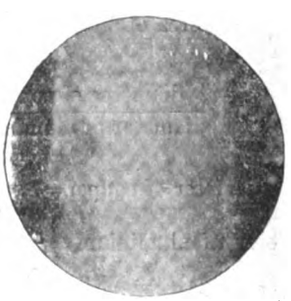

FIG. 26.

FIG. 25.—Same as Fig. 24, but × 20; this has, since taking previous photograph, been etched with HCl. It seems probable that the corrosion next solder is due to *positive* property of aluminium.

FIG. 26.—Same as Fig. 25, but × 80. A large number of soldered joints tested about a week after being made.

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They all broke about ½in. from the scarf. The solder held well.

FIG. 27.—Three methods of making a joint in aluminium wire. In each of these the wire is welded without softening the line wire.

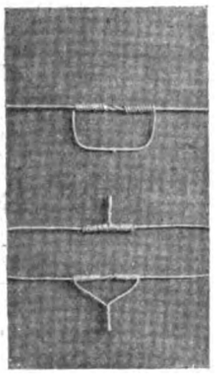

FIG. 27.

FIG. 28.—Section through a butt-welded joint, done in spirit blow-lamp. × 15. Not etched.

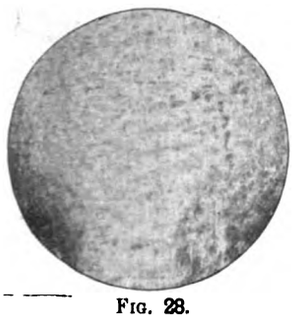

FIG. 28.

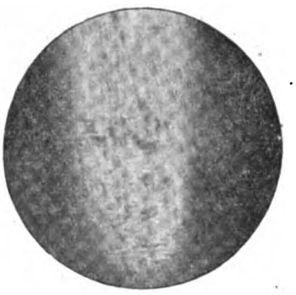

FIG. 29.

FIG. 29.—Section through wire broken on testing machine. × 15. Not etched.

FIG. 30.—Same as Fig 29, but × 40.

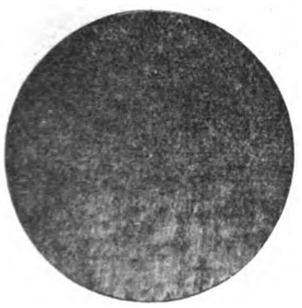

FIG. 30.

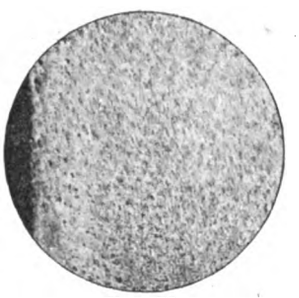

FIG. 32.

Fig. 32.—Section of aluminium wire as received from makers. Not etched, nor softened. × 20.

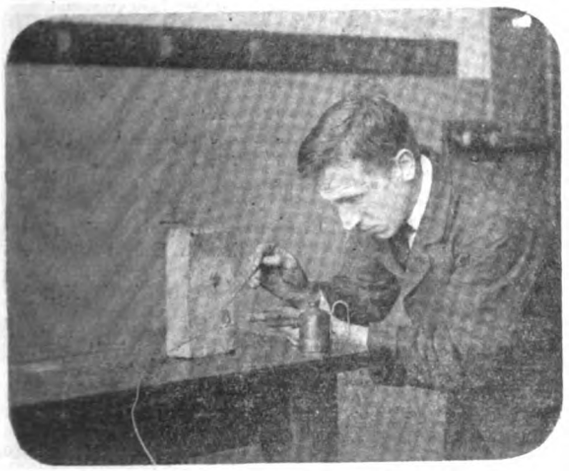

FIG. 34.

FIG. 34.—Making a joint similar to the lower two shown in Fig. 27. A carbon collar is placed round the twist and then heated to redness. When the aluminium is in a molten state it can readily be pushed together by means of a small carbon rod.

FIG 35.—Section through joint as shown in Fig. 34. Note where weld leaves off and twist begins. Not etched. × 7.

FIG. 35.

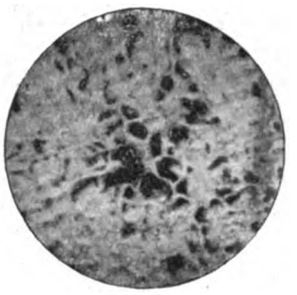

FIG. 36.

Fig. 36.—If a butt-welded joint is moved when solidifying, the joint becomes rotten. This is a piece of such faulty joint. × 40. Not etched.

Fig. 37.—Same as Fig. 36, but × 80.

Fig. 38.—Cast aluminium. × 40. Etched with dilute HCl.

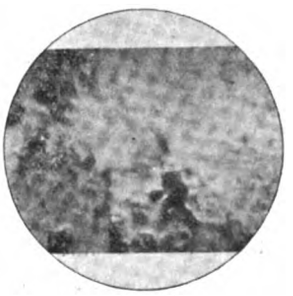

FIG. 37.

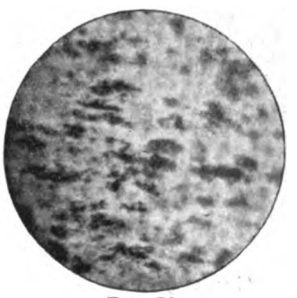

FIG. 38.

Gentlemen, we have looked at aluminium from several points—what it is, and from where it is obtained, its manufacture, and a few uses to which it is put, with suggestions for its further employment. We have considered briefly its fitness as an electrical conductor. Soldering the metal has been brought to your notice, also a new method of welding joints without softening the line wire. Some explanation, with examples and illustrations of its metallography, have been placed before you; samples are on the table for your inspection.

I trust that some of these things will provoke a discussion this evening. There may be some who do not feel confident enough to discuss the questions from an engineering point of view; but perhaps these gentlemen may have the pleasure of living in houses the grounds of which are fertilised by the pellucid waters of the meandering Rea. They will then, no doubt, be able to enlarge on the botanical part of the paper. I have to thank you for giving me such a patient hearing.

## SMOKE PREVENTION.

The Absolute Smoke Abolition Syndicate, Limited, are giving a number of demonstrations of their process daily from 11 a.m. to 1 p.m. and 2 to 4 p.m., at 26, Page-street, Westminster, to which steam users, their managers, engineers and stokers, are invited to inspect. On Saturday afternoon, special exhibitions are given for managers and steam users who cannot attend during factory working hours.

The invention they are showing is by Mr. Greaves, who is not unknown in the engineering world, and consists of an apparatus the object of which is to prevent smoke nuisance and to save coal. It consists principally of a second bridge of pipes or arches made of a special fire-resisting material and placed into the flue about 18in. behind the usual bridge. The flue between the two bridges is lined with firebrick at the bottom. The firebars are very deep with thin edges, and consequently expose large surfaces to the incoming cold air. They are thus kept from melting or burning, and should therefore last longer than the ordinary ones. The arrangement of the air

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spaces allows the greatest supply of air through the back bars further from the door, where the fire burns fiercest. This ought to tend to more complete combustion and consequently less smoke. The latter half of the bars are set upon a rising plane, making the weight of fire less at the back end, and thus giving a better passage to the incoming air at the distant end of the furnace, where it is most needed to ensured complete combustion. The bridge is so constructed that it can be used as an ordinary solid bridge or a controlled split from the boiler front, as may be desired. All products given off by the furnace must pass the second bridge, which becomes incandescent after firing, and its object is to destroy the carbon smut while it is still in its gaseous form, and thus prevent it from developing into black smoke.

Messrs. Burstall and Monkhouse have made a number of experiments with a Lancashire boiler before and after Mr. Greaves's arrangement had been fixed, and in their report they conclude that: "The result of the test shows that with the Greaves apparatus smoke may be done away with for all practical purposes, while at the same time a saving of over 7 per cent. in fuel may be obtained, even in boilers which are working economically before the apparatus is fitted. With boilers working uneconomically, the saving may be much greater than this, as the means taken to cure the smoke are not, like many smoke-preventing appliances, wasteful in themselves by the admission of an excessive amount of air. With the Greaves apparatus no excess air is admitted behind the bridge, but the unburnt gases are ignited by the incandescent 'honeycomb,' causing complete combustion."

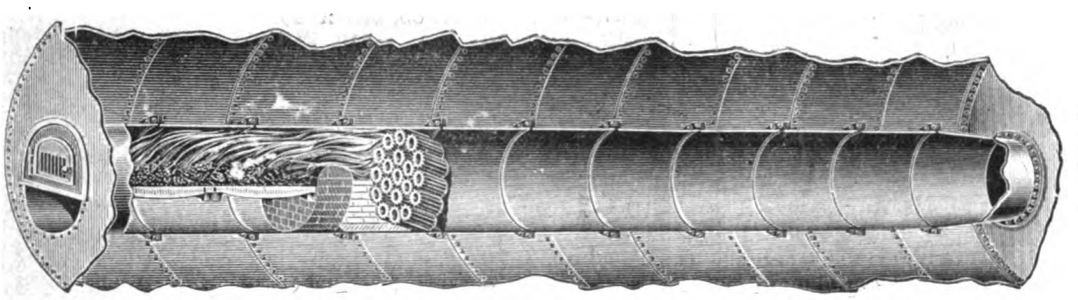
During our visit to Bridge-street a boiler was fired with a kind of coal-dust said to have cost 11s. per ton delivered, and only a thin film, more like steam, was emitted from the chimney. We are informed that the first cost is small, and that a boiler can be fitted within 24 hours. The firm maintain for 12 months, and guarantee against fines for smoke nuisance.

## A NOVEL INCANDESCENT LAMP.

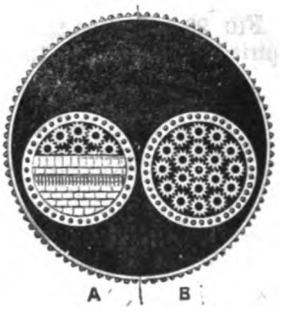
At a recent meeting of the Berlin Electrical Society (Jan. 17) Dr. von Bolton and Dr. Feuerlein delivered a lecture on the new tantalium incandescent lamp brought out by the Siemens and Halske Electric Company, making some interesting experimental demonstrations. Endeavours made of recent years to cheapen the cost of electric lighting, so that this might become a more powerful competitor to incandescent gas lighting, have given rise to the construction of incandescent lamps with an especially low consumption of energy per candle-power. Any attempts made in this direction in connection with carbon-filament lamps have, however, failed to be successful. While the luminous power of an illuminant increases as the temperature of the latter is raised, a carbon filament burning with 3·5 watts per candle can only stand an increase beyond the normal temperature of about 1,700deg. C. for a short time, after which the filament disintegrates, the bulb becomes black, and the lamp will soon be destroyed.

This suggested the idea of looking for such substances as might stand a higher temperature without being injured, and, after a series of thorough preliminary experiments, Mr. von Bolton, of the Siemens and Halske Company, found tantalium (the melting point of which is beyond that of platinum, lying at about 2,000deg. C.) to be such a material. Tantalium is very widespread in nature, being recovered in large amounts from the tantalite and columbite ores of Australia, America, Norway, and Sweden. After having undergone different purifying processes, it is melted in vacuum and drawn out to long circular filaments of 0·05mm. and 0·035mm. diameter. This wire is stretched on supports carried in an ordinary incandescent lamp bulb, and exhausted as is a carbon-filament lamp. The tantalium filament is formed into a zigzag round these supports, of which there are 11 at the top of the lamp and 12 at the bottom.

Tantalium lamps have an efficiency as high as 1 c.p. for 1·5 watts, and are designed in three types—for 16 candles and 110 volts, 25 candles and 110 volts, and 32 candles and 220 volts respectively. Their average life is said to be 1,000 hours, while their most economical life is from 400 to 600 hours.



Sectional Longitudinal Elevation.




Cross Sections.

This new lamp is said to be less sensitive in regard to fluctuations in pressure than carbon-filament lamps. The light from the lamp is very white, as would be expected from the high temperature employed.

## FORTHCOMING EVENTS.

FRIDAY, JAN. 27.

**Municipal and County Club.**—House dinner.

**Automobile Show.**—At the Crystal Palace (to Feb. 4).

SATURDAY, JAN. 28.

**Permanent-Way Institution.**—At 2.30 p.m. (at the Institution of Civil Engineers), annual winter meeting. At 6 p.m., annual winter dinner, Mansion House Station Restaurant.

**Institution of Electrical Engineers (Students' Section).**—Visit to the G.P.O. Central Telephone Exchange.

MONDAY, JAN. 30.

**Faraday Society.**—At 8 p.m., "Mass Analyses of Muntz's Metal by Electrolysis, and some Notes on the Electrolytic Properties of this Alloy" (illustrated), by Mr. J. G. A. Rhodin; "The Equilibrium between Sodium and Magnesium Sulphates," by Mr. R. B. Denison; "Refractory Materials," by Mr. E. Kilburn Scott.

TUESDAY, JAN. 31.

**Institution of Electrical Engineers (Manchester Section).**—At 7.30 p.m., "Some Points on the Selection of Electric Cables," by Messrs. L. B. Atkinson and C. J. Beaver.

WEDNESDAY, FEB. 1.

**Institution of Electrical Engineers (Students' Section).**—At 7.30 p.m., "The Present Electrical Equipment of the London County Council Tramways," by Mr. J. W. Anson.

**Institution of Civil Engineers (Students' Section).**—Visit to the National Physical Laboratory, Bushy House, Teddington.

THURSDAY, FEB. 2.

**Chemical Society.**—At 8 p.m., general meeting.

**Rontgen Society.**—At 8.15 p.m., Dr. Clarence A. Wright will read a paper, "Some Points in the Construction of a High-Frequency Machine," and will show probably some novel exhibits. Messrs. Newton and Son will show "Dr. Thurstan Holland's X-Ray Diaphragm Compressor."

**Civil and Mechanical Engineers' Society.**—At 8 p.m., "The Mechanics of Flour-Milling," by Mr. A. R. Tattersall.

FRIDAY, FEB. 3.

**Junior Institution of Engineers.**—At 8 p.m., "Recent Developments in Electric Lighting," by Prof. H. T. Davidge.

**Institution of Electrical Engineers (Manchester Students' Section).**—At 7.30 p.m., "The Electric Equipment of Automobiles."

SATURDAY, FEB. 4.

**Institution of Electrical Engineers (Glasgow Section).**—At 7.30 p.m., annual smoking concert at the Grosvenor Restaurant, Glasgow.

**The Dynamicables** will hold a dinner at the Trocadero on Feb. 8, preceded by a council meeting.

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## THE ELECTRICAL OPERATION OF TEXTILE FACTORIES.

The paper read by Mr. H. W. Wilson before the Manchester Section of the Institution of Electrical Engineers on the 17th in reference to the above subject was discussed on the same date before a good attendance of persons interested in this latest development of electrical enterprise. The paper was summarised in our issue of last week (p. 75), and it may be noted that the point principally touched on in the summary, that of cost, was the keynote of the discussion. It will be seen that the general feeling was that the public electricity supply schemes are unable to compete on price alone with present-day methods in the majority of cases (whatever may be the success of locally-installed electric plant), and so the business apparently will have to be built up on similar lines to the present supply for lighting purposes, where convenience, cleanliness, etc., are more to be considered than strictly comparative costs, light for light. The following tabulated advantages, mentioned in the paper, are therefore extracted for special notice in connection with this matter, and the item on p. 830 of this periodical for Dec. 9 last (concerning the application of electric power to the spinning and weaving mills at Malaga, where a saving in costs of 20 per cent. upon an output of 2,500 h.p. is mentioned) may further be appreciated for reference, especially as an English firm (Mather and Platt) was responsible for the plant.

1. The mill and the engine-house can be placed each in its most convenient situation without any regard to their relative positions.
2. The internal arrangements of the mill as regards shafting, gearing, and rope drives, etc., are greatly simplified and their costs reduced. The flexibility as regards extensions is, of course, obvious.
3. The grouping of machines is much less arbitrary than in a mechanically-driven mill, as the motors and the comparatively light shafting required by them can be placed where most convenient.
4. The reduction of a chance of breakdown, which would stop the whole mill, to a minimum.
5. The ease of running one section for overtime or on special work.
6. The reduction of the maintenance and depreciation charges.
7. The greater steadiness of drive which can be obtained under suitable conditions with a subsequent permissible higher speed and increased output.
8 The reduction in the total capital cost of the mill per spindle or per loom with a factory of above a given size.
9. The possibility of keeping a constant check upon the results obtained in each department of the factory.

The discussion was opened by Mr. C. D. TAITE from the chair, who commented on the appropriateness of the paper, Lancashire being the home of the textile industry. He thought the ·33d. per unit mentioned would be too low a rate for electricity works to compete with, as none yet supplied at that rate. Mr. Woodhouse had recently mentioned a rate of over a halfpenny, and he himself thought that "the higher we go the better."

Mr. SEATON was considerably struck with the originality of the paper, as, while other literature on the subject depended largely on Mr. S. B. Payne's researches, this person's name is only quoted once by Mr. Wilson. He mentioned the following obstacles in the way of introducing electricity into textile factories: (1) managers' scepticism as to the advantages of electrical working; (2) lack of expert advice, although this was a delicate point to make in such company; (3) opposition from mill-engine builders, steam-turbines especially being awkward opponents; (4) the economical working already attained would require a lot of beating. At present, to his knowledge, a horse-power per annum cost only 15s. 6d. for coal, and if any electric works manager could beat that, he would like to serve an apprenticeship with him. Further, there was the possibility of competition between plant makers and power makers, but the latter must come down to at least a halfpenny per unit. With most electrical generating stations this would mean "dumping," and that is only possible if one can find a certain number of other consumers prepared to pay through the nose to make up for the loss thus occasioned. As to the suggestion that other undertakings, such as coal mines, should take power by night to make up for this, he could imagine them, in reply, quoting the scribe Innocens, "Go thou unto the hottest place!"

Mr. W. B. WOODHOUSE was in agreement with Mr. Wilson on most points. He thought the knowledge of millowners as to their own costs was over-rated. The 15s. 6d. per horse-power per annum mentioned was probably made up of the total cost of coal divided by maximum load × total hours worked. He knew of mills with no less than five belts between machines and engines, most of the belts being like polished silver, and as the weather changed so did the speed of the machines. The advantages of obtaining power outside the works included the facts that there was less land to pay for, less worry to be encountered, and the capital could be reduced very considerably, or could be used more profitably in extensions to the mill itself. The ·3d. to ·35d. rate per unit he thought was too low for power companies to touch, but this low cost was not in accordance with his experience in Yorkshire, where the average equivalent price per unit would be more like 1d., and at lowest ½d., including capital charges of 10 to 15 per cent., the average efficiency being 50 per cent. He thought that single-phase reaction motors should be more successful than direct-current machines.

Mr. JOHN SHAW pointed out that America had had most experience in mill driving by electricity, and at one time their advocates of electric driving could not recommend it for economy when the engine-house was anywhere near the mill, but now there were no less than 27 mills built with self-contained electric power stations. It was safe to work at the maximum speed by electrical means, as the rate of speed was so constant, whereas with mechanical driving they had to be satisfied with a lower average speed on account of the greater variation, through pulleys slipping and accelerations breaking threads and so shutting down machines. He thought 2 per cent. a safe increase in speed. This steadier drive meant a further economy by increasing the number of machines that could be tended per operative, and therefore would lower the piecework rates. He agreed with Mr. Woodhouse that the ·3d. figure was too low, ·4d. to ·45d. being more like the cost per unit. An important point based upon his experience was that the first cost is less for the electrical installation than for mechanical driving gear. As to durability, although they could not yet point to 40 years' experience of electric driving, on electrically-driven mills 11 years of age no motor had yet been replaced. Motors had got to their topmost efficiency by now, and would never need superseding

Mr. WHITEHEAD gave evidence to show that mill managers were well posted as to the efficiencies and costs of their establishments, and were not guided by rough approximations, as Mr. Woodhouse surmised.

Mr. GAMLEN also agreed that the ·3d. to ·35d. figures were too low for even power companies, and thought that a halfpenny was nearer the figure. As to being sent "unto the hottest place," he took it that this meant down the coal pits, which was just where he hoped to carry his electric power.

Dr. BOWMAN spoke from practical experience of mill work in all its departments, and gave technical reasons for the difference between the efficiencies of Lancashire and Yorkshire mills. In many mills very considerable trouble was taken to find the exact costs. In one mill where diagrams were taken three times daily there was an average load of 90 per cent. It was heaviest on Monday mornings, due no doubt to the Monday feeling, and with belting as with men: undue moistness made them tight. The cost came to ·22d. per horse-power per hour, which equalled 33d. per unit, so he could endorse the much-questioned figures in the paper. He had included 10 per cent. for capital charges, and the cost of upkeep was only 2½ per cent. This mill had 80,000 spindles with 850 i.h.p, and he could fit up a mechanically-driven mill, as to plant and transmission, at £10 per indicated horse-power. He pointed out the advantages of rope driving over belting, and himself was

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the first to run a mill of over 1,000 h.p. with ropes—which cost in this case £400 against belts £1,500. He was told at the time that he had better hang himself with the ropes, but as his experiment was successful there were several hats (considered) eaten as a result. As regards efficiencies, he found more friction losses on the machines themselves than in the transmission gear. Plenty of mills, however, required altering to electric driving through inefficiency in transmission, the owners believing that the greater the load on the engines the more work was being done. He thought that estimates for electric power installations generally required revising, as they were too high to be of service.

Mr. C. C. ATCHISON was of the same opinion as previous speakers as to the impossibility of electric supply systems' rates being sufficiently low to tempt textile factory owners, owing to the extremely constant load. He had been told by the owner of a 700-h.p. mill that his own proposed charge for power was *three* times too much. A good deal might depend, however, in a technical knowledge of mills, and he thought that if the power companies had specialists in this line they could talk matters over more satisfactorily with millowners, and could possibly point out advantages that neither a mill-owner nor an ordinary electrical man could appreciate. He considered that ·75d. per unit was the lowest possible to sell at, but if the Board of Trade permitted overhead lines, he believed there would be more chance of reaching outlying mills without the comparatively prohibitive costs of underground work.

Mr. H. W. WILSON, in his reply, said that the ·3d. was not put in for fun, and emphasised that his figures were correct. He did not think piecework prices could be reduced by electric driving. The halfpenny per unit suggested by several speakers was in his opinion too high to be of use to many millowners, and he had known cases where this rate had been refused by them. He condemned gas-engines for the work, and especially for driving alternators in parallel, as an invention of the Evil One.

Mr. E. W. COWAN, in proposing a vote of thanks to Mr. Wilson, commented on the unusual freedom from statements and controversy of an interested trade nature in the paper and discussion.

Mr. G. F. METZGER seconded the vote.

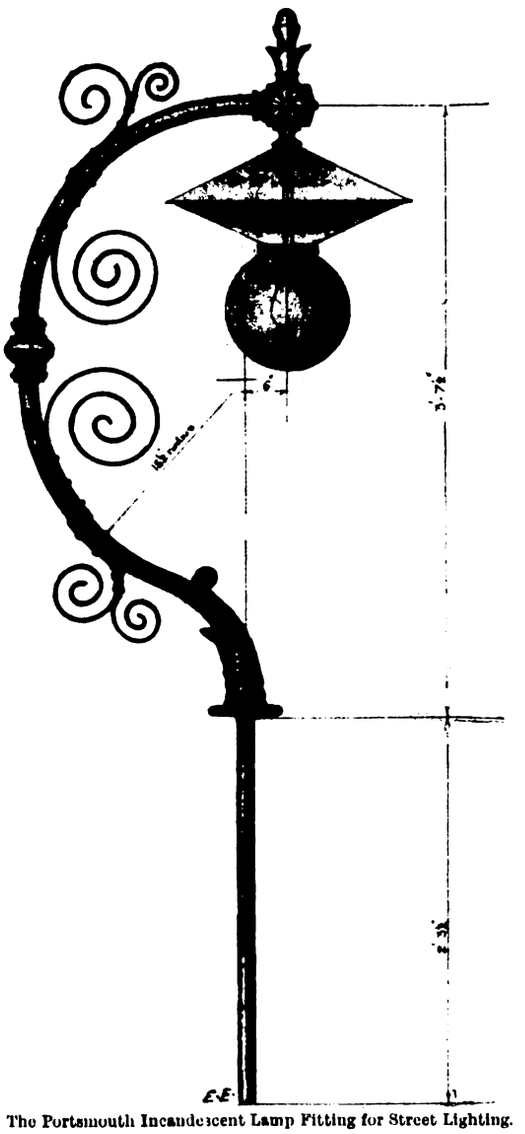
## TRADE NOTICES AND NOVELTIES.

### Water-Turbines.

From Mr. Alph. Steiger, M.I.C.E., 28, Victoria-street, Westminster, S.W., the London representative of Messrs. Escher, Wyss, and Co., of Zürich, Switzerland, and Ravensburg, Germany, we have received a new catalogue of water-turbines. The prominent position taken by Messrs. Escher, Wyss, and Co. as manufacturers of this special class of machinery is well known. Their turbines are in demand in every civilised country where water power is available for utilitarian purposes, and their name is associated with every important water-power scheme which we can call to mind. No matter whether it be Switzerland, Germany, France, Italy, Spain, India, the vast continent of America, these small islands, or elsewhere, the result is the same. The success of the firm may be attributed to the advantage of position which secures them a great local demand for hydro-plants, this being undoubtedly responsible for the development of the water-turbine to its present state of perfection in Switzerland, and we all know that the conditions which govern the satisfactory running of such plants are the same everywhere. It is especially interesting to note how the average power of each unit has steadily increased during the last few years. Thus in 1889 the average power per unit of plant installed was 104 h.p., while for the years 1895, 1900, 1902, and 1903 it was respectively 133 h.p., 311 h.p., 550 h.p., and 743 h.p. This is due to the increased employment of large units, a few additions of 10,000 h.p. each, such as those at Niagara Falls, causing, of course, an appreciable rise in the average. In all Messrs. Escher, Wyss, and Co. have supplied to the end of 1903 over 3,500 turbines, representing an aggregate of more than 600,000 h.p. They have paid special attention to the design and construction of two types of wheels—namely, the Francis turbine and the high-pressure impulse wheel. The principal features of these types are described and illustrated in the catalogue under notice, which also includes a mass of information relating to hydro-plants generally, together with a number of examples of installations erected in different parts of the world. Readers interested in the utilisation of water power should certainly obtain a copy of this catalogue.

### New Incandescent Lamp Support.

The accompanying illustration shows the incandescent electric lamp support and fittings as used for street lighting in Portsmouth. This design is a strictly original one, having been prepared for the Corporation by Mr. W. S. Foale, the engineer and manager of the electric supply undertaking. It will be seen that the lamp is enclosed in a clear globe, over which an inverted reflector is placed, which spreads the light in all directions. This type of reflector tends to equalise the illumination at all points of the roadway much more than the ordinary type, which rather concentrates the lighting on points near to the lamp column. With the use of incandescent lamps for street lighting, the details of the fittings make or mar the



The Portsmouth Incandescent Lamp Fitting for Street Lighting.

system, and we are pleased to reproduce the illustration herewith, which shows the type which has been most successful at Portsmouth.

### Simplex Conduit Erection and Wiring.

Together with the list dealt with in our issue for Jan. 20, we received from the Simplex Steel Conduit Company, Limited, a copy of their conduit wiring hand-book, which has been revised and brought up to date. The author of this little book is Mr. L. M. Waterhouse, M.I.E.E., A.M.I.C.E., engineer and general manager for the company, than whom no one could be better qualified to write upon the subject. His object, as explained in the preface, has been to give practical and detailed information concerning the various parts of the Simplex system and their application in practice. The best arrangement and design of circuits, and particulars of up-to-date installation methods, have also been included, in order to assist the observant wireman to an intelligent knowledge of how best to meet the varying requirements of conduit installation work, as well as to lead him to an appreciation of the capabilities of the system to carry out each and all of those requirements efficiently and economically. It is essential that the modern wireman should know all about conduit work, and to him especially the book in question will be invaluable for reference purposes.

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## Single-Phase Motors.

We are informed by the Rhodes Electrical Mfg. Co., Limited, 70 and 71, Bishopsgate-street Within, London, E C., that they are now manufacturing a single-phase motor of exceptional value to supply engineers, inasmuch as the machine has a very powerful starting torque and takes only a small amount of current in starting. It is a combination of a repulsion and induction machine, having constant speed when the induction side is cut in, and being reversible by means of simply changing two connections through the medium of an ordinary chopper-type switch. A 5-b.h.p. six-pole motor of the type in question, wound to operate on a 50-cycle circuit, has an efficiency of 82 per cent. and a power factor of 81 per cent. This motor will start 2½ times its full load running torque comfortably with a starting current not exceeding about double full load value, and will attain its rated speed in a smooth and gradual manner. We hope to give illustrations and further particulars of the above in a future issue.

## "Bristol" Novelties.

Many novelties are included in the latest catalogue issued from the Bristol Electric Safety Lamp Works, 40, Great Smith-street, Westminster, S.W. We have selected two for illustration. The first of these (Fig. 1) is a fishing light, consisting

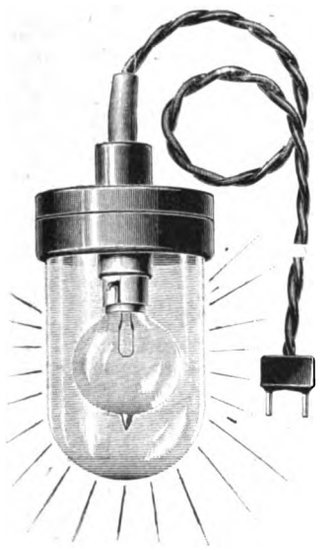

FIG 1.

of an incandescent lamp enclosed in a special waterproof fitting, and attached as shown to a length of flexible wire. This lamp is intended to be lowered into the water so as to attract fish to the bait. Fig. 2 shows a new fitting for suspending an electrical reading lantern from the top rail of a bedstead. It consists of an adjustable clamp, to which a socket for the lantern hook is fixed by means of a universal ball joint. No doubt this fitting will be widely appreciated. For the rest

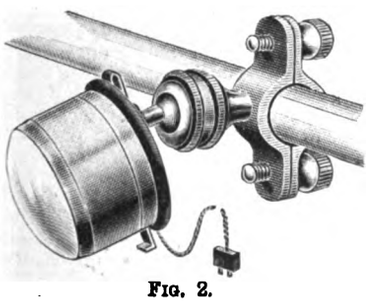

FIG. 2.

the catalogue deals with portable accumulators and electric safety lamps of various patterns, cycle lamps, small dynamos for charging purposes, measuring instruments, carriage lighting sets, and other well-known "Bristol" specialities.

## G. E. C. "Switchboards" List.

From the General Electric Company, Limited, 71, Queen Victoria-street, London, E.C., we have received a copy of their new "switchboards" list. Several fine switchboards recently erected by the firm in this country and elsewhere are illustrated in the front portion of this publication. Then we have some pages of information relating to the apparatus listed, followed by separate descriptions of the different panels for continuous-current switchboards, representing the firm's latest practice, alternative arrangements being included in each case, together with a diagram of connections and full particulars. Next come traction feeder pillars and panels; field excitation columns; resistances; details of standard cast-iron, angle-iron, and supported pillar frameworks for switchboards; 'bus-bar brackets and insulators; 'bus bars; holding-down bolts; slab-fixing bolts and screws; slate sub-bases; stay rods and turn-buckles; supports for 'bus bars; ground detector panels; lamp brackets; and swinging instrument brackets. The back portion of the list deals with panels for alternating-current switchboards, high-tension switches, and circuit breakers, lightning arresters, choking coils, liquid resistances combined with magnetic blow-out arresters, and high-tension fuses. Much care has evidently been taken in compiling this list so as to facilitate reference to the different items included. The issue of the list by the General Electric Company, Limited, as a separate section of their catalogue has been found necessary, we understand, owing to the increasing demand for panels for traction and lighting systems, to cope with which the company have recently added very considerably to this department of their business, thus placing themselves in a position to deal promptly with all orders.

## I.T.E. Limit Switches.

Users of electrically-driven machinery have frequently found it essential under certain conditions to be able to open the electric circuit instantaneously from distant points irrespective of the load, either by hand or predetermined mechanical conditions. The I.T.E. limit switch, of which we have particulars from Messrs. Robert W. Blackwell and Co., Limited, 59, City-road, E.C., is claimed to be a thoroughly reliable piece of apparatus for this purpose. It consists of the now well-known I.T.E. circuit breaker, but with a shunt or fine-wire coil substituted for the usual series actuating coil, passage for the main current still being through the switch bridge. The shunt coil may be so wound as to be operated from the main circuit, or, if more convenient, from a local or battery circuit according to the wishes of the user. By closing the shunt-coil circuit the limit switch will instantly open in the manner now so familiar to users of circuit breakers, and the main circuit will be interrupted. It is possible, where required, to still retain the series coil in combination with this fine-wire coil, the apparatus being then a circuit breaker and limit switch combined, giving protection also in the event of "overload" or "short-circuit" conditions. Examples of the practical application of these switches are given in a recently-issued section of Messrs. Robert W. Blackwell and Co.'s catalogue 59, their use in connection with travelling and jib cranes, on railways, in car-sheds, on printing presses and lifts, and as speed controllers being specially dealt with.

## Catalogues, etc., Received.

DYNAMOS AND MOTORS.—The Electrical Company, Limited, 121 to 125, Charing Cross-road, London, W.C., have sent us Sections D and E of their new list No. 1. The type of machine dealt with in these sections completes the series of slow-speed continuous-current machines, of which those in the preceding Sections A to C of the same list constituted part. Up to the 16-h.p. size, machines of the type in question may be used as motors, and on account of their slow speed and high efficiency are particularly suited for driving printing presses, paper machines, etc. As dynamos they may be advantageously used as exciters for direct coupling with three-phase generators, or they may be direct coupled to small steam or gas engines.

MISCELLANEOUS.—In addition to the list noticed above, we have recently received from the Electrical Company, Limited, a number of prints illustrating polyphase motors and generators of the different types supplied by them; also a leaflet dealing with carbons for flame lamps; and a card illustrating type B Nernst lamp, of which, we understand, there are three millions now in use. This lamp gives 35 c.p. at a guaranteed current consumption not exceeding that of an ordinary 16-c.p. lamp.

SIEMENS BROS.' PUBLICATIONS.—Several batches of leaflets have recently reached us from Messrs. Siemens Bros. and Co., Limited, York-mansions, York-street, Westminster, S.W. The latest includes the firm's standard specification 9-A for their large H machines; also the following diagrams of connections—viz., 150-M A motor starters; G machines (shunt and compound generators and motors); six-pole H machines (shunt and compound generators); eight-pole H machines (shunt and compound generators). These are intended to be filed with the respective leaflets and price-lists to which they belong. A useful form of binder is supplied by Messrs. Siemens Bros. for this purpose. It may be added that the diagrams in question are most excellent of their kind, and should prove of considerable value to the firm's customers. From the same source we have also a circular describing an interesting telpher line erected at the Blackburn Corporation gasworks for the purpose of handling coke from the retort-house to the coke store, a maximum distance of 240ft.

CIRCUIT BREAKERS.—From Messrs. Ernest F. Moy, Limited, Greenland-place, Camden Town, N.W., we have an illustrated sheet describing their circuit breakers type No. 16, single pole for continuous-current circuits up to 550 volts. These breakers are compact in appearance, and seem to be very substantially constructed.

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# LEGAL INTELLIGENCE.

## SIR HIRAM MAXIM ELECTRICAL AND ENGINEERING COMPANY, LIMITED.

In the Chancery Division Mr. Justice Buckley heard the case of Sir Hiram Maxim Electrical and Engineering Company, Limited—Tracy and another *v.* the company.

Counsel stated that it was a motion for the appointment of a receiver in an action brought by the debenture trustee. The company was now in liquidation, but the action was started before that event, and the official receiver had intimated that he would not object. The debenture stock amounted to £20 000, and his clients had a general charge on all the assets. The motion asked for the appointment of Mr. Alfred Hardie as receiver and manager. Counsel added that the company had a number of outstanding contracts, amounting to about £27.000, which had to be completed. The trust deed in favour of the plaintiffs was a charge on all the company's assets, including its uncalled capital.

Some question arose on the point whether the articles of association empowered to mortgage the uncalled capital, and his Lordship made an order, subject to the articles, authorising the mortgage.

## MOTOR TRACTION COMPANY.

In the Chancery Division, before Mr. Justice Buckley, Mr. Buckmaster, K.C., on behalf of the plaintiff, mentioned the case of Mason *v.* the Motor Traction Company.

Counsel stated that he had proposed to apply for an injunction restraining the company from continuing with a reconstruction scheme, but would ask for the motion to stand over, so that he could look into some accounts.

His Lordship assented to a postponement.

## EDEY v. SMITH.

This case was concluded in the City of London Court on Friday last. The action was brought by Mr. F. G. Edey, trading as F. G. Edey and Co., electrical engineers, against Mr. F. H. Smith, of Beaufort-street, Chelsea, to recover £76 for work done and materials supplied for electric lighting of certain flats. The defendant had been building flats at Chelsea, and had entrusted to the plaintiff the contract for supplying the electric lighting and electric bells. The plaintiff's case was that he had done the work satisfactorily, although he had no doubt been prevented from completing it. The defendant's case was that the plaintiff had refused to complete his contract, and that the work was done so badly that the defendant could not ask for payment for it from the Chelsea Electric Lighting Company, who were to approve of it. The electric bells which the plaintiff put up would not ring. No local authority would supply electricity to the flats in consequence of there being no fuses put in by the plaintiff.

When the case was last before the court, Judge Rentoul, K.C., gave judgment for the plaintiff for £20 on one item of the claim, and said that as to the rest the plaintiff was to complete the work. It was now stated that the defendant would not allow the plaintiff to do so, and judgment was given for the plaintiff for a further £46. 5s., with costs.

## THEFT OF ELECTRICITY.

Joseph Wallace, a miner, of Spennymoor, was charged at Auckland Police Court with fraudulently obtaining electric light belonging to the Northern Counties Electric Supply Company.

The accused inserted a pin between the flow and return wires, thus establishing a circuit independent of the meter.

Defendant was fined £1, or 14 days.

# COMPANIES' MEETINGS AND REPORTS

## NERNST ELECTRIC LIGHT.

The fifth annual meeting was held on Monday at the Westminster Palace Hotel.

**Mr. Bernard M. Drake,** in moving the adoption of the report, stated that, in accordance with resolutions passed at previous meetings, the capital had been reduced from £320 000 to £90,000. There were two alternatives open to the Board. The first was to liquidate the Company and reconstruct, which might have produced a bad impression among their customers, and the second was the course which had been adopted. A profit of £4 840 had been made during the year, against £3,926 in the former year, and a loss of £1,643 two years ago. The profit on sales of lamps and British royalties showed an increase of £1,401, which, in view of the disturbed state of some of the Company's territories, such as China, Japan, and Asia generally, where trading operations have come practically to a standstill, might be deemed satisfactory. Further agencies had been established in their different territories, the number at present being 56. It was recommended that the profit should be dealt with by placing £1,250 to a patent depreciation reserve fund and by paying a dividend at the rate of 3½ per cent., leaving £349 to be carried forward, after providing £100 to meet the alteration in the market value of investments up to Sept. 30 last. The question of the amount to be set aside for depreciation in the value of the patents had been the subject of considerable discussion, and, with the exception of one director, the Board were of opinion that, considering the wholesale way in which the book value of the patents had been written down, the figure for this year, at any rate, was all that they required to provide. The lamps as now made by the Allgemeine Gesellschaft contained many features covered by patents taken out by himself and other members of the technical staff. These patents were handed over to the Company without consideration, and were most useful to them in making the present agreement with the Allgemeine Gesellschaft. Referring to the dispute which had arisen in reference to the directors' fees, he said that his colleagues and himself placed themselves unreservedly in the hands of the shareholders as to the amount to be drawn by them in the future.

**Mr. J. G. Dalzell** seconded the adoption of the report.

Considerable discussion followed with regard to the management expenses and the directors' fees. A shareholder remarked that the Company were doing only a commission business, and he thought that a smaller office might be taken and the staff reduced. Until they commenced to manufacture lamps themselves he did not see why they should go to the expense of making a lot of experiments.

In answer to a question as to whether some reduction could not be effected in the amount of £3,025 for management expenses, the **Chairman** remarked that in their business, as in all others, there must be a definite percentage of standing charges to the turnover. There was every reason to hope that in future the percentage would decline materially, but he did not think that they would be wise to leave their present offices, which had been fitted up with testing instruments and other appliances, and go to some back garret. As to the staff, he did not know anyone with whose services they could dispense. They had one technical man who knew the whole history of the lamp, and whose knowledge would be of great value in the event of their commencing to manufacture the lamps themselves. He added that he and his partner held 6,000 shares, so that he had every inducement to try to make the Company successful.

The report was then adopted, and a resolution was passed fixing the directors' fees for the current year at £500.

**Mr. A. M. Oppenheimer** moved, and **Mr. Rushton** seconded, the election of Sir Henry Seton-Karr, M.P., in the place of Mr. Wallis-Jones. Mr. Oppenheimer said that Sir Henry Seton-Karr had promised to support his policy of retrenchment.

The **Chairman** stated that if Mr. Wallis-Jones were not re-elected he and Mr. Dalzell would leave the Board.

**Mr. G. Kitchin** strongly opposed the proposed election of Sir Henry Seton-Karr, remarking that they wanted technical men or good business men to conduct the business.

**Sir Henry Mance** observed that at present there were two solicitors on the Board, and he believed that Sir Henry Seton-Karr was a barrister. If they left the Company in the hands of legal gentlemen, he felt certain their shares would not be worth 1s. each.

The **Chairman** observed that the absent shareholders should be afforded the opportunity of considering the critical position which had arisen, and after a long discussion a resolution was carried adjourning the meeting for a month.

## CITY AND SOUTH LONDON.

The report for the half-year ended Dec. 31 last, to be submitted to the meeting on the 31st inst., states that receipts from all sources for the past half-year have amounted to £74,892, and the cost of working has been £35,369, leaving a profit of £39,523. Inclusive of the balance brought forward from June 30 last, the net revenue account shows an aggregate total of £40,224. After making provision for the debenture stock interest and the transfer to the renewal fund of £1,500, a balance remains available for dividend of £27,445. Out of this the directors recommend the full dividend of 5 per cent. per annum on the preference stocks, 1891, 1896, and 1901, and that a dividend at the rate of 1¾ per cent. per annum be paid on the consolidated ordinary stock for the half-year, leaving a balance of £1 450 to be carried forward. The number of passengers, exclusive of season-ticket holders, carried during the half-year was 8,401,846, a decline of 1.309 216. Receipts from this source (including season tickets) were £70,705, a decrease of £1,581. The decrease in traffic as compared with the corresponding period last year is attributable to the exceptionally fine and dry weather which prevailed during the greater part of the half-year, whereas the weather in the previous year was unusually wet. Arrangements with the various railway companies in respect to the Euston extension being now completed, a contract will be entered into for the construction of the extension. In providing the capital necessary for the work it is found to be more economical to issue the stocks authorised at the last meeting as part of and ranking with the other stocks of the Company and liable to dividend in the usual course, but arrangements are in progress by which the amount payable as dividend on these stocks will, it is anticipated, be met by receipts from other sources. The interchange traffic with the Great Northern and City Railway is increasing satisfactorily.

## ANGLO-AMERICAN TELEGRAPH.

After placing £10,000 to the renewal fund for the half-year, the directors recommend a balance dividend of 17s. 6d. per cent. upon the ordinary consolidated stock for the year ended Dec. 31, 1904, and a balance dividend of £1. 15s. per cent. upon the preferred stock for the year ended Dec. 31, 1904, leaving about £3,194 to be carried forward. The above dividends, together with those already paid, will amount to £2. 15s. per cent. on the ordinary consolidated stock and £5. 10s. per cent. on the preferred stock for 1904.

## NORTHAMPTON ELECTRIC LIGHT.

Resolutions have been unanimously passed by the several classes of shareholders in this Company, and also by extraordinary general meetings of the Company, whereby the rights of the shareholders have been so far modified as to extinguish on certain terms the special privileges lately attaching to the "first issue" ordinary shares, and also

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converting the 6 per cent. preference shares into 5 per cent. preference shares. The result is that as from the 1st inst., and subject to certain payments to be made out of revenue, there will be only two classes of shares—namely, ordinary and 5 per cent. cumulative preference.

## DIRECT UNITED STATES CABLE.

The half-yearly meeting of this Company was held on Tuesday, when the report, of which we gave particulars last week, was adopted.

## DUBLIN UNITED TRAMWAYS.

The half-yearly meeting of this Company was held in the Sackville Hall, Dublin, on Tuesday, Mr. Wm. Murphy (chairman) presiding.

The annual report stated that the amount available for division was £50,313 0s. 9d., out of which dividends were recommended at the rate of 6 per cent. on the preference shares and 6 per cent. on the ordinary shares. The sum of £6,847. 13s. 6d. was carried forward.

The **Chairman** stated that there had been a falling off in the passenger traffic for the first half of the year, but this was only a temporary decline, and the receipts for the second half of the year showed a favourable state of affairs. The increase in parcels traffic continued. A substantial reduction in the income-tax assessment was obtained on appeal to the Commissioners.

The report was adopted unanimously.

## METROPOLITAN RAILWAY.

The dividend for the past half-year is announced at the rate of 3 per cent. per annum, as last year, but with £10,000 placed to special reserve and £11,000 carried forward. The dividend on the surplus land stock is at the rate of 2¾ per cent. per annum, being also the same as last year. The report states that the installation of the power station, Neasden, is so far completed as to enable a service of passenger trains to be run between Baker-street and Uxbridge, and the number of such trains is being gradually increased. This working was commenced on Jan. 1, and it is intended shortly to run the whole service on this section by electrically-driven trains. The work on the Inner Circle is being proceeded with rapidly, and electric traction will follow on there as soon as the equipment is finished.

## LONDON, BRIGHTON, AND SOUTH COAST RAILWAY.

The half-yearly report of this Company contains the following reference to the electrification scheme: "The Board has now decided, on the recommendation of its consulting electrical engineer, made after a long and exhaustive enquiry, to carry out a scheme of electrification on the South London Railway from Battersea Park to Peckham Rye upon a system presenting many novel features, the working of which will be watched with great care. The initial cost will not be large, and the results will be very interesting, and may have a most important bearing upon the future working of the Company's traffic."

The accounts show a balance of revenue over expenditure of £832,230.

## NEW COMPANIES REGISTERED.

**Sunbeam Motorcar Company, Limited.**—Capital, £40,000. Object: to adopt an agreement with John Marston, Limited, and to carry on the business of manufacturers of motor cycles and carriages, motors, motorcars, builders of boats and other marine vessels propelled by electricity or other power, etc.

**Stanley Electric Carriage Company, Limited.** — Capital, £10,000. Objects: to adopt an agreement with A. E. Gadd and G. Stephenson, and to carry on the business of vendors and factors of and dealers in motors, motorcars, airships, launches, cycles, velocipedes, carriages, and other vehicles (whether propelled by electricity or other power), electrical, mechanical, and general engineers, etc.

**Foreign Electrical Bleaching Patents, Limited.** — Capital, £15,000. Objects: to acquire and work the patents, rights, and other assets comprised in an agreement, dated Nov. 4, 1901, between A. A. Vogelsang and W. Lewin, for the sale of an invention of a process of electrical bleaching known as the Vogelsang Process, for all countries except England, Germany, and Austria-Hungary, and to carry on the business of bleachers. Registered office: St. Michael's House, Basinghall-street, E.C.

**Langdon-Davies Motor Company, Limited.**—Capital, £5,000. Objects: to adopt an agreement with the Langdon-Davies Motor Company, Limited, for the acquisition of certain patents and other rights and properties, and to carry on the business of suppliers and sellers of alternate-current motors, etc. Registered office: 101, Southwark-street, S.E.

### Liens Registered.

**Wirral Railways Company, Limited.**—A trust deed, dated Dec. 30, to secure £60,000 debentures created Sept. 26, 1904, has been registered. Property charged: certain freehold property and shares and the company's general assets. Trustees: T. H. Jackson, The Manor House, Birkenhead, and J. Tomlinson, M.P., Willington Hall, Cheshire. Also issue on Dec. 20 of £3,000 debentures, part of the above-mentioned series.

**Buenos Ayres New Tramways Company, Limited.**—A trust deed, dated Dec. 1, 1904, to secure £300 000 debenture stock, with power to issue further stock not exceeding £50,000, has been registered. Property charged: the company's undertaking and property, present and future, including uncalled capital. Trustees: J. G. Le Marchant, 13, Thurloe-square, S.W., and J. Head, 40, Lowndes-square, S.W.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Keighley.**—The Corporation invite tenders for tramcars. Tenders by Jan. 30.

**Halifax.**—The Corporation invite tenders for coal conveyors. Tenders by Jan. 31.

**Todmorden.**—The Corporation invite tenders for the supply of electricity meters. See advertisement.

**Saragossa (Spain).**—Tenders are invited for 32 candelabra for the municipal theatre. Tenders by Jan. 30.

**Oporto.**—The Municipal Authorities require tenders for lease of their electric tramways. Tenders by March 15.

**Milan.**—The Mediterranean Railways require tenders for an electric crane to be erected at Gallarate. Tenders by Feb. 10.

**West Hartlepool.**—The Corporation require tenders for additional 250-kw. set, with the necessary switchboard, panel, etc.

**Arenas De San Pedro.**—The Municipality require tenders for public electric lighting for 20 years. Tenders by Feb. 12.

**Paris.**—The Colonial Office, rue Jean-Nicot 4, require tenders for 106,000 kilos galvanised telegraph wire. Tenders by Jan. 31.

**Paris.**—The Artillery Depôt, avenue de Saxe No. 2, require tenders for 370,000 kilos copper and 217,000 kilos zinc by Feb. 9.

**Ghent.**—The Municipality require tenders for 15 electric cranes for the harbour works. Provisional estimate, £1,200. Tenders by Feb. 20.

**Bucharest.**—The Government require tenders for the annual supplies to the Regie for lighting materials and accessories. Tenders by Feb. 7.

**Ilford.**—The Urban District Council invite tenders for the supply of about 2,400 yards ·4in. concentric armoured cable. Tenders by Feb. 7. See advertisement.

**Stockport.**—The Gas and Electricity Committee invite tenders for the supply of 10 complete feeder pillar boxes, with bases. Tenders by Feb. 1. See advertisement.

**Kirkcaldy.**—The Town Council invite tenders for the extension of about 500ft. in length of the present East Pier. Tenders to the Town Clerk by Feb. 4. See advertisement.

**Bury.**—The Electricity Committee invite tenders for the supply and erection of one 500-kw. direct-current high-speed generating set. Tenders by Feb. 14. See advertisement.

**Liria.**—The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

**Vienna.**—Tenders are required for telegraph and telephone materials. Particulars may be obtained from the K. K. Post Oeconomie-Verwaltung, Vienna. Tenders by Jan. 31.

**Grimsby.**—The Corporation invite tenders for (No. 30) motors; (31) water-purifying plant; and (32) 12 months' supply of stores. Tenders for 30 and 31 by Jan. 23, those for 32 by Feb. 1.

**Madrid.**—The Department of Agriculture, etc., invite tenders for installation and working for 60 years of an extension of the electric tramways in the north of the town. Tenders by Feb. 25.

**Stockport.**—The Tramways Committee invite tenders for the overhead equipment of about four miles of electric tramway, and also for copper rail bonds. Tenders by Feb. 6. See advertisement.

**Laventhem (Belgium).**—The Municipality require tenders for erection of central station, laying of mains, etc. Particulars (3s. 4d.) may be obtained from the Secretary of the Mayor of that place.

**Leith.**—The Corporation invite tenders for the supply and erection of one 600-kw. steam dynamo, one water-tube boiler, and one traction switchboard. Tenders to the Town Clerk by 6 p.m. on Feb. 15.

**Caen (France).**—The Prefect requires tenders for concession of a tramway from Ryes to Caen *via* Creully for goods and passengers. Particulars from the Prefect of Calvedos, Caen. Tenders by Feb. 1.

**Brussels.**—Tenders are required for erection of an electric station at the goods railway station at the port. Specification No. 391 is obtainable from the Belgian Government Railways. Tenders by Feb. 8.

**West Ham.**—The Council invite tenders for the supply of engine-room stores, cables, integrating wattmeters, double-pole house cut-out boxes, transformers, incandescent lamps, and coal. Tenders by Feb. 6. See advertisement.

**Stockton-on-Tees.**—The District Fund, Gas, Quay, and Electricity Committees invite tenders for the several articles and stores required by them for the year ending March 31, 1906. Tenders by Feb. 10. See advertisement.

**Switzerland.**—M. R. Vontobel, of Winterthour, and M. Charles Probst, of Lucerne, have obtained a concession for the construction of a narrow-gauge electric railway from Meiringen to Gletsch. The total cost of the enterprise is estimated at £241,600; £19,600 is to be expended on rolling-stock.

**Bermondsey.**—The Borough Council invite tenders for the supply of arc lamp carbons, conduits, electricity meters, demand indicators, and mains, fuses, engine oils, indiarubber cables and jointing material, lead covered cables and meter boards. Tenders to the Town Clerk by Feb 6. See advertisement.

**Christiania.**—The Government Railways require tenders for 8,000 kilos 4mm. galvanised iron wire, 5 000 kilos 3mm. ditto, 500 kilos salammoniac for Léclanche batteries, 500 carbons for ditto, and 4,000 insulators. Tenders, addressed to the office of the Administration, Jernbanetorret 8·9 in Christiania, in envelopes marked "Anbud paa Telegraf-og Telefon-materiel," to be received by Feb. 3.

**Shanghai.**—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative pro-

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posals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Pook and Co., 63, Leadenhall-street, E.C. Tenders by March 31, 1905.

**Hammersmith.**—The Council invites tenders for the supply of (*a*) arc lamp accessories; (*b*) arc lamp globes, etc.; (*c*) brooms and brushes; (*d*) carbons; (*e*) commutator brushes; (*f*) electrical goods; (*g*) files; (*h*) firebricks, clay, and lime; (*i*) gauge glasses; (*j*) incandescent lamps; (*k*) insulated wires; (*l*) lubricating oil; (*m*) metals; (*n*) meters; (*o*) oilman's goods; (*p*) packing and jointing materials; (*q*) screws; (*r*) tools; and (*s*) Welsh smokeless and other steam coal. Tenders by Feb. 8 See advertisement.

**Handsworth (near Birmingham).**—The Urban District Council invite tenders for the supply and delivery of the following in connection with the electric lighting undertaking: (Contract No. 10) power and lighting circuits and fittings in generating station; (11) pipework, feed pumps, economiser, etc.; (12) electricity meters. Tenders will only be considered for the whole of the work covered by each specification, and not for any part thereof. Copies of the specification, with the conditions of contract, etc., can be obtained from Mr. H. Ward, clerk. Tenders to the Clerk before noon on Feb. 2.

**Melbourne.**—Tenders will be received at the office of the Deputy Postmaster-General until noon on Feb. 7 for the supply and delivery of (1) 3,500 trunk-line multiple jacks, in strips of 20; (2) 1,320 yards of 64-wire wool-insulated switchboard cable. Specifications may be seen at the General Post Offices at Melbourne, Sydney, Brisbane, and Adelaide. Tenders, endorsed "Tender for ——," as the case may be, addressed to the Deputy Postmaster-General, Melbourne, may be deposited in the tender-box at the General Post Office, Melbourne, or, if sent by post, must be prepaid and registered. The deposit to be enclosed with the tender is 5 per cent. on the total amount.

**Johannesburg.**—The Municipal Council are prepared to receive tenders for 100 electric tramcars, two electric water-cars, one five-ton travelling crane, one electric car traverser, and various workshop tools, including erection at Johannesburg, to Specification No. 10 of their consulting engineers, Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W. Copies of the specification may be seen on and after Jan. 7 at the Council Offices, Johannesburg, and at the Consulting Engineers' Offices in London, and may be obtained on payment of five guineas, which will be returned on receipt of a bona fide tender. Duplicate copies of the specification may be bought for 10s. each (not returnable). Tenders must be addressed to Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W., and must be received by them not later than March 6. The Council will not be responsible for any expenses incurred in tendering.

**South Shields.**—The Corporation invite tenders for the execution of the works and the supply of plant in connection with the laying of proposed electric overhead tramways in the streets of the borough: (Part 1) permanent way and construction of track; (2) copper rail bonds, bonding of tramrails; (3) conduits, cables, and overhead equipment. Specification, etc., can be obtained from Mr. J. Moore Hayton, town clerk, on payment of £5. 5s. for each of Parts (1) and (3), and £2. 2s. for Part (2), which sum will be returned on receipt of a bona fide tender for each part. General and detailed plans of the proposed works can be seen as regards Part (1) at the office of Mr. S. E. Burgess, M.I.C.E., borough engineer, Chapter-row, and as regards Parts (2) and (3) at the office of Mr. J. H. Cawthra, M.I.E.E., the borough electrical engineer, West Holborn, South Shields. Tenders to the Town Clerk, Court-buildings, South Shields, by Feb. 20.

## RESULTS OF TENDERS.

**Falkirk.**—The Town Council have agreed to accept the offer of the General Electric Company, Limited, for the supply of lamps.

**London, E.**—The Whitechapel Guardians have accepted the tender of Cunningham and Co., of Edgware-road, for the installation of electric light at Section 2 of the infirmary.

**Belfast.**—The Corporation have accepted the tender of the Forest City Electric Company, 3, Gore-street, Piccadilly, Manchester, for protected rail bonds for the Leith and Belfast Corporation tramways.

**Oban.**—The Town Council have decided to accept the tender of J. Venner and Co. for the supply of meters for the ensuing 12 months—viz.: 1½ amperes, £1. 12s. 6d. each; 3 amperes, £2. 1s. each; 5 amperes, £2. 3s. 6d. each; 10 amperes, £2. 10s. each; 25 amperes, £2. 15s. each; 50 amperes, £3 each; 100 amperes, £3. 5s. each.

**Erith.**—The Urban District Council have accepted the tender of the British Westinghouse Electrical and Manufacturing Company, Limited, Norfolk-street, Strand, W.C., for 14 Brush car bodies, Mountain and Gibson trucks, own equipments, and seven Brush top-deck covers, at £8 522. 5s; magnetic track slipper brakes, at £700; and a track sweeping and watering car, at £626. 10s.

**Fulham.**—The following tenders have been received for the supply and erection of a 1,000-kw. alternator—viz.:

| | |
|---|---|
| General Electric Company (accepted) | £6 718 |
| Witting, Eborall, and Co. | 6,891 |
| Siemens Electrical Company | 6 894 |
| Mather and Platt | 6 910 |
| Bruce Peebles and Co. | 6,935 |
| J. Fowler and Co. (Leeds) | 6,935 |
| International Electric Company | 6 935 |
| British Thomson-Houston Company | 7,003 |
| Dick, Kerr, and Co. | 7 090 |
| Electric Construction Company | 7 135 |
| Westinghouse Electric and Manufacturing Company | 7.197 |
| Westinghouse Electric and Manufacturing Company (alternative) | 7.357 |
| Electrical Company | 7,535 |
| Vicars, Son, and Maxim | 7,545 |
| Brush Electric Manufacturing Company | 7,555 |

**Bradford.**—The Education Committee have accepted the tender of Messrs. Roberts Bros., 15 and 17, Lee-street, Thornton road, Bradford, for the lighting of the Dudley-hill new Council Schools by electricity.

**Dover.**—The British Electric Equipment Company, Limited, 11, Queen Victoria-street, E.C., have obtained the contract for the construction of the permanent way, overhead equipment, and laying of cables in connection with the Dover and River light railways.

**London.**—The Metropolitan Asylums Board have received the following tenders for extending telephone system, etc., at the North-Western Hospital:

| | | | |
|---|---|---|---|
| J. W. Gray and Son (accepted) | £126 | 10 | 0 |
| Private Wire and Telephone Installation Company, Limited | 140 | 0 | 0 |
| New System Private Telephone Company, Limited | 160 | 13 | 4 |
| A. V. Gifkins and Co. | 162 | 0 | 0 |
| Buchanan and Curwen | 168 | 0 | 0 |
| J. Richmond and Co. | 258 | 10 | 0 |

And for the installation of electric light, telephones, and fire alarms in a portion of the Belmont Asylum:

| | | | |
|---|---|---|---|
| Bromley and Batstone, 24-26, Holborn, E.C. (accepted) | £2,244 | 0 | 0 |
| F. A. Glover and Co., Limited, Vine-street, Clerkenwell-road, E.C. | 2,483 | 10 | 0 |
| Belshaw and Co., 53, Victoria-street, S.W. | 2,660 | 0 | 0 |
| Buchanan and Curwen, 64, Victoria-street, S.W. | 2,675 | 0 | 0 |
| Wenham and Waters, Limited, Croydon | 2,806 | 0 | 0 |
| Bergtheil and Young, Limited, 12, Camomile-street, E.C. | 3,176 | 10 | 0 |

# BUSINESS NOTES.

## TRACTION.

**Bradford.**—The Corporation will shortly issue a tramway time-table.

**Wolverhampton.**—It is reported that the Hunter-street route was opened on Monday.

**Dolter System.**—An exhibition of the Dolter surface-contact system was given at the Grand Hotel, Birmingham, on Monday.

**Underground Electric Railways Co.**—The London County Council have approved amended plans for Piccadilly-circus Station.

**Perth.**—A start has been made with the reconstruction of the tramway system, which it is hoped to complete in three or four months.

**Glasgow.**—The Corporation tramways have attained a record for their weekly receipts, the total being £17,069, against £16,040 in June last.

**London United Tramways Co.**—The Kingston Town Council have approved the plans submitted by the company for new tram routes, subject to one or two amendments.

**Falkland.**—At a meeting of the committee of the Fife County Council it was decided to form a local committee to make all the preliminary arrangements for the tramway scheme.

**Cardiff.**—Considerable alterations are about to take place in the tramway service, the result of which will be that certain routes will be abandoned and other routes will have a more regular service.

**Swansea.**—A satisfactory trial trip has been run on the Morriston section. It is not thought, however, that the Board of Trade will inspect this small section of the line before the others are ready.

**Baker-street and Waterloo Railway.**—The St. Marylebone Borough Council have decided to oppose this company's Bill, which provides for the construction of four new subways in the borough.

**Belfast.**—The contract with Messrs. J. G. White and Co. for the electrification of the tramways was completed last week, and it is reported that a commencement was to be made with the work on Monday.

**Dalkeith.**—The authorities are reported to be favourably disposed towards the electric tramway scheme referred to in our last week's issue, and it is stated that the line will ultimately be extended to several of the surrounding districts.

**Swindon.**—Since the opening of the trams on Sept. 22 the total number of passengers carried up to the 28th ult. was 674,474. The receipts amounted to £2,627. 7s. 9½d., while it is estimated that the total expenses will be £150 per week.

**Shoreditch.**—It is reported that the Borough Council have decided to propose that petrol or other power motors should be adopted for the trams within their district, so as to dispose of the question in regard to the type of electrical system.

**Central London Railway Co.**—The directors declare the following dividends: on the undivided ordinary and preferred stocks, 4 per cent. for the half-year; on the deferred stock, 4 per cent. for the whole year, £30,000 being carried to reserve and £22,000 forward.

**Lancashire and Yorkshire Railway Co.**—The dividend for the half-year ended Dec. 31 is announced at the rate of 3¾ per cent. per annum, as compared with 3½ per cent. per annum for the second half of 1903, carrying forward a balance of £31,000, as against £32,800

**Cheap Labour.**—We are informed that a mass meeting of electrical workers and others is to be held in the White Hart Hotel, Acton, W., on Feb. 2, at 8 p.m., to protest against the employment of cheap labour upon the electrification of the District and other underground railways of London.

**Greenock.**—In the arbitration case between the Greenock Corporation and the tramways company it is reported that the Board of Trade have awarded £602. 18s. 9d. as the proportion of profits due to

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the Corporation, while the company are to account for two sums of £75 set aside for maintenance and £1,500 placed to depreciation.

**Tube Railways.**—The Law and Parliamentary Committee of the Fulham Borough Council have prepared a lengthy list of recommendations for the protection of the borough's interests in connection with the Central London, the Hammersmith, City and North East London, and the Great Northern, Piccadilly, and Brompton Railways.

**Llanelly.**—At last week's meeting of the Town Council the chairman stated that he and the town clerk had gone into the draft agreement with the traction company very carefully. So far as the legal position was concerned, he believed that every point had been covered. After taking the advice of an electrical expert the agreement is to be submitted to a special meeting.

**Gainsborough.**—At the monthly meeting of the Urban District Council, Messrs. Harrison, Beaumont, and Smith, of Wakefield, wrote in connection with the Ackworth and Lindsey Light Railway that their clients' proposal was to carry a tunnel underneath the River Trent, and in no way to interfere with the navigation. The Council considered this reply satisfactory.

**Private Bills.**—The Examiners of the House of Commons have passed the following measures as complying with Standing Orders: Central London Railway (New Lines); Blackpool, St. Annes, and Lytham Tramways; Tyneside Tramways and Tramroads Company; North-East London Railway; Shropshire and Worcestershire Electric Power; and the Metropolitan District Railway.

**Exeter.**—The Tramways Committee have received a communication from the contractors, Messrs. Dick, Kerr, and Co., stating that they will be pleased to undertake the construction of the tramways through Heavitree at scheduled rates and under the same conditions as those obtaining for their present contract. The committee recommend that the work in Heavitree be now proceeded with.

**Kirkcaldy.**—The Kirkcaldy and Dysart Water Commissioners and Wemyss Parish Water Committee have had the tramway scheme under consideration in regard to the possibilities of it injuring their pipes. A request has been made for special protective clauses wider in scope than those given under the statute. It is, hoped, however, that the matter will be arranged so as to avoid opposition to the provisional order.

**Southend.**—At last week's meeting of the Town Council it was reported that the expenditure on the light railways for the current financial year would considerably exceed the estimate. Councillor Roberts stated that the matter was being carefully investigated, and that full particulars would be laid before the Council. A proposition to revert to the system of running the cars over the beach section was negatived after a close vote.

**Liverpool Overhead Railway Co.**—The accounts of this company for the past half-year show an available balance of £10,134. 18s. 6d., and the directors have resolved to recommend payment of a dividend at the rate of 5 per cent. per annum on the preference shares and 1½ per cent. per annum on the ordinary shares, against 1½ per cent. per annum on the ordinary shares for the corresponding period last year. Balance carried forward, £3,743 against £4,132.

**Through Running.**—Replying to our circular letter of Nov. 29, Mr. J. Lyon Whittle, the town clerk of Warrington, who has been unable to answer earlier, writes that his Corporation have recently been approached by the promoters of the Northwich light railway, and have conceded the principle of interchange of traffic, subject to terms to be mutually agreed upon. Mr. Whittle adds that the subject is one of great difficulty, but, in his opinion, is capable of satisfactory adjustment.

**Walsall.**—The report of the first year's working of the municipal trams has just been issued, and shows a gratifying result. This is made up to the end of 1904, and a net profit of £2 270 appears, after payment of all charges, including interest and sinking fund. The Tramways Committee strongly recommend that this surplus should be carried to a reserve fund, as they believe it will be a sound policy to build up such a fund to the maximum amount allowed by the Walsall Corporation Act.

**East London Railway.**—The report for the half-year ended Dec. 31 states that, anticipating the electrification of the Metropolitan and the Metropolitan District Railways, and the consequent suspension of their through train services over the line, a temporary scheme for future working and schedules of new train services have been agreed. Relative plans for cross-over roads and signals, and for facilitating the interchange of passengers with these railways at Whitechapel Station, have also been passed.

**Hastings.**—The Corporation have decided to formally lodge a petition against the company's Bill, referred to in previous issues. Councillor Gray, in moving the adoption of this course, remarked that it need not be any barrier to a conference between the parties on outstanding questions. At a meeting of the Bexhill Corporation a deputation from the company was received in reference to the route proposed for this section of the system. The promoters now contemplate a line to the centre of Bexhill only, deferring the construction of the line to Kewhurst. The Corporation decided that they could not assent to the company's Bill in its present form.

**Erith.**—At last week's meeting of the Urban District Council the consulting engineers, Messrs. Hawtayne and Zeden, submitted a report stating that the contractors had made fair progress with the permanent way. In the Bexley-road the track had been completed down to the double line near the bridge, where a short stoppage had to be made for the removal of gas and water mains. A letter was read from the Board of Trade provisionally approving of the system of electric traction proposed to be adopted, subject to any requirements which may be considered necessary on the inspection of the completed works.

**Mont Blanc Railway.**—M. Duportal, the author of the system accepted for running a tramway line up Mont Blanc, on the Chamounix side, has given some interesting details of the work, which has already been put in hand. Steel rails are being used, and each will rest upon 12 metallic sleepers or traverses. The trams will consist of an electric locomotive, a coupled car, and a trailer, capable of holding 80 persons. The speed on horizontal planes will be about 4½ miles an hour, and on vertical planes 1,236 yards an hour, with numerous stops, to enable passengers to enjoy the points of view and to gradually "acclimatise" them against mountain sickness. The journey will last four hours, and will cost 32s. 6d.

**The Municipal Tramways Association.**—At a meeting of the Sunderland Tramways Committee a letter was read from the Municipal Tramways Association calling attention to the fact that Bills were being promoted by the Midland, North-Eastern, and Great Western Railway Companies to enable them "to own, work, and use in any district, or to or from any place served by the companies' railways, omnibuses, coaches, cars, or other road vehicles to be drawn by animals, electrical, or any mechanical power, and therein to carry passengers, luggage, parcels, merchandise, etc." The committee decided to support the Municipal Tramways Association in an enquiry as to what was to be done in the matter.

**Aberdeen.**—The question of the renewal of the Aberdeen Suburban Tramway Company's lease for running powers over the Corporation system was under consideration at the meeting of the Tramways Committee. The committee considered that before any decision was come to it would be advisable to obtain certain information as to the facilities given in English towns by the corporation to suburban companies, and it was therefore agreed to defer the matter, and to call a special meeting on an early date to discuss the whole subject. One special point for consideration will be the recent decision of Lord Balfour, the arbiter between Glasgow and Paisley, where the arrangement is very much similar to that at present obtaining in Aberdeen.

**Huddersfield.**—The revenue account for the nine months ending Dec. 31, 1904, shows that the miles run numbered 1,272,682, as against 1,237,763 last year. The receipts amount to £54,095. 9s. 2d., representing 10·20d. per car mile, as compared with 9·83d. per car mile in the corresponding period last year. On the expenditure side £6,494 was the figure for maintenance and repairs (1·23d. per car mile, as against 1·01d. last year); £2,493 for generation of electricity (at the rate of ·47d. per car mile, the same as in the previous year); £12,521 for traffic expenses (2·36d. per car mile, as against 2·58d. last year). The total working expenditure was £27,422 (5·17d. per car mile, as against 5·29d. last year), leaving a gross surplus of £26,672 (5·03d. per car mile, as against 4·54d. last year). Of this amount £9,824 went as interest on debt, and £7,991 for redemption of debt, making a total of £17,815 (or 3·36d. per car mile, as compared with 3·78d. last year). The surplus, without making any allowance for depreciation, amounts to £8,857 (or 1·67d. per car mile, as compared with ·76d. per car mile last year).

**London County Council.**—The Board of Trade have given their approval to the conduit system, including an increase in the width of the slot from ⅜in. to 1in., for the reconstruction of the first sections of the Council's northern system. At Tuesday's meeting of the Council the Highways Committee reported that, owing to the assiduity of the tramway staff, the services had been well maintained during the foggy weather experienced recently. The receipts for the five weeks ending the 14th inst. totalled £61,923, against £46,268 last year, and from April 1 £526,542, against £410,000. The Council decided without discussion to abandon the suggested acquisition of Charing Cross railway station and of Hungerford Bridge for the purpose of carrying the tramways across the Thames. The Chairman of the Highways Committee stated, in reply to questions, that the covered tramcars earned on the average 1½d. per car mile more than the other cars, representing a difference per car of about £4 per week. Tramway fares to the amount of 1d. or ½d. can now be paid on the London County Council's system by celluloid discs, which are to be obtained in quantities of not less than 5s. in value.

**London Traffic Commission.**—At a conference between the Chairmen of Committees of Lords and Commons and the parliamentary agents, Lord Balfour announced, with reference to the intimation of the Board of Trade that the London tube schemes would not be taken until the report of the London Traffic Commission was presented to Parliament, that the Committees did not feel inclined to decide what would be done with those schemes until Parliament had had an opportunity of considering the report. The London Traffic Commissioners will meet on Thursday, Feb. 2, to further consider their report, but it is not anticipated that the report will be placed in the hands of the Government before the end of March. The Parliamentary Committee of the Westminster City Council recommend that, pending the finding of the Royal Commission on London Traffic, it is necessary for the Council to secure a right to be heard against any Bill proposing to construct a new railway which does not contain adequate protective clauses. The committee's report referred to the Waterloo Railway Bill; the Charing Cross, Euston, and Hampstead Railway Bill; the Central London Railway (New Lines) Bill; the Great Northern, Piccadilly, and Brompton Railway Bills (Nos. 1 and 2); the Hammersmith, City, and the North East London Railway Bill.

**Rhondda.**—At the adjourned public meeting held to consider the Bill which the Urban District Council propose to promote, the clerk explained in regard to the tramways that the Council was not going to pledge the rates to the extent of a single penny. The scheme provided for the leasing of the tramways to a company for a period of 42 years. On their part the company undertook to equip and complete the tramways to the satisfaction of an engineer to be appointed by the Council. It was not obligatory upon the company to carry out any street widenings, neither was it obligatory on the part of the Council to do so. The total rental paid by the company would be £2,250 per annum. The lease would contain a clause that in the event of failure on the part of the company to carry out any of the

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provisions of the lease, the Council would be in a position to determine the lease after giving three months' notice, at the expiration of which, if the company failed to remedy any breach, the Council would be entitled to take possession without paying any compensation whatsoever. The Council would have precedence over all debenture holders on the undertaking. At the expiration of 42 years the Council could purchase the tramways at an amount to be fixed by agreement or by arbitration, or re-lease the tramways for another period of 21 years. The lessors would have to keep the tramway for 42 years, otherwise the Council would enter into possession without the payment of any compensation whatsoever. The company would have to deposit £10 000 with the Council as security for the due performance of the agreement entered into. Eventually the Bill was approved.

**Halifax.**—A Gilbertian situation has been occasioned by the refusal, as represented by a meeting in the Mechanics' Hall, to endorse one section of the Corporation's parliamentary Bill. The Council, under powers previously obtained, have partly constructed a tramline on the flat from Salterhebble Hill towards West Vale. Under their present Bill they desired authority to connect this up with the existing tramway at Salterhebble. Why parliamentary authority to do this was not previously sought is explained by the fact that at that time the Corporation intended continuing the Salterhebble line to West Vale *via* a proposed "lift" tramway at the Dudwell-lane steep. Under this scheme, somewhat after the fashion of the Scarborough cliff tramways, the cars were to descend or ascend on a platform carriage and be deposited on the connecting metals to resume their journey. The opposition brought to bear against this scheme on the ground of the uncertainty as to its safety caused it to be abandoned. The Corporation, on their part, claimed that there would be less risk attached to it than would be involved in the adoption of the alternative scheme of providing a connection *via* the steep and curving route of Salterhebble Hill. With this latter scheme now also condemned by the ratepayers the Town Council are in the dilemma that they have a length of line constructed in the Valley-road with the only possible method of connection left them eliminated from their Bill. There is a feeling among some members that there should be an appeal from the limited body of ratepayers gathered at the Mechanics' Hall by a poll being taken of the ratepayers generally. Should this appeal be made the ratepayers will probably be asked to reverse, in addition, the amendment rejecting the intended tramway extension from West Vale to Elland.

## LIGHTING AND GENERAL.

**Southend.**—An extension of street-lighting by arc lamps at a cost of £128 has been agreed to.

**Bexhill.**—Sanction has been received for the borrowing of £3,400 for electric supply purposes.

**Blackpool.**—The electrical engineer has been asked to report upon the charges for current made to private consumers.

**Rochdale.**—An enquiry has been held into the application of the Corporation for sanction to borrow £42,500 for electric supply extensions.

**St. Marylebone.**—The Council will join the other boroughs in their opposition to the various proposed Bills which relate to the supply of electricity to the borough.

**Cardiff.**—Up to the present the Post Office telephone exchange is situated at the docks branch post office, and arrangements are now being made to transfer it to the head office.

**Coventry.**—The Corporation have experienced in the last three years an increasing demand for electric motors. Three years ago the extent of those in use was under 100 h.p.; now it is over 1 000 h.p.

**Buxton.**—The Urban District Council have decided to charge 5 per cent. for the engineer's services in cases where he is asked to specify and superintend wiring of premises, if it is agreed that he should do so.

**Swansea.**—It was stated at the last Town Council meeting that unless electric light was installed at the market the Corporation could not hope to get the £4,000 a year from the market plus interest that the late lessee used to pay.

**Wakefield.**—At the meeting of the City Council on Tuesday next it will be proposed that application be made for sanction to borrow a further sum of £18,000 for the purposes of extensions in connection with the electricity undertaking.

**Electrical Exhibition.**—The County of London Electric Supply Company announce that an electrical exhibition will be held at 118 to 122, Holborn, E.C., from March 20 to April 5, both days inclusive. Full particulars appear in another column.

**Hammersmith.**—The premises of six additional consumers, representing a maximum of 67 8 c.p. lamps, have been connected to the mains; five consumers have been disconnected. The present number of consumers taking current from the mains is 1,534.

**Westminster Electric Supply Co.**—The directors recommend, subject to audit, a dividend at the rate of 15 per cent. per annum (less income tax) for the half-year ended Dec. 31, payable on March 1 next, making, with the interim dividend already paid, 14 per cent. for the year.

**Bridlington.**—At Wednesday's meeting of the Town Council Councillor J. V. Mainprize said that within a few days it is hoped that electricity will be supplied to private consumers. It was decided to give notice to the gas company to terminate the public lighting contract.

**Hastings.**—At their last meeting the Town Council threw out a recommendation by a committee, who advised that consent be given to the Postmaster-General to place an overground telegraph line along certain streets, on condition that the poles used are painted green and repainted that colour once in every three years.

**Hampstead.**—The Borough Council have decided to lay mains for the supply of electric current in Fordwych-road and in Elsworthy-terrace, and, in order to provide for the probable additional demand for electric current during next winter, to purchase seven transformers and supply new feeders and additional distributors in various roads, at a total cost of £1,348.

**Chertsey.**—The Rural District Council have assented to the Woking Electric Supply Company's extension provisional order, from which Chobham district will be eliminated. The Chertsey Urban District Council have passed a resolution approving of the application of the Woking Electric Supply Company to extend their provisional order to the urban district of Chertsey.

**New Branch.**—We are informed that the Union Electric Company, Limited, 151, Queen Victoria-street, E.C., have decided, in view of the increased demand for their dynamos, motors, arc lamps, meters, and switchgear in the Tyne, Wear, and Tees districts, to open an office at 43, Grainger-street, Newcastle-on-Tyne. This office will be under the direction of Mr. James Gilman.

**Stock Exchange.**—The Stock Exchange Committee have ordered the undermentioned securities to be quoted in the official list: Commercial Cable Company's further issue of £29,000 sterling 500 year 4 per cent. debenture stock (redeemable); Edmundson's Electricity Corporation's further issue of 10 000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 70,001 to 80,000.

**Brighton.**—An underground cable is to be laid from the Hove borough boundary in Lansdowne-road to the Holland-road church, at an estimated cost of £182. 13s. 9d. Mr. Wright is retiring as consulting engineer and manager of the Corporation electricity department on April 19, 1905. The amended draft agreement for the supply of electricity to the parish of Aldrington has been approved.

**Launceston.**—At the last Town Council meeting a letter was read from the manager of the Electric Supply Corporation stating that the work at Launceston had not been lost sight of, but the work they had already in hand in other towns called for immediate attention. He was not able to fix a date for the commencement of their work in Launceston, but he hoped to see it in full swing within the next 12 months.

**London Gazette.**—A first and final dividend of 8½d. in the £ has been declared in the estate of Charles Manners Downie, electrical engineer, 4, Bloomsbury-street, London, and Heathville-road, Crouch Hill, Middlesex. A notice appears of intention to transfer the undertaking authorised by the Runcorn Electric Lighting Order, 1899, to the Mersey Electric Supply Company, Limited, Central Buildings, North John-street, Liverpool.

**Catalogues—How and Where to Place Them Abroad.**—There can be no more important question to the British manufacturer than the effective placing of his catalogues abroad—without unnecessary waste or expense. Some assistance to manufacturers on this point has long been needed, and we are glad to see that a system has been organised by Messrs. Pitt and Scott, Limited, 25, Cannon-street, London, E.C., who will send their explanatory booklet free on application.

**Arbroath.**—The Council have obtained from the Board of Trade delay of three months. It will be remembered that recently the Board of Trade intimated to the Council that it was their intention to revoke the order forthwith. Their reason was the delay between the Council and an electric light and power company in arriving at a settlement with a view to the company purchasing the provisional order obtained by the Council some years ago and proceeding with the installation of the electric light in Arbroath.

**Nynehead.**—The electric light has been installed in the parish church and approaches, and the change from the old form of lighting by candle is appreciated by all. What is more, this up-to-date form of lighting has in no way interfered with the charm of the interior of the church—one of the prettiest and most interesting for miles around—for the old candelabra have been fitted with sockets filled with porcelain candles with flame-shaped frosted bulbs. At first sight the fittings might be taken for ordinary candles, and when the light is on the effect is very pleasing. Altogether there are 72 5-c.p lamps. Messrs. Stansell and Son, Taunton, were the contractors.

**Durham Collieries.**—The Sunderland District Electric Tramways Limited, have arranged a contract for the supply of power to the important collieries in the county of Durham belonging to the Lambton Collieries, Limited, managed by Sir James Joicey, Bart., M.P., with Mr. A Kirkup as chief mining engineer. It is proposed to use the power for hauling, pumping, coal-cutting, lighting, and winding purposes, as well as for the engine works at Philadelphia, which will make these collieries one of the most up-to-date groups in the country. It is proposed to erect a large central power station on five acres of land at Philadelphia, from which the power will be taken to the collieries, and, in addition, the tramways, of which over 12 miles are fully completed, will be supplied with the necessary power, as well as the supply of power for electric lighting in the urban districts of Houghton-le-Spring and Hetton-le-Hole, and the rural district of Easington, over which the company has statutory lighting powers. Power will be available at a cheap rate for other collieries in these districts, as well as for manufactories, breweries, and other works. The power station will be close to the pit's mouth, and the coal will thus be obtained a cheap rate, enabling the power to be produced under the most advantageous conditions, and at a minimum cost to the consumer. This contract has been arranged by Messrs. Harper Bros., the consulting engineers, London. An immediate start is to be made with the construction of the power station.

**Finchley.**—A letter from the West Finchley Ratepayers' Association, containing a copy of the following resolution passed at the last meeting of the association—"That in the opinion of this association it

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is very desirable that the books and accounts of the Electricity Committee be audited under the supervision of or by a duly qualified accountant"—has been referred to the Finance Committee of the Urban District Council.

**Huddersfield.**—The borough electrical engineer's last report shows that there was an increase of 21 consumers at the beginning of this month as compared with December, and an increase of 159 as compared with the number at the beginning of January, 1904. At the beginning of this month 140,161 lamps had been connected, as compared with 1,133 in December last, and an increase of 7,579 as compared with the number at the commencement of 1904.

**London County Council.**—On Tuesday it was agreed to lend the Stepney Borough Council £10,000 for electric light installation. Sanction was also given to the borrowing by the St. Pancras Borough Council of £5,370 for electric light installation. Applications by Mr. A. Roberts on behalf of the Chelsea Electricity Supply Company, Limited, for the construction of a generating station, and from various metropolitan electric supply companies to lay mains, etc., were agreed to.

**Erith.**—With regard to the Bills of the Administrative County of London and District Electric Power Company and the City of London Electric Lighting Company, Limited, to be promoted in the next session of Parliament, it has been decided that in the first instance Sir William Hart-Dyke, Bart., M.P., be asked to oppose the Bills in Parliament, and that the clerk ascertain from the neighbouring local authorities what action is proposed to be taken to further oppose the Bills.

**Mexico.**—The following applications are reported: by Señor Julio Jaume for the appropriation, for irrigation, and for industrial purposes, of 3,060 litres of water per second from the River Tambaque, State of San Luis Potosi; by Señor Pedro Diaz Barreiro for the appropriation, for irrigation, and for industrial purposes, of 1,500 litres of water per second from the River Atoyac, State of Puebla; and by Señor Ituarte for the appropriation, for industrial purposes, of 1,500 litres of water per second from the Rivers Monte Alto and Los Tachos, State of Mexico.

**Spennymoor.**—The North-Eastern Railway Company receive their current from the generating station of the Northern Counties Electricity Supply at Spennymoor, and which is in close proximity to the railway station. The electric light has been installed at the railway station and its signal boxes for some time, and has proved successful. In consequence, cables have been laid along the line for a distance of about a mile from the station, and four signal cabins have been equipped, and a large number of signal lamps along the main line and the sidings have been converted into electric lamps.

**Kettering.**—The electrical engineer's report for December contains the following figures: Total applications to Dec. 31, 129; total consumers connected to Dec. 31, 123; number of consumers connected during month, 14; number of 8-c.p. lamps or their equivalent connected during month, 855; total number of 8-c.p. lamps or their equivalent connected to Dec. 31, 1904, 8,030; total brake horse-power in motors connected to Dec. 31, 1904, 100; total units generated during month, 22,614; coal consumed, 49 tons 6 cwt.; estimated quantity of coal saved by refuse destructor during month, 71 tons 3 cwt.

**New Shipbuilding Yard.**—The City Council of Sydney, Nova Scotia, will, it is anticipated, this week decide upon a grant of 250,000dol. towards the construction of a steel shipbuilding yard at the port. The Government have already decided to contribute 100,000dol. to that purpose, and as soon as the city grant becomes a fact, a company, of which Mr. J. A. Burchell is the president and Mr. W. Hayes, Sydney, N.S., is the secretary, will call for contracts for plant sufficient for the complete construction of one 15,000-ton steamer per year. The company will also build a floating dry dock to accommodate 8 000-ton steamers, and they will keep a wrecking steamer stationed at the port.

**Burnley.**—The borough electrical engineer (Mr. Birkett) and two of his staff were very severely damaged by 500-volt shocks on Friday last. Some trials of an electrically-driven air-compressor were being made before the Electricity Committee, and an accidental contact between the metalwork of this compressor and the tramway voltage was made, which metal caused the accident in question. The Guardians propose to apply for sanction to borrow £1,100, to be repaid in 15 years, to defray expenses in connection with electric light station, water-tank, and improved works of water supply to the workhouse—namely, electric lighting works, £567, being excess of expenditure over amount (£8,806) previously sanctioned.

**Thames Conservancy.**—The Parliamentary Committee have reported on a number of Bills which have been deposited for the ensuing session of Parliament, including that promoted by the City of London Electric Lighting Company for an extension of powers. By this Bill power is sought to supply electrical energy to certain riverside portions of the counties of London and Kent. Clause 2 provides that the provisions of Section 14 of the schedule to the Electric Lighting (Clauses) Act, 1899, shall apply to the laying down and placing of any cables or other works in, through, under, along, or across the bed and foreshore of any river. Clauses 16 and 17 provide that any cables, pipes, or wires under or across any tidal water shall be placed at such depth or height as the Board of Trade may require, and that any works below high-water mark shall not be commenced without the consent of the Board of Trade. In consequence application will be made to the promoters of the Bill for an undertaking to make the amendments required by the Conservators. In the event of the same not being given, a petition is to be presented against the Bill.

**Shoreditch.**—The Lighting Committee have reported that in their opinion it is necessary to instal additional plant at Whiston-street, where there is a vacant space for both boilers and engines, and that in view of the period which must elapse between the time when the extensions were approved and the time when the plant was installed and set to work, specifications should be prepared and tenders invited for the following alternative schemes: two steam turbo-generators, each of 1,000 kw. capacity, with all necessary condensers, pumps, boilers, superheater, steam and water pipes, switchgear, balancer, and underground mains, at an estimated cost of £37,000; two steam turbo-generators, each of 1,500 kw. capacity, with all necessary plant and necessaries as in scheme A, at an estimated cost of £46,000. The committee, with a view to having the fullest information in reference to the type of engine it is proposed to adopt, especially as regards the avoidance of vibration nuisance, suggested that they should be authorised to visit three of the principal stations in the country where steam turbo-generators have been in use for some time. The report was adopted at the last Council meeting.

**Spain.**—Señor D. Emilio Rodiequez has obtained a concession to take from Segre river, in the province of Lerida, water giving 4,356 h.p. Similar grants have been obtained by D. Iquacio Coll y Portabella and D. Julio Bielsa y Permu, of Barcelona; D. Julian Bosque and D. Antonio Ferrer, of Ollana, Lerida; and D. Miodesto Chillido, Toledo. Other applications are before the Government—viz., by D. Augustin Iza, of Bilbao; D. Juan Ayastuay, Vergarra; D. Victor Peadera y Larmube, San Sebastian; and D. Iquacio Romano y Suari, of Barcelona, who propose to derive electric power from various rivers. It is proposed to form an electric supply company at Navia, with a capital of 190,000 pesetas, to exploit a similar concession obtained by D. Mariano Luino, and to light La Caridad, Valdepares, El Franco, Salave, Tapia, Serantes, Barros, Figueras, Castropol y Vega de Ribadeo. The Hydro-Electric Company of Pindo at Coruna has now started two works, one for the manufacture of carburate of calcium and one for generating electric power. The current is transmitted from the latter to the former by a high-tension cable at a voltage of 10,000.

**Battersea.**—The Council have adopted a report with reference to the extension plant required at the central electric generating station to deal with the demand for the supply of electrical energy in the winter of 1905-6 stating that the electrical engineer has advised them that the plant at present installed at the station is capable of dealing with 1 990 kw. (the maximum load on the station this winter amounted to 1,400 kw.), and that it is probable that the demand for next winter will easily reach 2 000 kw. It is, therefore, essential that orders for the following additional plant and for the execution of the following works should be given without delay, so as to provide a sufficient reserve of plant, as in the event of a breakdown in one of the larger machines at the station great difficulty would be experienced in keeping up the pressure: one 750 kw. turbo-generator, £4 700; condenser with valves, £225; three watertube boilers with fittings, automatic stokers, including brickwork, £3,850; pipework in connection with turbo, boilers, and condenser, £1,400; two switchboard panels for feeders and generators, instruments, etc., £300; meter for generator, £25; cables for generator, £86; one motor-driven pump for condensing water, including pipes, starting switch, etc., £1.300; one boiler-feed pump, £150; valves for main steam line, £200; foundations for turbo and pump, to be carried out by Works Department, and chequer plating, £400; one Green's economiser with brickwork, £650; contingencies, £472; alteration to pipes in river, £1,500; office charges, £742. We understand that the necessary plant is to be procured and the necessary works carried out at an estimated cost of £16,000, and also that additional feeder cable, etc., be provided at an estimated cost of £2,100. Mr. W. Rines has been appointed one of the representatives of the Council upon the executive committee of the conference (the Law and Parliamentary Committee are to nominate the other representative) dealing with the opposition of private Electricity Bills affecting London areas. It has been referred to the executive committee to consider the advisability of inviting the co-operation of authorities outside the county of London affected by these Bills.

**Handsworth.**—A generating station is being constructed on a site adjoining Soho-road Station. A considerable length of mains has already been laid, and it is anticipated that the whole electric supply scheme will be in full working order by Midsummer. Dr. A. B. W. Kennedy is the Council's consulting electrical engineer. Handsworth is a very scattered district, and on this account the cost in regard to mains will be rather higher than in many places. It has an area of 3,647 acres, with a population of over 60,000, and stretches from Hockley Brook to the boundary of West Bromwich. The Council will, as soon as they are in a position to do so, light the main arteries of the district by electricity. The scale of charges for private consumers has not yet been settled. The length of tramway between the New Inns and the boundary of West Bromwich belongs to the urban authority, who have leased it to the tramway company. This line has already been electrified by the Council, and by the terms of the lease the Council have the option to supply current to the company. The Birchfield-road steam tramway system will shortly belong to the Council, and the electrification of this route will be only a matter of time. The Council have secured an excellent central site in Piers-road. A railway siding has been made to join the loop line from Soho Station to the Soho Pool goods station, so that coal can be conveyed straight into the bunkers at the works. The total cost of the undertaking will be about £45,000. The generating station will contain a large engine-room and boiler-house, a battery-room, stores, general offices, and workmen's rooms. The coal bunkers and the boilers will be in the lower level. The first floor will contain a meter-room, drawing office, committee-room, bath and lavatories, and spare rooms. There will be two ventilating towers and a stack 150ft. high. The system of supply to be adopted is the continuous-current three-wire system, with lamps working at about 240 volts. The dynamos will be driven direct by steam-engines, and a battery of accumulators will be provided for the purpose of supplying energy during the night time and at other periods of light load. Orders have been placed for 120 arc lamps, the standards of which will be placed 66 yards apart.

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## PROVISIONAL PATENTS, 1905.

JAN. 9.

**330. An improved insulated roller contact block for electrical traction.** William Ainsley, 2, Atherton-street, Durham.

**331. Method of and means for electrically lighting-up street and other gas-lamps whose burners are beyond reach of hand.** William Pare, 11, Burlington-chambers, New-street, Birmingham.

**392. Improvements in controlling the luminosity of electric lamps and their consumption of electric current.** Frances Alice Hunter, Rockcliff Hall, near Flint, N. Wales.

**400. Improvements in means or apparatus for controlling electric and other circuits.** George Harrison, 11, Southampton-buildings, Chancery-lane, London. (The Albert and J M. Anderson Manufacturing Company, United States.) (Complete specification.)

**401. Improvements in under-running current collectors for electric railways.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**402. Improvements in thermal-electric cut-outs.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**403. Improvements in and relating to electric heaters.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**404. Improvements in electric switches.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**405. Improvements in electric resistances.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**410. An improved electrical hydro-pneumatic governor for marine engines.** Rodolphe Jean William Grasset, Palace-chambers, Westminster, London. (Complete specification.)

**416. Improvements in or relating to electric insulators.** Henry Julius Trautmann and James Lloyd Copping, 111, Hatton-garden, London.

**417. Improvements in or relating to electric switches.** Henry Julius Trautmann and James Lloyd Copping, 111, Hatton-garden, London.

**424. Improvements in or relating to single lines of railway on the electric staff or other electric systems.** Charles Mark Jacobs, 70, Chancery-lane, London.

**432. Improvements in arc lamps.** George Blackford Bryan, 46, Lincoln's-inn-fields, London.

JAN. 10.

**446. An apparatus for testing and indicating the intensity of electric currents in cables or other conductors.** Wilfrid Branfield, Bank-buildings, George-street, Sheffield.

**493. Improvements in or relating to apparatus for measuring the strength or intensity of electric currents.** Otto Titus Blathy, 111, Hatton-garden, London. (Complete specification.)

**512. Improvements in and relating to electric generators.** Philip Dawson, 1, Queen Victoria-street, London.

**513. Improvements in alternating-current commutator motors.** Arnaldo Paolo Zani, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**521. Improvements in secondary batteries.** Pierre Meusnier and Guillaume Mounier, Norfolk House, Norfolk-street, Strand, London.

**522. Improvements in and relating to electric oil switches.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**523. Improvements in electric meters.** The British Thomson-Houston Company, Limited, and Frank Holden, 83, Cannon-street, London.

JAN. 11.

**530. Improvements in or relating to electric railways and trains.** Henry Courteen, The Homestead, Mill End, Rickmansworth, Herts.

**534. Improvements in twin or double carbon arc lamps.** Veritys, Limited, and Frederic Stanhope Worsley, 11, Burlington-chambers, New-street, Birmingham.

**535. Improvements in and relating to the lighting of electrical lamps by a self-connecting pole.** John Smith, 68, West Regent street, Glasgow.

**542. An improved electric switch or cut-out.** John Maclean, 100, Wellington-street, Glasgow.

**571. A method of and apparatus for indicating or checking the efficiency of electric train or car driving.** William McLellan and Charles Hesterman Merz, Norfolk House, Norfolk-street, Strand, London.

JAN. 12.

**605. An improved method of separating bodies capable of being magnetised from others with which they are associated.** Henry Ernest Bennett, James Rodda, and Thomas Henry Rule, Mayfair Villa, Eny's-road, Camborne, Cornwall.

**606. Improvements in portable electric drilling machines.** John Maclean, 100, Wellington-street, Glasgow.

**617. An improved construction of splicing ear for electric trolley wires or the like.** Thomas Ernest Raymond Phillips, 1, Broad-street-buildings, Liverpool-street, London.

**618. An improved method of controlling the feeding mechanism of electric arc lamps of the open and enclosed types.** Walter John Fry, 66, Tubbs-road, Harlesden, London.

JAN. 13.

**689. Automatic current feeder for electric railways.** Richard Duckworth, Henry Duckworth, and David Kerr, 45, Lower Bank-road, Fulwood, Preston. (Complete specification.)

**693. Improvements in and relating to electric incandescent lamps.** Sydney Heathcote Penning, 1, Heath-villas, Plumstead Common, London.

**700. Improvements in electric transformers for high-tension currents.** Hermann Heinicke, 3, Upper Vernon-street, London. (Complete specification.)

**718. Improvements in and relating to reverse-current electric cut-outs or circuit breakers.** The British Thomson-Houston Company, Limited, and Edmund Basil Wedmore, 83, Cannon-street, London.

JAN. 14.

**776. Improvements in alternating-current electromagnets.** Arnaldo Paolo Zani, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**778. Improved manufacture of accumulator plates.** Arthur George Bloxham, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Ferdinand Eduard Polzeniusz and Robert B. Goldschmidt, Belgium.)

**789. Improvements in the electric heating of electrically-propelled vehicles.** The Union Elektricitäts-Gesellschaft, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Jan. 16, 1904, being date of application in Germany.) (Complete specification.)

**797. Improved construction of electric fuse or cut-out apparatus.** Anthony Bernard Tubini, 173, Fleet-street, London.

JAN. 16.

**835. A new or improved apparatus for condensing steam and producing or generating electricity.** Edouard Laurent Celestin Mollard and Gerard Featherstone Griffin, 33, Chancery-lane, London.

**839. Improvements in electric storage battery negative-pole plates.** Alfred Julius Boult, 111, Hatton-garden, London. (Edward Wanton Smith, United States.) (Complete specification.)

**860. Improvements in trolley heads for overhead system of electrical traction.** John Alexander Orme, 46, Lincoln's-inn-fields, London.

**881. Improvements in or relating to apparatus for indicating consumption of electric energy and loss of current.** Fritz Wieland, 111, Hatton-garden, London. (Complete specification.)

JAN. 17.

**883. A new electrical immovable contact breaker and switch for ignition purposes on petrol motors, oil and gas engines.** Rowland Hughes Jones, Vronlaulog, Colwyn Bay.

**923. Improvements in electrical measuring instruments.** Frank Conrad, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Jan. 20, 1904, being date of application in the United States.) (Complete specification.)

**934. Improvements in apparatus for producing high-potential electric discharges, particularly for igniting the charge of an internal-combustion engine.** Arthur Harold Nicholson, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**948. Improved construction of electric fuse or cut-out apparatus.** Anthony Bernard Tubini, 173, Fleet-street, London.

**952. Improvements in and relating to electric motors.** Marius Latour, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Jan. 18, 1904, being date of application in France.) (Complete specification.)

**954. Vapour electric apparatus.** Alexander Churchward, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Jan. 18, 1904, being date of application in United States.) (Complete specification.)

**955. Improvement in vapour electric apparatus.** Samuel Ferguson, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Jan. 18, 1904, being date of application in United States.) (Complete specification.)

**956. Improvements in vapour electric apparatus.** Howard Irving Wood, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Jan. 18, 1904, being date of application in United States.) (Complete specification.

JAN. 18.

**1004. Improvements relating to dynamo-electric machines.** William David Seton Brown and Arthur Greenwood, 6, Breams-buildings, Chancery-lane, London.

**1009. Improvements in electrical connections for secondary batteries or accumulators.** Chaimsonovitz Prosper Elieson, 7, Southampton-buildings, Chancery-lane, London.

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**967. Improved semi-portable electric hand lamp.** Harry Willis, 260, Stapleton-road, Bristol.

**991. Improvements in electric switching apparatus.** John Leemann, 115, Fore-street, London.

**1015. Improvements in electrical accumulators or storage batteries.** Antonio Galanti and Redmond Barrett, 4, South-street, Finsbury, London.

**1017. Improvements in apparatus for the electrolytic treatment of gases.** Axel Larsen, 4, South-street, Finsbury, London.

**1022. Improvements in electric switches.** John Cox Dear, 40, Chancery-lane, London.

JAN. 19.

**1065. Improvements in incandescent electric light bulbs.** Martin Charles Burt, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**1072. Incandescent electric lamps.** Royal Gerow and George Hilliard Gerow, 4, South-street, Finsbury, London. (Complete specification.)

**1079. Improvements in electric distribution systems, applicable more especially to systems employed in train-lighting.** Allgemeine Elektricitäts-Gesellschaft, 83 Cannon-street, London. (Date applied for under Patents Act, 1901, Jan. 20, 1904, being date of application in Germany.) (Complete specification.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published Feb. 9.*

1904.

**1106. Electric incandescence illuminating apparatus.** Francis.

**3449. Electric clocks.** Campiche.

**4772. Controlling alternating-current motors.** British Thomson-Houston Company, Limited. (General Electric Company.)

**4773. Controlling alternating-current motors.** British Thomson-Houston Company, Limited. (General Electric Company.)

**5113. Transmitters suitable for wireless telegraphy.** Marconi's Wireless Telegraph Company, Limited, and Gray.

**5146. Dynamos and electric motors, with a view to preventing or lessening sparking at the brushes.** Armistead.

**5296. Electric fuses and fuse-boxes.** Davies.

**6402. Electric insulating compositions.** British Thomson-Houston Company, Limited. (General Electric Company.)

**6433. Electric switches.** London Electric Supply Corporation, Limited, and Partridge.

**6585. Saddle for carrying electric cables.** Sharp.

**6999. Manufacture of cement for use in electric lamps and for other purposes.** Cleminson Electric Lamp Attachment, Limited, and King.

**6996. Appliances for the manufacture of conduits for electric cables.** Sutton and Gregson.

**7489. X-ray apparatus.** Gaiffe.

**10119. Method of and means for adapting "electric candles" to sconces and the like.** Regnart.

**14933. Mode of protecting life from the "live-rail" danger on electric railways.** Curwen.

**20010. Holder for incandescent electric lamps.** Regnart, and Hunter Electric Candle Lamp Company, Limited.

**23653. Electric motors.** Siemens Bros. and Co., Limited. (Siemens-Schuckertwerke G. m. b. H.)

**25072. Protection of conductors and insulation of flexible cords for electrical apparatus.** Galsworthy.

**26269. Coils for electromagnets, solenoids, and the like.** Sipe.

**27348. Electrical switches.** Eason.

**27537. Vapour electric apparatus.** Wood. (Date applied for under International Convention, Dec. 17, 1903.)

**27705. Alternating-current electric motors.** Lamme. (Date applied for under International Convention, Feb. 27, 1904.)

**27713. Process for the formation of incandescence bodies for electric incandescence lamps.** Thompson. (Deutsche Gasglühlicht Akt.-Ges. (Auergesellschaft).)

**27714. Electric incandescence lamp with incandescence body fused in the conducting wires.** Thompson. (Deutsche Gasglühlicht Akt.-Ges. (Auergesellschaft).)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. £ | | Last price £ |
|---|---|---|---|
| **Commercial and Industrial.—** | | | |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ⅜-½ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 15/32 9/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 .... | 5 | – | 5-5½ |
| —— 6 per cent. Cum. Pref., 1-100,000 ..... | 5 | – | 5¼-5⅜ |
| —— 4½ per cent. Mortgage Debentures ..... | 100 | – | 101-104 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. ..... | 100 | – | 101-103 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 ..... | 5 | – | 2⅜-2½ |
| —— 4 per cent. Mortgage Debenture Stock ..... | 100 | – | 86-88 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 .. | 2 | – | ½-⅝ |
| —— Non. Cum., 6 per cent. Pref. ..... | 2 | – | 1¼-1½ |
| —— 4½ per cent. 1st Debenture Stock ..... | 100 | – | 93-96 |
| —— 4½ per cent. 2nd Debenture Stock ..... | 100 | – | 74-77 |
| Callender's Cable, Debentures ..... | 100 | – | 104 106 |
| —— Ordinary ..... | 5 | – | 9¼ 10 |
| —— 5 per cent. Pref. ..... | 5 | – | 5⅞ 5¾ |
| Crompton and Co. ..... | 3 | – | 2 2½ |
| —— 5 per cent. Debentures ..... | 100 | – | 95 98 |
| Edison and Swan United, "A" Shares, 1-89,251 ..... | 3 | – | ⅜-½ |
| —— "A" Shares, 01-017,159 ..... | 5 | – | 1-1¼ |
| —— 5 per cent. Debentures ..... | 100 | – | 79-84 |
| —— 4 per cent. Deb. Stock, Red. ..... | 100 | – | 77-82 |
| Electric Construction, Limited, Nos. 1 to 112,100 ..... | 2 | – | 1¼-1½ |
| —— 7 per cent. Cumulative Pref. ..... | 2 | – | 2¼ 2½ |
| —— 4 per cent. Perp. 1st Mort. Deb. ..... | 100 | – | 97-99 xd |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 | – | 9¼-10 |
| —— 4 per cent. 1st Mort. Deb. Stock ..... | 100 | – | 91-96 |
| W. T. Henley's Telegraph Works, Ordinary ..... | 5 | – | 10¼-11 |
| —— 4½ per cent. Preference ..... | 5 | – | 5¼-5⅜ |
| —— 4½ per cent. Debentures ..... | 100 | – | 110-112 |
| India Rubber, Gutta Percha, and Telegraph Works ..... | 10 | – | 15 16 |
| —— 4 per cent. Debentures ..... | 100 | – | 99-102 |
| Parker, Thos., Limited, Ordinary ..... | 10 | – | 10-10¼ |
| Telegraph Construction and Maintenance ..... | 12 | – | 38-40 |
| —— 5 per cent. Bonds ..... | 100 | – | 101¼-103¼ |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary ..... | 10 | – | 12-12½ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 ..... | 10 | – | 9¼-10 |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 .... | 10 | – | 11-12 |
| —— 4½ per cent. Debenture Stock. Red. ..... | 100 | – | 103-106 |
| Bromley (Kent) Electric Light and Power Co. ..... | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. 1st Debenture Stock, Red. ..... | 100 | – | 101-104 |
| Brompton and Kensington, Ordinary ..... | 5 | – | 10¼-11 |
| —— 7 per cent. Preference ..... | 5 | – | 10¼-10⅜ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 .. | 5 | – | 8¼ 8⅜ |
| —— Nos. 60,001-80,000 ..... | 5 | – | 6¼-6⅜ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. .... | 8 | – | 12¼-13¼ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 105-108 |
| Charing Cross and Strand, Nos. 1-70,000 ..... | 5 | – | 8¼-8⅜ |
| —— 70,001-80,000 ..... | 5 | .. | 8-8¼ |
| —— 4½ per cent. Cum. Pref. ..... | 5 | – | 5⅜-5⅝ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 4⅝-5 |
| —— 40,001-80,000 ..... | 5 | .. | 4⅝-5 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 | – | 101-103 |
| Chelsea Electricity Supply ..... | 5 | – | 6⅞-7¼ |
| —— 4½ per cent. Debentures ..... | 100 | – | 108 110 |
| City of London, Ordinary ..... | 10 | – | 11¼-12 |
| —— 6 per cent. Cumulative Pref. ..... | 10 | – | 13¼-14 |
| —— 5 per cent. Debenture Stock ..... | 100 | – | 121-125 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) .. | 100 | – | 100 103 |
| County of London Electric Supply, Ordinary ..... | 10 | – | 9 9¼ |
| —— 6 per cent. Cum. Pref. ..... | 10 | – | 12-12½ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Red. | 100 | – | 101-103 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. ..... | 100 | .. | 107-110 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000.. | 5 | – | 6¼ 6½ xd |
| —— 6 per cent. Cum. Pref. ..... | 5 | – | 5-6¼ |
| —— 4½ per cent. First Mort. Deb. ..... | 100 | – | 106-108 xd |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 1¼-2¼ |
| —— 5 per cent. Debenture Stock, Red. ..... | 100 | – | 86-91 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000..... | 5 | – | 5¼-6 |
| —— 4½ per cent. First Deb. Stock, Red. ..... | 100 | – | 102-105 |
| Havana Electricity, Limited, 1-15,000 ..... | 10 | – | 9¼-10¼ |
| Howe Electric Lighting, Limited, Ord., 1-15,000 ..... | 5 | – | 7½ 8 |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 100-102 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 ..... | 1 | – | 9/16-11/16 |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | | 12¼-13 |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red ..... | 100 | – | 102-104 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9¾-10¼ |
| London Electric, Ordinary ..... | 3 | – | 2¼-2½ |
| —— 6 per cent. Pref. ..... | 5 | – | 5 9/16 5 13/16 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red... | 100 | – | 96 98 |
| Metropolitan Ordinary ..... | 10 | – | 17¼-18¼ |
| —— 4½ per cent. First Mortgage Debenture Stock .... | 100 | – | 110-115 |
| —— 6 per cent. Cum. Pref. ..... | 5 | .. | 5¼-5⅜ |
| —— 5½ per cent. Mortgage Debenture, Red. ..... | 100 | – | 96 98 |
| Midland Electric Power Dis., Ld., 4½ p c. 1st Mort. Deb.. | 100 | – | 92-95 |
| Newcastle-upon-Tyne Electric Supply, Ordinary ..... | 5 | – | 98-101 |
| —— Preference ..... | 4 | – | 100-102 |
| Notting Hill Electric Lighting ..... | 10 | – | 14¼-15 |
| —— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.) .. | 100 | – | 102-104 |
| Oxford Electric, Ordinary, 1-95 and 4[illegible]-14,510..... | 5 | – | 6¼ 6⅜ |
| —— 4 per cent. Debenture Stock ..... | 100 | – | 98 100 |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures ..... | 100 | – | 100-102 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000.. | 5 | – | 2⅜-3¼ |
| —— 4 per cent. Debenture Stock ..... | 100 | – | 83-87 |
| South London, Ordinary ..... | | – | 4¼ 4⅜ |
| South Metropolitan Electric Light and Power Co., Ord... | 1 | .. | ¾-1 |
| —— 7 per cent. Cum. Pref. ..... | 1 | .. | 1⅛-1 7/16 |
| —— 4½ per cent. 1st Mort. Deb. ..... | 100 | .. | 107-110 |
| —— Ditto, June, 1904 ..... | | .. | |
| St. James's and Pall Mall, Ordinary, 101-80,080 ..... | 5 | – | 13¾-14¼ |
| —— 7 per cent. Pref. ..... | 5 | – | 8¼-9 |
| —— 5½ per cent. Deb. ..... | 100 | – | 98-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 ..... | 5 | – | 5-5¼ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5 1/16-5 3/16 |
| Westminster, Ordinary ..... | 5 | – | 13-13¼ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 ..... | 5 | – | 6¼-6⅜ |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-200,007 ..... | 5 | – | 5 9/16-5 11/16 |
| —— Ord. ..... | 5 | .. | 8¼-8½ |
| —— Permanent 6 per cent. Debenture Stock. 1888 .. | 100 | – | 140 143 |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 104-105 |
| Barcelona Tramways, Limited, Ord., 1-20,000 ..... | 10 | .. | 12-12¼ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 ..... | 10 | .. | 9 -10 |
| —— 5 per cent. Deb., Red., 1-600 ..... | 100 | .. | 99 102 |
| —— 4½ per cent. Red. Deb. Stock ..... | 100 | .. | 96-100 |
| Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606.. | 1 | .. | 11/16-13/16 |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 ..... | 1 | .. | ¾-1 |
| Belfast Street Tramways, Ord., 1-26,600 ..... | 10 | .. | 10½-11¼ |
| Blackpool and Fleetwood Tramroad ..... | 10 | – | 13⅜-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 ..... | 5 | – | 1¼-2 |
| —— 5 per cent. Cum. Pref., Nos. 1 75,000..... | 5 | – | 3¾-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 91-98 |
| British Columbia Electric Railway Co., Ord. Def. ..... | 100 | – | 100-103 |
| —— Ord Pref. ..... | 100 | .. | 100-103 |
| —— Non. Cum. 5 per cent. Pref. ..... | 10 | – | 10-10¼ xd |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 | – | 102-104 p s |
| —— 4½ per cent. Vancouver Power Deb. ..... | 100 | – | 97-100 xd |
| British Electric Traction Ord. 1-300,000 & 60,001-80,000 | 10 | – | 9⅜-10¼ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 ..... | 10 | – | 11¼-11⅜ |
| —— 5 per cent. Perpetual Debenture Stock ..... | 100 | .. | 118-120 |
| —— 4½ per cent. 2nd Deb. Stock ..... | 100 | | 97-99 |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Buenos Ayres and Belgrano Tram. Ord., 1-100,000 | 5 – | 4-4½ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 – | 5½-6½ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 – | 5½ 6½ |
| —— 5 per cent. Deb. Stock, Red. | 100 – | 105-107 |
| —— Prov. Cert., all paid | 100 – | 101-104 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 – | 94-97 |
| Calcutta Tramways, Limited, 1-102,258 | 5 .. | 8½-8¾ |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 .. | 106-108 |
| Cape Electric Tramways, Nos. 1-480,000 | 1 – | 1⅛ 1⅛ xd |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 – | 4¾-5¼ |
| —— 4 per cent. 1st Mortgage Deb., 1-5,000 (1917) | 100 – | 101-104 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | 102-104 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | 9½-10 |
| —— 5 per cent. Cum. Pref. | 10 – | 11-12 |
| —— 4 per cent. Debentures | 100 – | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 – | 13½-14½ |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 – | 15½-16½ |
| —— 5½ per cent. Mort. Debs., 1-5,000, Red. | 100 – | 94-97 |
| Imperial Tramways Ordinary | all – | 18-19 |
| —— 6 per cent. Cum. Pref. | all – | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 50,001-60,000 | 5 | 3¾-4 |
| —— 4 per cent. Debenture Stock | 100 – | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 – | 8-8½ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 – | 10½-10⅝ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 – | 104-106 |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 .. | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016. | 1 .. | 13/32 15/32 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 .. | 31/32-1 1/32 |
| —— 4½ per cent. Deb. Stock, Red. | 100 .. | 103-105 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000 | $1,000 .. | 106-110 xd |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 .. | 100-103 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 .. | 103-105 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000 | 5 – | ½-1½ |

| Name. | Amount paid. | Last price |
|---|---|---|
| | £ | £ |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 – | 12½ |
| —— 5 per cent. Cum. Pref. | 10 – | 9½-9¾ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk. | 100 – | 101-104 |
| Potteries Electric Traction, Ordinary 20,001-40,00 | 10 – | 8-9 |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 – | 8¼-8¾ |
| —— 4½ per cent. Debenture Stock | 100 – | 98-102 |
| South Lancashire Electric Traction and Power Company —— £260,000 Ordinary | 1 | 1 |
| —— £101,132 5 per cent. Preference | 1 | 1 |
| —— £528,093 4½ per cent. Debenture Stock | 100 p.c. – | 100 p.c. |
| **Electric Railways.—** | | |
| Central London, Ordinary | 100 – | 91-93 |
| —— 4 per cent. Pref. | 100 – | 101-103 |
| —— ,, ,, deferred | 100 – | 86-87 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 – | 107-109 xd |
| City and South London, Consolidated Ordinary | 100 – | 45½-46½ |
| —— 4 per cent. Debenture Stock | 100 – | 105-108 |
| —— 5 per cent. Pref. Stock '91 | 100 – | 122-125 |
| —— ,, ,, ,, '96 | 100 – | 119-122 |
| —— ,, ,, ,, '01 | 100 – | 117-120 |
| Liverpool Overhead, 5 per cent. Pref. | 10 – | 10-10½ |
| —— Ordinary, 1-50,000 | 10 – | 3¾-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — – | 98-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | — – | 97¼-98¼ |
| Waterloo and City, Ordinary | 100 – | 90-92 |
| **Telephones.—** | | |
| National Telephone, Preferred | 100 – | 108½-109½ |
| —— Deferred Stock | 100 – | 108-110 |
| —— 6 per cent. Cum. First Pref. | 10 – | 13-15 |
| —— 6 per cent. Cum. Second Pref. | 10 – | 12-13 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 – | 5¾-5½ |
| —— 5½ per cent. Deb. Stock, Red. | 100 – | 96-98 |
| —— 4 per cent. Deb. Stock, Red. | 100 – | 101-103 |
| —— 4 per cent. Prov. Cert. | — .. | 101-103 |
| Oriental Telephone and Electric Company | 1 – | 1-1½ |
| —— 6 per cent. Cum. Pref. | 1 .. | 1½-1 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905. | 1904. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Dec. 31 | 1,291 | 1,470 | – 179 | — h | 19¼ | 19¼ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·1 |
| Ayr Corporation | Jan. 21 | 155 | 166 | – 1 | + 529 | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 336,049 | 1·03 | 10·11 | 1,770 | 5 04 |
| Barking Corporation | ,, 21 | 58 | 41 | + 17 | + 164 | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 22 | 866 | 981 | – 115 | – 740 | 23·53 | 23½ | March 31 | 56,073 | 11,327,332 | 1,319,701 | 1·158 | 9·98 | 2,383b | 6·1 |
| Birmingham Corporation | ,, 21 | 310 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | ,, 20 | 4,585 | 5,083 | – 498 | — | 6¼ | 6¼ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | Dec. 16 | 765 | 723 | + 42 | + 3,363 | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10·94 | — | 4·59 |
| Blackpool Corporation | Jan. 19 | 256 | 255 | + 1 | + 6,051 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 21 | 151 | 190 | – 39 | – 101 | 16½ | 16½ | Dec. 31 | 32,021 | 2,258,984 | 600,757 | 3·34 | 12·75 | 2,001 | 7·05 |
| Bolton Corporation | ,, 22 | 1,502 | 1,612 | – 110 | + 301 | 38 | 38 | March 31 | 94,151 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·89 |
| Bournemouth Corporation | ,, 18 | 831 | 840 | – 9 | + 2,168 | 10·15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | Dec. 17 | 3,729 | 3,366 | + 363 | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | Jan. 22 | 698 | 689 | + 9 | + 3,517h | 9 | 7½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 13 | 4,661 | 4,547 | + 114 | — | 51½ | 51½ | Dec. 31g | 253,150 | 44,391,439 | 6,033,528 | — | — | — | — |
| Burnley Corporation | ,, 22 | 884 | 822 | + 60 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 22 | 2·4 | 269 | – 15 | — | 8¼ | — | March 31j | 11,574 | 2,556,134 | 282,378 | 1·08 | 9·84 | 1,570 | 7·57 |
| Cardiff Corporation | ,, 14 | 1,927 | 1,861 | + 65 | + 2,155 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 21 | 132 | 166 | – 34 | — | — | — | Dec. 31g | 9,987 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 21 | 7,425 | 7,100 | + 325 | + 591h | 6 | 6 | ,, 31 | 362,471 | 44,953,988 | 1,292,674a | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 22 | 3,144 | 3,227 | – 83 | – 183h | 6¼ | 6⅜ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Colchester Corporation | ,, 18 | 144 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 18 | 409 | 396 | + 13 | — | — | — | ,, 31g | 25,657 | 6,353,823 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | ,, 20 | 183 | 201 | – 15 | – 80 | 7·23 | 7·23 | March 31g | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 21 | 156 | 163 | – 7 | — | 4½ | 4½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0·94 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | ,, 20 | 85 | 92 | – 7 | — h | 7 | 6⅔ | Dec. 31g | 6,294 | 388,905 | 107,164 | 3·88 | 14·09 | 952 | 7·39 |
| Dublin U. T., electric cars | ,, 20 | 3,586 | 3,619 | – 33 | — | 47 | 46 | ,, 31g | 134,648 | — | 3,429,356 | — | — | — | — h |
| Dublin S. District, Electric | ,, 20 | 704 | 692 | + 12 | | | | | | | | | | | |
| Dundee City Tramways | ,, 11 | 835 | 781 | + 54 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 21 | 580 | 561 | + 19 | + 1,611 | 10·77 | 10·75 | March 31 | 34,312 | 12,950,269 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 21 | 13,478 | 13,374 | + 4 | +23,134h | 143 | 123 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Gloucester Corporation | ,, 18 | 205 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 11 | 2,497 | 2,173 | + 324 | + 4,516 | 33 | 30½ | March 31 | 68,289 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,069 | 8·77 |
| Huddersfield Corporation | — | — | — | — | — | 35 | 35 | ,, 31 | 65,545 | 11,899,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | ,, 21 | 1,958 | 1,979 | – 21 | +10,849 | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | ,, 21 | 318 | 310 | + 8 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | ,, 18 | 97 | 120 | – 23 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 18 | 180 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 21 | 4,923 | 5,020 | – 91 | +13,698 | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | ,, 21 | 1,618 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | ,, 14 | 9,931 | 9,531 | + 400 | + 1,005 | 103 | 103 | Dec. 31g | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | ,, 22 | 1,451 | 1,497 | – 46 | – 358h | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — e |
| London County Council | ,, 14 | 12,143 | 9,084 | +3,059 | — | 46½ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 23 | 125 | 113 | + 12 | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | ,, 19 | 85 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 21 | 10,805 | 10,729 | + 771 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Metropolitan Elec. Tramways | Dec. 30 | 2,327 | 1,029 | +1,298 | +14,945h | 10 | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | Jan. 21 | 96 | 93 | + 3 | + 1,350 | 2⅔ | — | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newcastle-on-Tyne Corptn. | ,, 21 | 3,357 | 3,444 | – 87 | — | 45 | 38½ | ,, 25 | 185,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111b | — |
| Newport (Mon.) Corporation | ,, 21 | 474 | 413 | + 61 | + 1,162 | 15 | — | — | — | — | — | — | — | — | — |
| Oldham Corporation | ,, 22 | 1,706 | 1,029 | + 276 | + 3,146 | 34⅔ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 21 | 1,311 | 1,282 | + 29 | + 6,369 | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·16 | 12·39 | — | — |
| Rochdale Corporation | ,, 21 | 368 | 113 | + 255 | + 4,937 | 4½ | 4½ | 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 19 | 356 | 409 | – 53 | — | — | — | ,, 31 | 20,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·68 |
| Salford Corporation | ,, 23 | 3,683 | 3,705 | – 22 | — | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | — | — | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 22 | 4,178 | 4,217 | – 39 | + 4,853 | 34½ | — | ,, 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 12 | 853 | 855 | – 2 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | — | — | — | — | — | 6¼ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 20 | 384 | 336 | + 48 | + 8,195 | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 22 | 1,018 | 1,024 | – 6 | + 1 381 | 19·54 | 18·48 | ,, 31 | 62,506 | 14,848,958 | 1,433,463 | 1·01 | 10·46 | — | 6·08 |
| Swindon Corporation | ,, 11 | 2,989 | — | — | — | 3⅔ | — | — | — | — | — | — | — | — | — |
| Wallasey U.D.C. | ,, 21 | 560 | 578 | – 18 | + 2,088 | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·60 |
| West Ham Corporation | ,, 19 | 968 | — | — | — | 8·62 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 18 | 614 | 392 | + 222 | — | 7½ | — | ,, 31g | 20,878 | 4,263,066 | 417,335 | — | 12·006 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. e Train mile.
b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.
Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**British Association.**—It is announced that Mr. G. H. Goch, the mayor of Johannesburg, will act as vice-president of the British Association during the visit to South Africa.

**Royal Institution.**—Prof. G. H. Bryan being unable to lecture on Friday evening, March 24, Sir Oliver Lodge, LL.D., D.Sc., F.R.S., will deliver a discourse on that date on "A Pertinacious Current." Sir Stirling Maxwell being unable to lecture, Mr. Thomas G. Jackson, R.A., will on Thursdays, March 23 and 30, deliver two lecture on "The Reasonableness of Architecture" (illustrated by lantern slides).

**Turbines.**—Some statistics issued by Lloyd's illustrate the growing use of the turbine for navigation. During 1904, 13 turbine vessels, aggregating some 42,000 tons, were launched. In addition to this there are at the present time under construction in the United Kingdom, besides the two large express steamers for the Cunard Company, five vessels totalling about 29,500 tons, which are to be fitted with steam-turbines.

**Glasgow Section.**—For their annual smoking concert, which is to be held to-morrow night in the Banqueting Hall of the Grosvenor Restaurant, Glasgow, at 7.30, we note that this section have organised an extensive and varied programme. Songs (humorous and sentimental), recitations, instrumental music, and miscellaneous items figure on the card, so that the entertainment of the party has been well looked after.

**International Electrical Units.**—The Foreign Office has under consideration, on the report of experts who attended the St. Louis Congress, the question of international uniformity in electrical units. It is stated that a joint commission will in all probability assemble before long at Geneva or The Hague to arrange such a system, in terms of the volt, ampere, and ohm. Many important countries, including Russia, Norway and Sweden, Denmark, the Netherlands, Italy, and Japan, have not yet legalised any electrical units.

**Royal Meteorological Society.**—The council of this society have arranged to hold an exhibition of meteorological instruments from March 14 to 17 next at the Institution of Civil Engineers. The exhibition will be chiefly devoted to recording instruments, but it will also include new meteorological apparatus invented or first constructed since the society's last exhibition, as well as photographs, drawings, and other objects possessing meteorological interest. Intending exhibitors are invited to communicate with Mr. William Marriott, the assistant secretary.

**Glasgow Electricity Department.**—The annual festival of the staff engaged in the Corporation's electricity department was held in the Queen's Rooms, Glasgow, on Friday last. Bailie Willock, who presided, gave a short sketch of the progress of the department, showing that the Corporation's electricity undertaking was now a paying concern, which yielded an annual revenue sufficiently large to silence the critics of the enterprise. He alluded in appreciative terms to the services of Mr. C. H. K. Chamen (the brother of the chief engineer), who has been appointed superintendent of mains to the Lancashire Electric Power Company. Vocal and instrumental performances contributed to the entertainment of the party, who spent a highly agreeable evening.

**Societe Belge d'Electriciens.**—We have received the January *Bulletin* of this society, which contains a number of communications of interest. The first of the papers, which is commenced in this issue, is one by Messrs. H. Haller and H. Hoern on "Modern Electrical Lifting Apparatus." The authors are engineers to the Internationale Electric Company of Liége, and a large amount of the apparatus described is actually manufactured by this firm. Good descriptions are given of electric lifting blocks, and there is a long description of a single-rail traverser, also operated by electricity. Mr. Carlier, one of the engineers to the State railways, is responsible for a paper on "Apparatus for Measuring Simultaneously the Time, Distance Travelled, Speed, and Acceleration of Trains." The volume is completed by reports as to the progress of the association in 1904.

**Engineering Standards Committee.**—We have received a copy of Report No. 10, which deals with standard tables of pipe flanges. The sub-committee appointed to investigate this subject held 24 meetings, at which they considered a large amount of matter collected from manufacturers and users of pipes of various classes. They were also greatly assisted by numerous experimental tests on specimens of flanges and joints lent by the Admiralty and several private firms. The committee recommended that flanges, etc., should be standardised in the following four classes: Low-pressure standard for steam pressures up to 55lb., and water pressures up to 200lb. per square inch; intermediate-pressure standard for steam pressures over 55lb., but not exceeding 125lb. per square inch; high-pressure standard for steam pressures over 125lb., but not exceeding 225lb. per square inch; and extra high-pressure standard for steam pressures over 225lb., but not exceeding 325lb. per square inch. There are sections upon the dimensions of flanges, number of bolts, and sizes of same. The report is supplemented by complete tables of dimensions.

**Iron and Steel Institute.**—Members of this association are invited to participate in an international congress of mining, metallurgy, mechanics, and applied geology, to be held at Liége on June 26 to July 1, 1905, in connection with the international exhibition. The subscription to the congress is £1, and members should enter their names in the section of which they wish to receive the publications. The general secretary of the organising committee is Mr. Henri Dechamps, 16, Quai de l'Université, Liége. The subjects to be dealt with in the metallurgical section comprise coke manufacture; blast-furnace practice; influence of titanium, arsenic, and other substances on iron and steel; removal of dust from blast-furnace gas; slag cement; use of poor gas as motive power in rolling-mills; new methods of open-hearth steel manufacture; alloys of steel with chromium, nickel, manganese, vanadium, and tungsten; the forging press and steam hammer; electro-metallurgy and the practical applications of metallography. Visits to the exhibition and to scientific and industrial establishments will be arranged. Further particulars may be obtained from the offices of the Iron and Steel Institute.

**Cables and War.**—At University College on Tuesday Sir John Macdonald delivered an opportune lecture on "Submarine Cables from the Point of View of International Law," this being the first subject dealt with in a resumed law course on the "Rights of Neutrals." The lecturer remarked that very little had been done by way of treaty or convention to decide the rights of nations to destroy cables while at war, notwithstanding the importance of the question. The Institute of International Law adopted a resolution that cables between neutral countries should not be cut, but between two belligerent countries, or two parts of a belligerent country, they might be cut at any point except in territorial or neutral waters. At the instance of the French Government a conference was held in 1884 to consider the protection of telegraphic communication, and under the convention which followed injury to a cable was

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punishable as a crime. The convention did not, however, interfere with the rights of nations at war. The lecturer concluded with the statement that no satisfactory solution would be arrived at unless it were agreed that in case of damage compensation should be paid to the owner, except the cable belonged to a belligerent country.

**The County of London Electric Power Company.** The Bill to authorise this mammoth scheme provides that dividends shall be limited to 8 per cent. until the price of power has been reduced below that of the preliminary schedule, ranging from 1½d. to just over ¾d. per unit. This has not sufficed, however, to ward off opposition, and it is evident that the London County Council will again be to the fore in resisting any such scheme. In an interview the other day, Mr. J. Allen Baker, the chairman of the Highways Committee, stated that the Council expected to provide themselves with energy, when the generating station at Greenwich has been completed, at a cheaper rate than any bulk-supply company could. Mr. Baker proceeded to state that he would "not be surprised if we can supply ourselves at less than 1d. a unit," which does not seem to imply any economy over the tariff named by the company for extended supply. The promoters of the scheme include several influential names, and a big combat between private and municipal enterprise is likely. It is hinted that the London County Council may, at the request of the boroughs, revive their Bill for constituting the Council the supply authority for the Metropolis.

**Rugby Engineering Society.**—A course of three lectures is to be given on the evenings of Feb. 24 and March 10 and 24 by Mr. J. T. Milton, chief engineer-surveyor to Lloyd's Register, the subject being "The Minute Structure of Metals." The following is a synopsis: Mechanical properties of metals dependent upon their minute structure—Examples of extreme divisibility of metals—Power of microscope in ascertaining minute structure of metals—Use of cooling curves in the study of alloys—Analogies between pure metals and water, and between alloys and aqueous solutions—Definition of eutectic alloys—Illustration by series of lead-tin alloys—Crystallisation of metals—Orientation of crystals—Effect of heat treatment both during and subsequent to freezing—Definition of solid solutions—Diffusion and segregation—Molecular motion and transference—Illustrations in brass and Muntz metals—Difficulty of drawing a line between iron and steel—Usual impurities or components of commercial iron and steel—Their influence upon structure—Definitions of ferrite, cementite, pearlite, austenite, etc.—Roberts-Austen's diagram—Critical temperatures—Effect of heat treatment on structure. The lecturer will show many diagrams and a large collection of typical metals and alloys.

**Municipal and County Club.**—This club held a very successful house dinner on Friday, the 27th ult., the guest of the evening being Sir William J. Collins, chairman of the Education Committee, London County Council. Mr. G. Laurence Gomme, clerk to the London County Council, presided, and a number of distinguished members were present. Mr. Gomme, in proposing the toast of the guest, said that Sir William Collins was known to all as a distinguished member of the London County Council, and as one of the ablest of its past chairmen. If it should happen among the political fortunes of the future that Sir William should transfer his sphere of action to another place, they felt sure that that other place would feel his influence. He considered that the County Council had dealt brilliantly with their new work in connection with education. Sir William Collins, in responding, observed that it had been truly said that a sound system of local government was a sure keystone of our political liberties, in as far as they found Parliament sometimes paralysed by the volume of work it endeavoured to undertake. It would devolve more and more upon local administrators to relieve Parliament of administrative work. After dinner an excellent musical programme was arranged under the direction of Mr. T. F. Noakes.

**The Metric System.**—The report of the Decimal Association for the past year is an optimistic document. After recording the passage through the Upper House of the measure introduced by Lord Belhaven to render the metric system compulsory, the report states that as the result of a special canvass amongst the Commons over 330 members promised their support. The number would not need to be many in excess of 330 to secure a majority in a full House. Every effort will be made, the report states, to carry the Bill through the Commons during the coming session. Mention is made of the favour with which the system is viewed in the Colonies and the United States, and the report alludes to the resolutions passed by the Associated Chambers of Commerce, the Society of Accountants and Auditors in London, and other institutions, who agreed to cordially support the measure. The receipts for the year totalled £1,544, against £768 for the previous 12 months, but the expenses of the compaign swamped the income and left the association with a debit balance. Since March 1, however, the organisation has received an accession of 377 members. Our own views on the matter have been expressed recently in our editorial columns. With Parliament as at present constituted said to be so favourably disposed towards the measure, it is no wonder that the Decimal Association are in a hurry to get it through in the ensuing session, lest—but that is another story.

**Personal.**—A representative meeting of the subscribers to the testimonial to Mr. Musgrave Heaphy was held in the Board-room of the Phœnix Fire Office on Friday afternoon last. In the unavoidable absence of the Right Hon. Lord Avebury, chairman of the committee, Mr. H. B. Guernsey, manager of the Phœnix Fire Office, occupied the chair. The chairman, in his opening remarks, said that Mr. Heaphy was an old friend and valued colleague, and that for a great number of years he had been loyally devoted to the interests of the company, gaining the respect of everybody. They were all sorry to lose him. It was always Mr. Heaphy's desire that installation work should be done in the best possible way, and the electrical profession, the fire offices, and his co-workers had every reason to be proud of the work he had accomplished. It was an open secret that Mr. Heaphy's ill-health was the result of continuous and strenuous services in the best interests of his profession. It was decided that the presentation should take the form of an engrossed address, a gold watch and chain, and an album with the signatures of the subscribers. In seconding the address, Mr. Alex. Siemens, president of Institution of Electrical Engineers, referred to the fact that to Mr. Heaphy belonged the honour of preparing the first set of rules for guidance in the erection of electrical installations. Owing to the present state of Mr. Heaphy's health, it was decided to convey the testimonial to him privately.

**New Publications.**—The Universal Electrical Directory (J. A. Berly's): Messrs. Alabaster, Gatehouse, and Co. have forwarded us a copy of the 1905 volume of this old-established reference book. It is divided into four sections—viz, British, Colonial, Continental, and the United States—each of which is again divided into alphabetical and classified sections, and in the case of the British a geographical section is also given. The entire publication has, as usual, been completely revised, and now comprises nearly 33,000 names, besides other information, so that its value is

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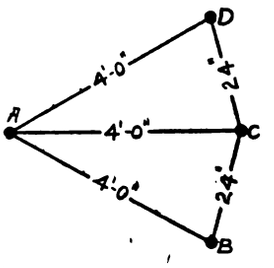
obvious. The price is 14s., post free.—The first volume of the *Transactions* of the Faraday Society in its new form is an excellently got-up publication, and contains several interesting papers recently read before the society, with the discussions.—The January number of the *Electric Club Journal*, Pittsburg, has as its frontispiece an illustration of a horizontal boring and drilling machine driven by a variable-speed direct-current motor. There are articles on "The Installation of a Transmission Plant," "The Application of Motors to Machine Tools," "Opportunities in the Electrical Business," "Dampers for Synchronous Machines," "Protective Apparatus," and "Oil-Saturated Commutators," while Messrs. H. W. Peck, E. H. Dewson, and R. E. Workman continue their series of articles on "Modern Practice in Switchboard Design," "Electric Railway Braking," and "Factory Testing of Electrical Machinery" respectively.

**Association of Technical Institutions.** — The Association of Technical Institutions held its annual general meeting on Friday last at the Municipal School of Technology, Manchester. After a vote of thanks had been unanimously accorded to the retiring president, Sir John Gorst, the newly-elected president, Sir Philip Magnus, said that the transfer of the work of the school boards to municipalities and county councils was a great step in advance. The closer association of Whitehall and South Kensington, the abolition of separate departments of science and art, and the recognition of the true place of science and art teaching in all curricula, the creation of one central authority for elementary and secondary education, and the acknowledgement that technological instruction was a matter of State concern as supplementing both, were epoch-making incidents in the history of education in this country. Sir Philip then proceeded to deal with the handicap which frequently confronted technical instructors because students who attended even the most elementary technological classes were often insufficiently prepared to profit by the teaching. They were deficient in power of expression; they lacked practical knowledge of arithmetic and the rudiments of science and the necessary skill in drawing. The lesson he deduced from this was that elementary teaching should be made more practical. He "believed that the workroom would gradually supersede the classroom in elementary schools, and that manual training would become the central feature of the training around which other studies would be grouped." At the other end of the scale the relations of technical institutions with the universities, in so far as the latter provided such teaching, were not yet fully adjusted. He concluded by appealing for greater access to the universities. In the evening the president and members of the association were entertained at dinner, at the Midland Hotel, by Sir William Mather, M.P., who, in proposing "Success to the Association," remarked that we should not occupy as prominent a position 25 years hence as we had in the past quarter or half century, unless greater attention were paid to technical education.

**Overhead Wires.**—Under the auspices of the Commons and Footpaths Preservation Society, the Postmaster-General received on the 26th ult. the deputation referred to in our last week's issue. Mr. Shaw-Lefevre, who introduced the deputation, was supported by, among others, Lord Farrer, Sir N. Fowell Buxton, Admiral Sir E Fremantle, Prof. Westlake, K.C., and Mr. F. Carruthers Gould. Mr. Shaw Lefevre said that the variety of interests represented showed the widespread feeling of alarm at the action of the Post Office. He argued that in no circumstances ought the lines to be carried over commons, and as to rural roads, although he quite admitted that they had to consider the balance of public convenience, it was thought that an effort should be made to prevent the disfigurement of roads of exceptional beauty. He quoted a letter from the President of the Royal Academy, in which Sir E. Poynter referred to the "hideous disfigurement of natural scenery," instancing the beautiful road along the Hog's Back, Surrey, which, he said, had been cruelly disfigured by telegraph posts. He expressed the hope that there was no truth in the rumour that the Government intended to reintroduce the Bill which would give further powers to the Post Office, and said the fact that the London County Council refused consent for wires and poles on any commons or parks under their jurisdiction was strong testimony in favour of the policy the deputation recommended. In a sympathetic reply, Lord Stanley assured the deputation that, as a general rule, he would be prepared, where there were two routes, to follow the less beautiful one, even though it were longer. The Post Office, however, was in an unenviable position, as it was expected to supply the public needs as cheaply as possible. Telegraph wires were to a large extent being laid underground, but this course was not practicable with trunk telephone wires, as it impaired their efficiency. His lordship intimated that the Department were greatly handicapped in respect to wayleaves, their choice of route often being restricted in consequence. He promised, however, to give careful consideration to any representations concerning threatened landscapes, and reassured his audience by stating that he had no intention of reintroducing the Bill of last session with the open-spaces clauses in it.

**Underground Waterflow**—Investigations as to the direction in which underground water travels are frequently necessary on the part of civil engineers in connection with water-supply schemes. In the *Journal* of the Western Society of Engineers, published at Chicago, there is an interesting description of some experiments made on the flow of such underground waters in Southern California. Amongst other means of investigation, the author, Mr. C. S. Slichter, describes an electrical one, with which he has carried out investigations at considerable depth. It consists of sinking four boreholes, as illustrated in the accompanying diagram. Where the wells are not driven




deeper than 25ft., an "up-stream" well, A, is located, and three other wells, B, C, and D, are driven at a distance of 4ft from A, the distance between B and C and C and D being about 2ft. The well C is located so that the line from A to C will coincide with the probable direction of the expected ground-water movement. If experiments are to be carried on more than 25ft. below the surface, the dimensions of the triangle are increased, and with depths exceeding 75ft., an interval of 8ft. or 9ft. between the boreholes is chosen. Having sunk the boreholes, electrical connection is made with the casing of each test-well. In each of the down-stream wells a screened electrode is then inserted, connection with which is maintained at the surface by rubber-covered wire. The method of investigation consists of keeping a regular record of the resistance between the well casing and this screened electrode. All the time the resistance of the water inside the well is constant, a constant reading is obtained from

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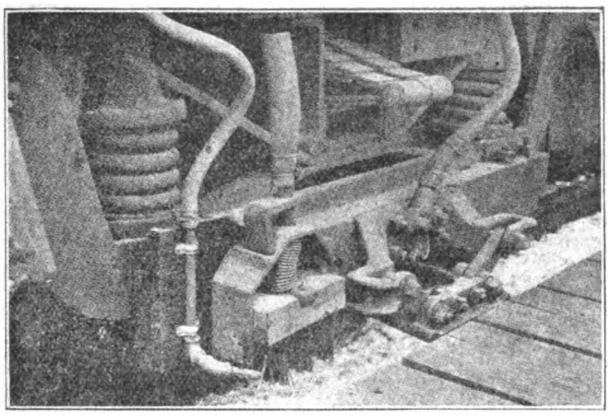
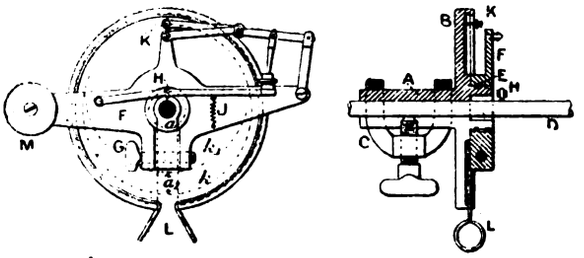
the apparatus. The next step is to insert in the up-stream well a certain amount of sal-ammoniac, which will be dissolved by the ground water, and carried down stream with the same. As this saturated water reaches the other three wells the resistance readings will be altered, and from the data so obtained both the direction and speed of flow of the underground water is determined. The author gives a number of curves to show results in actual experiments, from which we gather that the method is quite a practical one.

**Sleet on Third Rail.**—The sleet problem on a third-rail system becomes more difficult where the cars do not run frequently enough to prevent the sleet from re-forming after removal. Having made some satisfactory tests last winter, the Aurora, Elgin, and Chicago Railway has adopted the following remedy, described in the *Street Railway Journal*. A solution of calcium chloride, which does not have the corroding effects of common salt solution, is employed.

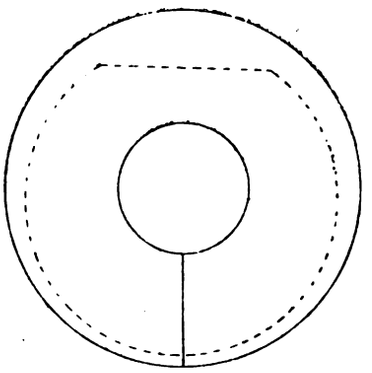


As shown in the accompanying illustration, a small pipe is connected to a rubber hose leading to the driver's cab. Through this the solution is led to the rail a few inches in front of the steel sleet brush. This brush, passing immediately afterwards, spreads the solution uniformly over the film of ice before it has had time to run over the side of the rail. Each car is equipped with four such pipes, one in front of each of the four shoes, so that no matter on which track or in which direction the car may be travelling, one of the pipes may be put in service. The hose to which the pipes are attached are connected to the discharge pipes of a 40-gallon can placed in the cab, and containing the solution of calcium chloride. As the solution is a conductor, it is necessary to ground the pipe on the truck frame to prevent the can in the cab from becoming charged, and consequently dangerous to the operators. The result, of course, is a current from the third rail to the truck by way of the stream of liquid, but the conductivity of the stream is not great enough to cause a dangerous current. The solution is composed of about 38lb. of calcium chloride to the cubic foot, say 7½ gallons, of warm water. When running at full speed the whole flow from the ¼in. pipe is thrown on the rail. The expense of installing the apparatus is comparatively small, and practically the only working cost is for the chemical, which, at the usual market price in the States, works out at about 3½d. per mile.

**Measuring the Wear on Trolley Wires.**—The following apparatus has been designed by Mr. M. A. Harrich, of Ratisbonne, to record graphically the wear on a trolley wire at any part of a tramway system. As seen in the first diagram, the apparatus, which is described in *L'Industrie Electrique*, consists of a tube, A, which carries a disc, B, of considerable diameter. The tube is secured on to the wire by means of the screw which is seen in the illustration. The other part of the apparatus is free to move round on the turned surface, E. On this movable part is fixed a system of levers, on which the touching point, H, rests against the wire the wear of which is to be determined.




As this movable part is revolved the movement of the pointer, H, is magnified by the system of levers which connects it with the pencil, K. The ratio of these levers is such that any movement of the point, H, is increased 10 times at the recording point, K. This pencil leaves a trace on a paper, which is secured against the disc, B, by means of springs. Fig. 2



is a diagram taken with the apparatus, which gives a magnified contour of the wire. The actual area of the figure shown is 100 times that of the wire itself. With this apparatus one can easily take the sections of the trolley wire at intervals, and keep a regular record of the wear. The frequency at which the records should be taken depends, of course, on the traffic, and it is necessary to take them more often at curves and points where the wear is excessive. The apparatus is constructed in Hanover by Messrs. Dreyer, Rosenkranz, and Droops.

**Speed Limits.**—In our issue of Dec. 16 we referred to the representations made by the Tramways and Light Railways Association to the Board of Trade upon the relative speed limits for trams and motorcars respectively. In their reply the Board dissent from the view that, except on very sharp gradients, trams may safely be allowed to run as fast as motorcars. Presumably, the Board, in taking this stand, are actuated by the greater mobility of the latter vehicle, though no reason is stated. The question of prescribing a general speed limit for trams has frequently been considered by the Board, who have come to the conclusion that, in order to grant the maximum speed consistent with the public safety, it is necessary to maintain the present practice of dealing with each route on its merits. The Board intimate their desire to assist tramway enterprise, and will be ready to consider any application for an increase of speed on any particular line. In a somewhat spirited rejoinder to this communication the association aver that in the opinion of many of their members, experts in tramway management, the present speed limits for trams could be generally extended with safety. The association quote the case of the motor omnibus now running in West London. This vehicle goes from Piccadilly-circus to Kensington Church, a distance of over 2 miles 1,000 yards, in 13 minutes. This represents a speed, inclusive of stops, of over 12 miles an hour. When

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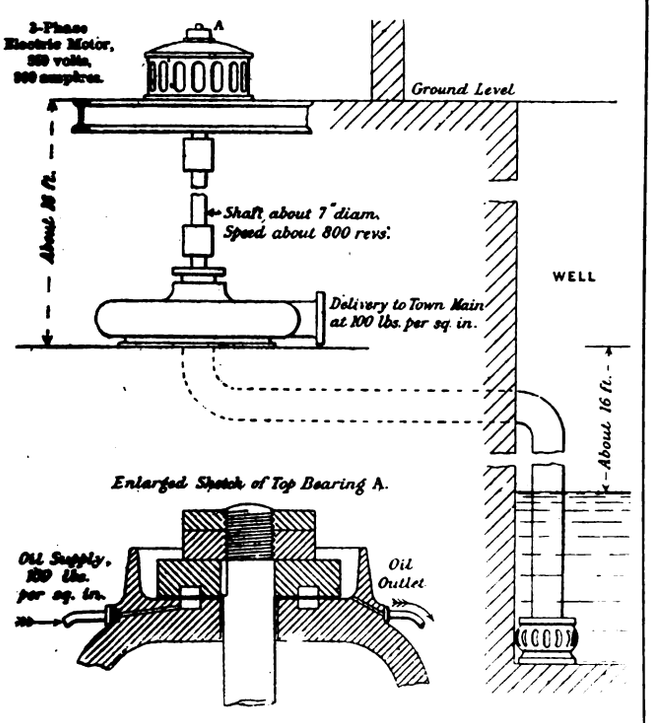
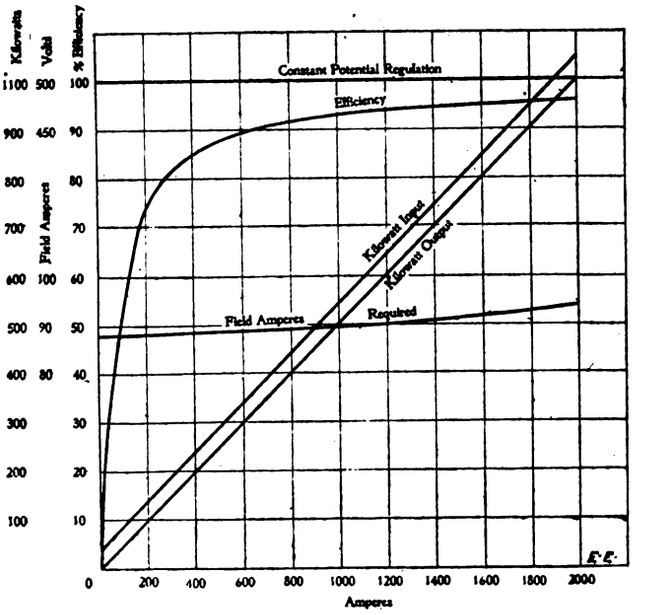
allowance is made for stops and for slackening in the crowded parts of Piccadilly and Knightsbridge, it signifies a running speed, for parts of the journey, of considerably over 14 miles an hour. This speed has been maintained with perfect safety. As compared with this the speeds granted on the London County Council tramways do not exceed 10 miles, except for a small stretch near Clapham Common, and are limited to eight, six, and four miles an hour at other places. The maximum running speed on the London United lines is 12 miles an hour on about 6 miles only of the 35 route miles in operation, and on the remaining 29 miles, 10 miles or less, though none of these tramways are within four miles of Charing Cross. In the northern suburbs the Metropolitan Company were recently refused a speed limit of 16 miles an hour in such a rural neighbourhood as that between Edgware and Cricklewood. Thus we have in London the curious contrast of a high speed for public service cars (other than trams) in crowded central streets and a low speed for trams in outlying suburbs. The association offer to organise tests of the relative stopping power of the tramcar and the motor omnibus or other autocar. In conclusion, the association suggest that, if the Board will not pass a general regulation, they should follow the practice of the Local Government Board in regard to motorcars by holding a local enquiry at which the objection to greater speed can be tested by evidence.

**High-Pressure Centrifugal Pump.**—In the paper read by Mr. A. J. Gimson before the Institution of Mechanical Engineers on his "Impressions of American Workshops" there is a good description of a large horizontal pump which is electrically driven. This pump is used at the Schenectady waterworks. As the illustration




shows, it consists of an electric motor, with its axis vertical, carried by girders at the ground-level and connected by a vertical shaft to the centrifugal pump. The three-phase motor is supplied with current at about 550 volts, 800 amperes, and the speed of motor and pump is about 800 revolutions per minute The centrifugal pump is about 6ft. internal diameter, and raises water from an adjoining well, the level being about 16ft. below the pump. The water is pumped into mains against a pressure of 100lb. per square inch. There is also a small auxiliary electrically-driven geared vacuum pump to exhaust the main pump and suction pipe from the well for charging purposes, also a set of small electrically-driven geared three-throw pumps to pump oil at 100lb. per square inch under the upper collar bearing of motor on which the weight of the armature, shaft, and pump disc all hang, so that the whole of moving parts are floating on an oil step bearing above, as shown in the accompanying diagram. The pressure of oil in the annular space between the two bearing discs just eases them apart, and takes the whole weight (amounting to several tons) of working parts. The water to be pumped amounts to over eight million gallons per 24 hours, which works out at about 500 pump horse-power.

**Approximate Determination of Alternator Regulation.**—In his serial article on "Factory Testing of Electrical Machinery," appearing in the Electric Club *Journal*, Pittsburg, Mr. R. E. Workman describes a method for determining approximately the regulation of an alternator from the open-circuit saturation curve and the armature short-circuit curve, where it is impracticable to obtain the regulation curve directly. The accompanying diagram




shows the regulation, calculated in this way, for a 1,000-kw. 500-volt alternator, with the following data: armature resistance from terminal to terminal at 50deg. C. equals 0 00405 ohm; the current per phase at full load equals 1,154 amperes; the I.R drop is 4·05 volts; the field amperes at 504 volts from the saturation curve equal 88 8; and the field amperes at 2,000 total amperes on short-circuit equal 30, the resultant field amperes equalling 93·8. With this field current the open-circuit voltage from the open-circuit saturation curve would be 527, so that the inherent regulation for full load with constant field current would be 5·4 per cent. The regulation curve shown in the diagram is that for constant potential, so that it is only necessary to calculate the field amperes required, with a number of different currents, to give the full terminal E M.F. of 500 volts. The method of computing the regulation consists of adding the armature resistance drop for a given load to the terminal voltage on open circuit. From the no-load saturation curve determine the field current corresponding to this voltage, and add this field current vectorially to the field current required to produce the same load with the armature short-circuited, these two quantities differing in direction by 90deg. Then from the open-circuit saturation the voltage corresponding to this resultant field current is found. The difference between this voltage and the terminal voltage of the armature at the chosen current, expressed as a percentage of the latter, is the regulation of the alternator for that particular current.

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## ARMATURE WINDINGS OF THE CLOSED-CIRCUIT TYPE.

BY WM. CRAMP.

(*Continued from page 116.*)

In passing from Fig. 6 to Fig. 7 it will have been noticed that attention has been naturally diverted from the *number of spirals* upon the armature to the *number of inductors*. This must always be so in the case of drum windings. Of course, such a section as that accentuated in Fig. 7 might be (and frequently is) considered as one spiral; but in complicated drum windings of many inductors it is very much more convenient to consider the number of inductors than the number of such spirals. Thus in future we shall rarely speak of the number of spirals in the case of a drum-wound machine.

Windings like Fig. 7 are known as *multiple-circuit drum windings*, and we may formulate a set of rules which will apply to all such armatures. These rules will be as follows:

**Rules for Simplex Multiple-Circuit Drum Windings.**

(1) The number of inductors must be divisible by 2.

(2) Rule for connecting: number every other inductor; start from No. 1, connect across to an inductor situated approximately $\frac{1}{p}\,w$ from No. 1 (where $w$ is the number of inductors, $p$ the number of poles), such an inductor being an unnumbered one; and then pass back to No. 2.

(3) To ensure re-entrancy, the distance between inductors Nos. 1 and 2 should be equivalent to $\frac{2}{w}$ of the total circumference if the winding is to be regular.

Now, the above rules, though accurate, are not convenient in practice, for it is not possible to draw out every armature with all its inductors and number them as suggested above. We can easily re-form the above rules as follows:

If we number *all* the inductors in Fig. 7 instead of only half of them, beginning with the same inductor as before, we find that all the original numbered inductors are now odd numbers, the unnumbered ones becoming the even numbers. Since in the original diagram we went from a numbered to an unnumbered inductor, we must now go from an odd to an even number, and so on. Thus in Fig. 7 we have connected No. 1 to an inductor lying between 3 and 4. Under the new arrangement (Fig. 8) this would be connecting No. 1 to No. 6, and we shall then pass back to what was originally No. 2, but is now No. 3. Thus our connections will go 1, 6, 3, 8, 5, and so on; it being understood that connections 1 to 6 and 3 to 8, etc., are at one end of the armature, 6 to 3 and 8 to 5 at the other end.

In Fig. 8 the connections 1 to 6, 3 to 8, etc., are shown at the front or commutator end of the armature, while connections 3 to 6, 5 to 8, which are supposed to be at the other end of the numbered inductors, are drawn as dotted lines outside the armature. This plan we shall pursue in all future figures, since it makes the diagram much clearer.

Fig. 8 is exactly the same as Fig. 7 except that all the inductors are now numbered, and nothing of the original appearance of a ring winding is left. These two diagrams, when compared with the preceding ones, show very clearly the close connection existing between ring and drum windings. Indeed, it is not too much to say that in all cases of difficulty with multiple-circuit drum windings, if the corresponding ring be drawn out, any intricacy or confusion at once vanishes.

To develop the new rules for multiple-circuit drum windings, we remember that the difference between the numbers of any two inductors connected together is called a *number-pitch* of the winding, so that the arrangement in Fig. 8 is said to have a forward number-pitch of 5, and a backward number-pitch of 3. Both these numbers must always be odd, since in any single winding we always connect from an inductor with an odd number to one with an even number, or *vice versâ*, as has been already explained. The difference between the number-pitches (forward and backward) must be 2, since we have shown that in each case we must return to the inductor next but one to that from which we started. Part of the winding in the figure has been again accentuated so as to bring out clearly its character.

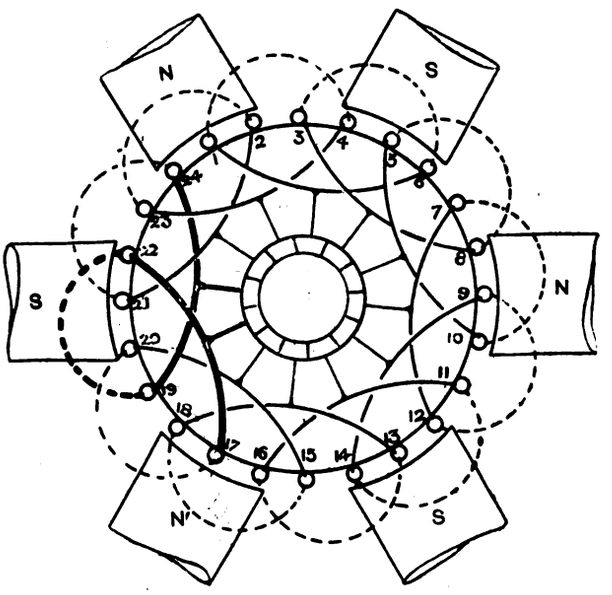


FIG. 8.

From all this it follows that Rule 2 given above for simple multiple-circuit drum windings might be stated as follows:

*Having found the number of inductors that will be required for any particular machine, imagine them numbered consecutively. Take as a forward number-pitch an odd number equal to or slightly greater than* $\frac{w}{p}$, *where* $w$ *is the number of inductors,* $p$ *the number of poles. Call this number-pitch* $y_1$, *then the backward number-pitch is* $y_2 = y_1 - 2$.

*This is the only rule of connection necessary for simple multiple-circuit drum windings.*

**Use of Conventional Winding Tables.**

Instead of drawing out in a diagram such a winding, it is useful to have a conventional form for expressing the arrangement.

These forms are known as winding tables, and there are various methods in use. One of the most convenient is that of placing in a row the numbers of the inductors in order as connected, and then drawing between these numbers lines alternately above and below so that the numbers represent the inductors, the lines the end connections. An example will make this clear.

Example: A four-pole drum-wound machine is to have 114 inductors upon its armature; what will be

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the winding table for a simple multiple-circuit winding?

We have $\frac{w}{p} = \frac{114}{4} = 28\frac{1}{2}$.

The nearest odd number to this is 29, and we therefore take as the forward number-pitch, $y_1 = 29$. From the rule $y_2 = y_1 - 2$, we have $y_2 = 27$, which gives us the backward pitch.

The winding table will run

1——30——3——32——5——34, etc.

**Drum Armatures with more than One Pair of Inductors per Commutator Section.**

In the case of all large machines the number of commutator sections is half the number of the inductors, or, as it is sometimes expressed, there is one turn (or spiral) per commutator section, exactly as in Figs. 7 or 8. In such cases the winding table above is usually a sufficient guide. It may be that there will be fewer slots in the armature than inductors if a toothed core is used. Of course, the number of slots

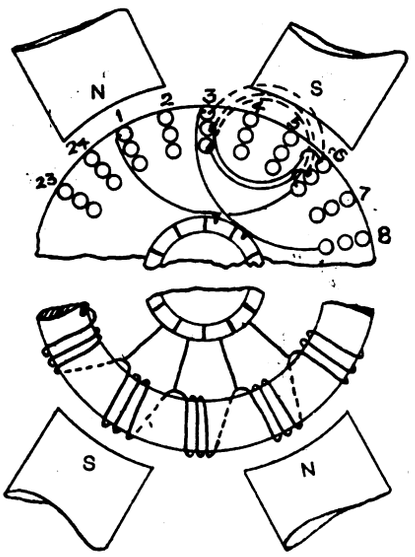


FIG. 9.

must be equal to, or a sub-multiple of, the number of inductors. But this fact will create no difficulty, as in Fig. 8 it is quite easy to imagine inductors 1 and 2 side by side in one slot, whilst 3 and 4 are side by side in the next; or we might have 1 above 2 and 3 above 4 in two slots. In such cases it is better, perhaps, to draw out a slot showing the numbered inductors for the guidance of the winder. The rule given above is in no way altered by these practical considerations, but it is clear in such cases that the *number-pitch* is much more convenient than the distance-pitch used before.

Now, suppose the number of inductors is more than twice as great as the number of commutator sections; we then have a drum armature which corresponds to a ring winding with more than one turn per spiral, such as has been already mentioned. Naturally, by drawing out a case like this in the form of a ring winding and developing the corresponding drum as in Figs. 6 and 7 the whole matter will make itself clear, and will be found to resolve itself into the substitution of a *coil* for a spiral. The total number of inductors must always be a multiple of the number of slots and of the number of commutator sections: and the easiest way of making sure of the connections being regular and correct is first to find the number-pitches, according to the above rule assuming that there are twice as many inductors as sections, and then to substitute for the spiral thus arranged the required number of turns. An example will make this more clear.

An armature of the simple multiple-circuit type is to be arranged with 36 turns (or spirals), and 12 commutator sections for a six-pole field. Give the diagrams both for a ring and for a drum.

According to the method outlined above, we first arrange the ring winding. This is easily done, for it will simply be a ring (like Fig. 6), but with three turns per section, as is shown in the lower part of Fig. 9. The upper part of Fig. 9 represents the corresponding drum winding, which (if we had not already arranged the ring), we should proceed to obtain as follows:

Since there are to be 36 turns on the armature there will be on the drum 72 inductors; and since there are 12 commutator sections the simple drum winding would have 24 inductors with a forward number-pitch of 5 and a backward number-pitch of 3, exactly as Figs. 7 or 8. This gives us the following arrangement, which is shown in the upper part of Fig. 9.

We assume an armature with 24 slots, and there will, therefore, be three inductors per slot, as shown in the diagram. In any case, however many slots there might be, it would still be best to divide for purposes of connection the inductors into 24 *groups*; indeed, in the diagram groups 3 and 4 might be assumed to lie in one slot, 5 and 6 in the next, and so on: this would give us the same number of slots as commutator segments, being probably the most common arrangement met with in practice for small armatures. We number then consecutively the 24 groups, and we know that the connections will be 1——6——3——8. Now multiplying this simplified armature, we start from any group such as that marked 6 and pass to group 3; then *back to group 6*, and continue this process until the inductors of groups 3 and 6 are all joined in. As in this case there are three inductors per group (which corresponds to three complete turns on the armature per commutator section), we shall really wind a little coil of three complete turns when we connect up groups 3 and 6.

When this is finished we pass from the last inductor of group 3 to the first of group 8, and complete 8 and 5 in a similar way to 3 and 6, passing afterwards from the last of group 5 to the first of group 10, and so on.

In the illustration, to avoid confusion, one coil only has been drawn in, and here, as before, the dotted lines represent connections at the back end of the armature. The lower and upper parts of Fig. 9 correspond just as Figs. 6 and 7, and it is immediately noticeable that whereas, in the case of the ring armature, it is almost impossible to wind the coils separately and slip them on the core (because of the armature supports, etc.), yet in the case of the drum armature it is quite possible to wind such a coil as that shown between 3 and 6, bringing out the ends to the commutator, and arranging the shape of the coil so that it will easily clear those wires which lie at 5 and 4.

**Former-Wound Coils.**

This is the foundation of all so-called "former" winding, in which the coil is wound apart from the armature and slipped into the slots afterwards. It is, no doubt, clear that we might have wound the coil between groups 1 and 6, when the connections 6 to 3 would have become the commutator connections, but this would obviously mean waste of armature wire, and in either case if we substitute for every group of three inductors only one, we return to the original arrangement shown in Fig. 8.

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It is not intended here to go fully into the various shop methods of winding these coils. Full details have been published in many text-books, and we may refer particularly to the excellent illustrations in the last edition of "The Dynamo" (Hawkins and Wallis).

On account of the fact that the connection of the inductors on a multiple-circuit drum gives on analysis the shape shown by the accentuated lines in Fig. 8, such armatures have been termed "lap wound," because after a forward connection there is a "lapping back" to an inductor near the one from which the winding was started. But inasmuch as in all coil windings there must *apparently* be some sort of lapping back, whether lap or wave wound, we prefer here to relinquish, as far as possible, the use of such terms as "lap" and "wave." The examples given should, we think, be sufficient to enable any simple multiple-circuit winding to be arranged or traced out, and without pausing to enter into such arguments as those for or against so-called "chord" winding, excellent examples of which appear elsewhere, we may pass immediately to the consideration of multiplex multiple-circuit armatures.

(*To be continued.*)

## THE LOTS ROAD POWER STATION.

About eighteen months ago we gave a description of the above power station, which was then in course of construction for the Underground Electric Railways Company of London. Now, through the courtesy of the British Westinghouse Company, we are able to reproduce photographs of the completed station, with which the following brief description will be of interest.

The power station (Fig. 1) is situated at the junction of Chelsea Creek with the River Thames, the former of which it bounds on the south, Lots-road running almost parallel on the north side. It is designed to supply energy for working the whole District Railway system and also the Baker-street and Waterloo, the Great Northern and Brompton, the Charing Cross and Hampstead, and the Edgware and Hampstead lines. These in total amount to over 63 miles of track, of which the District Railway supplies about 40, and will unitedly represent by far the heaviest and densest traffic of any electric line. Necessarily, the joining together in one working scheme of so many undertakings, all of considerable importance, has called for a generating station of unusual proportions and design, and the now practically completed Lots-road power-house contains 60,000 h.p. of generating machinery, covers over 3½ acres of land, including yards, etc., and has cost some 2½ millions of money.

The site upon which it stands was formerly occupied by dust destructor and other works, and measures on the water frontage 1,100ft. and on the Lots-road side, 824ft. The size of the building and the plant that it contains has involved the greatest care in laying the foundations, consisting of about 220 concrete piers, and these have been sunk through strata of made ground, gravel, and sand to the London clay at a depth of 35ft. The necessity of making all the excavations watertight as they proceeded was a troublesome and costly one, but the fact that they were well below the river level, even at low tide, made this course imperative. The timber bank or retaining wall of Chelsea Creek was found to be in a very rotten condition, and was replaced by a solid brick wall, which, for some distance, carries the superstructure of the power-house on the south side.

Fig. 2 gives an outline plan of the site and buildings, and it will be noticed that at the eastern extremity a large barge basin is situated, the function of which is to dock the barges conveying coal or other material to the works. Behind this is the oil-cooling plant, and on the western extremity of the site a large bin for containing the furnace ashes before shipment. In the construction of the buildings little less than 20,000 tons of steel have been used, of which some 6,000 tons have gone to the main framework. The chimneys, of which there are four, have now become a recognised landmark to Londoners. They are built on the Custodis principle, with an internal diameter at the base of 19ft. and a height of 275ft., and are placed symmetrically

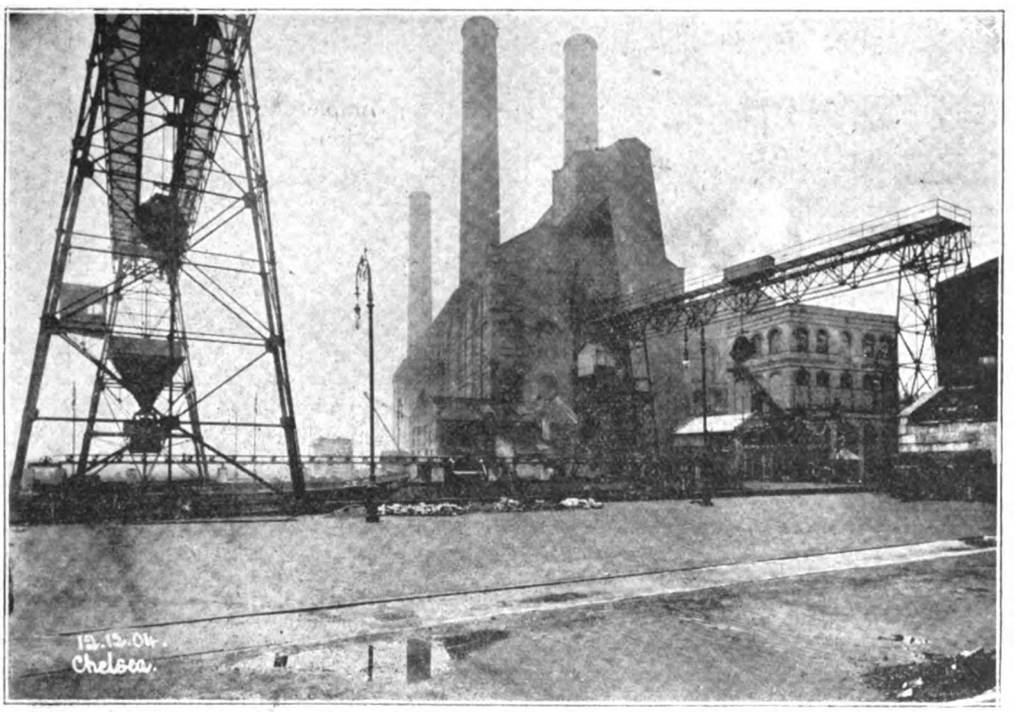


FIG. 1.—Exterior View of the Lots Road Power Station.

in pairs in the boiler-house section, about a quarter of the length of the building from the ends. There are few stacks in Europe that can equal them in size, as they have been designed with a margin for extensions beyond even the present enormous capacity of the station. The internal arrangements of the building, which measures 453½ft. long long by 175ft. broad and 140ft. high, are shown in plan and elevation in Figs. 3 and 4. It will be seen that, as usual, it is divided longitudinally into engine and boiler rooms, the latter of which is the larger, and contains several storeys. The arrangement of the boilers upon two floors is

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a decidedly novel one in England, but represents almost standard American practice. It has been necessary in the case of the Chelsea power-house on account of the large number of boilers installed and considerations of floor space.

Fig. 4 (the cross-section of the building) shows the coal bunkers situated on the top floor, the capacity of which is 15,000 tons. As the boilers will consume some 800 tons of fuel daily when the station is in full working order, it is

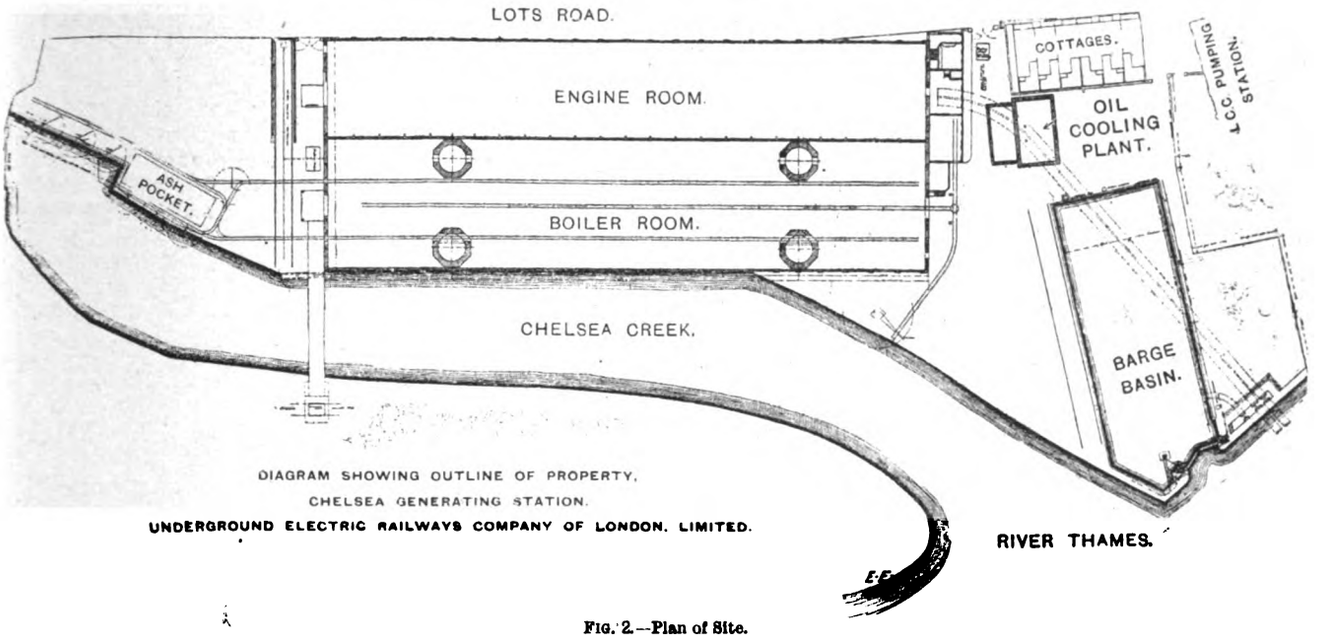


FIG. 2.—Plan of Site.

obvious that such a contents is necessary. The coal is picked up from the barges by two one-ton grab travelling cranes, and after being weighed, is carried by belt and inclined hoppers to the top of the building. Here it is deposited upon another belt conveyor, which is so arranged as to effect its distribution to the several bunkers in any desired quantity. As an alternative to water-borne coal, arrangements have been made to obtain the supply of fuel from sidings of the West London Extension Railway by further arrangements that bring the coal in at the opposite end of the bunkers. The ashes from the fires are dealt with in a most complete way by means of self-dumping buckets that run on rails laid under the ash hoppers on the ground floor. A storage battery locomotive hauls these to the barges, where they are unloaded by pneumatic hoists. Compressed air is used for sundry purposes, including the operation of the barge basin gate machinery, capstans, and sundry large valves in the power-house.

The boiler-house contains 64 Babcock and Wilcox water-tube boilers, supported directly on the steel framework of the building, and space is left for the installation of 16 more. Each possesses 5,212 square feet of heating surface, and is provided with a superheater of 672 square feet area. They are divided up into sets of eight, the number required to operate each turbine unit at full load. There is no steam connection between the various groups except in one case, where a header for supplying steam to the auxiliaries is fed from two of them. Chain-grate stoking gear is provided, with 83 square feet of surface for each boiler. Economisers with 10ft. tubes are grouped behind the boilers with a by-pass flue, as shown in Fig. 4, and the total pipe area installed allows 1,540 square feet of feed-water heating surface per boiler. The main steam-piping runs down the boiler-house side of the dividing wall and under the engine-room floor to the turbines, and is supplied with the usual valves and water-pockets.

In the engine-room (Fig. 5) there are installed eight Westinghouse steam-turbine generating sets, each consisting of a turbine of some 7,300 b.h.p., coupled direct to a three-phase alternator of 5,500 kw. capacity. The former are of the Westinghouse single-cylinder, double-flow type, and are designed to run with a steam pressure of

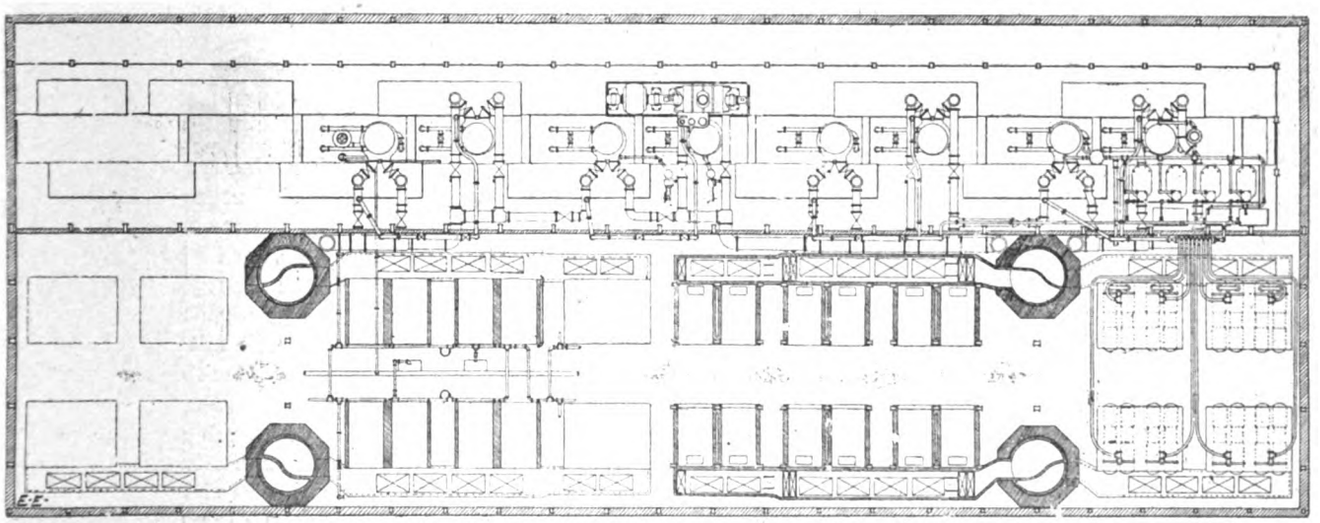

FIG. 3.—General Plan of the Generating Station, showing Steam and Exhaust Pipe Arrangements.

165lb. per square inch, a superheat of 100deg. F., and at a speed of 1,000 revolutions per minute. They are capable of sustaining an overload of 50 per cent. by aid of automatic by-passes, and are extremely economical in steam consumption.

As the Westinghouse steam-turbine differs in many points from others, some details of its construction and operation may not be out of place. The rolled-steel rotating drum to which the blades are fixed is fitted at each end with a forged steel umbrella-shaped disc, shrunk in. The steel shaft is pressed into these, and the result is

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an arrangement that, though light, is extremely strong. The blades are dovetailed and caulked into grooves cut in the surface of the drum, and are of a special metal in the case of the low-pressure series on account of the corrosive action of wet steam. The main bearings are of the spherical type, and are of cast iron, with Babbitt metal linings. Forged steel flexible claw couplings, running in oil, are provided for connecting the turbine rotors with the revolving fields of the alternators, and are so arranged as to provide for any inexactitude in the alignment of the two shafts.

The course of the steam through the turbine is as follows: Leaving the main disc-type stop-valve, which is actuated by gearing from the platform, the steam flows through an emergency quick cut-off valve, a strainer, and a double-seat poppet governor valve, which latter is operated by a steam relay controlled by the centrifugal governor. It now enters the cylinder at the centre, and, passing through a series of nozzles and impulse blades, expands down to practically atmospheric pressure, continuing then through a number of pressure blades on the Parsons principle to the condenser. The equal flow of steam each way gained by its admission at the centre of the turbine eliminates all end thrust, and therefore the necessity for balance pistons. One end of the shaft is fitted with a thrust block to allow of longitudinal adjustment of the turbine rotor, and a central system of lubrication supplies oil under pressure to each bearing in a separate pipe.

The three-phase Westinghouse alternators are of the revolving-field type, and on a non-inductive load will supply a current of 289 amperes per phase at a pressure of 11,000 volts. They are of 5,500 kw. capacity with a frequency of 33 3 per second. The revolving field is a solid forging of Whitworth fluid-pressed steel of good permeability, and is wound in the usual manner. The armature core of laminated iron is supported by a heavy cast-iron frame, divided horizontally, and is wound in slots on its inner surface.

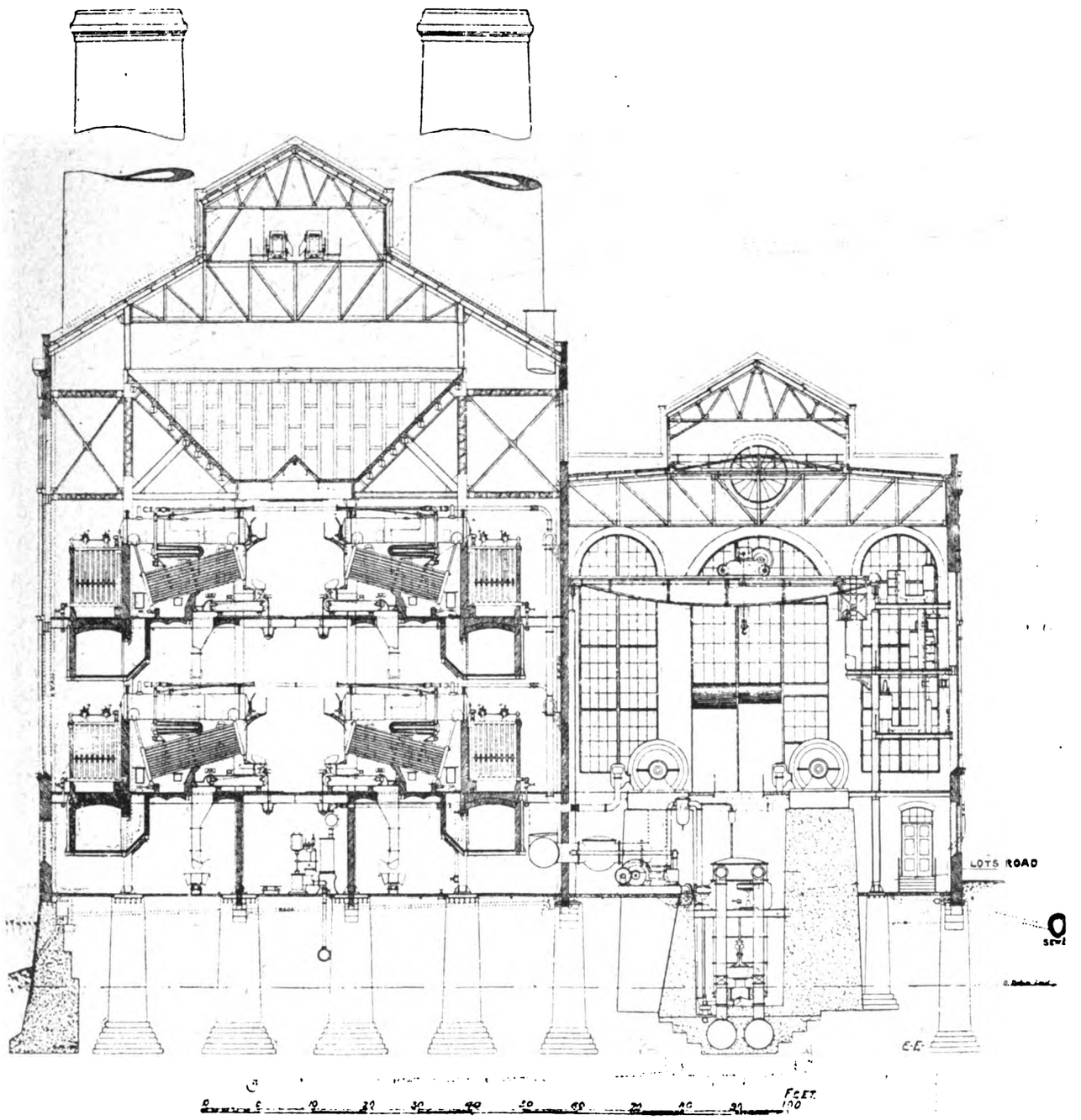


FIG. 4.—Transverse Section through the Engine and Boiler Rooms at Lots Road.

With regard to the auxiliary plant, the four exciter units consist of an Allen-British Thomson-Houston combination, and each have a capacity of 125 kw. at 125 volts when running at 375 revolutions per minute. The condensers are worked on the dry-vacuum principle, with separate motor-driven air and water pumps. They are installed in pits between the two rows of turbines, and have each 15,000 square feet of cooling surface, which is fed with circulating water conveyed through 66in. pipes from the Thames. The water-cooling system is based on the principle of the siphon, and the 20in. centrifugal pumps have simply to overcome the friction in the pipes. The condensing equipment was supplied by Messrs. J. H.

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Simpson and Co. The switchgear is arranged on three galleries, placed principally across the north side of the engine-room. It was supplied by the British Thomson-Houston Company, and all the high-tension switches are motor-operated by means of a low-pressure circuit con-

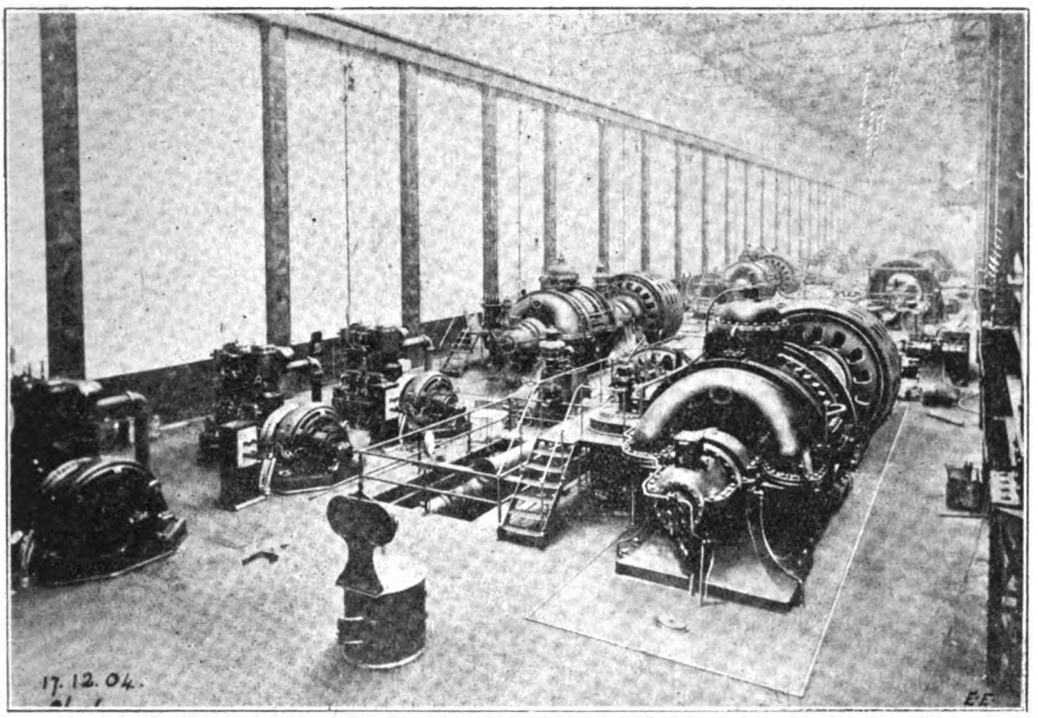


FIG. 5.—The Engine Room at Lots Road, showing 5,000-kw. Turbo-Generators.

trolled from a small pilot switchboard. These were supplied by the British Insulated and Helsby Cables, Limited, and are laid in Doulton stoneware ducts. There are 24 sub-stations on the line, to each of which a duplicate feeder is run; 64 ducts have therefore been laid, which allow for some extension. The feeders are carried through the

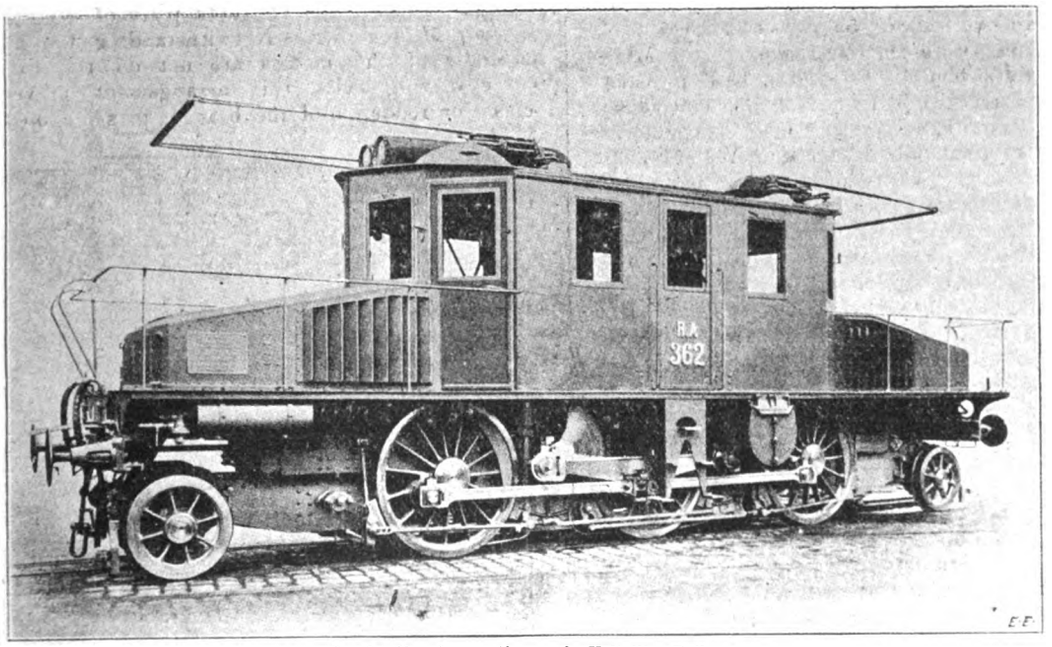


FIG. 1.—New Locomotive on the Valtellina Railway.

streets to the Earl's Court Station of the District Railway, which is the nearest point to Lots-road.

*(To be continued.)*

## NEW LOCOMOTIVES ON THE VALTELLINA RAILWAY.

Some interesting particulars of the new locomotives electrically equipped by Messrs. Ganz and Co., of Budapest, for the Valtellina Railway are contained in an article contributed by Béla Valatin to our contemporary, *Elektrische Bahnen u. Betriebe*. These locomotives are designed to haul heavy trains, and may be said to be the outcome of the great increase of traffic which has taken place since the line was equipped for electric traction, while, at the same time, their design partakes somewhat of the nature of an experiment, in view of the contemplated conversion of the main line Milan-Lecco for electric traction. It was specified that the locomotives should be built for two dominant speeds, the higher to lie between 60 km. and 70 km. and the lower between 30 km. and 35 km. per hour. That they should be driven by polyphase motors, wound for 3,000 volts terminal potential and a frequency of 15, capable of exerting a normal tractive effort of 3½ tons continuously at the circumference of the driving wheels for the higher speed, and of six tons similarly for the lower speed, the drive not to be transmitted from the motors to the axles of the locomotive through the medium of toothed-wheel gearing. It was further required that the locomotives should be able to accelerate a train weighing 400 tons on a gradient of 1 $^{0}/_{00}$ from a position of rest to a speed of

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30 km. per hour in the space of 55 seconds, or a train of 250 tons weight on the same gradient from rest to a speed of 60 km. per hour in 110 seconds. These accelerations correspond to about 1½ times the normal tractive efforts mentioned in the foregoing. Also that the above results should be obtained notwithstanding a drop in the line pressure from 3,000 to 2,700 volts. Moreover, each locomotive was to be able to start on a gradient of 20 $^0/_{00}$ with a train weighing 250 tons. The motors and other electrical equipment were to be capable of starting a train weighing 400 tons up to a speed of 30 km. per hour on a gradient of 3 $^0/_{00}$ thirty times without undue heating, an interval of two minutes being allowed between each stop and start. A further stipulation was that the motors should be capable of running 10 hours at both the designed speeds, with the above-mentioned normal load, without the temperature of any part rising to more than 60deg. C., and be able to withstand an overload of 100 per cent. for 200 seconds without heating to more than 40deg. C., and an overload of 50 per cent. for a period of one hour. These were the conditions which Messrs. Ganz and Co. were bound by. They had previously designed and constructed a four-axled locomotive with motors coupled coaxially, as in the case of the motorcars and locomotives originally built for the Valtellina line, which have continued to give complete satisfaction to date.

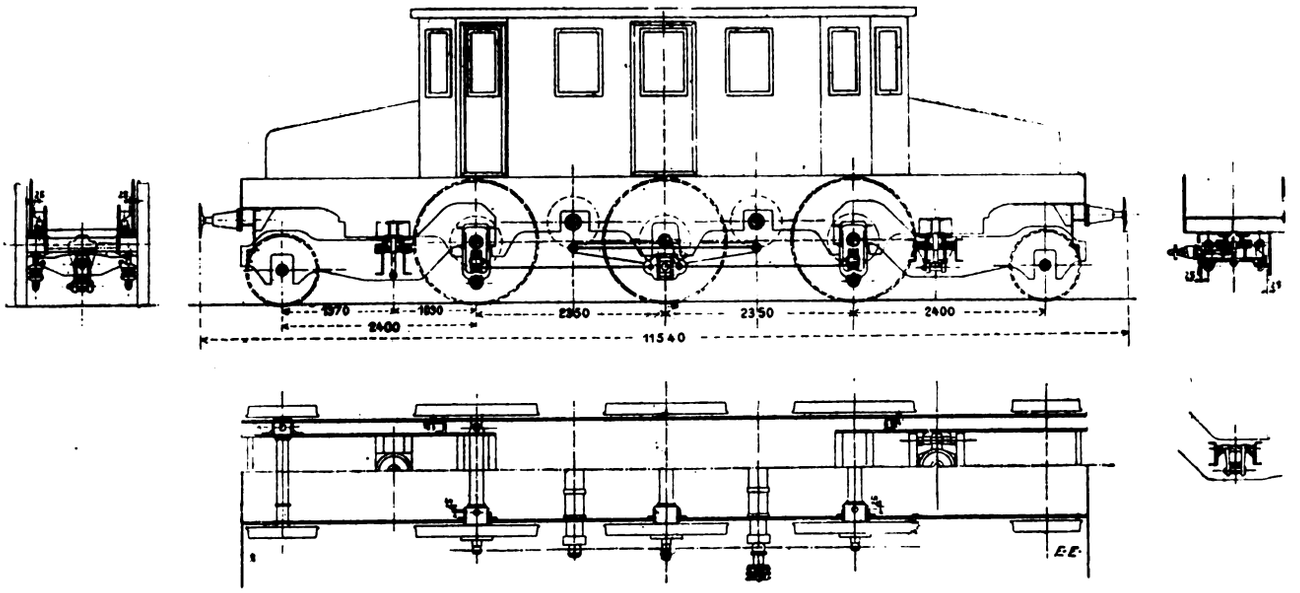


FIG. 2.—Details of New Locomotive on Valtellina Railway.

Each of the new locomotives was to have four motors, two wound for high tension and two for low tension, the latter to be employed only in cascade. The railway engineers did not favour the coaxial arrangement of the motors, despite its advantages. It certainly has the disadvantage that every repair required in the interior of the motor involves the removal of the wheels from the shaft which it drives. The idea of a new solution was arrived at almost simultaneously by the engineers of the Adriatic Railway and Mr. Karl Gölsdorf. This was subsequently elaborated and carried into effect by Messrs. Ganz and Co. and the Hungarian Government locomotive factory, the latter being responsible for the construction of the mechanical parts of the locomotives from designs furnished by the engineers of the Adriatic Railway. Referring to Figs. 1 and 2, the departure which the design marks from the usual practice will be at once seen. It consists in that the motors, although they perform the same number of revolutions per minute as do the driving wheels, are not direct coupled, but placed between the driving wheels, being carried independently by the frame of the locomotive, and driving the wheels through a system of cranks and connecting rods. Thus the motors can at any time be easily detached bodily and replaced. It will be seen from Fig. 2 that the locomotive has five axles in all—three driving axles in the middle and a running axle at either end. The locomotive can be driven at full speed in both directions, and is provided with two drivers' platforms. Its total weight is 62 tons, with 42 tons on driving axles. The extreme length of the locomotive is 11,540mm. (38ft.), the wheel base between each two adjoining pairs of driving wheels being 2,350mm. (7ft. 9in.), and that between an end driving wheel and running wheel 2,400mm. (7ft. 10in.). The diameter of the driving wheels is 1,500mm. (4ft. 11in.) and that of the running wheels 850mm. (2ft. 9½in.). The locomotive is equipped with two double motors, which will be described later on. The power from these motors is transmitted through cranks of 12½in. radius to a driving rod carrying a third bearing in its centre, which in turn is connected with the crank of the middle driving wheel. This bearing is of the peculiar construction shown in Fig. 3, and allows free movement between crank and driving rod in a vertical direction, to relieve any shocks received by the wheel. At either side of this bearing the driving rod is provided with a pivot which engages with one end of a connecting rod, the other end being connected to the crank of one of the two remaining driving wheels. Thus all three pairs of driving wheels are coupled together. Notwithstanding the fact that the shafts of the motors are not on the same level as the driving axles, this arrangement prevents any increase or reduction of the bearing pressure on the rails

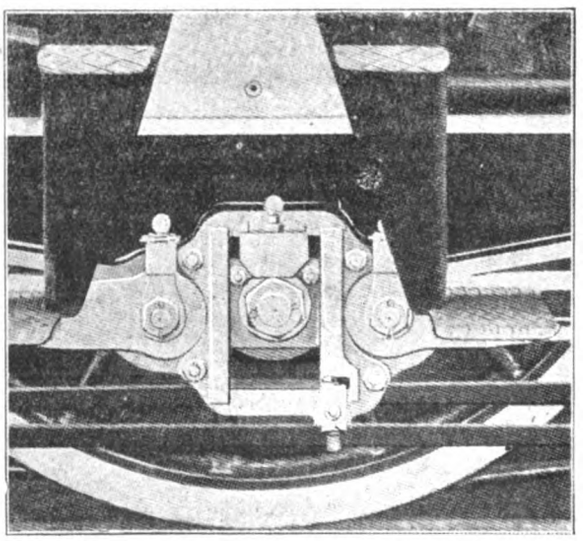

FIG. 3.—Details of Bearing in Centre of Driving Rod.

by vertical components of the driving forces There is an angular displacement of 90deg. between the cranks on the opposite sides of the locomotive so as to avoid a dead centre. It will be seen on referring back to Fig. 1 that the different parts of the system of cranks and connecting rods described are balanced by counter-weights, some of which are cast on the centres of the driving wheels and others bolted to the cranks of the motors. The truck of

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the locomotive is composed of two main girders of sheet steel construction, with cross braces riveted on. Of the three driving axles only the centre one is allowed no end play, the other two being able to slide in bearings through a distance of about 1in. The truck rests upon two turning centres, which serve as pivots for two bogie trucks of special

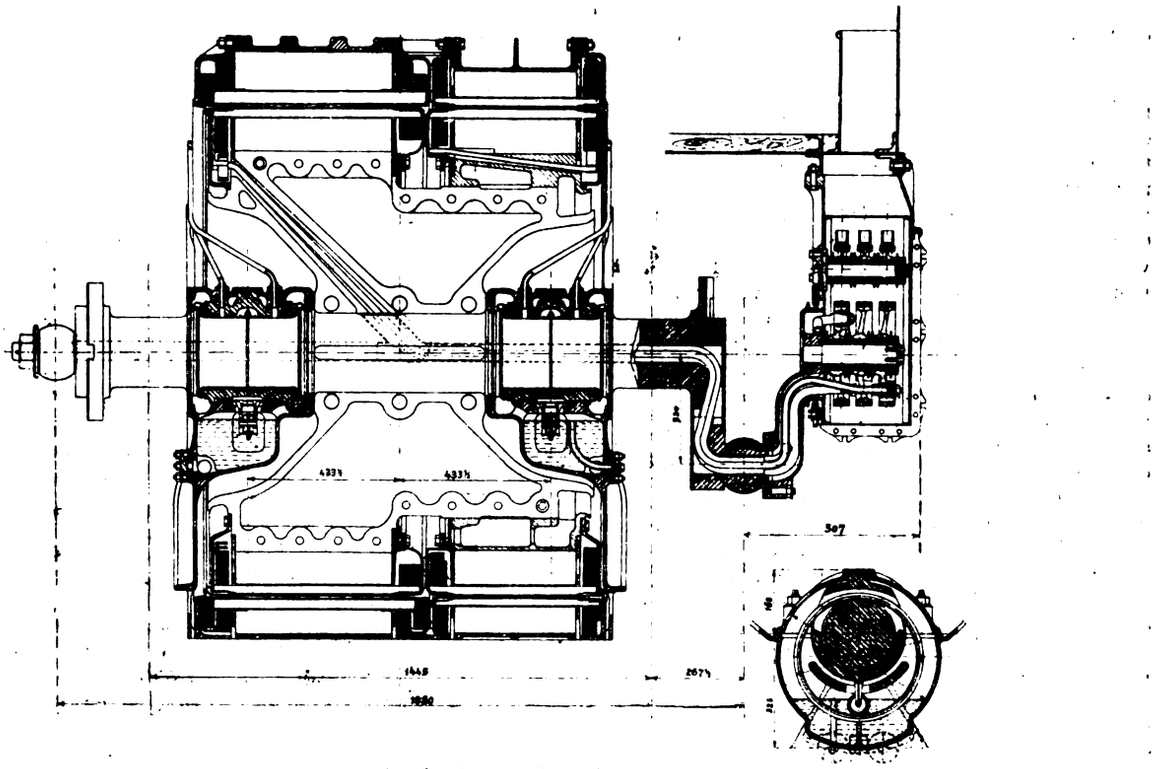

FIG. 4.—Details of Double Motor.

construction. The wheel base of the locomotive is really the distance between the centre driving axle and the centres about which the bogie trucks turn. This type of construction had previously been adopted for steam locomotives on the Adriatic lines with satisfactory results. The transference of the weight on to the bearings of the bogie trucks takes place through the turning centres and longitudinal girders of the trucks, thus ensuring an even distribution of the load.

## ELECTRICAL EQUIPMENT.

Each locomotive is equipped with two polyphase motors of equal power. The special feature in regard to these driving units is that each combines a high-tension motor with a low-tension motor on a common shaft. The low-tension motor is used only in cascade—that is to say, for the slower speeds. On test these motors repeatedly worked up to twice their rated output with a potential drop of 25 to 30 per cent. below the normal. Each side of the combination has eight poles, a synchronous speed of 225 revolutions per minute being attained with the high-tension motor working alone, and 112·5 per minute with the two sides in cascade. The stator windings are arranged as shown in Fig. 4, the separate cast-steel frames which support the respective cores and windings being ribbed externally, and held together by means of a cast-steel ring provided with flanges for bolting through.

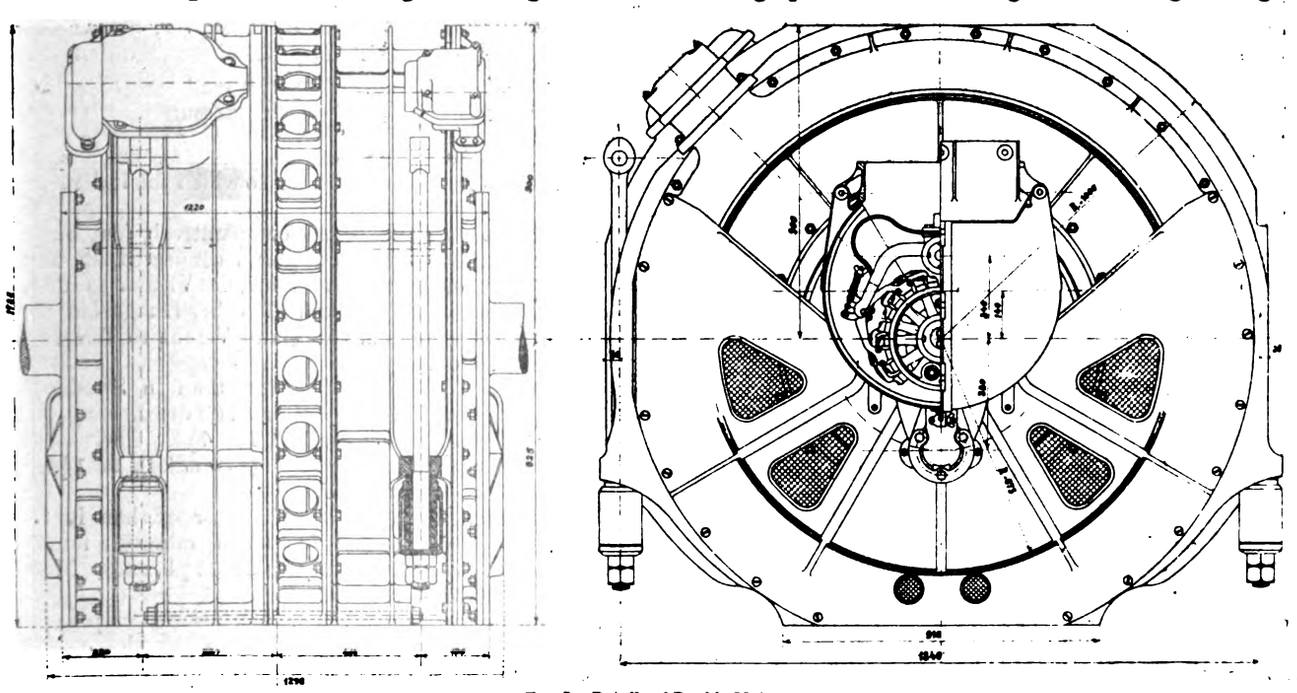

FIG. 5.—Details of Double Motor.

The maximum diameter of the frames is 6ft. 7in., but it will be seen on referring to Fig. 5 that the casing has been cut away in places so as to clear respectively the driver's platform above, the nearest driving wheels at the side, and to come within the minimum clearance allowed between the upper surface of the rails and lowermost portion of the motor. As a matter of fact, so much has been cut away below as to involve not only

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the ribs and frames proper, but also a portion of the core in each half of the motor. It has, therefore, been necessary to modify the slots and stator windings at this point. The windings are completely boxed in with a metal shield, being thus protected from both damp and oil.

The shaft of the double motor is forged in one piece, with a crank at either end for the two driving rods. In consequence of this, the hub of the motor consists of two parts, which are bolted together. The core plates and rotor windings of the high-tension motor are built up on this hub, but the rotor of the low-tension motor is built up on a special centre and afterwards forced as a whole on to the main hub. The high-tension current is supplied only to the stator belonging to the larger part of the motor, the windings of the second stator, as well as those of the corresponding rotor, being designed for a pressure of 400 volts. The high-tension windings were tested with 15,000 volts, and the low-tension windings with 1,200 volts. The windings of the two rotors are interconnected and protected from damp or oil by metal casings. Each double motor has four bearings. The two inner bearings are supported by cast-steel end plates bolted to the stator, and serve to maintain the rotor in its correct position relative to the stator, which must be exact in consequence of the small clearance in the polyphase motor. Referring to Fig. 4 it will be seen that neither the end plates supporting the inner bearings nor the bearings themselves limit the width available for windings, the distance between the longitudinal girders of the locomotive truck being, therefore, fully utilised for the motor. The method of construction described enables the motor to be detached from the locomotive bodily—that is to say, without dismantling any part. The two outer bearings are carried by the frame of the locomotive. The whole motor is further supported by means of four spring suspension bolts. Spring suspension is necessary, notwithstanding the fact that the outer bearings are rigidly fixed, in order to reduce the shocks due to the mass of the connecting rods and the working of the motor on the track. The details of the inner bearings of the motor are shown in Fig. 4. These bearings are fitted with ring lubricators. The leads connecting the slip-rings and rotor windings are enclosed within the hollow shaft of the motor. Instead of being inside the motor, the slip-rings are arranged outside the frame of the locomotive and driving crank, being attached to a returned crank arm in line with the shaft axis. It may be mentioned that the whole crank is made hollow to contain the connecting leads. There are only three slip-rings to each double motor, since the two rotors are permanently connected together. These slip-rings are used when the high-tension motor is working alone; they are not required when the two motors are in cascade.

The brush-holders are enclosed in a wrought-iron box which covers the crank extension. This box is suspended from the truck of the locomotive. The two parts of which it consists are hinged so as to enable ready access to the brushes at any time. Carbon brushes are used.

*(To be continued.)*

## TELEPHONE TRUNK-LINE CHARGES.

BY ALFRED R. BENNETT, M.I.E.E.

In my article on Jan. 6, on "The Proposed Telephone Deal," I remarked that as the trunk lines have practically been paid for twice over, it is not surprising that the Post Office finds it necessary to charge trunk rates about twice or thrice the amount levied by Continental telephone administrations. I made that statement on information gleaned several years ago, and in order to be sure that no change has occurred since, I communicated last month with the British consuls in the various European capitals, and from information supplied by them have satisfied myself that the statement still tallies with the facts. It even seems that in using the words "twice or thrice" I was guilty of an under-estimate, for it now appears that British Post Office charges are sometimes even four or five times as high for corresponding distances as some of the Continental ones. In Germany the trunk-wire system has received very great extension, and the present tariff is, for three-minute talks:

| | s. | d. |
|---|---|---|
| Up to and including 15 miles | 0 | 2½ |
| ,, ,, 31 ,, | 0 | 3 |
| ,, ,, 62 ,, | 0 | 6 |
| ,, ,, 310 ,, | 1 | 0 |
| ,, ,, 621 ,, | 1 | 6 |
| Exceeding 621 ,, | 2 | 0 |

This covers the whole of the German Empire, and as distances are long it is obvious that the telephone trunk system is exploited with an eye to the benefit of the commercial needs of the country. A German merchant or manufacturer can talk from Berlin to Memel (400 miles), or from Frankfort to Danzig (535 miles), or from Aachen to Hamburg (500 miles) for 1s. 6d.; or from Aachen to Memel (740 miles) for 2s. The same distances in Great Britain would cost from three to four times these amounts.

In France the trunk-line tariffs are based upon the distances between Paris and the various departments, and for three-minute talks work out as follows:

| | s. | d. |
|---|---|---|
| 40 miles | 0 | 4 |
| 100 ,, | 0 | 4½ |
| 200 ,, | 0 | 9½ |
| 260 ,, | 1 | 2½ |
| 377 ,, | 1 | 7 |
| 435 ,, | 1 | 9½ |
| 453 ,, | 2 | 0 |

One can talk from Paris to Lyons (250 miles) for 1s. 2½d., to Bordeaux (310 miles) for 1s. 5d., and to Marseilles (420 miles) for 1s. 9½d. The highest charge is from Paris to the Pyrénées-Orientales—2fr. 50c., or 2s. The corresponding British charge would be from 3s. 4d. to 5s. 6d.

Distances are very long in Sweden, but the trunk-line tariff is very cheap. Three-minute talks are charged as follows:

| | s. | d. |
|---|---|---|
| 25 miles | 0 | 1½ |
| 110 ,, | 0 | 4 |
| 260 ,, | 0 | 6½ |
| 380 ,, | 1 | 1 |
| 490 ,, | 1 | 7½ |
| 620 ,, | 1 | 11 |

In England three-minute talks from London to Birmingham or Nottingham cost 1s. 9d. In Sweden, corresponding distances, say Stockholm to Orebro, cost 4d. London to Dublin (491 miles) costs 7s.; Stockholm to Haparanda (525 miles), 1s. 11d.; London to Edinburgh (340 miles), 4s. 6d.; Stockholm to Umeä (335 miles) 1s. 7½d.

In Italy one can speak from Rome to the principal towns for 1s. 2½d. up to 150 miles (Rome to Florence), and for 1s. 7d. up to 380 miles (Rome to Messina), which appears to be about the greatest distance to which the Italian trunk lines reach.

In Austria trunk lines are comparatively few, but you can speak to the most distant places connected, about 220 miles, for 2s. 6d. for three minutes. Vienna to Prague, Cracow, Fiume, Budapest, and all other Hungarian towns costs 1s. 10d. for three minutes, and Vienna to Trieste (220 miles) costs 2s. 6d.

In Norway distances are shorter than in Sweden, the longest trunk lines being from Christiania to Levanger (265 miles) and Namsos (315 miles), 1s. 4½d.; Christiania to Stavanger (180 miles) and Bergen (175 miles), 1s. 1¼d. The shorter distances cost from 3½d. to 6½d.

In Russia trunk charges are also cheaper than in Great Britain, for one can talk for three minutes from St. Petersburg to Iver (298 miles) for 2s. 11½d., and to Moscow (402 miles) for 4s. 4d.

In the smaller countries the distances are comparatively short. Over the longest lines in Denmark the charge is 1s. 8d. for three minutes; over the shorter much less. One can talk all over Belgium for 1fr. (9½d.) for three minutes. In Holland 10d. for three minutes is the maximum charge. In Switzerland I cannot find that any fee exceeds 7½d. for three minutes, while most of the towns can be spoken between for 30 centimes or 50 centimes. Between Berne and Zürich (60 miles) the charge is 4½d., and from Berne to Geneva (80 miles) 7½d.

For the purpose of contrasting the great difference between the British Post Office charges and those in the larger countries named I have constructed the accompany-

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TABLE A.

| | Distance in miles. | British Post Office. Trunk rate. | Terminal fee. | Total. | Germany. | France. | Sweden. | Italy. | Austria. |
|---|---|---|---|---|---|---|---|---|---|
| | | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. |
| — | 25 | 0 3 | 0 3 | 0 6 | 0 1½ | — | 0 1½ | — | — |
| — | 40 | 0 6 | 0 3 | 0 9 | 0 1½ | 0 4 | 0 1½ | — | — |
| — | 45 | 0 6 | 0 3 | 0 9 | 0 4 | 0 4½ | 0 4 | — | — |
| — | 50 | 0 6 | 0 3 | 0 9 | 0 4 | 0 4½ | 0 4 | — | — |
| — | 70 | 0 9 | 0 3 | 1 0 | 0 4 | 0 4½ | 0 4 | — | — |
| — | 80 | 1 0 | 0 3 | 1 3 | 0 4 | 0 4½ | 0 4 | — | — |
| — | 90 | 1 0 | 0 3 | 1 3 | 0 4 | 0 4½ | 0 4 | — | — |
| — | 100 | 1 0 | 0 3 | 1 3 | 0 4 | 0 4½ | 0 4 | — | — |
| From London to Birmingham | 105 | 1 6 | 0 3 | 1 9 | 1 0 | 0 4½ | 0 4 | 1 2½ | — |
| From London to Nottingham | 110 | 1 6 | 0 3 | 1 9 | 1 0 | 0 4½ | 0 4 | 1 2½ | — |
| From London to Manchester | 165 | 2 0 | 0 4 | 2 4 | 1 0 | 0 7½ | 0 6½ | 1 2½ | 1 10 |
| From London to Swansea | 170 | 2 0 | 0 4 | 2 4 | 1 0 | 0 7½ | 0 6½ | 1 2½ | — |
| From London to Liverpool | 180 | 2 0 | 0 4 | 2 4 | 1 0 | 0 9½ | 0 6½ | 1 7 | — |
| From London to Plymouth | 200 | 2 6 | 0 4 | 2 10 | 1 0 | 0 9½ | 0 6½ | 1 7 | 1 10 |
| From London to Newcastle-on-Tyne | 260 | 3 0 | 0 4 | 3 4 | 1 0 | 1 2½ | 0 6½ | 1 7 | 2 6 |
| From London to Edinburgh | 340 | 4 0 | 0 6 | 4 6 | 1 6 | 1 7 | 1 1 | 1 7 | — |
| From London to Glasgow | 365 | 4 6 | 0 6 | 5 0 | 1 6 | 1 7 | 1 1 | 1 7 | — |
| From London to Dundee | 377 | 4 6 | 0 6 | 5 0 | 1 6 | 1 7 | 1 1 | 1 7 | — |
| From London to Belfast | 404 | 5 6 | 0 6 | 6 0 | 1 6 | 1 9½ | 1 7½ | — | — |
| From London to Aberdeen | 436 | 5 0 | 0 6 | 5 6 | 1 6 | 1 9½ | 1 7½ | — | — |
| From London to Inverness | 453 | 5 6 | 0 6 | 6 0 | 1 6 | 2 0 | 1 7½ | — | — |
| From London to Dublin | 491 | 6 6 | 0 6 | 7 0 | 1 6 | — | 1 7½ | — | — |
| From London to Cork | 619 | 8 0 | 0 6 | 8 6 | 1 6 | — | 1 11 | — | — |

ing Table A. It must be understood that there are no terminal charges on the Continent, but such a large proportion of trunk-line calls made in Great Britain are subject to terminal fees that in order to make a proper comparison it is necessary to include the terminal charge with the trunk-line charge, and this has accordingly been done. Up to 100 miles the table gives the comparative tariffs on distances alone; above that distance the British charges between London and the chief centres in the United Kingdom are first given, followed by the foreign charges for corresponding distances.

It is necessary to mention that in some of the Continental countries the already moderate rates are considerably reduced after business hours. Thus in Holland the 10d. rate applies only between 11.40 a.m. and 3.40 p.m.; for the rest of the day it is only 5d. In Denmark the rates are reduced by about one-third between the hours of 6 p.m. and 9 a.m. and all day on Sundays and holidays.

The result of my investigations is to thoroughly confirm the opinion that the British trunk telephone service is by very far the most illiberal in Europe. It even dawdles behind Russia. To what must we ascribe the fact? Why should the department to which the telegraphs were confided, in order that they might be worked for the benefit of the community, impose such an unwarrantable tax on British industry—such a strong restraint on the trade of the country? The trunk lines between all the great English and Scotch centres ought to be kept humming with commercial and industrial traffic, as those on the Continent are, but the rates are so prohibitive that the longest lines are used almost exclusively by stockbrokers, who alone can afford them. The answer is, I apprehend, three-fold: (1) the existing trunk lines have cost the Post Office at least twice, and probably three times, their real value considered as plant; (2) the expensive methods of working characteristic of the Post Office; (3) the desire to protect telegraphs, as distinguished from telephones—*i.e.*, to defy and work against the law of the survival of the fittest. For the purpose of hampering telephone development the Post Office got the telephone declared a telegraph, but now that the telephone challenges the supremacy of the telegraph for long distances, a new attitude is assumed—that they are not only distinct but hostile units, one of which must be suppressed as far as possible in favour of the other. It is not seen that it would pay to encourage the use of long telephone lines, as is done on the Continent. Probably, if they were asked, the Post Office officials would say that a 6d. telegram from London to Glasgow, Aberdeen, or Dublin does not pay, and that the State loses on every one dispatched. They would probably agree that a 6d. telegram rate pays up to 100 or 150 miles, after which every message represents a loss; but if the telephone rate from London to Glasgow, etc., were 1s. 6d. for three minutes (as for the same distance in Germany), they could afford to lose three 6d. telegrams for every telephone call. These calls would multiply exceedingly, and in the end the revenue earned would very likely be larger from telephone calls than it now is from telegrams. This is how it works out on the Continent, for it is impossible to believe that Continental governments, even the Russian, continue year after year to work their telephone trunk lines at a loss. Such a contingency is inconceivable, because they *all* are cheap, and only the British is dear. If one or two only were cheap it might be suspected that they were so from some special reason, such as subsidising intercommunication for commercial purposes within their own borders. But all are not likely to be smitten by the same fad. If the Continental rates are not only low, but sufficient, given good management, then the existing state of matters in Great Britain amounts to nothing less than a scandal. As I stated in my former article, there is great danger of the excessive charges made for trunk communication finding a counterpart in local telephone rates if the Post Office is allowed to purchase the National Telephone Company without proper supervision and without proper enquiry in advance as to probable results. Surely this trunk-line fiasco is an object lesson which cannot be ignored.

## CROYDON PUBLICITY DEPARTMENT.

In our issue for Jan. 20 we announced that Mr. G. R. Pepper had been appointed head of the publicity department in connection with the electricity supply system of Croydon. Through the courtesy of Mr. Alex. C. Cramb, the borough electrical engineer, we are now able to give full details of the work which will fall to this department, and the importance of which cannot be over-estimated. In those electrical supply undertakings where there is no opposition, the engineer and manager is apt sometimes to disregard the feelings of the consumers and to treat them in an autocratic way, which does much harm to the undertaking. We know of instances in which the dissatisfaction arising from such treatment has led to a great falling off in the demand, which could have been prevented had some such department as that now organised by Mr. Cramb been instituted. It is not enough nowadays for the supply undertakers to give a supply as authorised by their provisional orders, but they must also ensure that they give such satisfaction to the consumers that rival illuminants and suppliers of power are fought on at least equal terms. The expert supervision which the new Croydon department will exercise over the working of consumers' apparatus is one point greatly to be commended, and we trust that the vexed question of the quality of incandescent lamps used will be gone into as thoroughly as the adjustment of arc lamps. At first there may be a few of the

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local contractors who may object to the department in question, but in the long run it will assist these contractors quite as much as it will the Croydon consumers. The following is Mr. Cramb's letter to us explaining the lines on which the department is organised. We wish every success to this new departure.

"Dear Sir,—In reply to your letter of the 18th inst., the reason why I propose starting a separate publicity department is the evident necessity of the business of a supply company or corporation being sufficiently pushed. If a firm sells any line of goods, they do not expect to do a large business unless they put travellers on the road who bring before the people the advantages of same, and, in a similar way, a supply company or corporation which is anxious to sell electricity should, it seems to me, adopt a similar course. In those places, such as Durban, where there is no rival illuminant, the engineer has merely to order more plant to meet the increasing demand, but where one has a rival illuminant, which is very actively pushed, it is only by proper organisation and advertisement that there can be a hope of increasing to any considerable extent the business after the first rush of consumers have been connected.

"The lines upon which I intend eventually to run this department are somewhat as follows: There will be a departmental head, the same as in the other departments, who will deal with the question of present and prospective consumers. He would either personally, or by means of his staff, keep in touch with the consumers, and take in hand any complaints there may be made from time to time, as not only would new consumers be gained, but the present consumers would be kept in a state of content, and thereby kept from reverting to a rival illuminant. The gas company have found it good policy to inaugurate such departments; these departments have gone on somewhat similar lines to those indicated, and what has been found satisfactory with gas should undoubtedly be satisfactory with electricity.

"The manager of an electric supply undertaking, of course, relies to a certain extent, on the contractors, and in working harmoniously with them a considerable amount of business can be obtained. On the other hand, there are, unfortunately, contractors who, either from lack of knowledge or want of foresight, do not trouble to see that their customers are left in a satisfied and satisfactory condition. For instance, I received a complaint about certain arc lamps belonging to a consumer in this town that they were very costly. A casual examination of these lamps showed that they had been left by the contractor working with 15 amperes, instead of 10 amperes as they were rated. By sending one of my men to adjust these lamps, and reducing the current consumption, the noise which was previously quite noticeable ceased, the light was just as satisfactory, and the cost was a great deal less. It is these cases that the manager of a publicity department might be able to take in hand, and often prevent the loss of a consumer. It seems to me that every electric light undertaking which can possibly afford it should run a showroom, and this, of course, would be the headquarters of the publicity department. Exhibitions should, moreover, be held from time to time.

"The manager of a municipal undertaking is much handicapped from doing many things in furthering the business for which he is responsible owing to the questions of municipal trading and jealousies of the local contractors. I think it is a great pity that there is not a better understanding between the contractors and the supply companies. The interests of the two are, in the main, identical, and every contractor who does good work and shows proper consideration to his customers must be considered by the manager of a supply company as a friend and a helper in the promotion of his business.

"Among the contractors who have been properly trained as electrical engineers, and understand fairly well the connection of their work, there seems very little difficulty in working in harmony; but it is the men who have taken electrical work as an auxiliary to their main work, and who have not been trained thoroughly, who seem to look upon the supply manager as someone who is anxious to interfere with their business.—Yours faithfully,

"ALEX. C. CRAMB, Borough Electrical Engineer."

## BIRMINGHAM LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

On Jan. 25 Dr. D. K. Morris, associate member, read an interesting paper, fully illustrated by lantern slides, on "The American Visit of the Institution of Electrical Engineers," of which the following is an abstract. The first portion of the paper consisted of a brief outline of the tour. The Institution party landed at Boston, and proceeded to St. Louis *vid* New York, Schenectady, Montreal, Chicago, and Springfield. After about a week's stay at St. Louis, the party returned to New York, visiting *en route* Pittsburg, Washington, and Philadelphia. At each of these towns they were met by a local committee of the Institution of Electrical Engineers, who received them most cordially. No pains were spared or cost stinted. The hand-books which were presented to each member by the local committee contained a guide to the city, and a detailed description of all the electrical undertakings to be found there.

Proceeding to technical details, the author first dealt with central stations having steam generating sets. Of these they saw a large number, more especially in New York. This city possesses five huge central stations, in addition to a number of smaller ones in outlying parts. The former are: (1) The "Waterside," or Thirty-eighth-street station of the Edison Company, built for an output of over 75,000 kw. This station deals with most of the lighting of the city on the 110-volt three-wire system. (2) The Ninety-sixth-street station of the street railway or tramway system of 40,000 kw. (3) The Kingsbridge station, also working mainly on tramway load, and capable of an output of 30,000 kw. (4) The Seventy-fourth street station, which supplies the power which operates the New York Elevated Railroad. This is found to require at times a total of 50,000 kw., which is at least 5,000 kw. in excess of the station capacity. This excess is provided by the Fifty-ninth-street station. (5) The Fifty-ninth-street station was built to supply power to the recently opened New York Subway, and equipped with plant of more than 50,000 kw. capacity. A station of 60,000 kw. ultimate output is also being equipped in Brooklyn. The above shows the enormous demand for electric power in New York. Boston and Chicago have each two stations of similar output, and other great cities are proportionally equipped.

The standard size of unit is 3,500 kw. in the older to 5,000 kw. in the newer stations. A temporary overload capacity of even 50 per cent. on these figures is occasionally demanded. The generators are alternating current and wound three-phase for 6,600 or else 11,000 volts, speed 70 to 75 revolutions per minute, frequency 25. The maximum efficiency of such generators is high—over 97 per cent. The engines are largely of the vertical cross-compound condensing type with Corliss gear. In some cases the two high-pressure cylinders were placed horizontal and the cranks at 135deg., thus securing eight impulses per revolution. This facilitated parallel running. In most of the newer stations steam-turbines and high-speed alternators are being put down. Many stations obviously designed and built for large slow-speed engines had been installed with turbine sets. Stations designed at the outset for vertical-shaft Curtis turbines were, however, to be found at Boston and Chicago. Here the standard turbine set was of 5,000 kw.; output, 500 revolutions per minute. The floor space occupied is less than half that of one of the old 1,500-kw. slow-speed engine sets. In Boston the turbine-generators were three-phase, 7,500 volts, 60 cycles.

Beside the Curtis turbine, which is manufactured by the General Electric Company at Schenectady, the British Westinghouse Company do a large business in the Parsons type. The author had, however, gained the impression that the small vanes and high speed of the latter did not lead to such good results as with the Curtis type.

The most noticeable feature in connection with the switchgear was the motor-operated high-tension switch. It was common practice to place these switches in a separate building, in order to minimise fire risks. Small direct-current motors are used to compress springs which open and close the main switches. The motors themselves

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are controlled from the generating station, the switchboard for the purpose being frequently arranged on a sloping table. A red or green light shows whether the main switches are on or off. The relay motor may be supplied either from the exciting circuits or off a special 110-volt battery. Sub-stations are usually equipped with 1,000-1,500-kw. rotary converters running at 115 revolutions per minute, and having an efficiency of about 97 per cent., to suit which the pressure is transformed down to 175 volts. Sub-stations were usually provided with batteries.

Dr Morris then described the central stations visited in which water power was used. These were at Niagara and Shawinigan. The large and now well-known stations on the American side of the Niagara Falls are small when compared with the vast schemes on the Canadian side. (1) The Canadian Niagara Falls Company are building a 110,000-h.p. station; (2) the Electric Development Company, of Ontario, one of 125,000 h.p.; (3) the Ontario Power Company is starting a 135,000-h.p. scheme. The greater portion of this power will be taken by Toronto, 60 miles distant. The pressure of transmission is to be 60,000 volts. The lesser known falls at Shawinigan proved fully as interesting to the party as did Niagara. The power station is situated at the foot of the falls, and is of 30,000 h.p. capacity. Directly above the station, at the head of the falls, is a large aluminium works, to which low-tension direct current is supplied, two sets of aluminium rods of 22 square inch combined section being used for the short transmission. With the exception of this direct-current set the generators are two-phase 2,200-volt Westinghouse and Dick-Kerr types. The current is transformed, as in the older stations at Niagara, to three-phase by means of Scott connected transformers. The power is transmitted at 50,000 volts to Montreal, 83 miles distant. There are three $^{7}/_{7}$ aluminium wires, 60in. spacing, the pressure drop being 18 per cent. for 5,000 kw.

The author then dealt with electric traction methods, mentioning many interesting details. He was much struck by the amount of time and labour that the firms in America were devoting to the single-phase traction problem.

In conclusion, he considered that in nearly every case the greater advances made in electrical engineering in America compared with this country were due to the larger scale upon which necessity compelled them to work. The presence of ample water power great distances from the large industrial centres gave rise to large power long-distance systems of transmission. Their traction schemes were on a large scale. There were disadvantages in connection with the possession of such large organisations as the General Electric and the Westinghouse Companies There was a tendency to retain well-tried but partially obsolete methods, the persistence of two-phase plants in certain types of installation being a case in point. There were, however, many advantages, the most real being the enormous resources which can be directed to the development of great new problems, such as the perfection of the steam-turbine, the improvement of single-phase traction methods, and the working at the highest voltage limits in power transmission.

The following is a brief abstract of the discussion:

**Mr. Vaudrey** called attention to the immense size of all the electrical undertakings mentioned. Stations having a capacity of 100,000 h.p. could not be approached in this country. The combined capacities of London, Manchester, and Birmingham could scarcely touch it. It seemed to show that there was still an immense field open for electrical undertakings in this country.

A second speaker asked Dr. Morris for information as to the average charges for lighting and power made by the large supply companies.

**Mr. Taylor** asked for information as to the length of time which the 50 per cent. overload mentioned by the author could be maintained. The efficiency figure of 97 per cent. seemed high. He understood from descriptions of recent tests made on large sets in New York that the maximum figure reached was 96 per cent. He would like to know if the exciting current had been included. The frequency of 60 cycles per second mentioned in connection with turbine sets seemed to him excessive. He would like to know what was being done in the way of using rotary converters for lighting work in America. With reference to the use of batteries in sub-stations, he had not gathered whether the sub stations referred to were those of the Edison Lighting Company or of the large power companies. Was the battery used for night supply or to take up the peak of the load?

**Mr. Groves** asked Dr. Morris if he could give any reason for the continued use of 110-volt direct-current supply for lighting.

**Mr. Holden** would be glad of information as to the types of meters used in America. We have American-made alternate-current meters over here, but none for direct current.

**Dr. Morris**, in replying, said that the price at which current was supplied for lighting in America was often comparatively high—about 6d. to 8d. per unit. But for power it was about 1½d. per unit, leaving out of consideration exceptional cases like Montreal, where, subject to a restricted hours' clause, the charge did not work out to more than ½d. per unit. In connection with prices, however, it should be remembered that the purchasing value of money was about two-thirds that of the same amount in this country. That probably accounted for the high rate. In reply to Mr. Taylor, the 50 per cent. overload capacity he had mentioned was not specified to be maintained for any long period. It might safely be applied for five to ten minutes. The efficiency figure of 97 per cent. was for a very large generator. At 25 per cent. overload the efficiency was 97·2 per cent. Sixty cycles per second was the frequency of the generators for the lighting system at Boston, but the actual lighting was mostly direct current. Twenty-five cycles was the standard for the alternating-current transmission. When talking of the employment of batteries in sub-stations he had considered it more in connection with lighting than power. They were usually kept floating on the mains, and were thus used for the peak load. In reply to Mr. Groves, there were fairly good reasons for retaining the 110-volt system of supply for lighting. It had established itself as the standard voltage of the Edison combination. When the supply companies introduced high-tension alternating-current transmission, they found it as easy to transform down for 110 volts as for 220. The closeness of the converter sub-stations, due to the congested districts supplied, brought the areas well within the range of 110-volt distribution. In reply to Mr. Holden, the Edison illuminating companies used the General Electric Company's watt-hour meters almost exclusively. Quantity meters were very little used, if at all.

**Dr. Sumpner** (chairman) then moved that the cordial thanks of the meeting be accorded to Dr. Morris for his interesting and instructive paper.

## FORTHCOMING EVENTS.

FRIDAY, FEB. 3.

**Junior Institution of Engineers.**—At 8 p.m., "Recent Developments in Electric Lighting," by Prof. H. T. Davidge.

**Institution of Electrical Engineers (Manchester Students' Section).**—At 7.30 p.m., "The Electric Equipment of Automobiles."

SATURDAY, FEB. 4.

**Institution of Electrical Engineers (Glasgow Section).**—At 7.30 p.m., annual smoking concert at the Grosvenor Restaurant, Glasgow.

**Institution of Electrical Engineers (Students' Section).**—Visit to Messrs. Evershed and Vignoles's works.

**Glasgow Technical College Scientific Society.**—"Kathode Rays and Allied Phenomena" by Prof. Blyth.

MONDAY, FEB. 6.

**Society of Engineers.**—At 7.30 p.m., presidential address.

TUESDAY, FEB. 7.

**Institution of Civil Engineers.**—At 8 p.m., further discussion on Mr. L. E. Clark's paper, "Floating Docks"; and, time permitting, the following papers will be read: "Alfreton Second Tunnel," by Mr. E. F. C. Trench; and "The Reconstruction of Moncreiffe Tunnel," by Mr. D. McLellan.

WEDNESDAY, FEB. 8.

**Tramways and Light Railways Association.**—At 3 p.m., visit to the works of the London United Tramways Company.

**The Dynamicables.**—Dinner at the Trocadero, preceded by a council meeting.

**Association of Engineers-in-Charge.**—At 8 p.m., "Belt Driving," by Mr. J. Tullis.

THURSDAY, FEB. 9.

**Institution of Electrical Engineers.**—At 8 p.m., "Fuel Economy in Steam Power Plants," by Messrs. W. H. Booth and J. B. C. Kershaw (conclusion of discussion); "The Value of Overhead Mains for Electric Distribution in the United Kingdom," by Dr. G. L. Addenbrooke.

FRIDAY, FEB. 10.

**Olympia.**—Opening of motor exhibition.

**Physical Society.**—At 8 p.m., "Radiation Pressure," by Prof. J. H. Pointing.

**Institution of Civil Engineers (Students' Section).**—"The Reconstruction of the Santa Lucia River Bridge, Uruguay," by Mr. P. J. Risdon.

**Tramways and Light Railways Association.**—At 8 p.m., annual meeting.

SATURDAY, FEB. 11.

**Junior Institution of Engineers.**—At 7 p.m., coming-of-age dinner at the Hotel Cecil.

**Birmingham Electric Club.**—At 7.30 p.m., "Lightning Conductors," by Mr. W. H. Whitehouse.

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**Institution of Electrical Engineers (Manchester Section).**—Messrs. S. L. Pearce and H. C. Gunton will read their paper on "Manchester Tramways Power Supply" on Feb. 21, instead of Feb. 14.

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### TO CORRESPONDENTS.

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*All communications intended for the Editor should be addressed* C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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## MOTOR 'BUSES—OR WHAT?

It is just possible that the era of motor vehicles is nearer than is usually supposed, for the London County Council has had suggested to it by the Shoreditch authority the idea of such vehicles running on the existing system of old rails instead of electrification for the northern districts. It is estimated that a saving of nine hundred thousand pounds would take place were such a scheme adopted. There is no question as to the value of tramways when the conditions are favourable, but they are a nuisance when the conditions are unfavourable. Still, before adopting a scheme of motor traction, a good many things ought to be considered, and a pause made rather than a hurried acceptance. The conditions of town life are not good for the nerves, and doctors tell us that nervous complaints are increasing both in number and in intensity. Noise is a condition too prevalent. To obviate it in some measure various kinds of pavements have been adopted, and solid rubber or pneumatic tyres applied to vehicles. Can it be said that any of the motor 'buses at present running in the streets decrease the nuisance of noise? Rather do not these and the heavy motor engines conduce to a pandemonium that, if increased very largely, would drive half the population into lunatic asylums and the rest into the wilds of Canada? We are a curious nation. On the one hand, we spend extra thousands to get rid of noisy granite, while on the other encouraging the use and construction of noisier vehicles than the old broad-wheeled wagons. The result is very much as you were. There is a great lack of scientific imagination among the rising generation and the agitating section of the community, or we should long ago had in constant use a "unit of noise." Of course, we do not know its definition, or how its measure would be propagated, or we should have read a paper before some institution claiming two-and-twenty members, and our name would have had a chance to be remembered for more than nine days. However, there is hope yet. What cannot the student do when shown the way? A unit of noise. An Act of Parliament to prohibit anyone personally or by his vehicle or machine from producing more than $x$ units of noise at distance $y$ from any other living being. Pray, therefore, Mr. Councillor, reflect as to this question of noise before adopting for use motor vehicles which are promised for the future, but which do not exist in the present. We are credibly informed—indeed, it has been publicly announced at shareholders' meetings—that motor 'buses are soon to be running in considerable numbers in our streets. They are practical, have been successfully tried in units, and must come—so say the advocates. We have occasionally in our walks abroad met one of these monsters, but never when a second was within sight. One is quite enough, and we strongly fancy that when fifty or a hundred are found running within the length of the Strand they will be treated as an enemy within our gates, and destroyed without compunction or even a tear, unless the noisiness of the multitude is different in degree to that of the unit and considerably less. That practically noiseless motor carriages can be produced is certain. They can be seen daily in any part of the city. It is of the larger and more cumbersome vehicles, however, that we are speaking. Another nuisance is the stink. Multiply some motorcars in a crowded busy street, and the street would be unendurable. Still again a sign of the practicalness of the English. They multiply their sanitary "don'ts" on the one hand, and introduce a stinking, semi-combusted exhaust into the nostrils of every follower within a hundred yards or so. Mr. C. B. Fry

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says 'tis healthy to breathe long breaths of fresh air. Let him try it on the Embankment some fine morning when there is a slight block and the exhausts of half a dozen slowly-moving motors just in front. There are incidents in life which conduce to vulgarity and the use of language. One of these is being in the redolent track of a badly-designed motorcar. But we must put up with all these little inconveniences because the question is progress, and it savours of frivolity to make silly complaints when it is known that "use is second nature," and men can sleep in the middle of an engineering factory, so familiarity will soon breed contempt of the noise of the rambackle traction engine and the box of mechanical tricks of the motor 'bus. The time of the motor 'bus will come, but the type as at present illustrating that useful vehicle will soon, if adopted, be a candidate for the scrap heap, and this is our moral. Electrical engineers and municipal authorities have been nauseated with recommendations to scrap, scrap, scrap, and renew with more modern machinery. What is the probability of the London County Council having to scrap its motorcars if the samples at present on show are really samples of the bulk? The motorcar, with its flexibility and half a score other advantages, is not quite proved. If it were, we could not suggest pause before accepting the proposal. What might with a certain degree of force be suggested is that the London County Council go gently with their tram schemes in all parts not favourable, and be satisfied for a while in developing those lines already constructed, and restrict further constructional work to any change over from horse to electricity, leaving new constructional work till after a little more experience is gained in motor-'bus work. It ought to be emphasised that the Shoreditch suggestion is not of a flexible system; its cars would be fixed to the tramlines, and the greatest advantage of motor traffic—capability of passing—would be lost.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### TELEPHONE RATES.

SIR,—Rejoinder to the reply to a reply:

1. If this definition of an editor's job is correct, no wonder that some editors perennially *are* in queer street.
2. The consideration of differing conditions in comparisons of telephone rates is the whole point. It is a consideration that is usually ignored.
3. The whole of the paragraph, of which you quote only a mutilated sentence, shows clearly that my statement that £5. 10s. was the pivot of the argument was correct, and that your statement that £5. 10s. was a figure "merely assumed for argument's sake" was incorrect. The argument was that a rate of between £5 and £6 was the standard to go by. £5. 10s. is exactly in the middle between £5 and £6.
4. Absence of comment does not necessarily imply agreement; it may imply mere weariness of spirit.
5. If you take out the fixed amount, £5 10s., or some other figure between £5 and £6, you destroy Mr. Bennett's whole argument. If you agree that it is a debatable matter whether a flat rate or some other form of payment should form the basis of calculation, you attack all Mr. Bennett's arguments, past and present.

As for my final remark, it was obviously based on your final remark of the previous week, in which you gracefully announced that telephonic up-to-dateness might be discussed till all was blue for aught you cared.

You are good enough to say that I think to little purpose. Doubtless if I had always been able to think with the amount of purpose that vitalises the air of Salisbury-court, and to express my thoughts with the clearness and force (not to mention the grammar) which distinguish the editorial columns of the *Electrical Engineer*, I should long ago have been rich and beyond need of thinking—except how to amuse myself.

You claim to have devoted more attention to telephonic matters than all the other English technical papers combined. All the other English technical papers combined might be inclined to contest that statement. But what *kind* of attention to matters telephonic have you paid, Mr. Editor? I have read some of the articles on telephony published in the *Electrical Engineer*, and I have some thoughts on them. Those thoughts may be purposeless, but I desire to express them. There was a series of articles on "Independent Telephony in Great Britain." It would be unkind to comment seriously on these, as they were too obviously the product of youth and inexperience. Besides, I am always glad to see telephone men sufficiently interested in their work to want to write about it. But the elementary nature of the information was more suitable to the columns of the *English Mechanic* or the *Amateur Electrician* than to those of a serious technical journal.

Other articles have appeared in your columns describing in all seriousness the systems recently installed for some of the British municipalities. These descriptions are interesting, because one is glad to have a record of the kind of technical work done in the municipal telephone systems. But frankly, Mr. Editor, to telephone men who know their business, and know the state of the art of telephony, the class of telephone work described in these articles is what whist players would call "bumble-puppy."

The writer of these articles (can he be my talented friend "W. O. T."?), in a description of a particularly foolish switchboard installed at Brighton, published in your columns last year, displayed his ignorance of modern telephone practice by a single remark. He spoke scornfully of the *many* disadvantages (the italics were his) of relays in telephone work. Now, sir, relays have been used in telephone work for many years. At the time your contributor published his sapient remark relays were in use on telephone circuits literally by the million. In cities in all parts of the world, from Japan to Portugal, from Scandinavia to California, relays do their daily work swiftly and accurately on millions of telephone calls. Are the great majority of telephone men ignorant of their business that they use many relays, with their *many* disadvantages, or did your contributor simply make a foolish statement based on ignorance and prejudice?

It seems to me that the amount of attention devoted by a journal to a given subject is of less importance than the quality thereof.

Let us turn to lighter subjects. I am glad to have amused Mr. Bennett. He must have perplexities enough. His other remarks suggest a parallel drawn from the past. Just about a hundred years ago the nursemaids of England, especially along the South Coast, used to frighten their small charges by threatening that "Boney" would come over and eat them up. Similarly, when anyone interested in the existing municipal telephone system hears any criticism of the theory and practice which governs those systems, he turns pale, and, in a frenzy of horror, says, "Oh! My God! National!"

Why, when municipal telephone work is stated by its supporters to be everything that is up to date and flourishing, the very name of the National Telephone Company should be such an awe-inspiring bogey passes my understanding. But so it is.

Mr. Bennett credits me with a range of operations that even the activity arising from the possession of a sound digestion and a fairly long pair of legs is hardly equal to. But, at any rate, he will agree that such advice as I have given the National Telephone Company has had quite successful results. Whereas, according to Mr. Bennett's figures, the municipal systems in competition gained only 4,687 stations in 1904, the National systems in the same places gained 8,074 exchange stations. In Glasgow, where the competition has waged the longest, the National gain was 5,232 exchange stations, as against 1,504 stations of all classes gained by the municipal system. At Glasgow,

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therefore, the National rate of gain is 3½ times that of the municipal system, which shows pretty clearly how things are going, and indicates one reason why the Glasgow Corporation are obliged to consider rebuilding their telephone system.

I am frank to say that I should derive more pleasure from Mr. Bennett's communications to the Press if they were generally more logical and composed with greater respect for such details as grammar and spelling. The variety of work his lively imagination assigns me is obviously incompatible with an eight-hour day. Besides, when I "vilify," I never do it with more than one "l." (Happy thought: What length of praise is one ell of vilification equal to?) Mr. Bennett is very fond of criticising the work and ideas of others. Why should he be so susceptible and fly so readily to the use of hard words when his own work and ideas are criticised.—Yours, etc.,

HERBERT LAWS WEBB

[Mr. Webb is impulsive, and has to learn that abuse is not argument, but is regarded in legal circles as the refuge of the destitute. There are only two points in this very long letter that we care to touch. For the edification of Mr. Webb, the writers are not the same. Once more this £5. 10s. and argument. In our last issue we called attention to Mr. Bennett's article of Jan. 6, which was being criticised (save the word) by Mr. Webb in our issues of Jan. 20 and 27. We said that £5. 10s. was assumed for the sake of argument by Mr. Bennett, and that the argument would not suffer had the figures been £6. 10s. or £60. 10s. What Mr. Bennett's argument was, and, we presume, still is, is one easily put into abstract shape. Thus, American, Continental, British municipal, and certain of the National Telephone Company's concerns pay with a rate from $a$ to $b$ pounds per year; hence the Government in purchasing should not purchase at a price that when the system is made up to date should necessitate a rate more than $\frac{a+b}{2}$ pounds. If American, etc., practice had proved any other rate than $a$ to $b$ remunerative—say $x$ to $y$ pounds—then the factor before the Government would have been $\frac{x+y}{2}$ instead of $\frac{a+b}{2}$. The guide to Mr. Bennett was ascertained figures—the exact value of the figures not being necessary for the validity of the argument. The ascertained figures gave him £5. 10s.; it was not £5. 10s. that gave him the American, Continental, etc, figures. Mr. Webb is quite welcome to think the elimination of any special figure destroys an argument; it only shows that he needs very much to ponder Herbert Spencer's remarks: "We too often forget that not only is there a soul of goodness in all things evil, but very generally also a soul of truth in things erroneous. While many admit the abstract probability that a falsity has usually a nucleus of reality, few bear this abstract probability in mind when passing judgment on the opinions of others."

We have come to the conclusion that Mr. Webb's communications are not criticism—they certainly are not edifying, and unless he can restrict himself to the discussion of specific points of practice or organisation, leaving aside the absurd remarks which try to fashion a simple printer's error into personal inability to spell or write correctly, our columns are closed to him. We would suggest, if he is really in earnest, to give information and not vituperation, that he should amplify his views *re* flat rate or otherwise as a basis of calculation. If his otherwise does not involve a flat rate, direct or indirect, we shall be surprised—and edified.—ED. *E. E.*]

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SIR,—I observe in your issue of the 20th inst. a letter by Mr. H L. Webb on telephone rates, in which he refers to the contemplated rearrangement of operating service in Glasgow. Permit me to state that Mr. Webb's remarks as to the necessity of rebuilding plant are entirely incorrect, as no rebuilding of plant will be necessary. His further remarks regarding the probable cost and the so-called telephone muddle, which appear to be the outcome of a prejudiced imagination, are too ridiculous for comment.—Yours, etc.,

JOHN MACFEE.

Glasgow, Jan. 25, 1905.

## ALUMINIUM.

SIR,—May I point out a slight error which I notice in Mr W. Smith's paper on aluminium, printed in your issue of Jan. 27.

Comparing the relative advantages of aluminium and copper conductors, Mr. Smith shows that the diameter of an aluminium conductor must be 1·3 times the diameter of a copper conductor of equal conductivity. In order to have the same leakage current in both cases, the thickness of the insulation must be proportional to the leakage area. Now, this leakage area is proportional to the diameter of the conductor, not to its area, so that we ought to have

$$\frac{\text{Insulation on Cu.}}{\text{Insulation on Al.}} \propto \frac{1}{1{\cdot}3}, \text{ instead of } \frac{1}{1{\cdot}69}.$$

—Yours, etc.,

R. T.

Jan. 25, 1905.

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## THE METRIC FALLACY.

SIR,—Will you allow me to correct a few errors into which a recent letter of Mr. E. Johnson, secretary of the Decimal Association, indicates he has fallen regarding American weights and measures? He says: "Within the last few years the United States have adopted a ton of 2,000lb, and have adopted a yard derived from the metre."

I did not expect, in exposing the metric fallacy, to have occasion to defend the 2,000lb. ton against the charge of extreme youth. The following extract from the report on the metric system by John Quincy Adams, sent to Congress in 1821, shows not only that this ton was an established standard then, but also calls attention to some useful relations between our standards, which those who are accustomed to vilify the British system might study with profit: "There are, nevertheless, very useful proportions in our existing weights and measures, one of which is the ton measure of water and the pound avoirdupois. As 1,000oz. avoirdupois weigh exactly one cubic foot of water, it follows that the ton of 2,000lb. weight is the ton of 32 cubic feet measure. The other is between the pound avoirdupois and the pound troy; the former consisting of precisely 7,000 grains troy. The pound avoirdupois is, therefore, the connecting link between weight and linear measure."

The 2,000lb. ton is the popular standard for heavy weights in the United States. The 2,240lb. ton is used for mining, wholesale trade in coal, and some other purposes; it is called the gross ton to distinguish it from the other, and its use is decreasing as compared with the more convenient 2,000lb. ton.

In a former letter I referred to the pretence that our yard is derived from the metre, and will add here that the supposed verification of our yard bar at Washington by comparison with the lines on the metre bar is merely an approximation, because the yard is incommensurable with the decimal divisions of the metre, the ratio between the two, as determined by Kater, being 1·093633056. This claim of a yard derived from the metre is thus a fallacy based on a myth.

Mr. Johnson is also in error regarding the size of our gallon, which is the same as the old English wine gallon. It is one-sixth smaller than the British gallon, not one-fifth as he states. It is fortunate, however, not only that the difference between the two gallons is expressed by such a simple ratio, but that this, the only discrepancy in Anglo-American conformity, is found in liquid measures, where it causes less trouble in international transactions than in any other class of standards. The difference between the two gallons will not be without compensation if it serves as an awful warning against allowing further variations to arise.

Mr. Johnson's belief that it is only the names of the old standards that survive in some parts of France is not confirmed by French manufacturers. Thus Lamoitier, in *l'Industrie Textile*, Paris, October, 1902: "We are as much in the anarchy of weights and measures for the textile industry as at the time of the Revolution. . . . After having established the metric system, is it not truly ridiculous that more than 110 years later we should be still using the English yard, the old or French pound, the denier of Montpellier or of Milan, the ancient aune, the many different skeins, etc?" Greece is another example of

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the "majority of nations" that, according to Mr. Johnson, have "adopted the metric system" Greece adopted the metric system in 1834, being the first to take such action after France. Last year, or just 70 years later, a semi-official chart of Greek weights and measures was published. From beginning to end it is confusion worse confounded of old and metric measures.

Mr. Johnson asks if the survival of "customary" British standards is to be accepted as an argument against the British system of weights and measures Not an argument against the British system, but it is an unanswerable argument against any attempt to introduce the metric system If the "customary or illegal" units have survived, how can it be possible to sweep away the entire British system and supplant it with the metric? The metric proposition hinges on that question, and no satisfactory answer to it has been made on either side of the Atlantic. The introduction of the metric system means chaos for English-speaking countries, because the English system in use as a single standard by a rapidly expanding population of 140,000,000, inhabiting or controlling 14,000,000 square miles of territory, cannot be abolished. Such a proposition is an absurdity.

The greatest error Mr. Johnson makes is in thinking that "America is no longer with you." America is with you in language, common law, weights and measures. They are her birthright, which she is not likely to sell for a mess of metric pottage.—Yours, etc., SAMUEL S. DALE.

Boston, Mass., Jan. 20, 1905.

## THE LAY OF THE SPIDER.

### A Pathetic Ballad.

BY SIMPLEX.

NOTE.—*The Next Thing in Advertisements*—Shift engineer wanted for large generating station. Good mechanical training and previous experience in high and low tension electrical work essential. Salary, 10s. per week. Promotion according to ability. Free air and scenery provided. Write early and avoid the crush.

The Engineer (Junior) flung himself down
In a lonely mood, to think.
He'd searched all his pockets and hadn't a brown,
Or else he'd have taken to drink.

He'd wrestled with switches and battled with Fate;
He'd shifted a shift by himself;
He'd tended the voltmeter early and late;
He'd a pitiful absence of pelf.

He'd written for jobs by the dozen or score;
He'd petitioned the Chief for a rise—
The meek applications were heard of no more,
And the Chief had (beg pardon)-ed his eyes!

When lo! A big spider came down on a thread
And crawled from the 'bus bars to earth;
And that horrified spider curled up and was dead
(Which isn't a subject for mirth).

The Engineer (Junior) sprang up with a cry.
"That spider," quoth he, "shows the way!
There's a glut in the market! 'Tis for me but to die.
Let anyone else have my pay!"

He wrote to the Chief, with a tear in his eye,
A letter which caused Him surprise.
And then he sat down on the H.T. Supply—
Immediately getting a rise!

## FUEL ECONOMY IN STEAM POWER PLANTS.

A paper on this subject was read before the Institution of Electrical Engineers by Mr. W. H. Booth on the 12th ult., and elaborated by his co-author, Mr. J. B C. Kershaw, with experiments, on the 26th ult. The paper was divided under seven headings, any one of which was sufficient for a full paper if exhaustively treated. The seven headings were: feed water, fuel, air, boilers and furnaces, steam, waste gases, and draught and regulation of air supplies. It is under the third heading—boilers and furnaces—that the most valuable information is given, but here, again, the authors were evidently handicapped by the limited space at their disposal. Their remarks as to the design of furnaces for burning particular kinds of fuel with the three principal types of boilers will repay careful reading, and we regret that we cannot reproduce in full this section of the paper.

The paper concludes thus: "Finally, may the authors point out that the best results can only be attained if scientific methods of control are employed in relation to feed water, fuel, waste gases, and draught. Automatic apparatus for testing flue gases or any other product can never take the place of the trained chemist; for an automatic apparatus demands not less but more skill in its control and management than ordinary apparatus, if the records obtained by it are to be of permanent value. The results now being obtained by $CO_2$ recorders in many electricity works are, in the authors' opinion, of doubtful value, owing to the lack of trained expert assistance in their management. Automatic apparatus of all kinds is, we admit, of great service, but not in the direction popularly supposed. It enables one skilled and efficient man greatly to increase the number and extent of his duties, and practically to treble or quadruple his efficiency; but it does not, and cannot, give accurate and valuable records when placed in the hands of untrained men. It is remarkable that engineers, after their long experience of automatic stoking appliances, should imagine that automatic testing apparatus will achieve the impossible. In each case the best results can only be attained when the automatic apparatus is under expert supervision and control; and for testing apparatus, the expert control required is that of a specially trained and skilled chemist. In the working of a large modern boiler plant the chemist is, in fact, as much in place as in a chemical works, and the recognition of this truth will undoubtedly promote the economical working of such plants.

"The following words, written over 60 years ago by the pioneer in the movement to obtain more scientific use of coal and fuel in steam-raising—we refer to that remarkable man, C. Wye Williams—are still applicable to the position in this year, 1905, and there are few present who would guess that they were a quotation from a book entitled 'The Combustion of Coal,' published in the year 1841 in Liverpool, and dedicated to the proprietors of the City of Dublin Steam Packet Company: 'It may be asked how it has happened that hitherto the smokeless combustion of fuel has not been effected. I answer, because the *chemistry* of combustion has been neglected, not in the laboratory, but *in practice*, and because the construction of our furnaces has been too much left to those who know little of the chemical properties of the materials which are consumed in them.'"

The following is a summary of the discussion:

**Colonel Crompton** prefaced his remarks by stating that electrical engineers scarcely appreciated how much their interests were bound up in the subject of the paper, which was a most opportune one. He entirely agreed with the authors in regard to flame temperature and the cooling effect of the boiler surfaces. The method introduced in this country when water-tube boilers were first used of putting the furnaces very close to the cooling surface of the tubes was a barbarous one. The technical Press had urged that you could not prevent or consume smoke without loss. So long as there was an excess of air that view was to a certain extent correct, but the authors' method of deflecting the gases on a firebrick lining was the remedy for preventing smoke. Instead of causing loss, this method, properly worked, would give a higher economy. At Calcutta he had introduced water-tube boilers against the advice of all the practical engineers there, but the Calcutta electricity supply undertaking was virtually the only smokeless establishment in the district. He considered that thermal storage had not only come to stay, but would prove to be one of the greatest benefits ever introduced into power stations, particularly where there was a peak load. Not only did it signify economy in boiler plant, but there was an economy of a kind which could not be explained at the present time, as the energy became multiplied by some unknown means. On this point he did not agree with the authors that you must wait to ascertain the cause before utilising thermal storage; the effect was known, and that was sufficient. Mr. Booth still had an affection for the Lancashire boiler, but Colonel Crompton was glad to see that he now received water-tube boilers with toleration. With the latter you could arrange to have a superheated coil put in the right place, and you could have the superheater surfaces brought as near as possible to the hottest part of the fuel, which was almost impossible with the Lancashire boiler. Regarding furnaces, this was a question of fuel. When fuels with varying percentages of ash were

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used, a moving furnace was an enormous advantage, because it could be run at varying speeds to suit the varying percentages of ash. In regard to the inclined grate, the party which recently toured the States had several opportunities of seeing the Rooney type, but after extensive enquiries Colonel Crompton had come to the conclusion that the results were not comparable with those obtained with the flat grate worked on the chain or similar principle. Colonel Crompton spoke enthusiastically of superheated steam. When in America he discussed this very fully with Dr. Elihu Thomson, who considered that the steam-engine would be kept on a level with the internal-combustion engine, and in some respects surpass it, "if we have the pluck to go high enough in temperature." He hoped engineers would not accept the authors' view that the only advantage of superheating was to dry the steam. Superheating gave thermodynamic advantages the whole way up the scale. By its means Dr. Thomson and others had obtained results only to be accounted for by the third law. Superheating had been unjustly criticised because it was supposed to score the cylinders and to evaporate the lubrication. Colonel Crompton had satisfied himself by experiments that this did not occur when the boilers were properly worked. The gain amounted to between 30 and 40 per cent., not 15 per cent. as stated by the authors. He was sorry that in an otherwise excellent paper the authors did not give credit under this head to Profs. Callendar and Nicholson, who read a paper on the subject in 1898. Colonel Crompton was convinced that a new practice in steam engineering could be developed with quite as bright a prospect of profitable results as from internal-combustion engines.

**Mr. H. P. Boot** (Tunbridge Wells) said that his experience in regard to the separation of oil and grease from condensed water was that there was no trouble at all, provided the grease was put in the proper place and arranged at the right level. In regard to feed-water heating, he had for some time been trying a method of passing the water from a hot-well, after it leaves the economiser, into an arrangement of trays in the heat space of the boiler. This answered its purpose well, but it was necessary to provide for the contraction and expansion of the trays. He had been surprised to hear Colonel Crompton speak somewhat disparagingly of the Lancashire boiler. He considered the central-station engineer's lot was a happy one where a combination was in vogue, the Lancashire boilers being of great value in the daytime. The water-tube boilers were certainly very valuable for rapid steam-raising. As to refractory furnaces, it was a subject of surprise to him that makers of water-tube boilers should still go on constructing the old-fashioned type of chamber. As to the most economical class of fuel, it depended entirely on the location of the town, railway carriage being the determining factor. He had never been able to exceed 18 per cent. in the saving by superheated steam, but that figure was a good reason for adopting superheat.

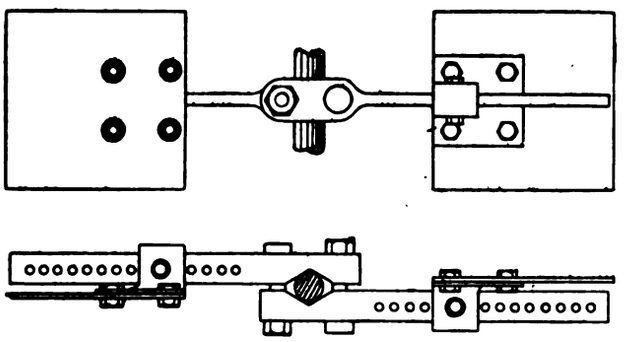
**Mr. Dale** (of Messrs. Crossfield, Warrington) said that his experience confirmed the authors' view as to the possibility of obtaining better fuel economy. As to the frequency of the analysis of the water, this depended upon local conditions. He agreed with the authors' view generally, but as the hardness of the water his company obtained from the Mersey fluctuated a good deal and was sometimes abnormal, it necessitated a certain amount of extra analysis. Great care should be taken to exclude animal oils from the feed water. In regard to firing, hand stoking introduced an element of irregularity, whereas with a first-rate mechanical type practical uniformity was obtainable. Respecting sampling and analysis of fuel, he agreed that as a general rule an approximate analysis was quite sufficient, and the calorific value could be calculated from this. In some cases it might be desirable to conduct an ordinary calorimeter test. With regard to superheating, Mr. Dale described a method employed at his company's works. Most of their Lancashire boilers were 30ft. by 9ft., and instead of covering the top with non-conducting material, they utilised it as heating surface, and over this were fixed two horizontal tubes. A gain of 7deg. to 8deg. of superheat was obtained, which, though not great, was uniform.

**Mr. Druitt Halpin** quite agreed with the authors' views about batteries. If a good battery were obtainable at moderate cost, it would be a boon. In regard to the boilers, he emphasised the need of getting rid of the dirt before the feed water could carry it into the interior. Regarding lubrication, animal oils had practically ceased to be used. In regard to fuels, he thought it as well to use the best where the prices were anything like proportionate, but did not believe in burning the best Welsh when the price was abnormal. Fans were the best method of improving chimney draught. He agreed with the authors that it was folly to have cheap engines to tide over the peak load. He favoured the water-tube boiler for all-round efficiency.

## TRADE NOTICES AND NOVELTIES.

### Absorption Dynamometer.

The dynamometer illustrated herewith has been designed by Mr. W. G. Walker, A.M.I.C.E., M.I.E.E., of 47, Victoria-street, S.W., for measuring the horse-power of electric and other motors. It will be seen from the illustration that it is of the absorption type, the energy produced in the motor being expended by the vanes revolving in air. Mr. Walker has designed such a dynamometer with a range of from $\frac{1}{4}$ h.p. to 20 h.p. For this range three different sizes of air-vanes are provided. The radial arms can be clamped on to shafts varying from $\frac{3}{4}$in. to $1\frac{3}{8}$in. in diameter. The weight complete of the whole apparatus, including the box, is about 22lb., and the over-all dimensions of the box is 24in. by 9½in. by 6in. The method of using the dynamometer to ascertain the horse-power of an electric or a petrol motor is as follows: The radial arms are clamped on to the spindle of the motor to be tested, and the vanes adjusted to such a radial position that the motor runs at the required speed under load. Knowing the speed and the position and size of the vanes, the horse-power is obtained from tables of results which are supplied with the dynamometer. There is no doubt that such an apparatus can be easily



Walker's Absorption Dynamometer.

fixed to a motor for testing purposes, but we are inclined to think that the reading of horse-power obtained will be considerably varied by the position of the motor relative to the floor, walls, or other surrounding objects. We presume the designer has looked into this and may be able to give some corrections to be applied in extreme cases.

### E.C.C. Machines of Recent Design and Construction.

Through the courtesy of the Electric Construction Company, Limited, Wolverhampton, we are able to illustrate herewith

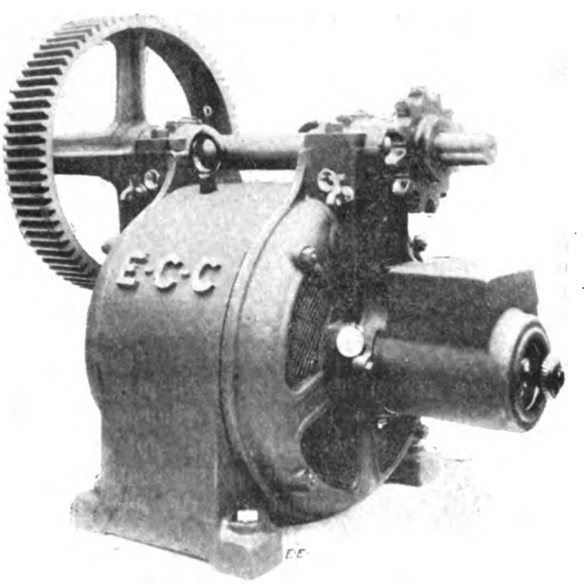



FIG. 1.—E.C.C. Standard Slip Ring Induction Motor.

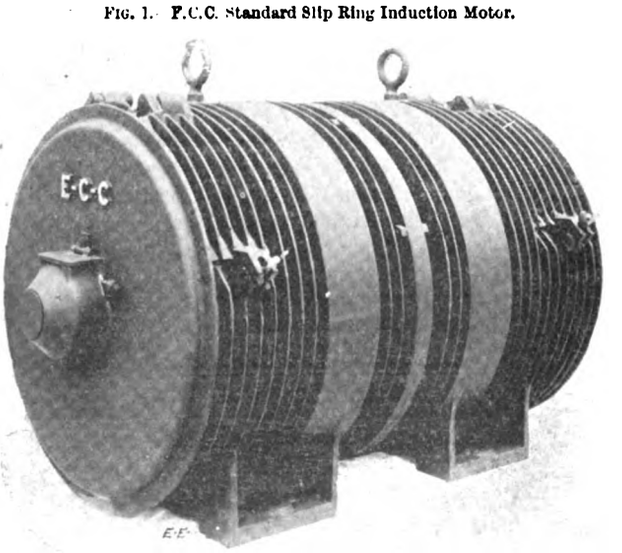



FIG. 2.—E.C.C. Enclosed Motor-Generator.

some of the machines recently manufactured by them. Fig. 1 shows one of the firm's standard induction motors, with brushes

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and slip-rings enclosed in a cast-iron ventilated cover. The brushes are of carbon, and the motor is provided with a short-circuiting and brush-lifting arrangement. The particular machine illustrated has an output of 15 b.h.p. when running at 720 revolutions per minute. It is wound for two-phase currents at a potential of 200 volts, and is geared by means of a raw-hide pinion and cast-iron spur wheel down to 240 revolutions per minute, the drive being then transmitted with further reduction to the countershaft through the medium of chain gear. Referring to the illustration, it will be seen that the starting resistance and switch are carried at the end of the shaft and completely enclosed. This arrangement saves the ohmic loss in leads which would be entailed by a separate starter, while it effects at the same time a saving in the initial cost, and renders the whole more efficient. The bearings for the countershaft are cast on the end casings. This construction, apart from the great stiffness obtained, is much preferable to the practice of bolting the bearings for the countershaft on to the motor case, since it ensures accurate pitch. It will also be noticed that the construction employed enables the end covers to be moved round bodily, with their respective attachments, to different points, so as to adapt the motor for any position. Thus it may be belted either to the floor, wall, or ceiling, as may be required, without difficulty. The countershaft bearings have very little overhang. Fig. 2 represents one of a number of motor-generators for a Government contract. This machine has an output of 50 amperes at 15 volts when running at 1,200 revolutions per minute. The motor and generator are direct coupled, the whole being completely enclosed in a cast-iron case ribbed externally, as shown, in order to obtain a greater heat-radiating surface. Sections of the casing are hinged to permit of ready access to the brushes. Fig. 3 illustrates a 220-kilo-volt-ampere motor-generator running at 428 revolutions per minute.

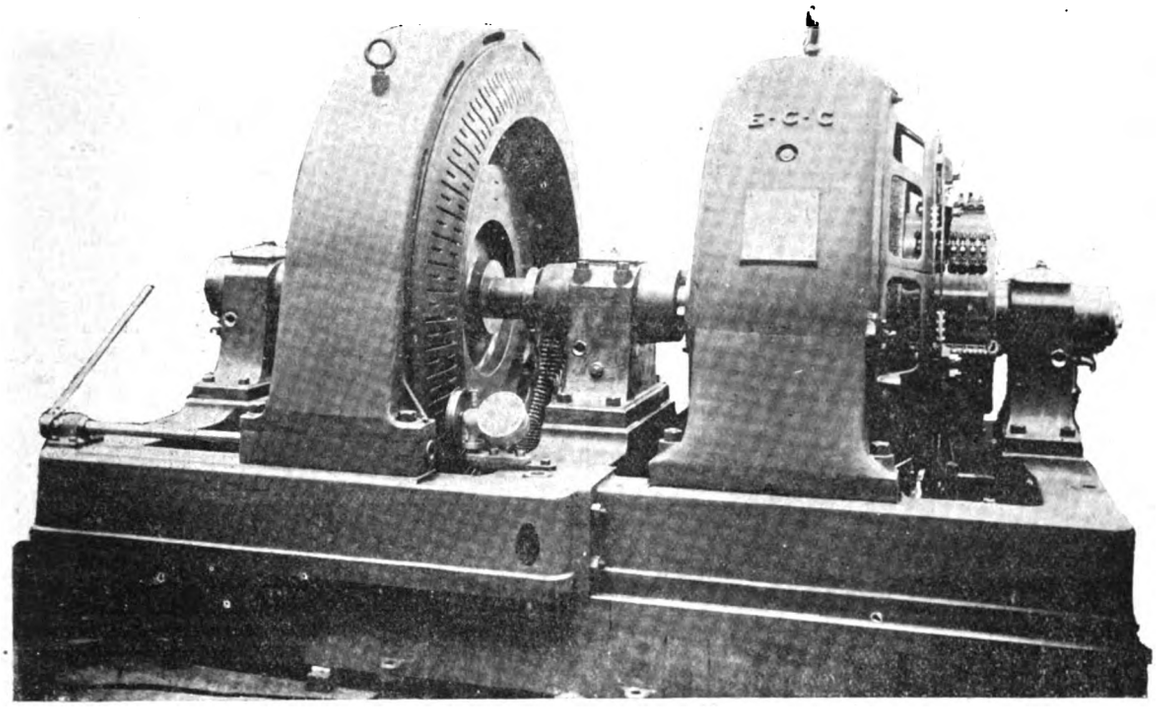


FIG. 3.—E.C.C. Motor-Generator.

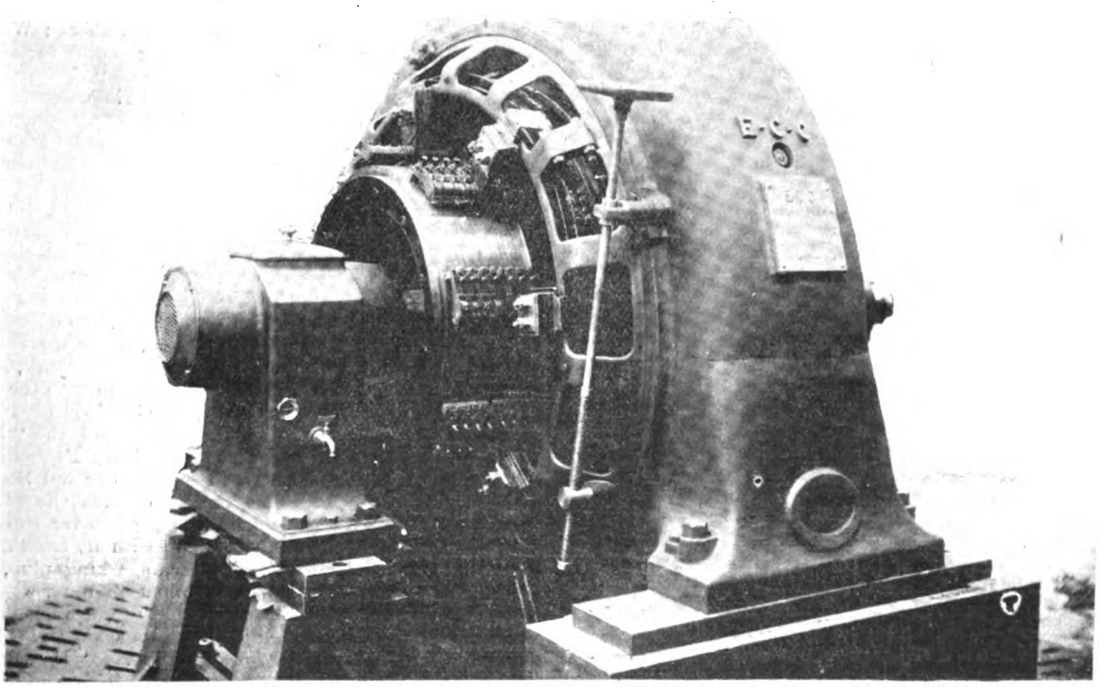


FIG. 4.—E.C.C. Traction Generator.

The motor half of this combination is shunt wound for 440 to 450 volts, and is supplied with current from tramway generators. It is direct coupled to a three-phase machine wound to generate current at 3,000 volts terminal potential. Thus the combination is the reverse of the usual order of things. The last of the accompanying illustrations (Fig. 4) shows a 375-kw. compound-wound traction generator of the firm's latest type of

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construction, designed for a speed of 350 revolutions per minute and a terminal potential of 500 volts. No better proof of the E.C.C.'s successful efforts to maintain a leading position in regard to the design and manufacture of modern electrical plant could be afforded than these illustrations, and we must compliment the firm upon their steady progress with the times.

### Steam.

Messrs. Babcock and Wilcox, Limited, of Oriel House, Farringdon-street, E.C., have sent us a copy of the fifth edition of their book entitled "Steam." In the new edition of this well-known work of reference no less than 180 pages are required to contain the information given. This book, which was first issued in the United States, gives concisely the history of the Babcock and Wilcox boiler since its inception in 1867. The development of these boilers, which now have reached the aggregate output of 4,700,000 h.p., has coincided with a great advance in the economical production of steam. It follows also that the company responsible for the manufacture of such a large number of boilers must be intimately in touch with every feature in connection with steam production. The book before us is evidence of this, and, quite apart from the descriptions given of Babcock and Wilcox apparatus, it contains data which is unprocurable elsewhere, and is invaluable to engineers. With the early part of the present edition we do not propose to deal, but must call our readers' attention to the valuable tables that are given from p. 63 onwards as to the theoretical heating values of the coals of the world. In this section information is given as to the calorific values of coals obtainable in Great Britain, the United States, Germany, France, and most other Continental countries. These figures are followed by useful information as to the Australian coals and the products of the coal mines in South Africa, Japan, etc. In places where fuel other than coal is found more economical, special furnaces are needed, and here, again, the information given in "Steam" will be invaluable to engineers having an export practice. The superheating of steam is now adopted in all new electricity works, and a number of our older stations have found it advisable to add independently-fired superheaters. This branch of steam engineering is much more fully dealt with in the present edition than in the earlier issues of this publication. Both the superheater worked as a part of each boiler and the independently-fired superheater are discussed. There has been in the past considerable trouble with the latter type, owing to the fact that there is no automatic relation between the heat produced by the furnace and the quantity of steam which is passed through the superheater tubes. If, however, the essential conditions which are laid down for the design of such superheaters are followed, the burning-out of tubes and other troubles will be avoided. It is essential that the tubes should not be subjected to the direct impact of the furnace gases rising from the firebars. They should instead be placed in a chamber completely filled with burnt gases of as low a temperature as practical to ensure the final superheat required. This involves a large heating surface, which is more than repaid by the increase of life of the superheater and the decrease in trouble and cost of repairs. The other details, such as ensure freedom of expansion for the tubes and tight joints between the tubes and the manifolds into which they are secured, should receive the attention of engineers when deciding between the relative merits of different superheaters. Elsewhere in the volume a considerable amount of new information is given on refuse destructors. The feature, however, of the issue from an electrical engineer's point of view are the illustrated descriptions of large boiler plants in power stations designed for the electrical distribution of power on a scale which was undreamed of when the first edition of "Steam" appeared. In connection with these the automatic coal-conveying installations are worthy of special notice, and automatic stoking is also dealt with. This last edition has also been improved by the inclusion of the results of some recent trials and by a number of additional tables of general interest. The book should find a place amongst every engineer's works of reference.

### Catalogues.

THE SIMPLEX STEEL CONDUIT COMPANY, LIMITED, Birmingham, London, E.C., and Manchester.—Leaflet No. 102 shows important percentage reductions in the price of material which were effected on the issue of their last list. The leaflet deals with light-gauge, heavy-gauge, and oval conduits, fittings, junction boxes, and miscellaneous. The reductions vary from 12·4 to 25·7 per cent., while the average reduction in screwed normal bends amounts to 57·6 per cent.

## AUTOMOBILE SHOW.

A small automobile show is being held at the Crystal Palace, and will remain open until Feb. 4. Perhaps its most interesting feature consists in trials of non-slipping devices, which are being held on a specially-prepared surface in the grounds. We learn that in order to ensure that all the appliances being tested are practical, they will be required to undergo a test of a 50-mile run on the roads. Some of the stands have made extensive use of 2-c.p. and 3-c.p. incandescent electric lamps, arranged in festoons, for effective and decorative lighting. The various tyre and accessory firms have been allotted prominent positions, and have not, as in former years, been hidden away in galleries or other out-of-the-way positions.

Electric carriages are, as usual, very much in the minority. The Kriéger Electric Carriage Syndicate, Limited, 48A, Gillingham-street, Eccleston-square, London, S.W., exhibit front-wheel-driven electric landaulets, coupes, landaus, victorias, 'buses, and delivery vans, all system Kriéger, with two compound 4½-h.p. motors. The following particulars are given: Speeds—six forward, two recuperation, one full brake, and one reverse; transmission—direct by means of pinions keyed to driving wheels; controller—situated below steering handle, and is easily manipulated; brakes—one electric and one mechanical; steering—is very simple, and can be fitted with either wheel or handle bar; chassis—steel stamped; tyres—either pneumatic or solid; accumulator—44-cell battery, which has a capacity of 45 miles on one charge for a four-seated car. The Scheele Electric Carriage Company, 41, Grosvenor-mews, New Bond-street, W., show an electric Victoria brougham having interchangeable bodies, with one chassis, a battery capacity 40 to 50 miles, five speeds forward and two backwards; the speed is given at 14 to 20 miles an hour. They also show an elegant electric private omnibus. Messrs. Glaskin and Co., Grosvenor-mansion, Victoria-street, Westminster, London, S.W., have on view their electric-Stanhope. Messrs. B. Kuettner and MacDonell, 3, Adam-street, Adelphi, London, W.C., have a splendid display of casting machines and moulds, and various types of grids, frames, and plates for accumulator makers for ignition, traction, or stationary work in England; also an electromagnetic sorting machine for separating metal by electricity, and a variety of accumulator accessories. We also noticed a complete outfit for electrically lighting motorcars, electric head, side, and tail lamps, and roof light for covered cars, all run off from one small accumulator battery.

Messrs. David Moseley and Sons, Limited, Chapelfield Works, Ardwick, Manchester, and London, Glasgow, and Birmingham, exhibit their well-known varieties—viz.: Moseley's beaded-edge and new wired motor tyres, Seddon's red tubeless motor tyre, and all rubber accessories for the motor trade. Messrs. J. G. Statter and Co., Newhall-street, Birmingham, show a new electrically-driven valve-grinding appliance for the use of car owners and garages.

Messrs. W. H. Willcox and Co., Limited, motor engineers' stores and lubricating oil refiners, 23 36, Southwark-street, London, S.E., have a fine show of their specialities, including Willcox aluminium-cased "centrifugal" and semi-rotary motor pumps for circulating water in the cooling chambers; Willcox gun-metal "semi-rotary" water-circulating pump for the cooling chambers (in two sizes); several types of "Penberthy" patent injectors, etc. The Gratze Patents and Engineering Syndicate, Limited, 44A, Whitfield-street, Tottenham Court-road, W. show a new speed indicator, which is formed on an altogether new principle of action; the indicating movement is quite distinct, and absolutely disconnected from the rotary portion of the instrument. It has a positive gear drive, thus obviating any slip that would otherwise accompany a friction drive. They also exhibit a type of accumulators suitable for ignition purposes, traction, or lighting—an altogether new formation on the Planté principle, in which the positive plates are not pasted. It appears that the firm guarantee this accumulator to give an output of 18 watts per pound weight, and they claim that it will give one volt even under a dead short-circuit, and that it can be charged at 200 amperes without injury to the plates.

Messrs. G. T. Riches and Co., 4, Gray's-inn-road, London, W.C., are the sole British representatives of the "Eisemann" high-tension magneto-ignition, as used by Panhard, Lavassor (exclusive), Brooke, Daimler, Merryweather and Son, Limited, M. M. C. Wolseley. This machine takes the place of the accumulator and contact breaker, and whatever the number of cylinders used requires only one coil without trembler. High-tension system with ordinary pattern sparking plug, in connection with which they show a combination plug, with porcelain interior, doing away with the trouble of mica heads; Simplex electric ignition (combined coil and sparking plug), and wipe contacts for 6 h.p., 8 h.p., and 9 h.p. "De Dion" (G. T. Riches and Co.'s registered design, guaranteed interchangeable) are also found on this stand. Voltmeters, coils, sparking plugs, accumulators, and ignition sundries of various kinds are also exhibited by Messrs. Alfred Dunhill, Limited, 359 and 361, Euston-road, N.W.; Leadbitter and Co., York-street, Westminster; Peto and Radford, Limited, Hatton-garden, E.C.; Longstreth's, Limited, 427A, Strand, W.C.; Chloride Electrical Storage Company, Limited, 39, Victoria-street, S.W.; C. A. Vandervell and Co., Chapter-road, Willesden, N.W.; and the Magneto Company, Winchester House, E.C.

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## INSTITUTION OF ELECTRICAL ENGINEERS.

At the ordinary general meeting on Jan. 26 the following candidates were elected :

*Associate Members.*—H. H. Couzens, Corporation Electricity Works, Temple Back, Bristol ; A. Crowther, W. R. Asylum, Menston, near Leeds ; J. N. Dodd, Messrs. Dick, Kerr, and Co., Preston, Lancs. ; D. B. Ingram, Ishapur Rolling Mills, Calcutta ; B. A. Mannerheim, care of Swedish and Norwegian Consulate, Johanneeburg, Transvaal ; W. H. Moore, superintendent-engineer to the Port Commissioners, Calcutta ; A. S. Munro, Corporation Electricity Works, Pietermaritzburg, Natal ; A. Peaker, Ashley House, Lady Pit-lane, Leeds ; F. K. Preston, Bradford Dyers' Association, Limited, Bradford ; T. B. Reader, Electric Lighting Station, Hindhead, Surrey ; T. W. Sampson, 18, Bute-street, Crookes, Sheffield ; W. T. Taylor, Rawhide Gold Mining Company, Rawhide, California, U.S.A.

*Associates.*—L. H. A. Shadwell, Government Harbour Department, Durban, Natal ; T. Wadsworth, 51, Bradbourne-street, Fulham, S.W.

*Students.*—W. Aked, Highfield House, Sutton-in-Ashfield, Notts ; S. M. Andrews, 41, Wellington-road, Old Charlton, S.E. ; J. T. Appleton, 91, Bewsey-road, Warrington ; A. Auer, 35, Victoria-street, Aberdeen ; H. A. Bastable, 41, Wellington-road, Charlton, S.E. ; G. C. Blackburn, 9, Circular-road, Birkenhead ; F. G. Broadhead, 9, Meyrick-road, Stafford ; S. Brooks, 71, Haworth-road, Gorton, Manchester ; T. A. Brown, 90, Hadham-road, Bishop's Stortford, Herts ; W. Browning, Laurel Bank, Mornington-road, Sale, Manchester ; R. P. M. Canty, 24, Woburn-place, W.C. ; H. A. Carney, 59, Marshall-place, Cheetham, Manchester ; L. H. A. Carr, 15, Albert-terrace, North Shore, Blackpool ; A. E. Clarke, 132, Hulton-street, Moss Side, Manchester ; G. W. Cosby, 86, Shrewsbury-street, Old Trafford, Manchester ; P. G. Dani, 5, Girdler's road, Brook Green, W. ; R. E. Dawson, 42, High-street, Southend-on-Sea ; A. J. C. De Renzi, 54, King-street East, Rochdale ; C. H. Dobson, Elmside, Rusholme-road, East Putney ; G. A. Egles, 192, Marylebone-road, N.W. ; C. F. Embleton, 90, Oxford-road, Manchester ; J. G. Farrow, 229, Albion-road, Stoke Newington, N. ; R. A. F. Fawcus, Red House, Altrincham, Cheshire ; H. A. Finlaison, 11, The Park, Eccles, Manchester ; D. Fox, 2, Lindum-terrace, Bradford ; J. W. Fraser, 11, Haverhill-road, Balham, S.W. ; J. P. Garner, Post Office, Spurstow, Tarporley ; W. W. Greenwood, Elsmore Heath Villas, Halifax ; C. H. W. Grimshaw, Fairy Hill, Bray, co. Wicklow ; J. W. Hambleton, 30, Bloomfield-avenue, S.C. Road, Dublin ; C. C. A. Hardie, 7, Melina-place, St. John's Wood, N.W. ; A. W. E. Harris, The Red House, Barnt Green, near Birmingham ; T. Hedberg, 349, Collins-street, Melbourne ; H. Helweg-Larsen, 63, Northern-grove, West Didsbury, Manchester ; P. H. I. Humphreys, Lendal-hill, York ; P. Kemp, 144, Stockport-road, Manchester ; E. W. Lace, St. Leonard's, Ryde, Isle of Wight ; E. Lawson, Scatcherel-hill, Morley, Yorks ; J. H. Lemon, Engineering Apprentices' Club, Stretford, Manchester ; L. J. Lepine, 6, Queen's-road, Loughborough ; A. E. McConnell, Mortimer House, Victoria-road, Stretford, Manchester ; R. L. McCulloch, 56, Aytoun-road, Pollokshields, Glasgow ; J. S. Mail, 1, Bisham-gardens, Highgate, N. ; A. Maling and S. Y. Maling, 11, Derbyshire-lane, Stretford, Manchester ; C. E. May, Treasurer's House, The College, Bromley, Kent ; E. N. G. Morris, Brentford Lodge, Old Brentford, Middlesex ; J. H. Mousley, St. Germains, St. Albans, Herts ; J. H. M. Nichols, 30, Maitland Park-villas, Haverstock-hill, N.W. ; A. E. O'Dell, 9, Gordon-road, Kingston-on-Thames ; W. A. Perry, 59, Wallwood-road, Leytonstone ; K. Preston, 7, Groby-road, Altrincham, Cheshire ; E. S. M. Prichard, 37, Derbyshire-lane, Stretford, Manchester ; V. J. Radbone, 58, Lordship-park, Stoke Newington, N. ; H. S. Rainforth, Central Technical College, South Kensington, S.W. ; N. Ramsay, Cams Hall, Fareham, Hants ; A. Riley, The Poplars, Morley, near Leeds ; J. M. Seddon, 10, Queen's-square, W.C. ; S. Simpson, 119, Earl-street, Horton-lane, Bradford ; J. W. Smith, 16, Gladstone-street, Loughborough ; N. B. Tomlinson, 13, Pembury-avenue, Tottenham, N. ; E. W. Tunbridge, Rocklands, Woodbourne-road, Edgbaston, Birmingham ; W. Turner, Grosvenor Lawn, Newbury, Berks ; G. W. Wadsworth, 13, Glenfield-street, Cloughside, Blackley ; T. F. Wall, 21, Norwood-grove, Liverpool ; J. W. Wheeler, 250, Amhurst-road, N. ; S. M. Wright, 20, Muswell-rise, Muswell-hill, N. ; A. R. Wuest, 17, Amherst-street, Withington-street, Manchester.

## PERSONAL.

Mr. A. A. Blackburn, A.M.I.E.E., who had resigned his position under the Manchester City Council for one with the Belfast Corporation, was on Friday last presented by Mr. Councillor G. T. Jackson, J.P., general secretary of the Tramworkers' Union, and on behalf of that body with a handsomely illuminated and framed address and a gold-mounted umbrella. In doing so, Mr. Jackson said it was one of the greatest pleasures which fell to the lot of a general secretary, for it showed that a happy understanding had existed between the men and Mr. Blackburn, whom they all hoped would continue to rise in his profession, and that however high, or wherever he went, the same happy conditions would exist around him as had prevailed during his 2½ years at Manchester. Mr. Blackburn had been previously presented by the staff and workmen at the Hyde-road shed with a very massive Chippendale drawing-room cabinet, and Mrs. Blackburn with an afternoon tea service and china ornaments. The Queen's-road shed staff gave him a handsome marble clock and pair of Oriental bronze vases to match. At each gathering the men expressed regret at losing so good a superintendent, yet wished him every success at Belfast.

The Electricity Committee of the Manchester Corporation have recommended the appointment of Mr. S. L. Pearce as chief electrical engineer, for a period of three years, on the following terms : salary for the first year at the rate of £900 per annum ; for the second and third years, £1,000 per annum. Mr. Pearce is to enter into an agreement to remain in the employ of the Corporation for three years from Feb. 1, 1905, and to devote the whole of his time to the duties of the position and in carrying out any electrical extensions or works in the future that may be required, the engagement to be subject to any arrangement which the Corporation may from time to time make with consulting engineers.

Mr. E. Hatton, Salford ; Mr. H. E. Yerbury, Sheffield ; and Mr. G. Conaty, Birmingham, are the three selected candidates for the Newcastle tramways managership. We are informed that the appointment, which is worth £700 per annum, will not be made for a month.

Mr. Arthur King, Sheffield, has been appointed overhead construction superintendent to the Belfast tramways. Mr. King was formerly with the British Electric Equipment Company and in the Sheffield Corporation's tramways department.

On Monday night Mr. Sidney Herbert Thomas, the electrician-in-charge of Shoreditch electric lighting department during the absence of the chief, was the recipient of a handsome suitably-inscribed marble timepiece with statuettes in celebration of his marriage a week previously. There was a large attendance of the chief officials of the staff and employés at the depôt, among those present being Mr. George Kemp, A.M.I.E.E., second engineer-in-chief (who made the presentation in the unavoidable absence of Mr. Chas. Newton Russell, engineer-in-chief) ; Mr. Alfred Vincent, general foreman of the station ; Mr. Lawson, engineer-in-charge, Whiston-street, Hackney-road ; Mr. Sydney Fairleigh, inspector of dynamos ; Mr. J. Week ; and Mr. W. G. Hackett, chief attendant of storage batteries.

## LEGAL INTELLIGENCE.

### THE PROPOSED TRAMWAY ON CANVEY ISLAND.

The case of Bruce Peebles and Co., Limited, *v.* Hester came before the Master of the Rolls and Lords Justices Mathew and Cozens Hardy on the appeal of the defendant from an order of Mr. Justice Jelf in chambers.

The plaintiffs, a firm of electrical engineers and contractors, brought the action to recover £3,630 against the defendant as accepter of two bills of exchange, dated June 3, 1904, which bills upon presentation were dishonoured. It appeared that the defendant owned an estate on Canvey Island upon which he wished to have a tramway built, and he entered into a contract with the plaintiffs to do the work. The tramway was to have been completed by June last year, but it was not, and it was agreed that a penalty of £1,000 should be paid. Afterwards an arrangement was entered into under which the bills, the subject of the present action, were given in respect of moneys admittedly due from the defendant to the plaintiffs in respect of the work, but the defendant contended that it was a condition precedent to the bills being presented that the plaintiffs' contract had to be completed by September, 1904. Mr. Justice Jelf, in chambers, gave the defendant leave to defend on bringing into court £1,000. The defendant now appealed from this, contending that he ought to have unconditional leave to defend.

The appeal was allowed.

### NORTH-WEST LONDON ELECTRIC SUPPLY COMPANY.

In the Chancery Division on Friday last Mr. Justice Farwell heard an application arising out of the sale of the undertaking of the North-West London Electric Supply Company to the Hampstead Borough Council for £12,000. The book debts were said not to be included in that sum. A holder of 32 debentures, representing £1,600 out of an issue of £30,000, asked for the appointment of a receiver and manager. The applicant complained that the price of £12,000 offered for the company's undertaking showed an extraordinary depreciation from previous values.

The application was opposed on behalf of all the other debenture holders, who asserted that the real object of the application was to prevent the sale of the undertaking. The first mortgagees were already in possession, and a meeting of debenture holders had already sanctioned the sale.

Eventually the matter was referred to Chambers, without prejudice, and with liberty to apply to the Court.

### MOTOR TRACTION COMPANY, LIMITED.

In the Chancery Division on Friday last, before Mr. Justice Buckley, **Mr. Buckmaster, K.C.**, applied for an interim injunction to restrain the defendant company from carrying into effect an agreement, dated Dec. 9 last, purported to have been entered into between the company and the defendant, Mr. Frank Grice Hackney, as trustee for an intended new company. Counsel argued that the memorandum of association did not empower the company to sell its undertaking for shares in another company, as it was proposed to do.

His Lordship reserved judgment.

### KILLARNEY ELECTRIC LIGHTING COMPANY.

In the Chancery Division on Friday last the Master of the Rolls heard the case of the Callender Cable and Construction Company, Limited, *v.* Killarney Electric Lighting Company.

**Mr. Leet** applied on behalf of the defendants to appoint a receiver in place of the receiver at present acting for the Court. The present receiver had issued a notice that he would shut down the works of the

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defendant company, and counsel stated that if this intention were carried out, the defendants would lose the benefit of the provisional order, and would expose themselves to a fine on foot of that order of £2 per day. This would be fatal to the electric lighting company, and to the possibility of a sale. If the works were to be sold, they should be sold as a going concern.

The **Master of the Rolls** adjourned the matter for a week, and intimated that he would then receive sealed tenders containing offers for the purchase of the works of the defendant company.

## OVERHEAD WIRES.

Before the Railway and Canal Commission last week the appeal of the Postmaster-General against the decision of Judge Russell, sitting at the Croydon County Court, with respect to overhead telegraph wires in the Croydon Rural Council's area was heard.

The **Attorney-General** said the inhabitants of South Bedington had petitioned to have the local post office connected by telegraph wire, but the Council would only give its consent if the wires were laid underground. To meet them the Postmaster-General proposed iron posts, 7½in. at the base, which would cost £50. It was explained that to put the wires underground would cost £132, a sum which would make the proposal impracticable. Inconvenience from the poles would be less than from the ordinary lamp posts.

The **Commissioners** announced that they would allow overhead wires at Wallington, provided light iron poles were used.

A conference then took place between the parties, with the result that an agreement was come to for the lines in Foxley-lane, Banstead-road, and Russell Hill-road to be laid underground, the Rural District Council to bear the cost of opening the trench. With regard to Selsdon-road, the Council agreed to the lines being overhead, the Council to have the right to require painted poles.

No order was made as to costs.

## MANCHESTER TRAMWAY COMPANY.

Vice-Chancellor Sir S. Hall, K.C., in the Lancashire Court of Chancery at Manchester on Tuesday, gave judgment in regard to the distribution of the surplus assets of the Manchester Carriage and Tramways Company, Limited (in liquidation) amongst the shareholders. There were three classes of shareholders—holders respectively of "A," "B," and "C" shares. The nominal value of the "A" shares was £20, with £15 paid up; of the "B" shares £10, fully paid up; and of the "C" shares £10, with £7. 10s. paid up. The question for decision was whether the distribution of the surplus money should be made on the basis of the nominal value of the shares or on the basis of the amount paid up.

The **Vice-Chancellor**, after reviewing the history of the concern, held that the surplus must be divided upon the basis of the nominal amount of the shares.

Leave was given for the immediate payment of a sum on account of about 4s. in the £ on the amount paid up.

## ELECTRICITY AND VIBRATION.

In the Lancashire Chancery Court at Manchester, the case of Barlow *v.* the Manchester Corporation came before Vice-Chancellor Sir S. Hall, K.C. The plaintiff, Mr. Barlow, is the owner of property in Dickinson-street, and he sought to restrain the Corporation from committing a nuisance to his property by vibration caused by the operations carried on at the electricity works of the Corporation in the same street.

**Counsel** for the Corporation said the action came on first for trial in February, 1903. The Corporation were then advised that by some alterations which were suggested by an eminent authority, the vibration complained of would be entirely removed. Terms were thereupon made putting the plaintiff in a favourable position. At the end of year the experiments were not completed, and as a matter of fact they were not completed till the spring of last year. The result of the experiments was a failure, and although the Corporation had spent £3,000 upon them, they had to acknowledge that there was nothing further to be done. As an alternative course, it was suggested that two large engines which, it is alleged, caused the vibration, should be taken out of the works and two turbines substituted. Contracts were entered into for the supply of the turbines, and they were promised for November last, but the contract had not yet been completed. Mr. Maberly's application now was that the trial of the action should be fixed for a date earlier than March 28.

The **Vice-Chancellor** said the plaintiff must have a reasonable time in which to observe the effect of the changes that were being made, and it was finally agreed that the trial of the action should stand over till the first Tuesday in 1906 on which witness cases are taken, the existing undertakings to be continued in the meantime.

## MIDLAND ELECTRIC COMPANY v. PARSONS AND SONS.

In the Wolverhampton County Court, Judge Howland Roberts delivered judgment in an action which was tried before him on Oct. 17. The plaintiffs were the Midland Electrical Corporation for Power Distribution, represented by Mr. R. C. E. Plumptre (instructed by Mr. Hayward), and the defendants (for whom Mr. J. Clarke, of West Bromwich, appeared) were Messrs. David Parsons and Sons, iron-founders, The Leys, Brierley Hill. The plaintiffs sought to recover £46. 19s. 3d. for electrical energy consumed by the defendants at their works between Sept. 28 and Dec. 31, 1903.

At the hearing of the action in October, Mr. Plumptre, in stating the case for the plaintiff company, said the defendants were under a contract to receive electrical power from his clients at the rate of 4½d. per Board of Trade unit. On Dec. 21 a man in the employ of the plaintiff company went to the defendants' works to take the reading of the meter. According to his reading the meter on that date registered a consumption of 770 units. He was a man of little experience in reading meters, and it was evident he had made a mistake, because on a further reading of the meter on Jan. 5 it was found to register a consumption of 1,770 units, although during the interval the works had not been in operation, and no electrical energy had passed through. There might have been a leakage owing to a defect in the installation, but the company were not responsible for that.

On the part of the defendants it was contended that they had not received the amount of electrical current for which they were brought in as debtors. Further than this, it was denied that they had ever received any communication from the plaintiffs that there was a defect in the installation.

The case was adjourned for independent expert evidence in regard to the meter, and Mr. J. B Clarke, A.M.I.E.E., electrical engineer to the Stourbridge Urban District Council, was called in to arbitrate. After careful investigation, he communicated his decision to his Honour, who pronounced the electric meter to be correct in its readings, and gave judgment for plaintiffs.

## TRAMWAY ACCIDENT.

At the Colne County Court Robert Hartley sued the Burnley Corporation for £50 for damages as the result of an accident alleged to be due to negligence on the part of the defendants' servants.

Counsel for the plaintiff stated that his client entered a car at Burnley which was proceeding to Brierfield. Being a fine night plaintiff rode on the top. When he got to Brierfield the car stopped at a compulsory stopping place, and plaintiff commenced to go down the stairway behind a young lady. When plaintiff got near the bottom of the stairway he saw a young lady on the platform. When the latter left the car the conductor touched the button and the car started. The result was that plaintiff was thrown to the platform and sustained a fracture of the left leg, as a result of which he was in bed six weeks, and was unable to follow his employment for 14 weeks. It was the duty, counsel contended, of the Corporation to afford passengers on the trams reasonable facilities for alighting.

For the defence counsel contended that there was absolutely no evidence of negligence on the part of the Corporation's servants.

After a protracted hearing the jury found for the plaintiff, for whom judgment was given, with costs.

# COMPANIES' MEETINGS AND REPORTS

## CITY AND SOUTH LONDON RAILWAY.

The half-yearly meeting of this Company was held on Tuesday under the presidency of Mr. C. G. Mott.

In moving the adoption of the report (particulars of which we gave last week), the **Chairman** remarked that the great bulk of the traffic of their line was of a permanent kind and varied very little, but unfortunately the exceptionally fine and dry weather which prevailed during the greater part of the half-year had been much against the Company, and their interests had also been affected by the active competition of the London County Council trams, which did their best by charging very low fares to draw the traffic from the underground railways. The Company had also suffered from the depression that had existed among local trades, notably the building trade, and which had resulted in the issue of fewer workmen's tickets. With all these adverse circumstances, he thought they might congratulate themselves that the falling off was not greater than it was—namely, about £1,600 for the half-year. The balance available for dividend was £27,445, and the directors recommended that the full dividend of 5 per cent. per annum be paid on the preference stocks 1891, 1896, and 1901, and a dividend at the rate of 1¾ per cent. per annum on the ordinary stock for the half-year, leaving £1,449 to be carried forward. He and his co-directors were emphatically of opinion that their line had a great future.

The report was adopted.

## EASTERN TELEGRAPH.

The sixty-fifth half yearly general meeting of this Company was held last week, Sir J. Wolfe Barry presiding.

In moving the adoption of the report and accounts (particulars of which appeared in our issue of the 20th ult.), the **Chairman** remarked that various branches of the traffic, notably that with India, showed a satisfactory increase.

**Sir J. Denison Pender**, vice-chairman and managing director, seconded the resolution, which was carried unanimously.

The retiring directors and auditors were re-elected, and a vote of thanks to the chairman, directors, and staff terminated the proceedings.

## SOUTH-EASTERN RAILWAY.

At the meeting of this Company on Monday the **Chairman** stated that they were feeling more strongly than ever the competition of the electric trams. The only way to meet this competition was by taking off a certain number of trains which had been put on for the accommodation of the working classes, and which the working classes were now leaving, and also to a certain extent partially closing some of those stations which were principally affected. Alluding to the proposed electrification by the London, Brighton, and South Coast Railway Company of the line from Peckham to Battersea Park, he

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said that a portion of that line belonged to the South-Eastern and Chatham Managing Committee, which had entered into an agreement with the Brighton Company by which they would take over that portion for the purpose of the experiment. The experiment would be extremely interesting to both companies, as it would give them reliable statistics, which were at present wanting, as to the cost of working an old line by electricity.

## GEORGE M. CALLENDER AND CO.

An extraordinary general meeting of the shareholders was held on Tuesday at the Westminster Palace Hotel, when a resolution increasing the capital of the Company by the creation of 25,000 additional preference shares of £1 each was carried. The resolution was confirmed at a meeting of the preference shareholders.

## CENTRAL LONDON RAILWAY COMPANY.

The report for the half-year ended Dec. 31 states that the amount expended on capital account has been £12 665. The receipts from all sources of revenue amounted to £176,281, being an increase of £1,046, and the working expenses to £95,937, a decrease of £1,425 as compared with the corresponding period of last year, leaving a balance of £80,343 carried to the net revenue account. The total number of passengers carried during last half-year shows an increase of 131,300, and the number to whom cheap return tickets were issued was 3,084,296, an increase of 72,086, or 2·39 per cent., as compared with the corresponding period. The average receipt per passenger is 1·86d., the same as in the half-year ended December, 1903. To meet the convenience of those who desire to avoid the daily purchase of tickets, the Company in August last commenced the issue of books of 12 tickets at 2s. per book. These have been much appreciated, and are very largely sold. After providing for interest on debenture stock, and other payments, the net revenue account shows a balance of £122,579. The directors recommend a dividend on the deferred ordinary stock at the rate of 4 per cent. per annum for the whole year, and that £30,000, with interest for the half-year, be transferred to the reserve fund, bringing the total of that fund up to £61,730, the balance of £22 111 being carried forward. In the expectation that the report of the Royal Commission on London Traffic would be presented at an early date, the directors deemed it necessary to redeposit in Parliament the Company's Bill entitled the Central London Railway (New Lines) Bill, 1905, which will be submitted for the consideration of the proprietors at the Wharncliffe meeting, to be held at the conclusion of the ordinary meeting. This Bill is practically identical with that which was deposited in 1902, and approved by the proprietors, but afterwards withdrawn in consequence of the appointment of the Royal Commission. It provides for the continuation of the Central London Railway, *via* Hammersmith, Piccadilly, and the Strand, and thence to Liverpool-street and the Bank, forming, with the existing line, a complete circular route through the centre of London. The Great Western Railway Company have also deposited a Bill which, among other matters, includes provision for a station adjoining that of the Central London Company at Shepherd's Bush. They propose to deal with such portion of their suburban traffic as can be most conveniently served at this station, and the fullest facilities will be provided to enable passengers to exchange from one system to the other. This connection with the Great Western Company's Railway, in addition to those proposed with the Great Eastern, North London, and South-Eastern and Chatham Railways, gives further force to the view which the directors have previously expressed—that a continuous circular railway, with convenient exchange stations, though without physical junctions with other lines, will enable the Company to provide the public with the best, safest, and most economical service, and they, therefore, recommend the proprietors to approve the Bill. The directors have approached the Charing Cross, Euston, and Hampstead, and Baker-street and Waterloo Companies with a view to the construction of low-level subways for the exchange of passengers at Tottenham Court-road and Oxford-circus stations respectively, but nothing has yet been settled.

## LIVERPOOL OVERHEAD RAILWAY.

The report for the half-year ended Dec. 31 last, to be submitted at the meeting at Liverpool on the 14th inst., states that the gross revenue receipts amounted to £41,717 and working expenses to £31,530. The number of passengers carried during the half-year was 5,613,752, a decline of 282,751. The directors point out that this is the first time they have had to record a reduction in traffic, which has been partly due to the quiet state of trade during the early part of the half-year, but mainly caused by the competition of the frequent and rapid service of trains on the Liverpool and Southport line since its electrification. This falling off in traffic has to some extent been met by economies in the working expenses. The works to connect the line with the Lancashire and Yorkshire Railway at Seaforth are well advanced. Receipts from passenger traffic amounted to £40,837 and miscellaneous receipts and interest to £880—together £41,717—less working expenses £31,530, and interest on mortgage debentures and on calls paid in advance £4,104, leaving £6,082. To this must be added balance brought forward from June 30, 1904 (£4,052), leaving available for dividend £10,134. The directors recommend a dividend at the rate of 1¼ per cent. per annum on the ordinary shares, leaving £3,743 to be carried forward.

## WATERLOO AND CITY RAILWAY.

The gross receipts of the line for the half-year ended Dec. 31, less Government duty, amounted to the sum of £17,676, and the working expenses to £7,891, being at the rate of 44·64 per cent., as compared with 46·44 per cent. for the corresponding period of 1903. The balance available for dividend, after providing for interest on debenture stock, is £9,030, and a dividend at the rate of 3¼ per cent. per annum on the ordinary stock will absorb £8 775 leaving £255 to be carried forward. This dividend compares with 3 per cent. for the corresponding period of 1903, and will be payable on Feb. 11. The number of passengers carried during the past six months, exclusive of season-ticket holders, was 2 256 832, showing an increase of 15 968 compared with the corresponding period of 1903. The season-ticket holders on Dec. 31 last numbered 1,645, as against 1,434 at the end of December, 1903.

## DUBLIN AND LUCAN ELECTRIC RAILWAY.

The report of this Company, to be submitted at the meeting on the 16th inst., states that the receipts on revenue account from all sources are £7. 12s. 1d. less than those of the corresponding period of 1903, whil st the total working expenditure also shows a reduction of £6. 19s. 1d., the net result being practically identical. After providing for debenture interest there is an available balance of £1,425 on the half-year, out of which the directors recommend the usual half-yearly dividend on the 5 per cent. preference shares, and of a further half-year's dividend of a similar amount on the same shares, so as to clear off all arrears of dividend on those shares up to Sept. 30 last; and that £200 shall be paid to the electrical contractors, being one year's instalment to the same date on account of the sum remaining due to them for electrical equipment, and to carry forward the balance of £375.

## SMITHFIELD MARKETS ELECTRIC SUPPLY.

The report for the year 1904 states that the gross profit amounts to £6,269, compared with £6,691 last year. The net profit for the year is £4,296. 17s. 4d., to which must be added the balance brought in to the accounts from last year, £1,262. 13s. 11d., making a total of £5 559. 11s. 3d. A sum of £1,500 has been placed to general reserve fund, bringing the total at the credit of this account to £5,740, and a further £1,000 to depreciation fund. The directors now propose to deal with the balance of £4,059. 11s. 3d. as follows: by the payment of a dividend at the rate of 4 per cent. for the year, £2,400; and to carry forward £1,650. 11s. 3d. Notwithstanding an increase in the number of lamps installed, the amount of current sold in the markets has been less, owing to general economy on the part of the consumers, due mainly to the bad condition of trade. A saving has been effected in the costs of production, and the sale of current may be expected to increase as trade improves. A new boiler was installed in the latter part of last year which has increased the efficiency of working, and will be sufficient to meet extensions and additions to the Company's business for some time to come. The plant and machinery have been fully maintained out of revenue and are in good condition.

## GREAT NORTHERN AND CITY RAILWAY.

The traffic receipts for the six months ended Dec. 31 last amounted to £36,509, as against £19,354 for the previous 4¼ months. The numbers of passengers carried for the same periods, excluding season-ticket holders, were 5,227,595 and 2 711,152 respectively. The number of local season tickets issued during the half-year was 2,511. By a supplemental agreement with the contractors, the working expenses retainable by them will be calculated for the first year of working at the rate of 60 per cent. and for the second and third years at 50 per cent. of the gross receipts.

## NEW COMPANIES REGISTERED.

**British Electric Company, Limited.**—Capital, £2,000. Object: to acquire from J. C. Dear, of 8, Mortimer-street, Cavendish-square, W., the benefit of a certain existing invention relating to improvements in holders for electric incandescent lamps, and to carry on the business of manufacturers of and dealers in electrical and gas fittings, installers of electric light and gas, etc. Registered office: 8, Mortimer-street, Berners-stret, W.

### Liens Registered.

**Electrical Bleaching Company (1904), Limited, Manchester.**—Lien registered Jan. 21 for £12,000 6 per cent. debentures, part of £14,000 authorised. No trustees. Charged on the undertaking and all the property and assets, present and future, except the uncalled capital.

**Willey and Co., Limited, Gas and Electrical Engineers, Exeter and London.**—Particulars of a series of £20,000 debentures, created by resolution of Aug. 8, 1904, and covered by a trust deed dated Dec. 29, 1904 (registered Jan. 5, 1905), have been filed, pursuant to Section 14 (4) of the Companies' Act, 1900. The debentures are issued by virtue of Article 116, subject to an agreement, dated Aug. 8, 1904, with G. W. Durant, which was confirmed by resolution of preference shareholders on same date. Property charged: the company's undertaking and property, present and future, including uncalled and unpaid capital. Trustees: W. Cash, 90, Cannon-street, E.C., and E. Herbert, 6, Finch-lane, E.C.

**Electrolytic Alkali Company, Limited (Middlewich).**—Issue on Jan. 12 of £1,560 debentures, part of a series created July 9, 1904, to secure £50,000, charged on the company's undertaking and property, including uncalled capital. Trustees: Liverpool Mortgage Insurance Company, Limited, 6, Castle-street, Liverpool. Total amount previously issued of same series, £12,200.

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## APPOINTMENTS VACANT.

**Chief Foreman Winder**, Messrs. Dick, Kerr, and Co. See advertisement. (The position is vacant owing to the sudden death of Mr. B. Elliott, who had been chief winder since the opening of the Preston works.)

**Various**—Electrical Mechanic, 42s. per week; Electrical Assistant, 52s. 6d. per week; London County Council Engineer's Department.

**Test-Room Assistant**, central station. Commencing salary, 30s. per week. See advertisement.

**Assistant Electrical Engineer**, West Bromwich. Commencing salary, £120 per annum. Applications to the Borough Electrical Engineer and Manager by Feb. 4. See advertisement in last issue.

**Clerks**, St. Marylebone Borough Council. Ledger clerk, at a commencing salary of £100 per annum, and a junior clerk, at a commencing salary of £50 per annum. Applications by Feb. 4. See advertisement in last issue.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Oporto.**—The Municipal Authorities require tenders for lease of their electric tramways. Tenders by March 15.

**Todmorden.**—The Corporation invite tenders for the supply of electricity meters. See advertisement in last issue.

**Milan.**—The Mediterranean Railways require tenders for an electric crane to be erected at Gallarate. Tenders by Feb. 10.

**Arenas De San Pedro.**—The Municipality require tenders for public electric lighting for 20 years. Tenders by Feb. 12.

**Ghent.**—The Municipality require tenders for 15 electric cranes for the harbour works. Provisional estimate, £1,200. Tenders by Feb. 20.

**Bucharest.**—The Government require tenders for the annual supplies to the Regie for lighting materials and accessories. Tenders by Feb. 7.

**Swindon.**—The Corporation invite tenders for the supply, delivery, and erection of switch panels, etc. Tenders by Feb. 21. See advertisement.

**Dublin.**—The Corporation invite tenders for the supply of arc lamp carbons to their electricity undertaking. Tenders by Feb. 23. See advertisement.

**Ilford.**—The Urban District Council invite tenders for the supply of about 2,400 yards ·4in. concentric armoured cable. Tenders by Feb. 7. See advertisement in last issue.

**Liria.**—The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

**Kirkcaldy.**—The Town Council invite tenders for the extension of about 500ft. in length of the present East Pier. Tenders to the Town Clerk by Feb. 4. See advertisement in last issue.

**Newport.**—The Visiting (Lunacy) Committee invite tenders for the installation of fire-alarms, telephones, etc., at the county borough asylum. Tenders by Feb. 14. See advertisement.

**Bury.**—The Electricity Committee invite tenders for the supply and erection of one 500-kw. direct-current high-speed generating set. Tenders by Feb. 14. See advertisement in last issue.

**Madrid.**—The Department of Agriculture, etc., invite tenders for installation and working for 60 years of an extension of the electric tramways in the north of the town. Tenders by Feb. 25.

**Laventhem (Belgium).**—The Municipality require tenders for erection of central station, laying of mains, etc. Particulars (3s. 4d.) may be obtained from the Secretary of the Mayor of that place.

**Leith.**—The Corporation invite tenders for the supply and erection of one 600-kw. steam dynamo, one water-tube boiler, and one traction switchboard. Tenders to the Town Clerk by 6 p.m. on Feb. 15.

**Stockport.**—The Tramways Committee invite tenders for the overhead equipment of about four miles of electric tramway, and also for copper rail bonds. Tenders by Feb. 6. See advertisement in last issue.

**Brussels.**—Tenders are required for erection of an electric station at the goods railway station at the port. Specification No. 391 is obtainable from the Belgian Government Railways. Tenders by Feb. 8.

**Manchester.**—The Tramways Committee invite tenders for the supply and erection of a main switchboard, auxiliary distribution boards, etc., for their car-repairing works. Tenders by Feb. 14. See advertisement.

**Stockton-on-Tees.**—The District Fund, Gas, Quay, and Electricity Committees invite tenders for the several articles and stores required by them for the year ending March 31, 1906. Tenders by Feb. 10. See advertisement.

**West Ham.**—The Council invite tenders for the supply of engine-room stores, cables, integrating wattmeters, double-pole house cut-out boxes, transformers, incandescent lamps, and coal. Tenders by Feb. 6. See advertisement in last issue.

**Switzerland.**—M. R. Vontobel, of Winterthour, and M. Charles Probst, of Lucerne, have obtained a concession for the construction of a narrow-gauge electric railway from Meiringen to Gletsch. The total cost of the enterprise is estimated at £241,600; £19,600 is to be expended on rolling-stock.

**Bermondsey.**—The Borough Council invite tenders for the supply of arc lamp carbons, conduits, electricity meters, demand indicators, and mains, fuses, engine oils, indiarubber cables and jointing mateirial, lead covered cables, and meter boards. Tenders to the Town Clerk by Feb. 6. See advertisement in last issue.

**Portsmouth.**—The Corporation invite tenders for 12 months' supply of electrical and other stores, laying cables, etc., and for carting coal from steamer to bunkers at the electric lighting station, Portsmouth. Tenders, by Feb. 15, to the Manager, Electric Light Station, Gunwharf-road, Portsmouth, from whom forms of tender can be obtained.

**Christiania.**—The Government Railways require tenders for 8 000 kilos 4mm. galvanised iron wire, 5.000 kilos 3mm. ditto, 500 kilos salammoniac for Léclanche batteries, 500 carbons for ditto, and 4,000 insulators. Tenders, addressed to the office of the Administration, Jernbanetorret 8-9 in Christiania, in envelopes marked "Anbud paa Telegraf-og Telefon-materiel," to be received by Feb. 3.

**Stockport.**—The Gas and Electricity Committee invite tenders for the supply, delivery, and erection complete of one 21-kw. tramway rail return booster. Specification, conditions, and form of tender may be obtained from Mr. A. J. H. Carter, borough electrical engineer, Millgate, Stockport. Tenders, addressed to the Chairman of the Gas and Electricity Committee, Town Clerk's Office, Stockport, by noon on Feb. 15.

**Bridlington.**—The Corporation invite tenders for the installation of electric lighting (1) on the Prince's Parade, (2) in the Victoria Rooms, and (3) in the town hall. Specifications may be seen on application to Mr. J. Lomas, Electricity Works, Quay-road, Bridlington. Separate tenders, endorsed "Parade," "Victoria Rooms," and "Town Hall" respectively, to be sent to Mr. A. E. Matthewman, Town Hall, Bridlington, by Feb. 9.

**Bournemouth.**—The Town Council invite tenders for the following: Contract No. 1 (Section A) steel grooved girder rails, etc.; (B) permanent-way construction and rail bonding; (C) wood blocks and granite sett edging. Further particulars and drawings, etc., may be obtained at the office of the engineer, Mr. F. W. Lacey, M.I.C.E., Municipal Offices, Bournemouth. Tenders to the town clerk, Mr. Geo. Wm. Bailey, by 10 a.m. on Feb. 15.

**Shanghai.**—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Pook and Co., 63, Leadenhall-street, E.C. Tenders by March 31, 1905.

**Hammersmith.**—The Council invites tenders for the supply of (*a*) arc lamp accessories; (*b*) arc lamp globes, etc.; (*c*) brooms and brushes; (*d*) carbons; (*e*) commutator brushes; (*f*) electrical goods; (*g*) files; (*h*) firebricks, clay, and lime; (*i*) gauge glasses; (*j*) incandescent lamps; (*k*) insulated wires; (*l*) lubricating oil; (*m*) metals; (*n*) meters; (*o*) oilman's goods; (*p*) packing and jointing materials; (*q*) screws; (*r*) tools; and (*s*) Welsh smokeless and other steam coal. Tenders by Feb. 8. See advertisement in last issue.

**Melbourne.**—Tenders will be received at the office of the Deputy Postmaster-General until noon on Feb. 7 for the supply and delivery of (1) 3,500 trunk-line multiple jacks, in strips of 20; (2) 1,320 yards of 64-wire wool-insulated switchboard cable. Specifications may be seen at the General Post Offices at Melbourne, Sydney, Brisbane, and Adelaide. Tenders, endorsed "Tender for ——," as the case may be, addressed to the Deputy Postmaster-General, Melbourne, may be deposited in the tender-box at the General Post Office, Melbourne, or, if sent by post, must be prepaid and registered. The deposit to be enclosed with the tender is 5 per cent. on the total amount.

**Johannesburg.**—The Municipal Council are prepared to receive tenders for 100 electric tramcars, two electric water-cars, one five-ton travelling crane, one electric car traverser, and various workshop tools, including erection at Johannesburg, to Specification No. 10 of their consulting engineers, Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W. Copies of the specification may be seen on and after Jan. 7 at the Council Offices, Johannesburg, and at the Consulting Engineers' Offices in London, and may be obtained on payment of five guineas, which will be returned on receipt of a bona fide tender. Duplicate copies of the specification may be bought for 10s. each (not returnable). Tenders must be addressed to Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W., and must be received by them not later than March 6. The Council will not be responsible for any expenses incurred in tendering.

**South Shields.**—The Corporation invite tenders for the execution of the works and the supply of plant in connection with the laying of proposed electric overhead tramways in the streets of the borough: (Part 1) permanent way and construction of track; (2) copper rail bonds, bonding of tramrails; (3) conduits, cables, and overhead equipment. Specification, etc., can be obtained from Mr. J. Moore Hayton, town clerk, on payment of £5. 5s. for each of Parts (1) and (3), and £2. 2s. for Part (2), which sum will be returned on receipt of a bona fide tender for each part. General and detailed plans of the proposed works can be seen as regards Part (1) at the office of Mr. S. E. Burgess, M.I.C.E., borough engineer, Chapter-row, and as regards Parts (2) and (3) at the office of Mr. J. H. Cawthra, M.I.E.E., the borough electrical engineer, West Holborn, South Shields. Tenders to the Town Clerk, Court-buildings, South Shields, by Feb. 20.

## RESULTS OF TENDERS.

**Motors.**—The Brush Electrical Engineering Company, Limited, have obtained a contract for 32 traction motors for the Birmingham and Midland Tramways.

**Leicester.**—The Town Council have accepted the tender of Messrs. Yates and Thom, at £6,062, for two boilers and boiler-house appliances at the tramways main power station.

**Pudsey.**—The Corporation have accepted the tender of Messrs. Johnson and Phillips, Old Charlton, Kent, for underground cables, boxes, and switchboard. The contract includes laying and erecting.

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**Ormskirk.**—The Guardians have accepted the tender of the Hart Accumulator Company, Marshgate-lane, Stratford, London, E., for the supply of storage battery of 116 of their standard lighting type cells.

**Enfield.**—The War Office has accepted the tender of Messrs. Johnson and Phillips, Old Charlton, Kent, for the necessary rubber and paper cables, with boxes, for the electrifying of the Royal Small-Arms Factory, Enfield Lock.

**Cheltenham.**—The Corporation have given the Lancashire Dynamo and Motor Company, Trafford Park, Manchester, an order for an automatic reversible booster (Turnbull and McLeod patent), together with a switchboard for operating same.

**Belfast.**—The Electricity and Tramways Committee have accepted the tender of the Hadfield Steelfoundry Company, Limited, at £1,126, for special track work at the Sandy-row depôt, and the tender of M'Laughlin and Harvey, Limited, at £19,690, for the erection of the generating station.

**London County Council.**—The following tenders have been received for the execution of the roadwork and platelaying in connection with the construction, for the underground conduit system of electrical traction, of the tramways authorised by the London County Tramways Act, 1904, from the existing lines in Clerkenwell-road, *viâ* Rosebery-avenue and St. John-street-road, to the existing lines at the Angel, Islington :

| | | | |
|---|---|---|---|
| John Mowlem and Co., Limited, London (accepted) ... | £27,925 | 0 | 0 |
| Robert W. Blackwell and Co., Limited, London ..... | 29.149 | 14 | 6 |
| Wm. Griffiths and Co., Limited, London ..... | 29,704 | 1 | 5 |
| Dick, Kerr, and Co., Limited, London ..... | 29 924 | 9 | 10 |
| J. G. White and Co., Limited, London ..... | 31,218 | 7 | 10 |
| Muirhead, Greig, and Matthews, London ..... | 31,619 | 15 | 6 |

The engineer's estimate of the cost of the work was £26,432. 16s. 5d.

# BUSINESS NOTES.

## TRACTION.

**Dublin.**—The company's extension to Rathmines has been opened.

**Llandudno.**—An early start is to be made with the construction of the tramways.

**Chesterfield.**—The system has now been completed, and a satisfactory trial trip was made the other day.

**Musselburgh.**—It is reported that the company is likely to be asked to extend their system towards Newcraighall.

**Leighton-Hitchin.**—It is stated that the light railway scheme has been abandoned, owing to the opposition of certain landowners.

**Barry.**—It is reported that the Urban District Council have now resolved to apply for a provisional order for electric tramways and lighting.

**Exeter.**—At the meeting of the City Council it was stated that the generating machinery for the electric trams was practically complete.

**Raunds.**—The Urban District Council have decided to ask the County Council to have the clause relating to option of purchase inserted in the company's Bill.

**Metropolitan District Railway Co.**—The directors recommend a dividend on the 4 per cent. guaranteed stock at the rate of £1. 7s. 6d. per cent. per annum for the past half-year.

**British Electric Traction Co.**—The directors declare a half-yearly dividend on the preference shares at the rate of 6 per cent. per annum. Warrants will be posted on 15th inst.

**Rochdale.**—Major Druitt's inspection proving satisfactory, the Heybrook section was opened last week. The laying of the lines from Heybrook to Littleborough will shortly be begun.

**Swinton.**—The Urban District Council have arranged with the tramway promoters to abandon the destructor scheme, the promoters paying compensation and agreeing to complete the trams within two years.

**Ackworth and Lindsey Light Railway.**—Evidence is now being gathered by the promoters of the Ackworth and Lindsey Light Railway. The enquiry by the Light Railway Commissioners into the proposal is to be held at Barton early in March.

**Waterloo and City Railway Co.**—The directors recommend a dividend on the ordinary stock at the rate of 3¼ per cent. per annum for the half-year ended Dec. 31, 1904, carrying forward £255. The dividend at December, 1903, was at the rate of 3 per cent. per annum.

**Lincoln.**—It is probable that the Corporation will make an early commencement with its tramway scheme, the Board of Trade having intimated that a new Act is not necessary to sanction the laying of a 4ft. 8½in. track instead of the 3ft. 6in. gauge mentioned in the Corporation's Act.

**Coventry.**—At a special meeting of the company a Bill which is being promoted to secure an extension of time for the completion of the works was approved, although it was stated that in all probabilty there would be no necessity to proceed with it, as the required work might be completed.

**Cardiff.**—At a meeting of the Tramways Committee last week a discussion took place as to the advisability of running trams earlier, or to charge a fare and a half, in order to make the Sunday service remunerative. It was eventually decided that Mr. Ellis should prepare a report on the matter.

**Blackpool and Fleetwood Tramways Co.**—For the past half year the company has a surplus of £10,426 available, and a dividend of 6½ per cent. for the half-year, equal to 9 per cent. for the year, is recommended. There is put to reserve and depreciation £1,500, to general reserve £500, and carried forward £1,964.

**Valparaiso.**—The municipality has sequestrated the property of the new electric traction company for a debt of 20,000dol. owed by the old tramway company. Although both companies settled their accounts in November, a receiver has been placed in possession. The action of the municipality is of interest to foreign capitalists.—*Globe.*

**Grimsby.**—In reference to the note which appeared in our issue of Jan. 20 concerning the light railway to be promoted by the Great Central Railway Company in connection with their Immingham Dock scheme, the Rural District Council have agreed to give their support, stipulating only that the fares and freight rates be kept within reasonable limits.

**Hammersmith, etc, Railway Bill.**—At the House of Commons the Senior Examiner of Standing Orders had before him last week the Hammersmith, City, and North-East London Railway Bill. Four memorials had been lodged in the Private Bill Office alleging that this measure does not comply with the Standing Orders. Consideration was deferred.

**Derby.**—The receipts of the Corporation tramways during the four weeks ended Jan. 21 amounted to £2,399. 17s. 1d., being an increase of £1,162. 7s. 6d. as compared with the corresponding period last year. The committee recommend that the route from the Market-place to the borough boundary on the Kedleston-road should be proceeded with.

**Edinburgh.**—A sub-committee last week considered several proposals for the extension of the tramways throughout the city. The matter was referred to the borough engineer to prepare preliminary plans and report. Consideration of a letter from the National Electric Tramways Company asking consent to lay a line from Fountainbridge to Slateford was deferred.

**Plymouth.**—Sanction has been received to a loan of £6 380 for the construction of new tramways from Pound-street, through Cobourg-street, to Pennycomequick, and it is understood the work will be put in hand at an early date. The committee have decided to apply for sanction to a loan of £1,222 for the alteration of the tramways at the corner of Ebrington-street.

**Swansea.**—A *plébiscite* was taken on Tuesday to decide whether parliamentary powers should be applied for to enable the Corporation to treat next year with the Swansea Tramway Company for the compulsory acquisition of its property, subject to a lease to the company for 21 years. The poll resulted in an affirmative vote, the majority in favour numbering about 800.

**Light Railways.**—The Board of Trade have recently confirmed the undermentioned orders made by the Light Railway Commissioners : Blackpool and Fylde Light Railway (Change of name, etc.) Order, 1905, amending the Blackpool and Garstang Light Railway Order, 1901 ; North Lindsey Light Railways (Amendment) Order, 1904, amending the North Lindsey Light Railways Order, 1900.

**Brighton.**—In an article on the completion of the third year's traffic on two of the routes of the Brighton municipal tramways (Ditchling-road and Beaconsfield-road), the *Sussex Daily News* shows that, although the total of 4,769 820 passengers exhibits a decrease of 134,457 on the number carried the previous year, the reorganisation and increase of fares have led to a revenue of £20,766. 11s. 10½d., or an increase of £332. 2s. 1½d.

**Belfast.**—It is reported that the town clerk has received a letter from a local firm of solicitors announcing that proceedings are about to be taken against the mayor, aldermen, and councillors who have accepted free passes for the trams. Application will be made in the Chancery Court for an order directing the resolution of the Council granting the passes to be rescinded, and ordering the councillors who accepted passes to deliver them up.

**Croydon.**—Polling took place at Croydon on Tuesday on the question of extending the tramways, for which purpose it is proposed to borrow about £150 000. Although there was strong opposition to the scheme, the result was favourable to the project, the voting being as follows: for, 3,523; against, 3 435. It is reported that the frontagers, prominent among whom is Sir William Treloar, will appear before the parliamentary committees by counsel.

**Walsall.**—The following particulars relating to the first year's working of the municipal trams are supplementary to those given in our last week's issue : revenue £25 089 ; working expenses, £17,157 ; average revenue per mile, £1,558. The number of car miles run was 632,368 ; passengers carried, 4 514,471 ; units of power consumed, 707,654 ; average number of cars in use per day, 17 ; average speed per hour, seven miles ; average car hours per day, 13 ; average number of passengers per mile, seven.

**New York Central Railway.**—It is reported that the New York Central and Hudson River Railroad Company has placed an order with the General Electric Company of New York for 60,000 h.p. in Curtis steam turbo-alternators, consisting of eight units of 7,500 h.p each. This will be, when completed, the largest steam-turbine installation of any kind in the world, and the first large steam-turbine installation used for supplying the motive power over nearly 300 miles of track now operated by steam locomotives.

**Elland.**—The Halifax Corporation having decided not to extend their system to Elland, the latter Council are disposed to favour the scheme of a syndicate for running a line between Halifax and Huddersfield, though it would be too late to obtain powers in the coming session. It is stated that an effort is to be made by the syndicate to secure running powers over the lines of both Halifax and Huddersfield, and they propose to get over the difficulty of variation in the gauge of the lines by obtaining powers to lay down a third line in the Huddersfield borough.

**London United Tramways Co.**—The Wimbledon Urban District Council have decided to lodge with the company notice of objection to the work in Wimbledon, on the ground that the plans and sections were not in accordance with the Act, and that the company did not

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comply with several requirements in the matter of footpaths, street widenings, etc. The New Malden District Council have arranged with the company to suspend opposition to the company's application for an extension of time, pending negotiations as to the widening of the railway bridge in Kingston-road.

**Heckmondwike.**—The Examiner has had before him the Heckmondwike Urban District Council Bill for proof of compliance with the Standing Orders of the House of Commons. The Bill, amongst other things, seeks to empower the Council to enter into agreements with the British Electric Traction Company for the supply of electrical energy for tramway purposes. Opposition was offered by the Yorkshire Electric Power Company, the Liversedge Urban District Council, and the Batley Urban District Council. The Examiner decided that he must report non-compliance with Standing Orders.

**Olympia Motor Show.**—On Feb. 10 the Society of Motor Manufacturers and Traders will open their automobile exhibition at Olympia. The whole of the interior of Olympia, which is now one vast hall, giving a floor space of 440ft. long by 250ft. wide, will be entirely devoted to motor vehicles, while the galleries, a quarter of a mile in circuit and 40ft. broad, will be assigned to tyres and accessories. Electric light up to about 400,000 c.p. will be available. Arrangements are now being made for 105 exhibitors of cars, 22 of heavy motor vehicles, 17 of motor boats, 2 of machinery, 13 of tyres, and 51 of accessories.

**Great Eastern Railway.**—At the half-yearly meeting of this company, Lord Claud Hamilton, who presided, stated that the decreased earnings were partly due to the depression of trade, but he was afraid the competition of electric tramways, which were not only running in every part of their district, but in many cases were running alongside their railway, was mainly accountable for the decrease. As sensible men, they could not find fault with tramways run by public companies, but what they did complain of was the competition of municipal tramways supported by the rates to which the Great Eastern Company were the chief contributors.

**Glasgow.**—At last week's meeting of the Corporation reference was made to the position of the negotiations with the County Council of Renfrew regarding the proposed tramway from Spiers Bridge to Barrhead. In reply it was stated that the negotiations had come to a deadlock. The Renfrewshire Committee would not give their consent to the order going forward, and requested that Glasgow should withdraw the rating clause and do other things that they could not agree to. The Tramway Committee undertook that if consent to the Bill going forward was given, they would agree not to lay a single yard of line until permission was accorded. The County Council, however, remained obdurate.

**Natal.**—The *Natal Government Gazette* of Dec. 13 contains notices of applications for leave to introduce Bills into the Legislative Assembly of Natal to authorise the construction and working of tramways either by electricity or other power: (1) from a connection on the south bank of the River Umgeni with the Durban Corporation tramways to Prospect Hall; (2) from a point at or near Hillary's Station to the boundary of the Bellair estate; and also to contract for the supply of electric light or electric power to the residents in the districts to be served by the said tramways. The *Gazette* may be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C.

**Turkey.**—It is reported from Constantinople that the syndicate associated with M. Empain, the Belgian financier who is connected with the Paris Metropolitan Railway and other electrical enterprises, has acquired from Izzet Pasha the concession granted to the latter by the Sultan for the construction of electric tramways and light and power works at Damascus. The *Frankfurter Zeitung* states that the syndicate has paid for the transfer of the concession £26,000 in cash and £4,000 in shares of the company to be formed to carry out the scheme, with a share capital of £250 000. The concession carries with it the right to utilise for the production of electrical power all the available water power within a distance of 18 miles of Damascus.

**Hastings.**—Local associations are busy in obtaining signatures to petitions against the overhead system on the front. On the other hand, Councillor Boutwood delivers a warning in the local Press against the Council involving itself in costly litigation. The two sections in which work was originally began now join, and good progress is being made with other lines. It is the company's intention to continue the Silverhill lines through Bohemia and down London-road, St. Leonards, where they will join trams from Bexhill. A large plot of land has been acquired near Ore Station, on which it is proposed to erect the main power station. The Bexhill Town Council have decided to take all necessary steps to oppose the company's Bill.

**Queensferry.**—The solicitors to the National Electric Construction Company have written to the town clerk of Edinburgh, the town clerk of Queensferry, the county clerk of Midlothian, and the county clerk of Linlithgow, formally notifying them that an application would be made in March for a provisional order to authorise the construction of tramways from Edinburgh to Queensferry. The starting point in Edinburgh would be the west end of Princes-street or the termination of the cables at Comely Bank. It was further stated in the letter that if the order was got from Parliament, satisfactory guarantees would be given that the tramways would be laid and working in the shortest possible time after sanction had been got. In the letter to the town clerk of Edinburgh it was also suggested that the current might be taken from the Corporation.

**East London Railway.**—The wail at more than one railway company meeting during the last few days has again been the competition of electric tramways. The East London Railway, however, prefers to continue its policy of sitting on the fence in regard to electrification, apparently in the hope that the Metropolitan and District Companies, who join on to the East London system at Whitechapel, will undertake the conversion of the line. It is true that the East London Company are not in a very happy state financially, but they would probably be able to raise the funds necessary for such a promising work as the electrification of the system. As one reason for not embarking on this enterprise at the present juncture, the chairman referred to the experiment of the Brighton Company in trying the overhead principle. Assuming, however, that this system proves a success, it would complicate a physical junction with the Underground lines if adopted by the East London Railway.

**Gloucester.**—In submitting the minutes of the Tramway Committee last week, Councillor Fream referred to correspondence demanding a more frequent service of cars, and gave the results of an experimental increase of the services. Periods of three weeks ending respectively on Dec. 21 and Jan. 25 were compared. In the first three weeks they had an average of 14 cars in service, and the last three weeks 16 cars. In the first period there was an average car mileage of 8,620 per week, in the second 9 176 miles per week. The average receipts in the first period were £211. 5s. 4d.; in the second, £206. 19s. 11d. The extra cars were run from 8 to 9.30 in the morning; 12 to 2.30 middle day; and 4.30 to 7 in the evening. Notwithstanding an average increase of 500 car miles per week, the gross receipts had dropped £5 per week, and the average per car mile had, of course, dropped as well—from 5·88d. to 5·41d. The time-table service had been strictly adhered to, and the suggestion that a disturbance of the times of the ordinary cars might account for the diminution of receipts was incorrect. It had been stated that it cost 3d. for every stop and restart of a car. As the average number of stops per car mile run was four, and as the total cost of energy for operating the system was only 1½d. per mile, the statement was ridiculous. A request was made that a balance-sheet of the first six month's running should be published.

**North-Eastern Railway.**—On Friday last the company received a large and influential deputation, composed of representatives of municipalities and of the passengers, in regard to greater travelling facilities, chiefly as concerned the first class passengers. Sir Edward Grey, in reply, observed that, as regarded overcrowding, the company had been trying to cope with the difficulty for some time. They admitted there had been overcrowding, and they hoped that in time this would disappear altogether. They were gradually gaining experience in the amount of accommodation required, the difficulty having been inseparable from a new system. As regarded first class compartments, the company had found it would not pay to run a whole coach for first-class accommodation. They hoped, however, that in time they would partition off part of a coach on each train for first-class passengers. This would necessitate they thought, at present, the first-class accommodation being non-smoking. As to the doors of trains opening inwards, the company had under consideration a new door which would open outwards. It would take some months before the improvements contemplated by the company for first-class passengers were carried out. Sir Edward, in conclusion, hoped that the company would remove eventually all the friction that at present existed between the public and the North-Eastern Railway.

**Llandilo-to-Lampeter.**—At a meeting of the Carmarthenshire County Council a large deputation attended in support of an application for a grant towards the preliminary expenses of obtaining a provisional order for the proposed Llandilo and Lampeter Light Railway. Mr. Dudley W. Drummond, in introducing the deputation, said they represented the parishes of Talley, Llansawel, Cayo, Llanyorwye, Pencarreg, and Lampeter. If the preliminary expenses of surveying, etc., were assured, they hoped to go with the scheme before the Light Railway Commissioners in May next. The following sums had already been promised by public bodies along the route—namely: Llandilo Rural District Council, £300; Llandilo Urban District Council, £100; Llandovery Rural District Council, £100; Lampeter Town Council, £100; and Llanybyther Rural District Council has also promised financial aid. The railway, 23 miles in length, would be a connecting link between important districts. It was to be of standard gauge. The estimated cost of the provisional order was £800, and £500 had been already voted. There was absolute unanimity amongst the public of all classes and creeds along the route, and the promoters were representative landowners throughout the district. The lowest estimate of the annual receipts to be received by the railway was £14 000, and after taking into consideration the usual estimate of 50 per cent. for working expenses, this would leave a net profit of £7,000 a year. The County Council unanimously resolved to make a grant of £300.

**Metropolitan Railway.**—At the half-yearly meeting of this company the chairman observed that electric trains were now running regularly on the railway. They had been rewarded with an increase in their traffic. They had so far completed the electrical equipment of their line as to admit of the working of a portion of their trains, between Baker-street Station and Uxbridge, through Harrow, by the new method of traction. They were gradually increasing the number of electric trains into and out of Baker-street, and they hoped shortly to be able to dispense with steam entirely on that section. On the Inner Circle the works were being pushed on, and they hoped very soon to run some electric trains on that section. He understood that the District Company were also well forward with their installation; so that they might reasonably expect, in the near future, when both companies were ready, to see the trains on the Circle driven by the new power. So far as regarded this company's section of the Circle, their contractors hoped to enable them to run a few trains as early as March. In their new electric trains they had provided two classes only, and this, of course, meant ultimately abolishing second class entirely on the Circle trains and on the trains between Baker-street and Uxbridge. They proposed at the same time to revise and reduce their first-class fares, so that they would, speaking generally, not exceed the third-class fares by more than one-half. This would apply both to single and return journey fares, and there would also be some reduction in the season-ticket rates.

**Liverpool.**—The following proposal is down for consideration at the monthly meeting of the Bootle Town Council: "That the Bootle

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Corporation will in the next session of Parliament apply for a provisional order authorising them to construct the following two lines of tramways in Bootle: (1) Breeze-hill, Balliol-road, and Miller's Bridge to Regent-road; (2) Linacre-lane, from Knowsley-road, *vid* Aintree-road, to the borough boundary at Hornby-road, Walton; that such order shall contain power for the Liverpool Corporation to continue the construction of both lines and connect same with the Aintree and Fazakerley line; that such new lines shall be worked by the Liverpool Corporation in conjunction with existing tramways and for similar purposes only; that the rental provided in the existing agreement of Sept. 1, 1902, be increased in respect of the additional cost of special construction and maintenance of the Balliol-road line." Mr. Bellamy has now reported on the question of fares. He thinks a universal 1d. fare would cause much dissatisfaction as resulting in unequal value. Halfpenny fares, he considers, would entail a net annual loss of £75,000. With regard to workmen's fares, Mr. Bellamy submits that Liverpool has adopted a general fare which is below the statutory fare of ½d. per mile fixed for workmen. In conclusion, Mr. Bellamy suggests that the committee might consider whether it would not be a wise policy, having secured to the Liverpool public many advantages in their car service, to refrain for a time from experimental concessions which it would be difficult to recall, and which might prove disastrous.

**London County Council.**—The Streets Committee presented to the City Corporation last night a recommendation that the proposal of the County Council to run tramways over Blackfriars Bridge and along the Victoria Embankment for the purpose of linking up the southern tramway system be opposed. The committee arrived at this decision by a narrow majority. At the same time it is reported that Mr. Deputy Algar has been elected the chairman of the Bridge Houses Estates Committee, to which body has been referred the proposal to widen the City side of Blackfriars Bridge in order that the passage of the tramways may be facilitated. At Tuesday's meeting of the Council the Highways Committee recommended that Messrs. J. Mowlem and Co.'s tender, amounting to £27,925, for the roadwork and platelaying in connection with the line from Clerkenwell-road to the Angel, Islington, be accepted. Particulars of the tenders will be found in our usual column. The receipts for the week ended Jan. 21 amounted to £11,470 as against £8 906 last year, and from April 1 to that date the total was £538 012, against £418,907. Questioned upon the remarks made by the chairman of the South-Eastern Railway Company, the Chairman of the Highways Committee stated that so far from being aided by the rates the municipal trams of London had aided the rates to the extent of £293 592. This amount, Mr. Baker went on to explain, was handed over in relief of rates from the profits earned in the six years of working from 1897-8 to 1902-3. In addition, the interest on the loan had been paid and the debt reduced to the extent of £246 591. A further amount of debt had been paid out of the proceeds from the sale of property, horses, and fodder no longer required, and this reached a total of £93,376. "It is true," Mr. Baker proceeded, "that owing to the cost of reconstructing the lines we did not pay anything in the reduction of rates last year. We were, however, able to carry forward a credit balance of £18 565. This year the working of the lines has been so successful that when the accounts are presented we have reason to believe the Council and the ratepayers will again be highly satisfied." In addition to this it has to be remembered that the improved labour conditions under the Council represent a substantial amount, besides which ½d. fares have been introduced.

**Birmingham.**—The Tramways Committee in their report to be presented to the Council on the 7th inst. deal with the acquisition from the City of Birmingham Tramways Company, under Section 43 of the Tramways Act of 1870, of so much of the company's undertaking as is situated in the district of Balsall Heath, which district became part of the city in 1891. A proposition was made by the company in June that the Corporation should pay a lump sum, which was to include the purchase of the lines and a release from all statutory obligation to purchase rolling-stock, depôts, etc., which might arise under the Tramways Act, 1870, Section 43. The company stipulated that they should have a lease of these lines until Dec. 31, 1906, at a rent equal to the interest and sinking fund on the amount which might be agreed upon as the lump sum payable by the Corporation. The negotiation afforded an opportunity of raising the whole question of electrically equipping all the horse and steam routes under lease until Dec. 31, 1906, before the actual expiration of the leases, so that any break in the service might be avoided. At first there was a large difference between the parties as to the value to the Corporation of a concession to electrify the lines before the expiration of the lease, but the following terms have now been provisionally arrived at, the Corporation agreeing to take over the large car-sheds and repairing shops in Kyott's Lake-road: (1) The Corporation to pay to the company £220 000 for: (*a*) the lines of the Balsall Heath tramway; (*b*) full satisfaction of their statutory liability in respect of the Balsall Heath system; (*c*) the concession stated in Clause 4. (2) The Corporation to have immediate possession of the Balsall Heath tramway, and the purchase money to be paid on Dec. 22, 1906. (3) The Corporation to immediately lease the Balsall Heath tramway to the company to Dec. 31, 1906, at a peppercorn rent. (4) Immediately on the execution of the agreement, the Corporation to be at liberty to enter upon the steam routes and horse routes in lease until Dec 31, 1906, for the reconstruction thereof, and to construct crossover roads, increase or alter passing places, situation for loop, etc., and to make connections with junction to overhead equipments in accordance with a plan already signed by the managers. (5) The company to have option as to order of reconstruction, but all lines to be reconstructed by Dec. 31, 1906. (6) The Corporation to proceed with the reconstruction expeditiously, and to compensate for loss of traffic receipts consequent upon any interference with the company's car mileage in the course of reconstructing the lines, but the company to do their best to maintain their car mileage. (7) The Corporation to protect and indemnify against accidents, during reconstruction, not attributable to negligence of the company or their employés. (8) Until reconstruction, the company only to be liable for such repairs as may be sufficient to maintain the existing steam services with safety to the public; liability to cease during reconstruction, and after reconstruction the company's liability to be the same as under existing leases. (9) The Corporation to purchase the Kyott's Lake-road depôt for £16 000, and the purchase to be completed on Dec. 22 1906. (10) The company to give possession of so much of the Kyott's Lake-road depôt as is required for Corporation purposes on July 1, 1906 (this is defined by plan), and thereupon the Corporation to pay half of the purchase money. (11) The company to remove their cars, engines, etc., immediately after Dec. 31, 1906, and, in default, the Corporation to be entitled to remove and recover expense at March 31, 1907. (12) Disputes to be referred to arbitration. The committee recommend the approval of these terms, being satisfied that the cost to the Corporation would not be less if the leases were allowed to expire with no provision as to re-equipment, and that great public inconvenience will be avoided by ensuring an uninterrupted service when the transfer of control from the company to the Corporation takes effect in January, 1907.

## LIGHTING AND GENERAL.

**Barnet.**—The Herts County Council intend to oppose the Barnet electric lighting order.

**Sunderland.**—Application is being made for a loan of £15,000 for additional electric supply plant.

**Battle.**—Enquiries are being made with regard to the provision of telephonic facilities in the town.

**Cumberland Asylum.**—The proposed electrical installation at the lunatic asylum is estimated at £6 600.

**Stirling.**—Sanction has now been obtained to borrow £4,000 for the Town Council's electric light undertaking.

**Macclesfield.**—It is proposed to appoint a consulting electrical engineer to formulate a scheme of electricity supply, the cost of which must not exceed £20,000.

**Islington.**—At to-night's meeting it will be recommended that conduits and mains be laid along Holloway-road from Eden-grove to Canonbury-road, by St. Paul's-road, at an estimated cost of £2 800.

**Nantwich.**—The Urban District Council have referred to the General Purposes Committee consideration as to the steps to be taken to carry into effect the electric lighting scheme for which they were granted a provisional order in 1900.

**South Africa.**—The Village Main Reef Company have just ordered the first large electric hoist adopted for the Rand. The winder will be placed at a vertical depth of 1,100ft. The generating plant will be of 900 h.p. and the hoist of 500 h.p.

**London Electric Supply Co.**—The company have sold 10,531,785 units of energy during 1904, estimated to produce a net revenue of £65 333, and not £60,333 as previously announced. A dividend of 3 per cent. is recommended on the ordinary shares.

**Ilfracombe.**—The manager of the local electric light company, Mr. A. Alan Jenkins, arranged for an exhibition which is now being held in the Runnicleave Theatre, and where numerous appliances for electric light and power, heating, and medical purposes are on view.

**Carlisle.**—The second annual dinner of the staff employed at the electricity works was held on the 19th ult. Mr. Burnet, who presided, gave some very interesting figures of the present and past working of the electricity works, and proposed "Success to the Carlisle Electricity Works."

**Telephone Trust.**—It is announced by the New York papers that 43 telephone companies in the United States and Canada have formed a trust with a capital of £50,000,000. It is projected to run one great trunk line from New York to San Francisco, taking in the branch traffic all along the route.

**"Excello" Arc Lamps.**—We are informed that the Union Electric Company's "Excello" arc lamps are now being installed for lighting up the most important parts of the city of London. A commencement was made on Jan. 31 with lamps around the Bank of England and the Mansion House.

**Farnham.**—The Council are about to withdraw the instructions to the parliamentary agents to apply for a modification of the proposed Farnham and District Electric Supply Company's provisional order, whereby the Council would be enabled to purchase the company's undertaking in 21 years instead of in 42.

**Manchester.**—A report will shortly be submitted to the Town Council, in which Mr. Pearce recommends the following extensions to provide for their requirements of next winter: three 500-kw. motor-generators, £6 000; low-tension switchgear, £1,500; foundations, etc., £600; extensions to mains and sub-station plant, £21,000.

**Tredegar.**—At the last meeting of the District Council the letter of Mr. A. S. Tallis, suggesting that the Council should purchase electrical power from the Tredegar Company and supply private consumers, was further considered, and it was decided that a deputation representing the Council be appointed to meet Mr. Tallis upon the question.

**Ripon.**—At the meeting of the City Council on Monday night, Mr. C. Watson stated that several companies were making application for lighting orders for Ripon. The Corporation had an order in their own hands, but they would do nothing until they knew the intention of the Power and Traction Company, who had already obtained a tramway order for Ripon.

**London Gazette.**—The partnership between John Sandford and Henry W. Wartnaby Dix, carrying on business as electrical engineers at 44, Waterloo-street, Birmingham, has been dissolved by mutual

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consent. The Midland Electric Corporation for Power Distribution have given notice of intended application to Parliament for power to supply electrical energy in bulk to Stourbridge.

**Brighton.**—A party of about 30 members of the Brighton and Hove Natural History and Philosophical Society paid a visit to the Corporation electricity works in North-road on Friday, the event being arranged as one of the series of winter monthly visits to places of interest. They were conducted around the works by Mr. Christie, the resident engineer, and Mr. Philpott, works engineer.

**Gloucester.**—The electrical engineer has reported that, judging from the result of the nine months' trading to Dec. 31 last, he estimated that the trading for the full year ending March 31 next would show a net profit of about £1,100 after paying instalments of interest and sinking fund. The Council are asking Mr. R. A. Chattock, M I E E., to report upon the plans and specifications for the proposed extensions at the electricity works.

**Hull.**—At the last meeting of the Corporation Electric Lighting Committee estimates were submitted by the engineer for the coming year of £36,000 on capital account. Mr. Bell considers that no further expenditure would be necessary on capital account for the next two years, but they would have to decide upon the question of changing over the greater part of the old town system to high pressure. Next year he anticipated an income of £46,887.

**Lennoxtown.**—The Postmaster-General in August last agreed to include Lennoxtown and the surrounding district in the Glasgow free-speaking telephone area, which now stretches from Blanefield and Kilsyth on the north, to East Kilbride and Eaglesham on the south, Bowling on the west, and Baillieston on the east. The National Telephone Company have just opened their Lennoxtown exchange, to which 45 subscribers are joined or are being joined.

**Grimsby.**—The last monthly report of the borough electrical engineer (Mr. W. Vignoles) shows that 2,319 more private lamps and motors have been connected, bringing the total to 42,705. Thirteen new consumers have been added. Compared with the same period a year ago, 977 more units have been sold for traction purposes, 12 more for public lighting, and 25,548 more to private consumers. Steam has been supplied to the station from the destructor works to the value of £12. 4s. 6d.

**Croydon.**—The Attorney-General has obtained from the Railway and Canal Commissioners an order authorising the Postmaster-General to lay telegraphs and telephone wires overhead on the road within the jurisdiction of the Rural District Council. The District Council had refused to consent to wires being laid unless they were placed underground, alleging the road was too narrow. The Postmaster-General is willing to provide narrow iron posts so as not to interline with the road.

**Wimbledon.**—The Urban District Council have adopted a recommendation to the effect that, considering the engine floor space available at the generating station, the plant should be extended by the addition of three 1,000-kw. turbo-alternators with condensers, that the necessary foundations be excavated forthwith, and also that a 1,000-kw. turbo-alternator with condenser be obtained and erected. The electrical engineer is to prepare plans and estimates for such foundations and a 1,000-kw. turbo-alternator with condenser.

**Removals.**—Messrs. E. P. Allam and Co., 11, Hatton-garden, E.C., inform us that, owing to rapid increase of business, they have opened larger offices, showrooms, factory, and stores at 11, Red Lion-street, Clerkenwell-road, E.C., where additional plant has been put down. They call special attention to their department for armature winding and motor repairs, and to new specialities in iron-clad motor accessories. Also due to increasing business is the removal of the General Contracts Company (the Strut Switch) to 62, Rosebery-avenue, E C.

**St Marylebone.**—A special meeting of the Corporation will be held at the town hall on 9th inst. for the purpose of taking into consideration the following Bills affecting the interests of the borough and intended to be introduced into Parliament in the ensuing session—viz.: Metropolitan Electric Supply Company (Various Powers), Central Electric Supply Company, Administrative County of London and District Electric Power Company, Metropolitan Pneumatic Dispatch Company, Baker-street and Waterloo Railway, and London Building Acts Amendment Bills.

**Thornhill.**—The Thornhill power station of the Yorkshire Electric Power Company is now practically completed, and the company have commenced to supply electrical energy. The foundations were laid down in November, 1903, and in December last not only was a supply of energy available, but 26 miles of cable were laid. The generating plant is of a capacity of 9,000 h.p., and, on account of the high pressure adopted, energy may be transmitted from the station over long distances. Contracts are already made for supply to a number of local authorities, collieries, mills, and a variety of trades.

**Halifax.**—The Mayor (Alderman E. Robinson) on Wednesday started a new generating set at the Corporation electricity works, which has been provided at a total cost of £6,631. Alderman Hey stated that this brought up their equipment to 8,000 h.p., with a capacity of 4,500 kw. They had now only a margin of one engine over the maximum demand. If the rate of consumption increased as it had done hitherto, they would before very long be compelled to extend their plant still further. The new engine was given the name of "Enoch Robinson," as a compliment to the mayor.—*Yorkshire Post.*

**Diesel Engines at St. Louis.**—We are informed that the three 225-b.h.p. Diesel engines used in the light and power installation of the St. Louis Exhibition gave excellent results. The engines ran uninterruptedly from the beginning to the end of the fair except on Sundays, when it was closed. They were direct coupled to three Bullock generators, each of 165 kw., and supplied 588,500 kilowatt-hours at a cost of 1,830·60dol. for fuel (60,120 gallons at three cents per gallon). The average cost for fuel was $\frac{3}{10}$ cent (about 0·15d.) per kilowatt-hour on the switchboard, including all generator and line losses.

**Liverpool.**—The Corporation electric supply accounts for last year show that the income on revenue account totalled £236 404, of which £135,631 was from electrical energy for lighting and power, £2,371 from public street-lighting, and £91,674 from tramways. On the expenditure side there is £65 192 for the generation of electricity, £4,752 for distribution, £16 431 for rent, rates, and taxes, and £11 455 for management expenses. The net balance amounted to £44,510, of which it has been resolved to transfer £16,285 to the reserve fund, £11,289 to the renewal fund, and £16,934. 9s. 5d. to the general rate.

**Glasgow.**—The Corporation have adopted the following recommendations of the Committee on Telephone Service: (*a*) that the present call wire system should be gradually superseded, and that in lieu thereof the automatic calling and clearing lamp system should be adopted; (*b*) that in the first place the new system should be applied to the Hillhead exchange, the probable cost of which is estimated at £1,500; and (*c*) that offers be invited for carrying out the necessary works. The general manager reported that it was necessary to extend the switchboard in the Hillhead exchange, and it was agreed to get offers for the work.

**London County Council.**—On Tuesday it was agreed to lend the Hammersmith Borough Council £18 482 for electric lighting purposes. It was reported that a loan of £7,515 to the St. Pancras Council for electric light installation and meters had been completed, and that the Treasury had approved of a term of 42 years for the repayment of a loan of £10,000 for electric light installation. Part of the lighting plant at the Education Offices is to be disposed of, and current is to be obtained from the Charing Cross and Strand Electricity Supply Company. The rearrangement of the mains will entail an expenditure estimated at £250.

**Power Gas.**—We are informed that the Tranmere Bay Development Company, Birkenhead, have placed a contract with the Power-Gas Corporation, of 39, Victoria-street, Westminster, for a gas-driven electric installation for their new shipyard at Birkenhead. The installation consists of a power-gas plant of 6 000 h.p. capacity, the larger portion of the gas generated being intended for firing furnaces. The electric generating plant comprises two 400-i.h.p. Premier gas-engines, each direct coupled to a Bruce Peebles 220-kw. dynamo, and three 250 i h.p. Premier gas-engines, each direct coupled to a Bruce Peebles 140-kw. dynamo.

**Metropolitan Private Bills.**—The following Bills have been passed for first reading: City of London Electric Lighting Company, Limited (Extension of Powers); Woolwich Borough Council; Great Northern, Piccadilly, and Brompton Railway (No. 1); Great Northern Railway; Edgware and Hampstead Railway; Charing Cross, Euston, and Hampstead Railway; Baker-street and Waterloo Railway; Metropolitan Electric Supply Company (Acton District); Whitechapel and Bow Railway; and London County Council (General Powers). Consideration of the Metropolitan Electric Supply Company (Various Powers) Bill and of Great Northern, Piccadilly, and Brompton Railway (No. 2) Bill has been postponed.

**Dartmouth.**—An exhibition will be held at the Dartmouth Subscription Rooms from Feb. 22 to 26 in connection with the Urban Electricity Supply works in the town. There will be a charge made for admission, and the entire proceeds will be devoted to the Dartmouth Cottage Hospital. A string band and the Dartmouth Borough Band will be in attendance. Machinery will be erected and driven by electrical power for sewing, drilling, printing, etc., and there will be on view the most modern appliances in regard to electric lighting, heating, etc. A room containing hospital appliances will be a special feature. The arrangements are in the hands of the company's local engineer and manager, Mr. G. E Smith.

**Edinburgh.**—The Electric Lighting Committee have adopted Prof. Kennedy's report on the proposed extension of plant at M'Donald-road station, and will recommend the Council to authorise an extension at a probable cost of £8 000. They have resolved to recommend that the department should undertake the testing of incandescent lamps at a small cost, with a view of ensuring to users of electric light in the future a supply of current through lamps which had thus been officially tested for the purpose. The number of lamps applied for in the three weeks from Dec. 29 was 5,096, compared with 2,444 in the corresponding period of the previous year. The total for the year from May 15 was 74,458, against 57,156 in the preceding year.

**Stock Exchange.**—The Stock Exchange Committee have appointed Feb. 9 special settling day for Cape Electric Tramways' further issue of 11,222 shares of £1 each, fully paid, Nos. 480,001 to 491,222. The committee have ordered the undermentioned securities to be quoted in the official list: Anglo-Argentine Tramways Company's 50,000 vendors' ordinary shares of £5 each, fully paid, Nos. 380 008 to 430,007; Cape Electric Tramways' further issue of 11,222 shares of £1 each, fully paid, Nos. 480 001 to 491 222; and South African Lighting Association's further issue of 1,000 shares of £10 each, fully paid, Nos. 7,001 to 8 000. Applications have been made to the committee to allow the following securities to be quoted in the official list: Folkestone Electricity Supply Company's 10,000 5 per cent. cumulative preference shares of £5 each, fully paid; and South Wales Electrical Power Distribution Company's 42,750 shares of £10 each, and £150,000 debenture stock.

**Aberdeen.**—The members of the Town Council on Tuesday inspected the Corporation electricity works and the extension of the subway from Holburn-street to Crown-street, under the guidance of Councillor Kemp (convener), Mr. Bell (chief engineer), and his assistants. Mr. Kemp made an interesting statement on the progress of the work during the year, and said that for the 5½ months ending Jan. 19 there

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was an increase of 602,418 units of electricity generated as compared with the corresponding period last year, and that the increase in the number of consumers this year compared with last year was 173. The length of the subway was 780 yards. It took 13 months to build it, and the cost was £10,200.

**Mansfield.**—The Mansfield Woodhouse Urban District Council have appointed a sub-committee to meet the Town Council on the subject of the supply of electricity to Mansfield Woodhouse. Messrs. Hammond and Son are to be retained to maintain a general supervision over the works and to advise the Corporation from time to time upon any points that may arise for a period of 12 months, at a fee of 50 guineas and out-of-pocket expenses. The light railway company have been asked to give a guarantee to pay from May 13 next a minimum sum of £300 per quarter for current whether any is taken by them or not. Layton-avenue will be lighted by electricity, and in addition to the ½-ampere Nernst lamp already fixed in the avenue eight ¼-ampere Nernst lamps will be installed.

**An Aid to Rates.**—Mr. James Carter, the borough treasurer of Preston, in an interesting table of receipts from profitable undertakings, etc., by which rates levied in various towns have been reduced, mentions the following amounts estimated for the current year to be transferred to the borough, district, or other fund from electric light and tramways undertakings: Electric light—Bolton, £4 500; Blackpool, £2,000; Burnley, £4,100; Bury, £300; Cardiff, £3,000; Dewsbury, £1,000; Halifax, £2,500; Hastings, £1,500; Liverpool, £10,298; Nottingham, £6,000; Salford, £4,500; Southport, £2,750; South Shields, £300; and Swansea, £744 Tramways—Accrington, £150; Bolton, £2,740; Belfast, £8,500; Blackburn, £6,000; Blackpool, £500; Devonport, £584; Hull, £11,500; Leeds, £55,000; Liverpool, £32,081 (the latest accounts mentioned in another column give £16,934); Manchester, £51,000; Nottingham £13,000; Salford, £13,000; Sunderland, £4,014; South Shields, £204; West Ham, £8,000; and Wigan, £3,595.

**Printed Matter for Australia.**—In reference to letters and paragraphs that have appeared in different newspapers from a firm of London shipping agents under the above heading, we are informed that printed matter can be posted from England to the Commonwealth of Australia as hitherto without incurring the expense of cases for packing printed matter, freightage, dock and landing dues, customs entries, etc. If sent in bulk to the various States of Australia there is the cost of unpacking and the different rates of postage—*i.e.*, printed matter can be posted from England at the rate of 2oz. for ½d., but if posted in Australia the rate is the same in some of the States, but in others 2oz. for 1d. New Zealand is adopting the same principle as Australia in reference to duty on printed matter. We are informed that the British and Colonial Agencies and the Australian Commercial Agency, 75, Chancery-lane, Holborn, W.C., have made special arrangements for the posting of such matter.

**Coventry.**—The following report was submitted by the General Purposes Committee to the City Council on Tuesday: "Having considered a letter from the Coventry Chamber of Commerce with reference to the present high charges of the National Telephone Company to their subscribers, the establishment of a municipal telephone exchange, and the undesirability of the Government purchasing the undertaking of the National Telephone Company on terms which would prevent a lowering of rates now charged by that company, the committee resolved that it was undesirable that the Government should purchase the undertaking of the National Telephone Company on such terms as would prevent a lowering of the telephone rates now charged by that company to its subscribers, and that the resolution be communicated to the Postmaster-General and the member for the city." The following gentlemen have been appointed a sub-committee to obtain information from other towns where municipal telephone exchanges are established, and to report: The Mayor, Alderman Bird, Councillors Gardner, Goate, and Lee.

**Telephone Exchange Fire.**—There was an outbreak of fire at the Central Exchange of the National Telephone Company in London Wall, last Friday, which, however, was not of a very destructive character, and was very speedily got over. The fire originated in the "cable" or "wire" room on the second floor of the exchange, the same room in which a similar outbreak occurred more than a year ago, and is supposed to have been caused through the fusing of a wire by one of the gas stoves. The operators who were at work there at once went into the adjoining room, which was filled with girl operators, in order to warn them to leave the premises. The girls at once went from the building and across the road to Finsbury House, where in one of the large rooms the superintendent called the muster-roll. The whole strength of the company's staff from all parts of London was immediately concentrated on the new exchange, which has been constructed in the neighbourhood, and with the object of transferring the subscribers to these new switchboards during the night about 500 men were set to work under the superintendence of the company's engineer-in-chief, Mr. Gill, and its metropolitan superintendent, Mr. Clay.

**Hydro-Electric Plant.**—Numerous concessions and applications for concessions to take water from rivers in Spain, in addition to those mentioned in our last issue, have appeared in recent issues of the Board of Trade *Journal*. It is also reported that Signor L. Marcello Ciurlo, Genoa, has applied to the Italian Government for the appropriation of 450 litres per second from the Laccio waterfall at Torriglia for the production of power primarily for industrial purposes and eventually for electric traction. The cost of the works and machinery incidental to this concession is estimated at £25,600. There is, further, an application from Signori Curletti and Erba, Milan, for the appropriation of sufficient water from the Val Paghera and Val Pallobbia falls (Brescia) to produce 7,840 h.p. The cost of the works and machinery incidental to this concession is estimated at £32,000. The concession, which in 1900 was granted by the municipality of Rio de Janeiro to a local firm for the supply of electric energy generated by hydraulic force, was transferred on Jan. 1 to the Rio de Janeiro Tramway, Light, and Power Company, Limited. This company has been formed, with a capital of £5,000 000, by a group of American and Canadian capitalists and electricians, who have already floated other important undertakings of a similar nature in Brazil, Mexico, Canada, and the United States of America.

**Durham.**—At their last meeting the County Council discussed a recommendation and report of the Electricity Committee, and finally referred same back for further consideration. The committee recommended the promotion of a Bill in Parliament for the establishment of a system of electrical services for the county, and also the appointment of an expert to draft a working scheme, the expert to report also as to the practicability of making use of waterfalls (no particular reference to the High Force and Cauldron Snout in Teesdale) as a means of generating electricity. The report read as follows: "The area occupied by electric companies for traction and light extends over 125,921 acres. As the administrative county has an area of 638,037 acres, it will be seen that the county is less than one-fifth covered by existing companies. We find that there is comprised in the area covered by companies a population of 310,508, as against a total population in the administrative county, at last census, of 771,619. There is contained in the area covered by companies a rateable value of £1.261 283, as against a total county basis rateable value of £3,379,748, which is little more than one-third. We desire to point out that it appears from the returns that in a number of cases, districts with large rateable values and populations are only committed to companies for a short term of years, at the expiration of which they will be at liberty to join any public scheme that may have been developed by the authorities. We would point out as evidence of the rapid development of the county that between the census of 1891 and 1901 the population increased nearly 94,000. This rapid rate of growth in population seems to accentuate the need of some more popular means of transit that will disperse them over a larger area, and avoid that congestion which it is so desirable to avoid. In this enquiry we have exerted every effort to obtain reliable data as to the workings of public schemes of electric service. In one large group of public undertakings owned and managed by local authorities we found that the authorities charged their customers 1·34d. per unit less than the companies. This saving in charges aggregated to nearly one million pounds upon an invested capital of 17½ millions, equal to a return of 5½ per cent. per annum, and in addition to this great saving in charges they earned a commercial return of 6·14 per cent., or nearly ¾ more than the companies. This difference was due to two great causes: first, the authorities saved the huge sum of £472,344 in working expenses as compared with the scale of working expenses prevailing with the companies; second, in consequence of selling their electricity at so much less per unit the authorities sold an extra volume of electricity, which brought them an extra income of £585,222 as compared with the scale of sale by the companies for the same plant. Those two large items of economy and extra sale made up the considerable total of £1,057,568, so that the authorities really earned their business profit from those two main sources, and hence were able to sell their products for a million pounds less to the public. Having collected such a mass of general and local information upon the subject we as a committee were authorised to investigate, we think we are fully justified in asking the Council to empower us to have an expert report as to the practicability of a county scheme of electric services."

**Poplar.**—The Borough Council have decided that Glengall-road, Millwall, be lighted throughout with 15 arc lamps, at an estimated cost of £375, and that an agreement be entered into with the Millwall Dock Company for the placing of four of the lamps in the private road of the company. With regard to the cost of the electricity undertaking, the *East end News* stated that at the last Council meeting the Finance Committee reported, with regard to the Council's instruction to the borough treasurer to transfer the ascertained profits of the electricity undertaking to the general funds of the Council, and the instructions to the Finance Committee to use such funds for the purpose of lowering the cost of the public lighting in the borough, and of assisting the rates during the present period of financial strain, that the Electricity Committee had submitted to them the following report of the borough electrical engineer on the subject, with an expression of opinion that no money should be transferred to the general fund from the present credit balance of the electricity undertaking: "With reference to the above, I beg to bring before you, in as concise a form as possible, what I trust you will consider sufficient reasons for withholding this sum from the relief of the rates at the present time: loans accounts—1901-1902, deficit £383, borrowed capital £135,810, repayments deferred £2,279, repayments made £34. 16s. 5d.; 1902-1903, surplus £3,908, borrowed capital £28,170, repayments deferred £3,362. repayments made £168. 5s. 6d.; last year (1903-1904). surplus £2,984, borrowed capital £9,953, repayments deferred £3,707, repayments made £803. 7s.; present year (1904-1905), borrowed capital £45,000, repayments deferred £1,777. repayments due £3,044. 18s. 2d. Total: borrowed capital, £218,933; repayments deferred, £11,125; repayments made, £1,006. 8s. 11d.; repayments due, £3 044. 18s. 2d. If the repayments had not been deferred for 1901, 1902, and 1903, we should now have a deficiency on account of revenue amounting to £2,455. 8s. 7d., instead of a surplus of £6,892. 13s. 5d. The repayments of loans this year amount to £3,044. 18s. 2d., as against £803. 7s for last year, an increase of £2,241. 11s. 2d., and, in addition, the amount of repayments deferred until next year is £1,777. The repayments on loans next financial year (1905-1906) on money already borrowed will amount to £4,362. 13s. 6d., as against £3,044. 18s. 2d. for this year, an increase of £1,317. 15s. 2d. The above statement does not deal with any public lighting capital, this having been transferred to the general borough fund account from April 1 last. In view of the reduction in price of public lighting, which already represents up to Sept. 30 a saving to the borough of

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£1,048. 12s. 7d., the reduction in power rate to consumers, which I estimate will reduce the revenue by approximately £700, and the statement of accounts to September last which my predecessor presented to you, and which showed a loss on the six months' working of £2,235. 15s. 1d., I do not consider it at all advisable to assume that the gross profits this year will meet all our liabilities on account of capital charges; therefore we must be prepared to pay the repayments of loans stated above out of the surplus to March last, and, after doing this, we shall only have a small credit balance for general working purposes and for providing a reserve fund, which the Board of Trade state should equal 10 per cent. of the capital expenditure, and to answer any future deficiency or meet any extraordinary claim." The report was adopted, and the reference to the committee discharged.

## PROVISIONAL PATENTS, 1905.

JAN. 20.

1136. **Improvements in or relating to electrical condensers.** John Rymer-Jones, 111, Hatton-garden, London.

1153. **Improvements relating to current-collecting devices of electrically-propelled vehicles.** Oscar Howard Baldwin, Westinghouse-building, Norfolk-street, Strand, London.

1154. **Improvements in or relating to devices for supplying current to electrically-operated vehicles.** Oscar Howard Baldwin, Westinghouse-building, Norfolk-street, Strand, London.

JAN. 21.

1169. **Improvements in and relating to magnetic separators.** William Simm and John Shuttleworth Sellers, 9, Tempest Hey, Liverpool.

1173. **A system of electric current generation.** Frederick Henry Loring, 7, Doughty-street, London.

1190. **Electric igniter for motor gas-lamps.** Frank Griffin Carter, 55, Upper-street, James-street, Brighton.

1221. **Improvements in electric meters.** Claude William Atkinson, 1, Queen Victoria-street, London.

1224. **Improvements in and relating to trolley retrievers for electric tramcar and the like.** Charles J. Earll, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

1231. **Apparatus for operating gas-taps and electrically igniting the gas.** James Grieve Lorrain, Norfolk House, Norfolk-street, Strand, London. (Société Anonyme des Allumeurs-extincteurs Automatiques, Switzerland.) (Complete specification.)

JAN. 23.

1243. **An improved clip or apparatus for the screwing up or the removal of the nut or ring used for securing the shade or reflector to electric lampholders.** John Parry, 32, King-street, Dudley, Worcestershire.

1247. **Improvements in conduits for the protection of electrical conductors.** David Maxwell, 41, Reform-street, Dundee.

1249. **Electric relay with time control for closing circuits of electromagnets.** James Ferguson and Kelvin and James White, Limited, 154, St. Vincent-street, Glasgow.

1281. **Improved devices for use in controlling polyphase and alternate current motors.** Siemens Bros. and Co., Limited, and Hereford Berry, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

1299. **Improvements in or relating to apparatus for use in recording telephonic messages or sounds.** Hans Starcke, 111, Hatton-garden, London. (Complete specification.)

1300. **Improvements in or relating to electric switches, controllers, and the like.** Arthur Burgess Soar and Henry Frank Joel, jun., 111, Hatton-garden, London.

1308. **Improvements in magnetic ore separators.** Henry Charles Jenkins, 18, Southampton-buildings, Chancery-lane, London.

1313. **Improvements in electric meters.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

1321. **Improvements in and relating to railway electric signals.** Slaughter William Huff, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JAN. 24.

1335. **Improved brackets or holders for the brushes or carbons of dynamos or motors.** William Thomas Thorley, Longport, Stoke-on-Trent, Staffordshire.

1360. **Apparatus for producing electric arcs, sparks, or flames for bleaching or sterilising purposes.** William Cramp, 7, Sellous-avenue, Harlesden, London.

1380. **Improvements in telephone selecting mechanism.** William David Watkins, John Wesley Bolster, and William Edward Goodsell, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

1384. **Improvements in electric apparatus for felling trees or sawing wood.** Thomas Oscar Wilson, 36, Chancery-lane, London. (Date applied for under Patents Act, 1901, Jan. 30, 1904, being date of application in the United States.) (Complete specification.)

1389. **A new electro-therapeutic ray tube.** Alfred Charles Cossor, 54, Farringdon-road, London.

1391. **Improvements in systems of electrical distribution.** Ray Philip Jackson, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, June 6, 1904, being date of application in United States.) (Complete specification.)

1399. **Electric governor.** James Robert Fyfe Smith, 2, East Sheen-avenue, Mortlake, London.

1400. **Improvements in incandescent electric lamp sockets.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

1406. **Improvements in and relating to the manufacture of plates for secondary electric batteries.** Louis Nestor Joseph Roselle, 7, Southampton-buildings, Chancery-lane, London.

1407. **An improved process of and apparatus for the manufacture of plates for secondary electric batteries.** Louis Nestor Joseph Roselle, 7, Southampton-buildings, Chancery-lane, London.

1413. **Improvements in electric and magnetic appliances.** Illius Augustus Timmis, Edgar William Timmis, and John Robert Cook, 2, Great George-street, Westminster, London.

1421. **Improvements in or relating to the manufacture or production of carbons suitable for use in electric arc lamps.** Vivian Byam Lewes, 46, Lincoln's-inn-fields, London.

1430. **Improvements in the method of compounding alternators.** Sautter, Harlé, et Cie, 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Feb. 4, 1904, being date of application in France.) (Complete specification.)

1432. **Improvements in and relating to telephone directories.** Charles Alexander Pomeroy, 322, High Holborn, London. (Complete specification.)

JAN. 25.

1482. **Improvements in electrical contact makers and breakers.** Percy Warren Noble, 18, Hertford-street, Coventry.

1493. **Improvements in electric time switches.** James Joseph Coachman. Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

1507. **Improvements relating to electrodes for arc lamps.** Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (La Compagnie Générale d'Electricité, France.) (Complete specification.)

1522. **Improvements relating to distributing boards for electric installations.** Frederick Hagger Headley, 322, High Holborn, London.

1526. **Improvements in or relating to coils or windings for transformers and other electrical apparatus.** Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

JAN. 26.

1552. **Electric fans.** Wallace Fairweather, 65, Chancery-lane, London. (Diehl Manufacturing Company, United States.) (Complete specification.)

1553. **Method of drying hygroscopic insulation of electric conductors.** George Hinde Nisbett, 65, Chancery-lane, London. (Complete specification.)

1559. **Improvements in gas lamps and electric lamps.** John Baker Colbran, 58, Chiswell-street, Finsbury, London.

1560. **Improvements in dynamo-electric machines.** Arthur Serveau, 7, Staple-inn, London. (Date applied for under Patents Act, 1901, Jan. 26, 1904, being date of application in Belgium.) (Complete specification.)

1563. **Improvements in electrical measuring instruments.** Michael Birt Field, St. John's House, Sevenoaks, Kent.

1589. **Improvements in and relating to electric train-lighting systems.** The Union Elektricitäts-Gesellschaft, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Jan. 27, 1904, being date of application in Germany.) (Complete specification.)

1592. **Improvements in and relating to brush-holders for dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

1607. **Alarm fuse for telephone exchanges.** Edward B. Craft, 24, Southampton buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Feb. 5, 1904, being date of application in United States.) (Complete specification.)

JAN. 27.

1637. **An electromagnetic purifier for use in milling.** John Lawson Lawson, 34, York-place, Edinburgh.

1638. **Improvements in or relating to the "party line" system of telephones.** Harry Benwell Stocks, 5, John Dalton-street, Manchester.

1658. **An improved electromagnetic switch for use in connection with electric railways on the sectional conductor system.** Edmund Fenton, 33, Chancery-lane, London.

1677. **Improvements in arc lamps.** John Morecraft Wellington and Walter Francis Daniell, 88, Chancery-lane, London.

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**1670. Improvements in alternating electric current motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**1681. Improvements in insulators for electric conductors.** Marconi's Wireless Telegraph Company, Limited, and George Elliott Turnbull, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JAN. 28.

**1710. Improvements in electric incandescent lamps.** Charles James Hall and Frederick John Anson, 10, East-parade, Leeds.

**1732. Improvements relating to controller and brake mechanism for electrically-driven road vehicles.** Stuart Arthur Russell and Edward Ford, 6, Breams-buildings, Chancery-lane, London.

**1754. Improvements in electric ignition devices for explosion engines.** Henri de la Valette, 4, South-street, Finsbury, London. (Date applied for under Patents Act, 1901, Jan. 28, 1904, being date of application in France.) (Complete specification.)

**1756. Improvements in and relating to electric time switches.** Norman de Maid Watsham, 1, Queen Victoria-street, London.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published Feb. 16.*

1904.

**1860. Conductors of electric railways or tramways.** Boardman.

**2285. Apparatus for polarisation of Hertzian waves.** Green. (Date applied for under International Convention, Jan. 29, 1903.)

**2288. Electric signalling apparatus for tramways and railways.** Wilson and Marshall.

**2450. Controlling electric switches and cut-outs.** British Thomson-Houston Company, Limited. (General Electric Company.)

**4874. Trolley poles for cars electrically propelled on the overhead system.** Kilbourn and Flower.

**5582. Electrostatic wattmeters or watt-hour meters.** Wilson.

**5731. Electrical regulating devices applicable to clocks.** Howorth. (Actiengesellschaft "Magneta" Electrische Uhren ohne Batterie und ohne Contacte.)

**6792. Method of preliminary treatment for electric accumulator plates.** Leitner.

**6857. Electrical switching apparatus.** Dick.

**6878. Electrical ignition apparatus.** Eckstein and Coates.

**7061. Electro-depositing apparatus.** Leeds Cooper Works, Limited, and Jobling.

**7217. Magneto-electric machines.** Simms.

**8189. Bayonet joint for electric lamps and other articles.** Barlow.

**9964. Electrical percussive drill.** Centner.

**13463. An electric block signal system.** Werner.

**19525. Electromotors.** Baumann. (Date applied for under International Convention, Sept. 12, 1903.)

**22494. Device for preventing broken trolley wires on electric tramways from falling.** Kirwan and Quanay.

**26262. Magnetic separating apparatus.** Scholl.

**27060. Electric switches and electromagnets therefor.** Lindquist.

**27096. Electrical signalling apparatus, particularly applicable to fire-alarms.** Abel. (Siemens und Halske Akt.-Ges.)

**27114. Operating gear for moving the rail points and conductor points or switches on electric and other tramways.** Virgin.

**27862. Electric accumulators.** Gardiner.

**27903. Secondary batteries and grids therefor.** Gardiner.

**28123. Counting apparatus for electric current, gas, water, or similar meters.** Biermann.

**29658. Terminals for electric conductors.** Renault. (Date applied for under International Convention, May 2, 1904.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | Last price |
|---|---|---|
| **Commercial and Industrial.—** | £ | £ |
| **Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000** | 1 – | ⅝-¾ |
| **Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000** | 1 – | 15/32 9/16 |
| **British Insulated and Helsby Cables, Ord., 1-100,000** .... | 5 – | 5-5¼ xd |
| —— 6 per cent. Cum. Pref., 1-100,000 ..... | 5 – | 5¼-5⅜ |
| —— 4½ per cent. Mortgage Debentures ..... | 100 – | 101-104 |
| **British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.** ..... | 100 – | 101-103 |
| **British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000** ..... | 5 – | 2⅜ 2⅝ |
| —— 4 per cent. Mortgage Debenture Stock ..... | 100 – | 86-88 |
| **Brush Electrical Engineering, Ordinary, Nos. 1-105,751** .. | 2 – | ½-⅝ |
| —— Non. Cum., 6 per cent. Pref. ..... | 2 – | 1¼-1½ |
| —— 4½ per cent. 1st Debenture Stock..... | 100 – | 93-96 |
| —— 4½ per cent. 2nd Debenture Stock ..... | 100 – | 74-77 |
| **Callender's Cable, Debentures** ..... | 100 – | 104 106 |
| —— Ordinary ..... | 5 – | 9¼ 10 |
| —— 5 per cent. Pref. ..... | 5 – | 5⅛ 5⅜ |
| **Crompton and Co.** ..... | 3 – | 2 2¼ |
| —— 5 per cent. Debentures..... | 100 – | 96 98 |
| **Edison and Swan United, "A" Shares, 1-98,251** ..... | 5 – | ⅞-1 |
| —— "A" Shares, 01-017,139 ..... | 5 – | 1-1⅛ |
| —— 5 per cent. Debentures..... | 100 – | 79-84 |
| —— 4 per cent. Deb. Stock, Red. ..... | 100 – | 77-82 |
| **Electric Construction, Limited, Nos. 1 to 112,100** ..... | 2 – | 1⅛-1⅛ |
| —— 7 per cent. Cumulative Pref. ..... | 2 – | 2⅛-2⅜ |
| —— 4 per cent. Perp. 1st Mort. Deb. ..... | 100 – | 97 99 |
| **Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.** 100 – | | 90-95 |
| **General Electric Company (1900), 5 per cent. Cum. Pref.** .. | 10 – | 9¾-10 |
| —— 4 per cent. 1st Mort. Deb. Stock ..... | 100 – | 91-96 |
| **W. T. Henley's Telegraph Works, Ordinary** ..... | 5 – | 10¾-11 |
| —— 4½ per cent. Preference ..... | 5 – | 5⅛-5⅜ |
| —— 4½ per cent. Debentures ..... | 100 – | 110-112 |
| **India Rubber, Gutta Percha, and Telegraph Works** ..... | 10 – | 15 16 |
| —— 4 per cent. Debentures..... | 100 – | 99-102 |
| **Parker, Thos., Limited, Ordinary** ..... | 10 – | 10-10½ |
| **Telegraph Construction and Maintenance**..... | 12 – | 38 40 |
| —— 5 per cent. Bonds ..... | 100 – | 101½-103½ |
| **Electric Lighting and Supply.—** | | |
| **Bournemouth and Poole, Ordinary** ..... | 10 – | 12-12½ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 ..... | 10 – | 9¾-10 |
| —— 5 per cent. Cum. Second Pref., 15,001-22,500 .... | 10 – | 11-12 |
| —— 4½ per cent. Debenture Stock. Red. ..... | 100 – | 103-106 |
| **Bromley (Kent) Electric Light and Power Co.** ..... | 5 .. | 5¼-5⅜ |
| —— 4½ per cent. 1st Debenture Stock, Red. ..... | 100 – | 101-104 |
| **Brompton and Kensington, Ordinary**..... | 5 – | 10¾-11 |
| —— 7 per cent. Preference ..... | 5 – | 10¾-10⅞ |
| **Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000** .. | 5 – | 8⅜ 8⅝ |
| —— Nos. 60,001-80,000 ..... | 5 – | 6¼-6⅜ |
| **Cambridge Electric Supply Company, Ltd., £10 Ord.** .... | 8 – | 12¾-13¼ |
| **Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock** 100 – | | 105-108 |
| **Charing Cross and Strand, Nos. 1-70,000** ..... | 5 – | 8¼-8⅜ |
| —— 70,001-80,000..... | 5 .. | 8-8¼ |
| —— 4½ per cent. Cum. Pref. ..... | 5 – | 5⅜-5⅝ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 – | 4 15/16 5 1/16 |
| —— 40,001-80,000..... | 5 .. | 4 15 16-5 1/16 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 – | 101-103 |
| **Chelsea Electricity Supply** ..... | 5 – | 6⅞ 7¼ |
| —— 4½ per cent. Debentures ..... | 100 – | 108 110 |
| **City of London, Ordinary**..... | 10 – | 11⅜-12¼ |
| —— 6 per cent. Cumulative Pref..... | 10 – | 13½-14 |
| —— 5 per cent. Debenture Stock ..... | 100 – | 121-125 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) .. | 100 – | 101-103 |
| **County of London Electric Supply, Ordinary** ..... | 10 – | 9 9¼ |
| —— 6 per cent. Cum. Pref. ..... | 10 – | 12-12½ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 – | 101-103 |
| —— 4½ per cent. 2nd Debentures Prov. Certs..... | 100 .. | 107-110 |
| **Edmundsons' Electricity Corporation, Ordinary, 1-50,000**.. | 5 – | 6¼-6⅜ |
| —— 6 per cent. Cum. Pref. ..... | 5 – | 6-6¼ |
| —— 4½ per cent. First Mort. Deb. ..... | 100 – | 106-108 |
| **Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000** | 5 – | 1¼-1⅜ |
| —— 5 per cent. Debenture Stock, Red. ..... | 100 – | 86-91 |
| **Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000**..... | 5 – | 5¼-5⅜ |
| —— 4½ per cent. First Deb. Stock, Red..... | 100 – | 101-104 xd |
| **Havana Electricity, Limited, 1-15,000** ..... | 10 – | 9¼-10½ |
| **Hove Electric Lighting, Limited, Ord., 1-13,000** ..... | 5 – | 7½ 8 |
| **Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red.** 100 – | | 100-102 |
| **Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000** .. ..... | 1 – | 9/16-11/16 |
| **Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000** | 5 – | 12⅜-13¼ |
| **Kensington and Knightsbridge and Notting Hill, 4 per cent Debenture Stock Red** .. ..... | 100 – | 102-104 |
| **Kidderminster and Dist. Elec. Lighting and Traction, Pref.** | 10 – | 9⅜-10⅛ |
| **London Electric, Ordinary** ..... | 5 – | 2¼-2½ |
| —— 6 per cent. Pref. ..... | 5 – | 5 9/16 5 13/16 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red... | 100 – | 96 98 |
| **Metropolitan Ordinary** ..... | 10 – | 17½-18¼ |
| ——4½ per cent. First Mortgage Debenture Stock .... | 100 – | 110 115 |
| —— 4½ per cent. Cum. Pref ..... | 5 .. | 5¼-5⅜ |
| ——3½ per cent. Mortgage Debenture, Red. ..... | 100 – | 96 98 |
| **Midland Electric Power Dis., Ld., 4½ p c. 1st Mort. Deb..** | 100 – | 92-95 |
| **Newcastle-upon-Tyne Electric Supply, Ordinary** ..... | 5 – | 98-101 |
| —— Preference ..... | 4 – | 100-102 |
| **Notting Hill Electric Lighting** ..... | 10 – | 14¼-15½ |
| —— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.) .. | 100 – | 102-104 |
| **Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,310**..... | 5 – | 6¼-6⅜ |
| —— 4 per cent. Debenture Stock ..... | 100 – | 98-100 |
| **Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures** ..... | 100 – | 100-102 |
| **Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000**.. | 5 – | 2⅜-2¾ |
| —— 4 per cent. Debenture Stock ..... | 100 – | 85-87 |
| **South London, Ordinary** ..... | – – | 4¼ 4⅜ |
| **South Metropolitan Electric Light and Power Co., Ord...** | 1 .. | ⅞-1 |
| —— 7 per cent. Cum. Pref. ..... | 1 .. | 1⅛-1 7/16 |
| —— 4½ per cent. 1st Mort. Deb. ..... | 100 .. | 107-110 |
| —— Ditto, June, 1904 ..... | .. | |
| **St. James's and Pall Mall, Ordinary, 101-80,080** ..... | 5 – | 13⅜-14¼ |
| —— 7 per cent. Pref. ..... | 5 – | 8¼-9 |
| —— 5½ per cent. Deb. ..... | 100 – | 98 100 |
| **Urban Electric Supply Co., Ordinary, 8-30,007** ..... | 5 – | 5-5⅛ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 – | 5 1/16-5 3/16 |
| **Westminster, Ordinary** ..... | 5 – | 13 13½ |
| —— 5 per cent. Cum. Pref., 110,101-158,251..... | 5 – | 6¼-6⅜ |
| **Electric Tramways.—** | | |
| **Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007** ..... | 5 – | 5⅜-5⅝ |
| —— Ord. ..... | 5 ..8 | 11/16-8⅛ |
| —— Permanent 6 per cent. Debenture Stock. 1888 .. | 100 – | 140 143 |
| **Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red.** | 100 – | 104-105 |
| **Barcelona Tramways, Limited, Ord., 1-20,000** ..... | 10 .. | 12-12½ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 ..... | 10 .. | 9-10 |
| —— 5 per cent. Deb., Red., 1-600 ..... | 100 .. | 99 102 |
| —— 4½ per cent. Red. Deb. Stock ..... | 100 .. | 96-100 xd |
| **Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606..** | 1 .. | 11/16-13/16 |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 ..... | 1 .. | 15/16-1 1/16 |
| **Belfast Street Tramways, Ord., 1-26,600** ..... | 10 .. | 10½-11¼ |
| **Blackpool and Fleetwood Tramroad** ..... | 10 .. | 13⅜-13⅝ |
| **Brisbane Tramway Invest., Lim., Ord., 1-75,000** ..... | 5 – | 1¼-1⅜ |
| —— 5 per cent. Cum. Pref., Nos. 1 75,000..... | 5 – | 3¾-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 – | 91-98 |
| **British Columbia Electric Railway Co., Ord. Def.**..... | 100 – | 100-103 |
| —— Ord Pref. ..... | 100 .. | 100-103 |
| —— Non. Cum. 5 per cent. Pref. ..... | 10 – | 10-10¼ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-4,250, of £240 each | 40 – | 102-104 p c |
| —— 4½ per cent. Vancouver Power Deb. ..... | 100 – | 97-100 |
| **British Electric Traction Ord. 1-300,000 & 60,001-90,000** | 10 – | 9⅜-10¼ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 ..... | 10 – | 11¼-11½ |
| —— 5 per cent. Perpetual Debenture Stock ..... | 100 .. | 119-121 |
| —— 4½ per cent. 2nd Deb. Stock ..... | 100 | 97-99 |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Buenos Ayres and Belgrano Tram. Ord., 1-100,000 | 5 | 4-4¼ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | 5¼ 5½ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | 5⅜ ⅝ |
| —— 5 per cent. Deb. Stock, Red. | 100 | 106-108 |
| —— Prov. Cert., all paid | 100 | 102-105 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | 94-97 |
| Calcutta Tramways, Limited, 1-102,268 | 5 | 8⅜-8⅝ |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | 106-108 |
| Cape Electric Tramways Nos. 1-480,000 | 1 | 1⅛ 1⅜ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | 4⅞-5⅛ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | 101-104 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1s Mortgage Debenture Stock, Red. | 100 | 102-104 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | 9½-10 |
| —— 5 per cent. Cum. Pref. | 10 | 11-12 |
| —— 4 per cent. Debentures | 100 | 101-103 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | 13-14 xd |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 | 15½-16½ xd |
| —— 3½ per cent. Mort. Debs., 1-3,000, Red. | 100 | 94-97 |
| Imperial Tramways Ordinary | all | 18-19 |
| —— 6 per cent. Cum. Pref. | all | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000 | 5 | 3¼-4 |
| —— 4 per cent. Debenture Stock | 100 | 90-95 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | 8-8½ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | 10¼-10⅜ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | 104 106 |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016. | 1 | 13/32 15/32 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | 31/32-1 1/32 |
| —— 4½ per cent. Deb. Stock, Red. | 100 | 103-105 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1925, 1-5,500 and 7,001-8 000 | $1,000 | 106-110 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 | 101-104 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 | 103-105 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000 | 5 | ¼-1½ |

| Name. | Amount paid. | Last price |
|---|---|---|
| | £ | £ |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | 11½ |
| —— 5 per cent. Cum. Pref. | 10 | 9½-9⅝ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk. | 100 | 102 105 |
| Potteries Electric Traction, Ordinary 80,001-40,00 | 10 | 8- |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | 8¼-9¼ |
| —— 4½ per cent. Debenture Stock | 100 | 99-102 |
| South Lancashire Electric Traction and Power Company —— £250,000 Ordinary | 1 | 1 |
| —— £101,132 6 per cent. Preference | 1 | 1 |
| —— £528,083 4½ per cent. Debenture Stock | 100 p.c. | 100 p.c. |

## Electric Railways.—

| | | |
|---|---|---|
| Central London, Ordinary | 100 | 92 94 |
| —— 4 per cent. Pref. | 100 | 101-103 |
| —— ,, deferred | 100 | 86-87 |
| —— 4 p.c. Deb. Stock (Prov. Scrips Certs., fully paid) | 100 | 107-109 |
| City and South London, Consolidated Ordinary | 100 | 46-47 |
| —— 4 per cent. Debenture Stock | 100 | 105-108 |
| —— 5 per cent. Pref. Stock '91 | 100 | 122-125 |
| —— ,, ,, ,, '96 | 100 | 119 122 |
| —— ,, ,, ,, '01 | 100 | 117-120 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | 10-10¼ |
| —— Ordinary, 1-50,000 | 10 | 3¼-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — | 99-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | — | 97¼-98¼ |
| Waterloo and City, Ordinary | 100 | 91-93 |

## Telephones.—

| | | |
|---|---|---|
| National Telephone, Preferred | 100 | 108¼-108½ |
| —— Deferred Stock | 100 | 107-109 |
| —— 6 per cent. Cum. First Pref. | 10 | 13-15 |
| —— 6 per cent. Cum. Second Pref. | 10 | 12-13 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | 5¼-5½ |
| —— 5½ per cent. Deb. Stock, Red. | 100 | 96-98 |
| —— 4 per cent. Deb. Stock, Red. | 100 | 101-103 |
| —— 4 per cent. Prov. Cert. | — | 101-103 |
| Oriental Telephone and Electric Company | 1 | 1-1¼ |
| —— 6 per cent. Cum. Pref. | 1 | 1¼-1 |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905. | 1904. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Car mile. | Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Dec. 31 | 1,291 | 1,470 | − 179 | — h | 19¼ | 19¼ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·14 |
| Ayr Corporation | Jan. 21 | 165 | 166 | − 1 | + 529 | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 336,049 | 1·03 | 10·11 | 1,770 | 5 0 |
| Barking Corporation | ,, 28 | 57 | 43 | + 14 | + 178 | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 29 | 928 | 960 | − 38 | − 768 | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,319,701 | 1·158 | 9·98 | 2,383b | 6·1 |
| Birmingham Corporation | ,, 28 | 329 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | ,, 20 | 4,585 | 5,083 | − 498 | — | 6¼ | 6¼ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | Dec. 16 | 765 | 723 | + 42 | + 3,353 | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10 94 | — | 4·59 |
| Blackpool Corporation | Jan. 26 | 251 | 256 | − 5 | + 6,049 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 28 | 183 | 181 | + 2 | − 49 | 16½ | 16½ | Dec. 31 | 32,021 | 2,253,984 | 600,757 | 3·34 | 12·75 | 2,001 | 7 05 |
| Bolton Corporation | ,, 29 | 1,633 | 1,625 | + 8 | + 309 | 38 | 38 | March 31 | 94,161 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·89 |
| Bournemouth Corporation | ,, 25 | 769 | 776 | − 7 | + 2,161 | 10·15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | Dec. 17 | 3,729 | 3,366 | + 363 | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | Jan. 29 | 729 | 683 | + 51 | + 3,558h | 9 | 7½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 27 | 4,294 | 4,372 | − 78 | — | 51½ | 51½ | Dec. 31g | 253,150 | 44,331,439 | 6,033,528 | — | — | — | — |
| Burnley Corporation | ,, 28 | 940 | 808 | + 132 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 24 | 219 | 232 | − 13 | — | 8½ | — | March 31i | 11,574 | 2,556,134 | 282,378 | 1·08 | 9·81 | 1,570 | 7·57 |
| Cardiff Corporation | ,, 14 | 1,927 | 1,851 | + 65 | + 2,155 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 28 | 125 | 176 | − 51 | − 90 | — | — | Dec. 31g | 9,937 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 28 | 7,200 | 6,992 | + 208 | + 794h | 6 | 6 | ,, 31 | 362,471 | 44,953,938 | 1,292,674a | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 29 | 2,994 | 3,258 | − 264 | − 449h | 6½ | 6⅝ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Colchester Corporation | ,, 18 | 144 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 26 | 391 | 385 | + 7 | − 92 | — | — | ,, 31g | 25,657 | 6,353,323 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | ,, 27 | 142 | 200 | − 13 | − 94 | 7·23 | 7·23 | March 31a | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 28 | 161 | 161 | — | — | 4½ | 4½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0 91 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | ,, 27 | 89 | 91 | − 2 | — h | 7 | 6¾ | Dec. 31g | 6,234 | 588,905 | 107,164 | 3·88 | 14·09 | 952 | 7·39 |
| Dublin U. T., electric cars | ,, 27 | 3,525 | 3,618 | − 93 | } — | 47 | 46 | ,, 31g | 134,643 | — | 3,429,356 | — | — | — | — h |
| Dublin S. District, Electric | ,, 27 | 731 | 702 | + 29 | | | | | | | | | | | |
| Dundee City Tramways | ,, 25 | 765 | 781 | − 16 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 30 | 607 | 581 | + 26 | + 1,636 | 10·77 | 10·75 | March 31 | 34,312 | 12,950,269 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 24 | 13,6 4 | 13,420 | + 214 | +23,349h | 145 | 123 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Gloucester Corporation | ,, 25 | 195 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 25 | 2,209 | 2,160 | + 49 | + 4,555 | 33 | 30½ | March 31 | 68,283 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,059 | 8·77 |
| Huddersfield Corporation | — | — | — | — | — | 35 | 35 | ,, 31 | 65,545 | 11,893,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S | ,, 28 | 2,001 | 1,935 | + 15 | +10,865 | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | ,, 28 | 307 | 205 | + 22 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | ,, 25 | 91 | 109 | − 18 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 25 | 171 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 31 | 5,093 | 4,978 | + 115 | — | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | ,, 21 | 1,618 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | ,, 21 | 9,278 | 9,557 | − 279 | + 711 | 103 | 103 | Dec. 31g | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·28 |
| Liverpool Overhead Railway | ,, 29 | 1,461 | 1,505 | − 41 | − 402h | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — e |
| London County Council | ,, 21 | 11,0·0 | 8,9 6 | +2,044 | +103,486 | 46½ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 20 | 125 | 110 | + 15 | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | ,, 25 | 83 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 28 | 11 2·7 | 10,80 | + 459 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Metropolitan Elec. Tramways | Dec. 30 | 2,327 | 1,029 | +1,298 | +14,913h | 10 | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | Jan. 21 | 96 | 93 | + 3 | + 1,350 | 2½ | — | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newcastle-on-Tyne Corptn. | ,, 28 | 3,192 | 3,159 | − 17 | — | 45 | 38½ | ,, 25 | 135,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111b | — |
| Newport (Mon.) Corporation | ,, 28 | 488 | 433 | + 55 | + 1,217 | 15 | — | — | — | — | — | — | — | — | — |
| Oldham Corporation | ,, 24 | 1,160 | 1,062 | + 237 | + 3,444 | 34½ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 28 | 1,291 | 1,237 | + 57 | + 6,426 | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·15 | 12·39 | — | — |
| Rochdale Corporation | ,, 21 | 368 | 113 | + 255 | + 4,937 | 4½ | 4½ | 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·65 |
| Rotherham Corporation | ,, 26 | 361 | 407 | − 46 | — | — | — | ,, 31 | 20,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·68 |
| Salford Corporation | ,, 30 | 3,800 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 28 | 63 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 29 | 4,393 | 4,101 | + 292 | + 5,144 | 34½ | — | ,, 25q | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 25 | 719 | 705 | + 13 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 25 | 198 | 182 | + 16 | — | 6¼ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 27 | 405 | 356 | + 49 | + 8,214 | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 29 | 1,107 | 1,072 | + 35 | + 1 416 | 19·54 | 18·48 | ,, 31 | 62,506 | 14,848,958 | 1,433.463 | 1·01 | 10·46 | — | 6·08 |
| Swindon Corporation | ,, 25 | 150 | — | — | — | 3¾ | — | — | — | — | — | — | — | — | — |
| Wallasey U.D.C. | ,, 28 | 609 | 571 | + 38 | + 2,126 | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·60 |
| West Ham Corporation | ,, 26 | 1,018 | — | — | — | 8·62 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 25 | 657 | 389 | + 268 | — | 7½ | — | ,, 31g | 20,878 | 4,263,066 | 417,335 | — | 12·005 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
b Per mile of single track. c Include rail and tram. d Including depreciation. e Including one section of horse traction. g 1903. h Half-year's figures.
Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**Personal.**—The President of the Board of Education has appointed Prof. Henry Adams, M.I.C.E., late of the City of London College, to be a member of the Board of Examiners at South Kensington in the engineering section.

**Royal Institution.**—A general monthly meeting of the members of the Royal Institution was held on Monday afternoon, the Duke of Northumberland, president, in the chair. Lieutenant-Colonel H. E. Gaulter, Mr. E. P. Harvey, Mrs. Ludwig Mond, Dr. Tcherniac, and Dr. Evelyn C. B. Wilbraham were elected members.

**Electrical Contractors' Association.**—A special meeting of the London section of this association is to be held at Frascati's to-night, commencing at 8 o'clock. A paper on the wiring clause of the London County Council's Bill, to which we referred recently, will be read, and signatures to a petition in opposition to the measure will be invited. The association hope to have a large gathering.

**Wireless Telegraphy.**—The London, Brighton, and South Coast Railway Company began last week a series of experiments in wireless telegraphy between Newhaven and Dieppe. The results are stated to have been very satisfactory, and if further tests prove satisfactory, the system adopted, that known as the Mors, will be in regular operation in a few days' time. It is only for the private purposes of the company, the Government having granted the privilege to that extent.

**Calcium Carbide.**—At Monday's meeting of the Thames Conservancy a communication from Messrs. Anderson, Anderson, and Co. in reference to the transport of calcium carbide from Norway to Australia was discussed. A large trade is carried on between these countries, the chemical having hitherto been exported by way of Hamburg owing to the restrictions imposed on British vessels by the authorities. The Conservators have now decided to allow calcium carbide to be conveyed on ships carrying explosives, and it is expected that this will enable London to secure the trade.

**Leeds Section.**—This local section has made arrangements for its second annual dinner, which will be held at the Hôtel Métropole, Leeds, on Friday, the 3rd prox., Mr. W. Emmott, the local president, in the chair. The president and secretary of the parent institution, in addition to the presidents of other local sections, will be present. The Council trusts that all members will make every effort to be present, so as to render the gathering fully representative. Tickets, price 6s., may be obtained from Mr. G. R Blackburn, the hon. secretary, to whom early application should be made, so that seating accommodation may be arranged accordingly.

**North-East Coast Institution of Engineers.**—We have received the January number of this institution's *Transactions*, which contains the presidential address of Lord Armstrong. In the course of his address Lord Armstrong remarked that the substitution of electricity, generated in large central power stations, for the small steam-engines installed in various works, has probably reduced the total consumption of coal per available horse-power by 50 per cent. There is also Mr. W. R. Cummins's paper on "A Comparison of Vertical and Horizontal Tubes in Water-Tube Boilers," of which we gave an abstract recently, and the discussion on same.

**Yorkshire Electric Power Company.**—We learn that the Thornhill power station of this company is now practically complete, and the company have commenced the supply of energy. The foundations were laid down in November, 1903, and in December of last year a supply of electricity was available and 26 miles of cable laid. The generating plant consists of three 1,500-kw. turbo-generators and three 200-kw. direct-current exciters. Three-phase current is generated at 11,000 volts, and direct current at 230 volts. Contracts are already made for supply to a number of local authorities, to collieries, mills, and a variety of trades. A more detailed description of this undertaking will probably appear in our columns at an early date.

**Canadian Duties.**—We have received a list of the goods which the Canadian Customs Department have declared to be exempt from special or, as it is generally termed, "anti-dumping" duty. It does not comprise all the goods that may be exempt, but only those on which decisions have been given. Amongst these we notice boiler plates, flange plates, and fire-box plates, when used only in the manufacture of boilers; universal mill or rolled-edge bridge plates when imported by manufacturers of bridges for that purpose; rolled-edge plates, not less than ¼in. thick and over 15ft. long, when imported for tyres of traction engines; flat galvanised sheet iron; steel beams, tees, girders, for structural purposes, when not punched, drilled, or in any further stage of manufacture than as rolled; double tape fuses; bicarbonate of soda; rubber brushes; peroxide of hydrogen; hydrozone. In most cases the goods have to be formally declared in order to secure the exemption.

**No Embankment Trams.**—At one time the opinion was current that the Streets Committee of the City Corporation would this time report favourably upon the London County Council's embankment scheme. This, however, proved erroneous, as the committee resolved to recommend that all necessary steps be taken to oppose the measure, albeit this decision was only arrived at by a majority of one. On the report coming before the Common Council last week various amendments were proposed and rejected, and finally the committee's recommendation was adopted by an overwhelming majority. The objection to the scheme on the score of traffic congestion was supplemented by questions of motor omnibuses and the construction of a line by the Corporation itself. Apart from any consideration of the thin end of the wedge, we think the Corporation have acted advisedly for the reasons which we stated in an article a few weeks back. Presumably the Council's Bill will again be fought out in Parliament.

**Junior Institution of Engineers.**—A paper was presented to the members of this institution last week at the Westminster Palace Hotel, by Prof. H. T. Davidge, on the subject of "Recent Developments in Electric Lighting." The lecturer ran through the whole range of electric lamps from incandescents to high-frequency lamps without wires. Descriptions were given of arc, electrolytic, mercury vapour, cathodic bombardment, and high-frequency lamps without wires, and specimens of recent types were exhibited. Tables of relative efficiencies were duly submitted to the audience, and the lecturer traced out the general improvements in the various lamps. These, however, are well known to our readers, and there is no need to recapitulate them. A discussion followed, and in replying thereto Prof. Davidge stated that the proprietors of the Cooper Hewitt lamp and Mr. Bastian were endeavouring to obviate the objection to vapour lamps on account of the peculiar colour of the light by introducing red rays into the tube. The chairman (Mr. Cutler) humorously remarked that, having had a paper on gas at the previous meeting, followed by Prof. Davidge's paper on electric lighting, he hoped they would next have one on the combined subjects, as whenever he heard a gas paper he was told that electric lighting was nowhere, and *vice versâ*.

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**New Publications.** — The "Manual of Electrical Undertakings and Directory," by Emile Garcke (London: The Electrical Press, Limited. 15s.). The 1905 volume of this well-known reference book is in the press, and will make its appearance in a few days. This makes the ninth year of publication, and, despite the general trade depression and the concise form of the information, the latest volume will contain an addition of 200 pages, bringing the total up to some 1,700 pages. The number of undertakings about which particulars are given approximates to some 2,400 against 200 in the first volume, while the amount of capital issued in connection with these undertakings (which include both municipal and joint-stock enterprises) has risen from a little over £61,000,000 to close on £267,000,000. The arrangement of the statistics and other material remains substantially in the convenient form adopted in previous volumes. There are also several special articles on such subjects as the London Traffic Commission, the inter-running question, and municipal telephones. The financial section has been brought up to date, and a highly useful feature included in the new volume is a number of urban and inter-urban tramway maps.

**Single-Phase Motors.**—From information we have just received it is evident that single-phase motors are coming greatly into use in connection with the electricity supply station at Burton-on-Trent. Last year an electrical exhibition was organised in the town, and this has done a good deal in the way of educating the inhabitants as to the possibilities of electric motors. Amongst the recent contracts which Mr. P. J. Pringle, the borough engineer, has secured is the electrification of a sawmill, where over 70 h.p. of motors are now being laid down. In this case the steam-driven plant will be entirely displaced by the electric motors, which will consist of two 30-h.p. Siemens-Schuckert motors and one 10-h.p. and one 1-h.p. Fuller-Wenstrom motors. These single-phase motors are to be used for driving circular saws, planing machines, etc. In other parts of the town equal success has been obtained with this type of motor. In one large stores a 4-h.p. Langdon-Davies motor has been so successful in driving a hoist that further motors with an aggregate of 22 h.p. are being put in as extensions. Including applications on hand the station has now to deal with over 270 h.p., whereas some 15 months ago the motor load amounted to only 60 h.p. This extension with the single-phase system speaks well for the efforts of the engineer-in-charge, who has in this way increased the total load at his station by over 35 per cent. in 12 months.

**Incandescent Lamp Trials.**—At the request of the commission which is now considering the future policy of electrical distribution in Paris, Mr. P. Janet has carried out a series of trials on the incandescent lamps for 110 and 220 volt circuits respectively. The experiments have been made in the laboratory of the Société Internationale des Electriciens on lamps of 5 c.p., 10 c.p., and 16 c.p. respectively. Five different makes of lamps were tried for high voltage. The results of these trials are interesting, and they will be presented in detail to the society. They remind us, however, of the fight which raged three or four years ago in this country over the conversion from the declared pressure of 110 volts to 220. The mean figures attained are somewhat as follows: With the 110-volt lamps the average consumption of energy was 3·6 watts per candle at the commencement, and after 200 hours 3·87 watts per candle. The 220-volt lamps required at the commencement of the trials 4·4 watts per candle, and 5·19 watts per candle after 200 hours. The increase in the watts per candle during the first 200 hours is thus 7 per cent. for 110-volt lamps, and 18 per cent. for 220-volt lamps. Without more information as to the type of lamp and the conditions of trial, it is not possible to criticise these figures fairly, but they seem to us to be high. It would be more economical, having regard to the high price of current in Paris, to run the lamps at a higher efficiency and with a shorter life.

**Liability for Accidents.**—Presumably the last of the Sheffield Corporation's now historic by-law limiting liability for accidents to £25 was heard last week, when the Lord Chief Justice, with Justices Kennedy and Ridley, quashed the conviction of the Sheffield stipendiary against Mr. Muir Wilson. It will be remembered that Mr. Wilson, a member of the Corporation, disputed the legality of the by-law, and, in order to test the same, he refused to produce a ticket to the inspector when travelling on a car, for which a nominal fine was inflicted upon him. Subsequently the Corporation withdrew the unpopular clause, and the proceedings last week were of little more than a formal character. While we are glad to see this clause has been disposed of, the ground on which their lordships quashed the conviction is worthy of note. When a ticket was tendered to Mr. Wilson he allowed it to fall at his feet, and refused to pick it up when requested by the inspector. The Court held that the magistrate's decision was wrong, since Mr. Wilson had not refused to let the inspector have the ticket, and it was open to the inspector to pick it up himself. Lord Alverstone elaborated the point by imagining the case of a lady who had accidently dropped her ticket, which his lordship hoped the inspector would have the courtesy to pick up for her We hope so too; but since Mr. Wilson avowedly let his ticket fall on purpose, the cases scarcely seem analogous, and the precedent does not look very favourable to tramway management.

**Olympia Motor Exhibition.**—The motor exhibition to commence at Olympia to-morrow, which will be the third exhibition of the kind promoted by the Society of Motor Manufacturers and Traders, is expected to be the largest and finest show of motorcars, motor vans, and motor boats ever held in this country, and promises to rival in importance the great annual French exhibition. As an international show it will excel that held in Paris, for not only will the bulk of the British makers exhibit, but every country which manufactures automobiles will be represented. The great building, Olympia, which has been adapted for the show at a cost of several thousands of pounds, will be literally filled with the latest and finest products of motor engineering both for pleasure and practical business purposes. The comfort of the public has been studied in every way, so that visitors will be able to spend a most enjoyable afternoon at Olympia. Music will be provided by Lieutenant Charles Godfrey's band, and J. Lyons and Co., Limited, will undertake the catering. Trials of exhibitors' cars are arranged for, whilst there is ample room on the Hammersmith side for motorcars belonging to visitors. The exhibition, which is under the patronage of the Prince of Wales, and officially recognised by the Automobile Club, is easily accessible from all parts of London. The charge for admission will be 1s., except on Thursday, 16th inst., which is the Automobile Club day, when 2s. 6d. will be charged up to 5 p.m. Reference to the scope of the exhibition was made in our last week's issue.

**Physical Society.**—At the meeting of this society last week Dr. R. S. Willows read a paper on "The Action of a Magnetic Field on the Discharge through a Gas." It had been shown previously that a transverse magnetic field, if applied at the cathode, may in some cases reduce the potential difference at the terminals of the tube. It was

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shown in the paper that the pressure at which this decrease commences corresponds to the pressure at which the voltage required to maintain this discharge under normal conditions is a minimum. This was also found to be the pressure at which the positive column is first completely striated, reasons why such action takes place being given. A paper on "The Action of Radium on the Electric Spark," by Dr. R. S. Willows and Mr. J. Peck, was also read. In certain cases the authors had found that the spark from a Wilmshurst machine is extinguished by the action of the radiations from radium, and that the current passing is decreased. The action is altogether different according to the direction of the discharge. Using a spark-gap longer than 2cm., and making the larger knob of the machine used positive, the radiations had practically no influence. With the smaller knob positive, the radium in most cases extinguished the spark. The phenomenon is found to be due to the action of the $\beta$ rays. Röntgen rays do not produce this effect, even if their ionising power at the spark-gap is some thousand of times greater than that of the radium. Lenard rays are, however, effective. Prof. F. T. Trouton expressed his interest in the paper, and referred to the fact that the action of the radium depended upon the direction in which the current was passing, of which he could see no obvious explanation.

**Electrically-Driven Hydraulic Pump.**—On the 25th ult., Mr. F. W. Steele read a paper before the Liverpool Engineering Society on the design and work of hydraulic pressing, stamping, forging, and similar machinery. In his paper the author deals with the design of heavy hydraulic presses for forging and welding processes. With these presses we are not intimately concerned as electrical engineers. The supply of these presses with water under heavy pressure can, however, be effected by means of motor-driven pumps. When this is the case the pump motor needs to be controlled from the hydraulic accumulator, and Mr. Steele describes the following arrangement as being most satisfactory. The automatic starting gear used for the motor is of the solenoid type, consisting of a main switch and a solenoid multiple-step switch. The solenoid actuating the main switch is energised as soon as the hydraulic accumulator sinks low enough for a tappet switch to close the solenoid circuit. Immediately this is done the main switch is closed and current is supplied to the motor through a number of external resistances connected in the armature circuit. At the same time current is supplied to the solenoid of the multiple-step switch, the speed of movement of which can be regulated by means of a dash-pot. As this switch moves over the contacts it closes successively by means of other solenoids subsidiary switches, which cut out the different sections of the external resistance in the main circuit. This solenoid type of control answers its purpose well, allowing the motor to be brought gradually up to full speed. The pumps then continue to supply the accumulator until it rises to such a point as to open the solenoid circuit. All the switches are then opened and the motor stops.

**Electrolysis of Solutions of Copper Sulphate.**—In the *Zeitschrift Elektrochemie* Messrs. F. Foerster and G. Coffetti contribute an article upon this subject, of which an abstract appears in the *Journal* of the Chemical Society. Referring to the discovery by Bose of two cathodic decomposition points in solutions of cupric salts, the authors describe some experiments which show that at cathode potentials below the upper point cuprous oxide is deposited from neutral solutions of copper sulphate, and cuprous sulphate is formed in acid solutions. The phenomena are best observed in hot solutions, because the concentration of the cuprous ions in equilibrium with cupric ions is greater at higher temperatures. The observations are best explained by assuming that the reaction $Cu^{\cdot\cdot} - F = Cu^{\cdot}$ takes place at the cathode so long as the solution in contact with it contains less than the quantity of cuprous ions corresponding with the equilibrium $2\,Cu^{\cdot} \rightleftarrows Cu + Cu^{\cdot\cdot}$. Cuprous ions are constantly removed from the neutral solutions by hydrolysis (owing to which cuprous oxide is precipitated), and from acid solutions by oxidation by atmospheric oxygen. At a copper anode, similarly, the copper dissolves in the cuprous condition until equilibrium is attained, and since the layer of solution in contact with the anode always contains more cupric sulphate than the body of the solution, a greater number of cuprous ions will be formed there than can exist in the more dilute mass of the liquid, and, therefore, as the concentrated solution diffuses away from the anode, copper must be deposited. This explains the fact that the loss of weight of the anode is greater than the gain of weight of the cathode, and also the presence of copper dust in the anode slime.

**Electrolytic Iron.**—This subject is dealt with by A. Skrabal in the *Zeitschrift Elektrochemie*, and an abstract of his paper appears in the *Journal* of the Chemical Society. Electrolytic iron of type A is white, compact, and extremely hard. It is obtained by electrolysing a solution of a ferrous salt with an iron anode and a small current density. Type B is greyer in colour, less compact, and softer than type A. It is obtained by using a platinum anode, a large current density, and a solution of some complex ferrous salt. Between these two extremes there is a series of intermediate qualities of iron obtained by combinations of the conditions mentioned. Iron of type A (obtained by electrolysing a solution of very pure ferrous ammonium sulphate with a platinum cathode, an anode of electrolytic iron, and an E.M.F. of about 0·4 volt) is silvery-white and sometimes distinctly crystalline. It dissolves very slowly in warm dilute sulphuric acid and rusts in moist air. Occasionally specimens are obtained which are hardly attacked by acids or haloids. Type A iron is always very hard (it usually scratches glass) and brittle, but it loses these qualities when heated to redness. When the iron is exposed to air it slowly loses hydrogen, or more rapidly when it is immersed in hot water; this loss of hydrogen does not diminish its hardness and brittleness. The author takes the view that electrolytic iron of type A is $\gamma$-iron; it is, therefore, in unstable equilibrium at the ordinary temperature. When heated, it changes into the stable $\alpha$-iron, which is soft. It cannot be hardened by heating and sudden cooling, owing to the high temperature at which $\gamma$-iron changes into the $\beta$ form in pure iron. The presence of large quantities of hydrogen is attributed to the greater solvent action of $\gamma$-iron, which is known to dissolve carbon much more readily than $\alpha$-iron.

**Electricity in Mills.**—This subject has come in for a good deal of discussion in the provinces of late, and it may be hoped that the attention which it is receiving from technical men will prove to be the precursor of its early adoption by millowners on a large scale. The Dundee Institute of Engineers considered the question at their last week's meeting, when Mr. H. Richardson, the borough electrical engineer, while not advocating electric driving under all conditions, specifically combated the following objections to same: (1) that it is in its experimental stage, and therefore its extensive use in mills is not justified; (2) that the cost of repairs to electrical plant is higher than in the case of mechanical energy; (3) that the efficiency of electrical driving is lower than mechanical driving; and (4) that electric driving could not possibly make better and steadier running than the best mechanical driving, and that it is

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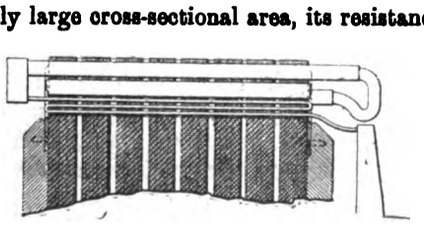
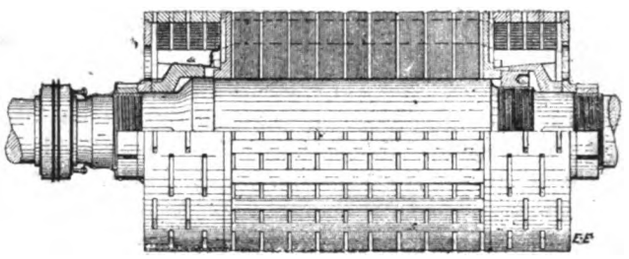
only advantageous in special cases. In support of this, Mr. Richardson quoted the case of the United States, where plant to the extent of some 20,000 h.p. has been installed for this purpose in cases where it would have been equally easy to instal the best mechanical driving. He proceeded to show that owing to the steadiness of speed, readier facilities for the observation of efficiency, and the comparative absence of shafting, belting, and gearing, the balance of advantage rested with electric driving. After dealing with the local aspect of the question, Mr. Richardson referred to the additional benefits in regard to light, smoke, and cleanliness secured by electric driving, and concluded by gently rallying the Dundee millowners upon their ultra-cautiousness. The advocates of mechanical power made a great point of the admirable qualities of the mill engine, which was echoed by Mr. D. J. Macdonald, the chairman, in his summing up; but they refrained from dealing with the inefficiency of the connecting gear between the engine and the mill plant. It is gratifyng to see that some of the millowners appear disposed to give electric driving a trial.

**Resistance Leads for Single-Phase Motors.**—The *Electrical World* of New York describes a patent just obtained in the United States by Mr. B. G. Lamme, the object of which is to so proportion the resistance leads in connecting the armature windings to the commutator bars in alternating-current motors as to reduce to a minimum the sparking between the commutator cylinder and the brushes. The current which flows in the coil under the brush is composed of two elements—that due to the working current and that due to the transformer action of the alternating flux. The amount of the induced currents in the armature winding depends upon the E.M.F. set up in them by the field magnetisation, and upon the amount of resistance in the closed circuit introduced by the coils, leads to the commutator, and the brushes. The inventor states that for minimum loss in the leads the induced current should equal the working current of the motor. It is evident, therefore, that the best value for the resistance of the leads is such that the induced currents may be limited to one-half the value of the total current supplied to the armature from an external source, so as to cause the current induced in the leads to equal the working current passing through them. Another patent issued to Mr. Lamme at the same time relates to a method of locating the resistance leads so as to secure the maximum mechanical strength. In order to obtain this the resistance lead should have a comparatively large cross-sectional area, its resistance being



proportioned by adjusting its length. As shown in the accompanying illustration, the lead is placed in the bottom of the armature slot, and preferably in the slot that contains one side of the corresponding armature coil, and is folded upon itself a sufficient number of times to obtain the proper length for the desired resistance. If the resistance leads are folded upon themselves an even number of times, they become non-inductive.

**Rotor of Turbo-Generators.**—Considerable difficulty has been encountered in the construction of dynamos for direct connection to steam-turbines on account of the centrifugal forces due to the high speed, and of the excessive noise due to air resistance when attempt is made to secure ventilation. The *Electrical World* of New York describes a design just patented in the States by Messrs. B. A. Behrend and W. D. Pomery to secure a compact and rigid well-balanced construction with all parts well protected and firmly held in place and to obtain good ventilation of all heated parts. The core, which is of the slotted type, is built up of laminæ grouped in sections spaced from each other by separators. The accompanying illustration represents a revolving field magnet, the windings being connected in series, so as to produce, when excited by direct current, a north pole and a south pole diametrically opposite each other, giving a bipolar field.



The windings are retained in the slots by wedges of phosphor-bronze, and the external surfaces are finished so as to give a perfectly smooth exterior. The end connections of the windings are covered by cylindrical pieces of nickel-steel having great mechanical strength. These cores serve not only to protect the coils, but also to withstand the great centrifugal force exerted upon them. The coils are separated from each other by spaces for ventilation, and the cylindrical covers are provided with openings for the same purpose, the openings coinciding with the spaces between the coils, and additional openings which are provided in the retaining end plates. At the interior surface of the end connections are located wedge pieces, four of which comprise an expansible ring, one of which rings is used at each end of the rotor. Within the wedge pieces is placed a clamping ring which, when forced into position, causes the wedge pieces which seat against the end plates to press outwardly against the end connections and securely hold them in a fixed position. In the operation of the rotor there is a free circulation of air through the openings in the end covers, and between the projections of the wedge pieces and out through the spaces between the coils and through the openings in the cylindrical covers. Ventilation is further secured by air passing into and out of the spaces between the sections of laminæ.

**Telephony and Telegraphy in the States.**—We have been favoured with a report on the telephonic and telegraphic systems of the United States for the year 1902, prepared by Mr. W. M. Steuart on behalf of the Department of Commerce. As these statistics deal largely in millions, not to say billions, they require a considerable amount of digesting, but the following is the substance of them. Under the head of telephone service three systems are recognised—commercial systems, including all systems operated by individuals, firms, or corporations for revenue; mutual systems, including systems operated through mutual arrangement between the persons deriving benefit from the service, primarily for the benefit of the owners; and independent farmer or rural lines having no regular exchange or central office. The first of these was by far the most important, and during the year covered by the report had in operation nearly 94 per cent. of the total number of telephones, while the mutual systems had in operation a little less than 4 per cent., and the independent or rural lines but a little over 2 per cent. Taking the total population of the continental United States for the year, as estimated by the Bureau of Census, it is found that there

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was an average of one telephone to every 33 inhabitants, though different States show remarkable fluctuations. The commercial systems embraced 4,779,571 miles of wires, with 2,371,044 subscribers; the mutual, 70,915 miles, with 89,316 subscribers; and the independent rural, 49,965 miles, with 55,747 subscribers. During the year 4,971,413,070 messages were exchanged on the commercial systems, and 99,141,483 on the mutual systems. The value at par of all the companies' stock is some £70,000,000. The total revenue of all the companies for the year was between £17,000,000 and £18,000,000; the operating expenses and fixed charges, except interest on bonds, aggregated to slightly under 12½ millions; and after allowing for interest on bonds, and paying dividends to the amount of nearly £3,000,000, there was a net surplus of £1,335,610. The Bell system owned 3,387,924 miles of line against 1,462,562 by the independent companies, and the subscribers numbered 1,222,327 and 956,039 respectively. The messages on the Bell lines totalled 3,074,530,060 against 1,996,024,493. In regard to telegraphy there are 1,318,350 miles of wire, and 91,655,287 messages were dispatched during the year, the revenue totalling over £8,000,000. Dividends to the amount of some £1,300,000 were paid, leaving a net surplus of about £800,000. The outstanding stock represents £24,000,000. Besides this, the railways owned 884,349 miles of wire. It will be seen that the telephone systems own between three and four times as many miles of line as the telegraph systems, but a glance at some statistics for 1880 contained in the report demonstrates the enormous growth of both industries in the States.

**Fog.**—The city engineer and surveyor of Westminster, Mr. J. W. Bradley, has made a special study of the dispersal of fog, and last week at the Caxton Hall he lectured on the subject to the Westminster Debating Society, several members of the Westminster City Council being present. The causes which give rise to fog in varying circumstances of temperature, wind, and situation, were first of all dealt with, and the different types of fog were considered under three heads—steaming water fogs, cold surface fogs, and cloud fogs. Special reference was also made to the smoke fog or dust cloud which occasionally rises in the Metropolis. Mr. Bradley observed that, while the higher districts of the Metropolis usually enjoyed comparative immunity from fog, this was not always the case, as low-lying districts such as Rushey Green and Hammersmith also show marked freedom from fog, while over the higher part of Regent's Park it is by no means infrequent. Having alluded to the good work done by the Coal Smoke Abatement Society under the presidency of Sir William Richmond, Mr. Bradley referred to the Hon. R. Russell's estimate of £5,000,000 as the annual loss sustained by the people of London through smoke and smoky fogs. Particulars were given of the dispersion of fog by wind, and it was stated that when the velocity of prevailing wind reached 13 miles per hour, all fogs except very smoky fogs are dissipated, and that these require a velocity of about 30 per cent. greater. The dispersion of fog by electricity was then fully described, reference being made to the work of Sir Oliver Lodge in this direction. A demonstration was given of the dispersion of smoke produced by the burning of magnesium ribbon and its precipitation by an electric discharge. It was stated that the cost of fitting up the electrical method of dispersion in Piccadilly-circus, Trafalgar-square, Victoria Station, Hyde Park-corner, together with a few other centres, would probably be from £5,000 to £6,000, while the Strand or Victoria-street could be dealt with at about half that cost. A description was given of the method adopted by the Westminster City Council to light central spaces in time of fog by means of portable compressed-air oil lamps, and of their experiments with orange-tinted globes and special carbons in the electric arc lamps for the purpose of gaining a greater penetrative effect through the fog. Mr. Bradley further stated that, apart from the heavy indirect loss through fogs, there was a direct loss of some £200 per day in extra lighting, so that from the point of view of the central-station engineer fogs are not an unmixed evil. The welfare of the whole community, however, is a still more important consideration, and Mr. Bradley, in conclusion, made the interesting announcement that he and several engineers of the electrical supply companies in Westminster had accepted Sir Oliver Lodge's invitation to view his electrical installation for fog dispersion at Birmingham.

**Traction Progress in 1904.**—An interesting survey of the year's progress in the various fields of engineering is contained in the *Scientific American*. Coming to the electrical section, the author deals with the application of electric traction to trunk lines, not merely for their suburban service, but for long-distance travel between widely-separated centres. Pioneer work on an ambitious scale has, as our readers are aware, been begun by the New York Central, the most interesting feature of their scheme being that the express service will be operated electrically for a distance of 40 miles out of New York. This experiment is naturally fraught with the greatest interest, as so much depends upon the result. Reference is made to the competitive trials now being carried out in Germany between steam and electric traction over the Berlin-Zossen stretch of road, on which a speed of 131 miles an hour was reached by an electric car in 1903. Several high-speed express locomotives of special design are being tested, but up to the present time there have been no grounds for believing that for hauling heavy trains at speeds of 80 to 100 miles an hour the steam locomotive can compare with electric traction. On the other hand, the results already obtained during the experimental runs of the New York Central electrical locomotive on a six-mile stretch of their track near Schenectady (an account of which we published a few weeks ago) are very satisfactory. The data thus far secured prove that this electrical locomotive has all the powers of rapid acceleration, which is one of the best features of this form of traction. Its total weight is 95 tons, its maximum horse-power 3,000, and the maximum drawbar pull is 32,000lb. Already in the course of the tests a speed of 63 miles per hour has been reached with an eight-car train, and 72 miles per hour with a four-car train; and in the starting test a speed of 30 miles per hour has been reached in 60 seconds with an eight-car train weighing with the locomotive 431 tons, which is an acceleration of one-half mile per hour per second. With a four-car train weighing with locomotive 265 tons, the acceleration was at the rate of 0·8 of a mile per hour per second. This engine weighs 95 tons, and there is a possibility of its developing a maximum horse-power as high as 3·500. The author considers it would be quite feasible to build a locomotive for high-speed service, of 5,000 h.p. and 125 tons weight, that would not overtax the track and bridges, although if the New York Central venture leads to the general electrification of the trunk road for long distances, it is probable that the Sprague system of multiple control will be preferred. Meanwhile the trolley road systems throughout the country are gradually approaching the steam railroads in the solidity of their tracks, the size of their rolling stock, and the general comfort of travel. Already on interurban roads the electric sleeping-car and the electric dining-car have made their appearance, and are giving satisfaction.

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## ARMATURE WINDINGS OF THE CLOSED-CIRCUIT TYPE.

BY WM. CRAMP.

*(Continued from page 152.)*

### MULTIPLEX MULTIPLE-CIRCUIT WINDINGS.

**Double Windings Doubly Re-entrant.**

In Fig. 10 we have re-drawn Fig. 1, having added a second winding exactly similar to the first, but spaced in such a way that its spirals occur exactly half-way between the spirals of the first winding (the piece of the first winding included between the lines A and B being called, as before, one spiral). This winding is to the simple winding of Fig. 1 exactly what a double-threaded screw is to a single-threaded screw. Such an arrangement is called *a double (or duplex) multiple-circuit* ring winding, and since each winding is entirely independent of the other, each closing upon itself, it is said to be *doubly re-entrant.* It will be noticed that when the second winding is connected down to the commutator in the same way as the first winding, its segments naturally occur alternately interspaced with those of the first winding, hence the commutator belonging to this form will have twice as many segments as the corresponding armature with a single winding.

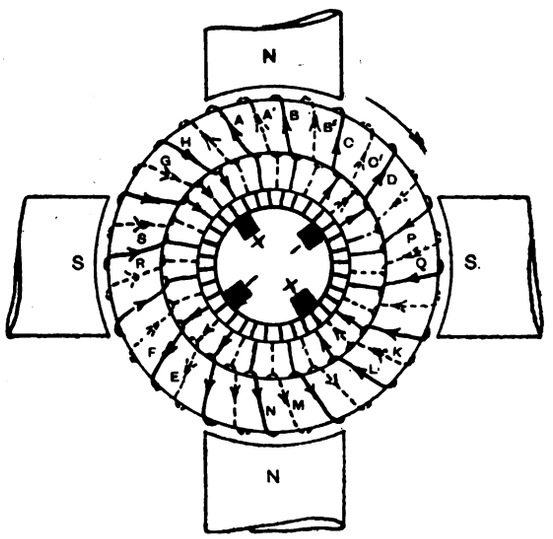


FIG. 10.

Now, if each brush bearing upon the commutator be made so wide that it never touches less than two sections, we find that we have, with respect to these brushes, the two windings on the armature continually in parallel.

For imagine for a moment that the two windings were moved toward one another until such a spiral as A coincided with $A^1$, then it is obvious that (if the wire with which A and $A^1$ are wound is the same as was used in Fig. 1) we have simply wound the armature of Fig. 1 with two wires in parallel, but have connected the winding to double as many commutator sections.

**Object of a Double Winding.**

Thus the sole object of a double, or duplex, winding is to enable the armature to carry more current, and to split up this heavier current into sufficiently small parts while it is being commuted.

This matter is made more clear when in Fig. 10 we note that between the two upper brushes there are *in series* the spirals marked A, B, and C, and also as a separate series the spirals $A^1$, $B^1$, and $C^1$. Now A, B, and C are *not* in series with $A^1$, $B^1$, $C^1$, but *in parallel* with them, therefore (considering the upper part of the winding alone), between these two upper brushes we have the sum of the electromotive forces due to three spirals, but the current is due to two sets of three spirals.

Thus has a double winding no advantage over a single winding of twice the section except so far as it enables a heavy current to be commuted satisfactorily; and we should never use a double winding until we had reached (without satisfactory commutation), the maximum possible number of segments with a single winding—*i.e.*, one segment per spiral. This point is further discussed at the end of this section.

**Comparison of Duplex and Simplex Windings.**

To sum up, we might compare Figs. 10 and 1 as follows: Supposing each winding in Fig. 10 to be exactly similar to the winding in Fig. 1, the two armatures when revolving at the same speed and in the same field will give exactly the same voltage and will have the same number of brushes.

Fig. 10 will give, without dangerous heating, practically twice the current of Fig. 1, because it has a second set of circuits on its armature placed in parallel with the original set. Fig. 10 will have a commutator with twice as many segments as Fig. 1, and the peripheral length of brush will be arranged so that it covers at least 1½ segments. But it must, of course, be remembered that in practice a ring armature is not wound as Fig. 1, but with the spirals packed close together; therefore, as a rule, to any simplex winding we cannot add another, making it duplex, without some special provision, such as boring out the air-gap. If we use the same core first for a simplex winding and then for a duplex winding, we should probably have in each case the same number of spirals upon the armature and the same number of commutator sections, if we assume one section per spiral. But the duplex winding will have between each pair of brushes half the number of spirals in series that the simplex winding has, while in the simplex winding the spirals between any pair of brushes are all in series as compared with the duplex winding, which will have them divided into two sets in parallel. So that for a given core, with a given speed and a given field, we can obtain a certain output. If we wind the armature simplex, this output is A amperes at V volts; while with a duplex winding it will be 2 A amperes at $\frac{V}{2}$ volts, with the same number of commutator sections. If, on the other hand, we wind it with two wires in parallel and simplex (or one wire of twice the section), we shall obtain 2 A amperes at $\frac{V}{2}$ volts, but with half the number of commutator sections.

A double winding, then, in general only supplies a method whereby we are enabled to change the output of a machine by simply altering the pitch of the winding, without changing either the number of turns upon the armature or the number of commutator sections. But should there chance to be on any machine room for adding more turns, then we might have such a contrast as that existing between Figs. 10 and 1, where we see that though in Fig. 10 there are twice as many spirals upon the armature as in Fig. 1, and though the former gives twice as much current as the latter, yet the number of commutator segments is increased in proportion to the number of spirals, so that the current commuted per segment remains the same. This, as has been said, is the real advantage of this type of

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winding—viz., that it enables the machine to give a larger current without commutation difficulties.

**Multiplex Ring Windings in General.**

To return to Fig. 10, we might have placed two windings or three, or any number for which there was room, each exactly similar to that in Fig. 1, between the spirals of the simplex winding. In the illustration we have placed only one extra, and the armature is double wound, doubly re-entrant. Had we placed two extra, it would have been triply wound (or triplex), triply re-entrant, and so on. A very convenient notation has been introduced to express this. If an armature is single wound, it is denoted by o; if double wound, doubly re-entrant, by o o, to show that there are two absolutely independent windings. Hence the full description of Fig. 1 is—

four-pole multiple-circuit ring, 16 spirals, o.

That of Fig. 10 is—

four-pole multiple-circuit ring, 32 spirals, o o.

That of Fig. 8 is—

six-pole multiple-circuit drum, 24 inductors, o.

**Multiplex Drum Windings.**

Now, as from Fig. 6 Figs. 7 and 8 were derived, giving drum windings exactly analogous to

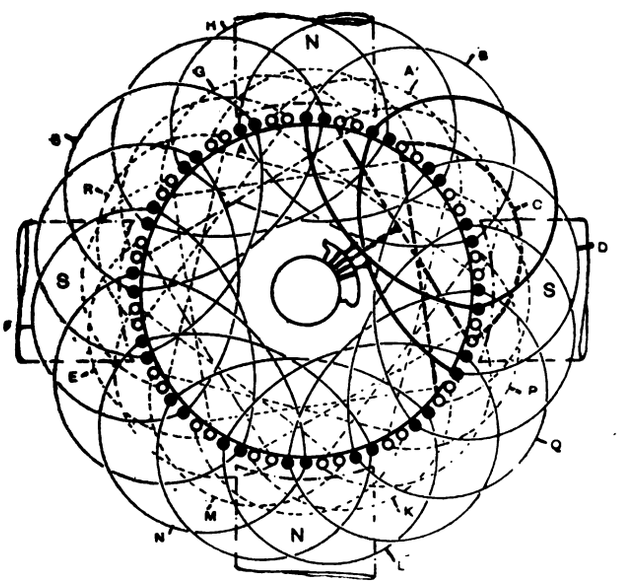


Fig. 11.

the original ring winding, so from Fig. 10 by the same process we may develop a *double-wound* drum. The two windings on the drum will be entirely separate, just as with the ring, and the commutator segments will be similarly interleaved. Fig. 11 shows the drum counterpart of Fig. 10. The connections belonging to the second winding are drawn dotted, and a close study of this figure will show all that is to be learnt about these doubly-wound doubly re-entrant drum windings.

The diagram is likely to appear at first sight confusing, but the scheme of each winding has, as far as possible, been kept separate by the use of heavy black dots to represent the inductors of one winding, while circles represent those of the other. To the same end a single turn of each winding has been accentuated, and the commutator has been omitted except for three segments, which just serve to show how the parts belonging to one winding are interleaved with those of the other winding, exactly as in Fig. 10.

**Rules for Multiplex Drum Windings of Multiple Re-entrancy.**

Now, since for a single drum winding the total number of inductors must be divisible by 2, it follows that, when two such windings are placed upon the same armature, the total number of inductors must be divisible by 4; or if three such windings are used it will be divisible by 6, and so on, *no matter what the number of poles.* Each time that a new winding is added, a new set of commutator segments must be allowed for; and since the only object of adding a winding is to increase the current capacity of the machine without risk of sparking, it follows that all the windings must be in parallel to be effective, and consequently at each collecting point the brush must be wide enough to touch a number of segments at least equal to the number of windings upon the armature. The number of poles determines the number of collecting points *only*, and there is no difference in the behaviour of the multiple-circuit ring and the multiple-circuit drum except this—that whereas in a ring winding all *return* connections pass within the armature (out of the active field), the return connections in the drum pass under a pole of different sign. Thus the same ring armature may be placed in a two, four, six, or eight pole field with a corresponding number of brushes, and work satisfactorily in each; but a drum winding, if arranged for a four-pole field, would not act well in an eight-pole field, because the return inductors would lie under a pole of the wrong sign. This is best seen by drawing out a simple four-pole drum winding and then sketching eight poles around it.

Though perhaps it is better in the case of double and triple windings of this sort to consider them as so many *separate* windings, yet we might develop a set of rules to apply to such windings similar to those for the simple windings given above. If in Fig. 11 we number all the inductors consecutively, we find that the following rules will hold; they are developed from previous reasoning:

(1) The number of spirals on the armature must be a multiple of the number of independent windings—*i.e.*, in the case of a drum winding the number of inductors must be divisible by *twice the number* of independent windings.

(2) For connecting a drum, number all the inductors belonging to one winding, and consider it as alone upon the armature. Then connect according to the rules given above for simple windings.

We have already laid stress upon the point that for a simple or simplex multiple-circuit drum winding, starting from inductor No. 1, the second end connection brings us naturally to inductor No. 3. By the same reasoning, in a double or duplex multiple-circuit winding the second end connection must bring us to inductor No. 5. Similarly the second end connection of a triple or triplex multiple-circuit winding will bring us to inductor No. 7, and so on.

From this it follows that whereas in a simplex multiple-circuit drum winding the difference in the number-pitches $y_1$ and $y_2$ is 2, in a duplex multiple-circuit drum winding it will be 4, in a triplex 6, etc. So that $y_1 - y_2$ depends upon the number of windings, and becomes $= 2\,m$, where $m$ is the number of windings.

Thus we may write Rule 2 as follows:

(2A) Number all the inductors. Take as a forward number-pitch an odd number approximately equal to, or slightly greater than, $\frac{w}{p}$; call this pitch $y_1$, then the backward pitch becomes obviously $(y_1 - 2\,m)$, where $m$ is the number of independent windings.

*(To be continued.)*

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## THE LOTS ROAD POWER STATION.

(*Continued from page 155.*)

In our last issue we carried the description of the above station down to the point at which the current generated by the turbo-alternators is dealt with by the switchboard for distribution to the various sub-stations. This switchgear, which was designed and supplied by the British Thomson-Houston Company, of Rugby, we now propose to describe more in detail, using photographs and drawings kindly lent us by that firm. The design of suitable switchgear to properly handle 50,000 kw. at 11,000 volts constituted one of the most difficult problems in the development of this great station, owing to the dependence of reliable operation upon the switchgear, the impossibility of making experiments on anything like full power, and the lack of precedent in the United Kingdom. Such precedent as there was existed only in one or two large steam-power stations in New York City. In its main features the gear of the Chelsea station follows the general lines of these stations, which approach it in power and voltage.

A brief history of the development of switchgear for handling with ease the output of large stations at high voltage may be of interest. The chief detail of such gear is the power-actuated oil-break switch. Previous to the construction of the large New York stations, a number of power-actuated oil-break switches of rather primitive form had been in experimental use in several large stations using high-voltage transmission. One form for these switches consisted essentially of wooden barrels filled with oil in which a crude form of knife-switch was immersed, all connections and operating gear being taken out through the top of the oil. The relatively good behaviour of these first types under emergency conditions proved that for large powers the air-break switch was not worth consideration. These primitive switches were then redesigned to the various forms considered the most satisfactory at the present day.

In the form which has been used in the station here described, the large oil-barrels have been replaced by metal oil-pots, the bases of which form the live contacts. The moving part of this switch consists of an inverted "U" shaped rod, the two ends of which dip centrally into two oil-pots. The oil-pots themselves are electrically connected to the incoming and outgoing cable of one phase respectively. When the U-shaped rod is forced down into contacts in the bases of the oil-pots, the circuit is closed. When the U-shaped rod is pulled up out of the contacts through the oil, the circuit is broken. Insulating stuffing boxes at the top of the oil-pots prevent the oil from being thrown out in case the disruption of the circuit raises a high pressure within the oil-pot. The advantage of this construction over the previous form lies in the fact that a much smaller amount of oil is used, and this oil is enclosed in a series of metal vessels, and is, therefore, less likely to spread a serious fire if ignited at any point. Absolutely all of this oil is above the points where the circuit is broken, and is therefore available to drown out the arc.

In their original form the switches were actuated by compressed-air cylinders, the valves of which were electrically controlled. Pneumatic control has since been superseded by direct electric control, usually by means of a small direct-current motor mounted on each complete three-phase switch. The switches used in the Lots-road station of the London Underground Railways Company, Limited, follow this precedent, and also resemble their predecessors in the distribution of the extra high-tension parts over a large area, the remote control feature allowing the scattered oil switches to be operated from one central keyboard. The high-tension oil switches, of which there are about 100 complete three-phase sets, are scattered with the corresponding 'bus bars, cables, etc., over three switchboard galleries running the whole length of the station, about 450ft. on the Lots-road side—*i.e.*, the side of the turbine-room, away from the river and boiler-room (Fig. 4).

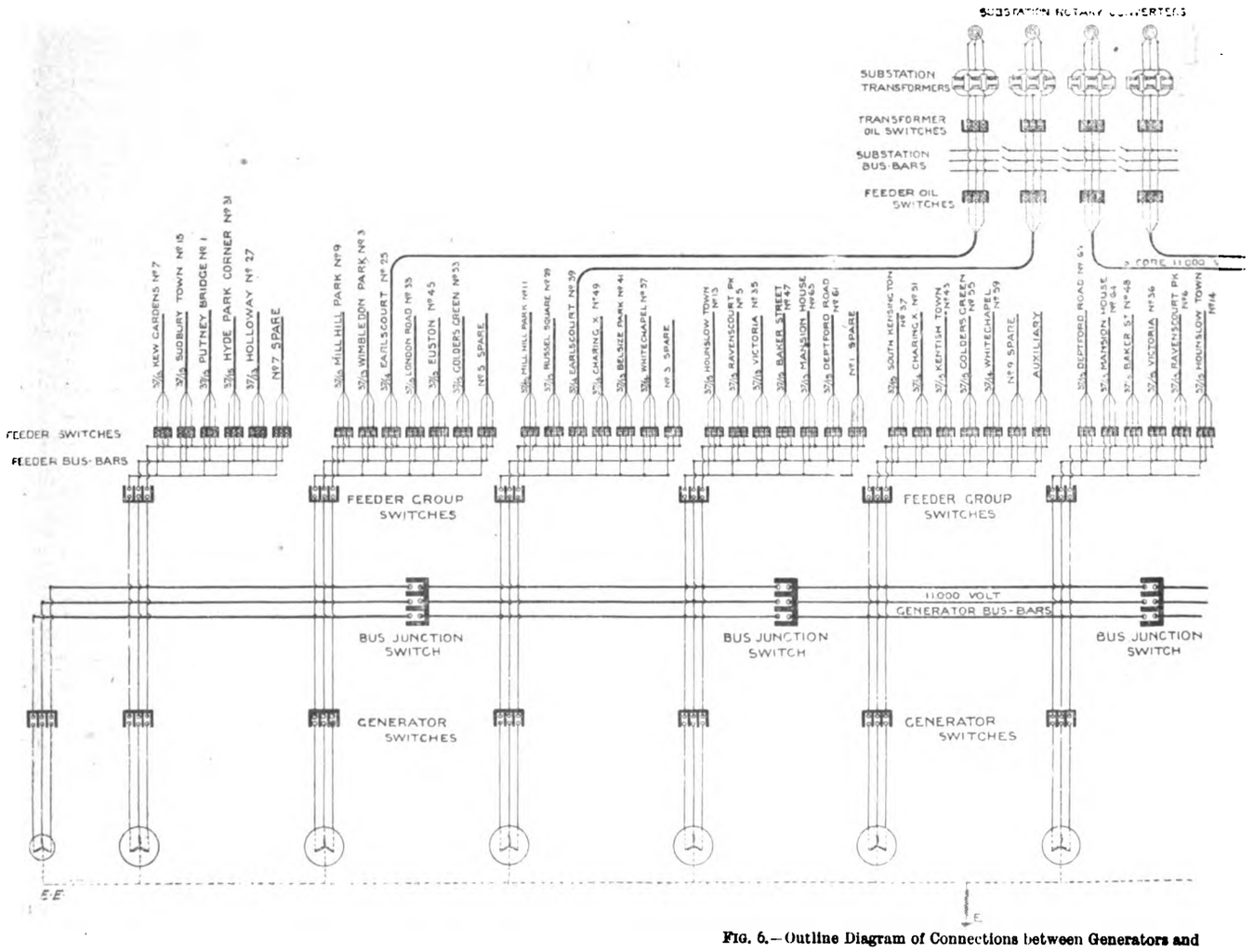


FIG. 6.—Outline Diagram of Connections between Generators and

In general the arrangement is such as to make the extra high-tension leads as direct as possible. For example, the several generator switches are not grouped together, but

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are located nearly opposite their respective generators. The oil switches supplying the outgoing lines are also

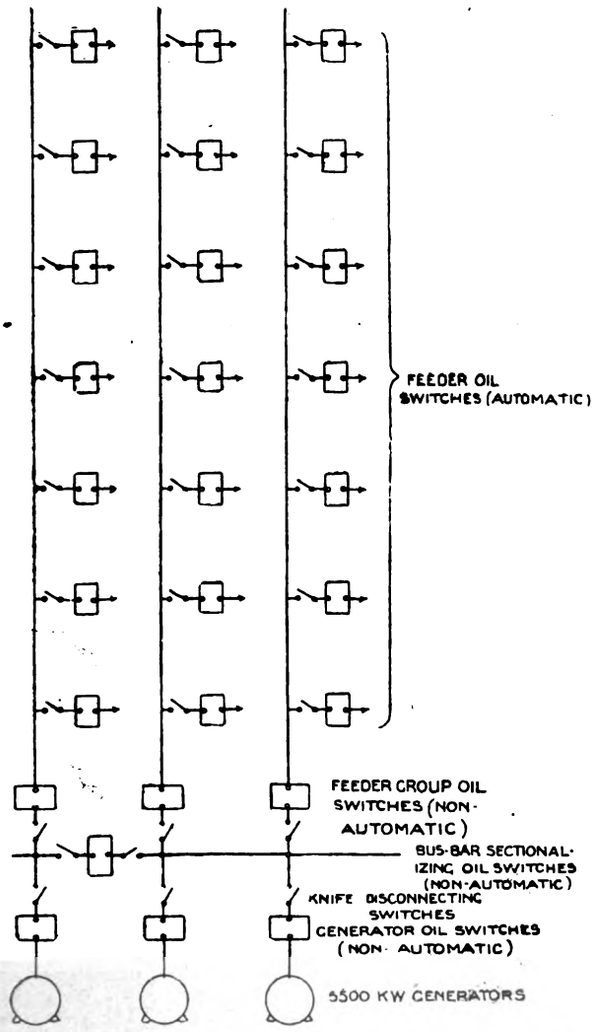
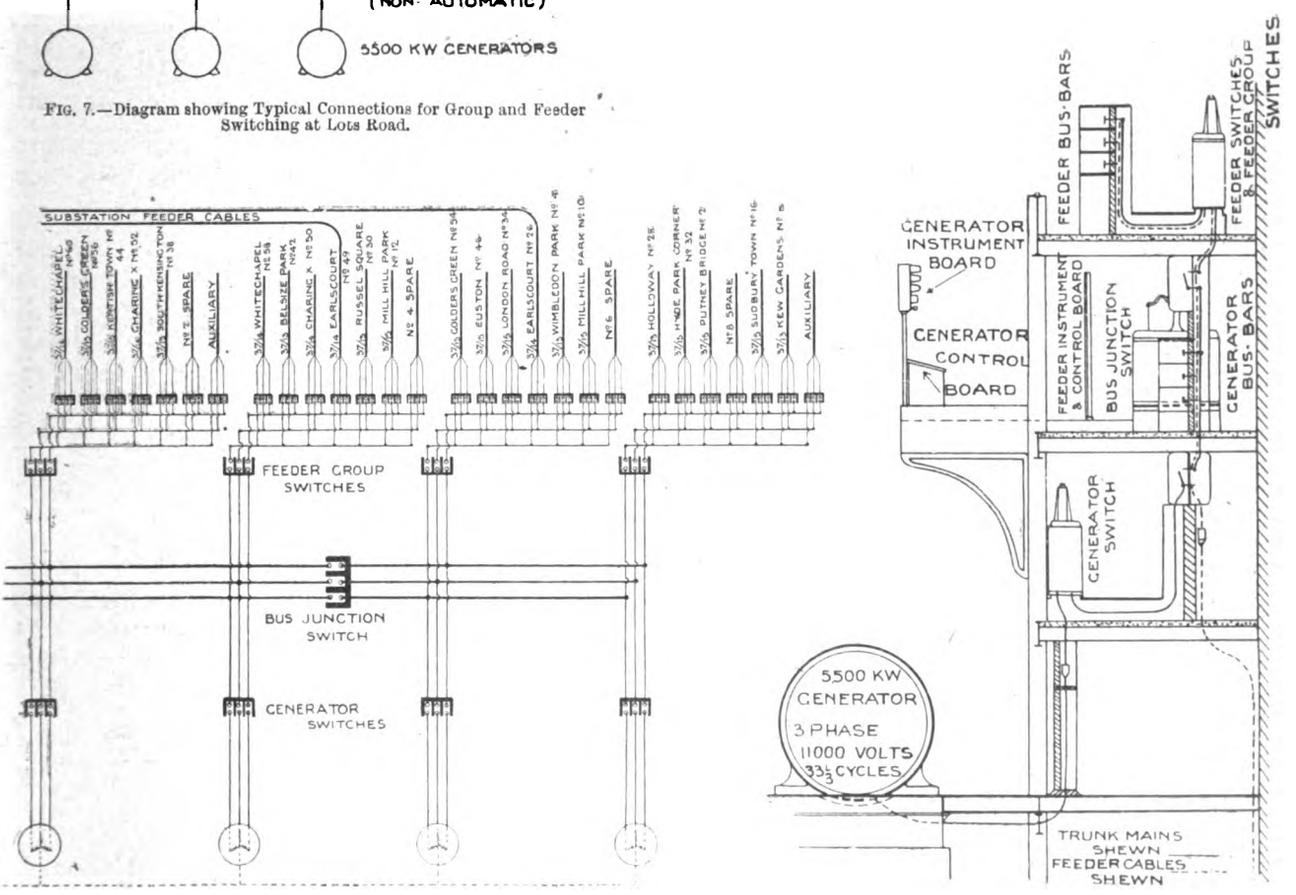



FIG. 7.—Diagram showing Typical Connections for Group and Feeder Switching at Lots Road.




Sub-Stations on the Underground Electric Railway Company's System.

scattered the whole length of the house, and are supplied from the main 'bus bars between the several generator switches. Thus there is no single 'bus carrying the whole station output. The extra high-tension 'bus bars are not in duplicate, owing to the complications which a duplicate arrangement involves in extra high-tension work, with its isolating barriers, and also owing to the complications in operations which might arise if, for example, the duplicate 'bus bars should be unintentionally paralleled through two or more high-tension transmission lines running to the same sub-station.

To enable a fault even on the extra high-tension main 'bus to be cleared without suspending service, and to make it possible to inspect, repair, or alter any part of the extra high-tension main 'bus, this is divided into five sections by means of four oil switches, as indicated in the accompanying general diagrammatic sketch of connections (Fig. 6). To each of the five sections are connected two of the 5,500-kw. main generators, each of which is provided with one complete motor-operated three-phase oil switch. From each of the five main sections of the 'bus bar, about 13 of the total number of 68 three-phase cables leading to the sub-stations are supplied. Each of the outgoing cables is provided with its own complete motor-operated oil switch, but the connection is not made directly from this feeder switch, as it is called, to the main 'bus. From each of the five sections of the main 'bus power is delivered through two "feeder group" or "group" oil switches, each such switch feeding a short length of 'bus bar, termed a "group 'bus," from which in turn six or seven feeders are supplied through their respective oil switches. This principle of grouping the feeders was adopted with the object of getting two oil switches in series with each other, so that in case of the failure of one from any cause, the other would be available to open the circuit in case of an emergency. Obviously two complete motor-operated oil switches for each of 60 or 80 feeders would add so greatly to the number of parts and general complication that the duplication would be of doubtful advantage. A compromise was obtained by putting a single oil switch in each feeder, with a group switch for each six or eight. Each sub-station is provided with two or more separate extra high-tension feeders, each consisting of a three-core cable. These feeders supply one high-tension 'bus bar in the sub-station. The several feeders to one sub-station are taken from different

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sections of the extra high-tension 'bus bar in the generating stations, so that all sub-stations can be supplied through part of their feeders, even with one complete section of the main 'bus bar in the generating station out of service.

### The Oil-Break Switches.

Each oil switch is enclosed in a fireproof brick and stone cellular compartment (Fig. 8), designed to prevent the spread of a burn-out in case the oil switch should for any reason fail. This principle is also carried further by isolating each phase in its own cell with masonry barriers between the cells, the idea being that if one phase should fail the other two would open the three-phase circuit if the spread of the trouble to them is prevented. The general construction of the switch is shown in the accompanying illustrations (Figs. 8 and 9). The contact rods within the oil are capable of carrying about 300 amperes continuously. This is ample for any one of the outgoing feeders in this station, but is not equal to the load which may come upon any one of the 'bus-bar section or group switches. For these cases an auxiliary contact in air is made across the tops of the oil-pots, this contact being broken before the contact within the oil-pot. These air contacts can be seen in the front view of one of the 'bus-bar section switches (Fig. 9). The moving parts of the switch are thrown from the "off" to the "on" position or from the "on" to the "off" position by means of powerful coil springs contained within the mechanism above the stone slab which forms a cover to the extra high-tension parts. When thrown by one spring against the other, they are caught and prevented from rebounding by means of a clutch through which the driving motor immediately takes hold and supplies the necessary power to complete the compression of the receiving spring. In other words, the moving parts are tossed from one spring to the other, the motor simply serving to make up the losses and complete the stroke. The first throw of either spring is ample to close the switch from the open position, or open the switch wide from the closed position. This feature of throwing the somewhat heavy moving parts from one spring to another gives quick action without violent jars, as one spring cushions the throw of the other.

Each oil switch is connected to the 'bus bars through three knife-blade isolating or disconnecting switches, which are not intended to be opened when carrying current, but can be readily opened when the circuit has first been broken by means of the oil switch. These knife switches are operated by means of long wooden rods with hooked ends, which may be engaged in holes through the knife blades.

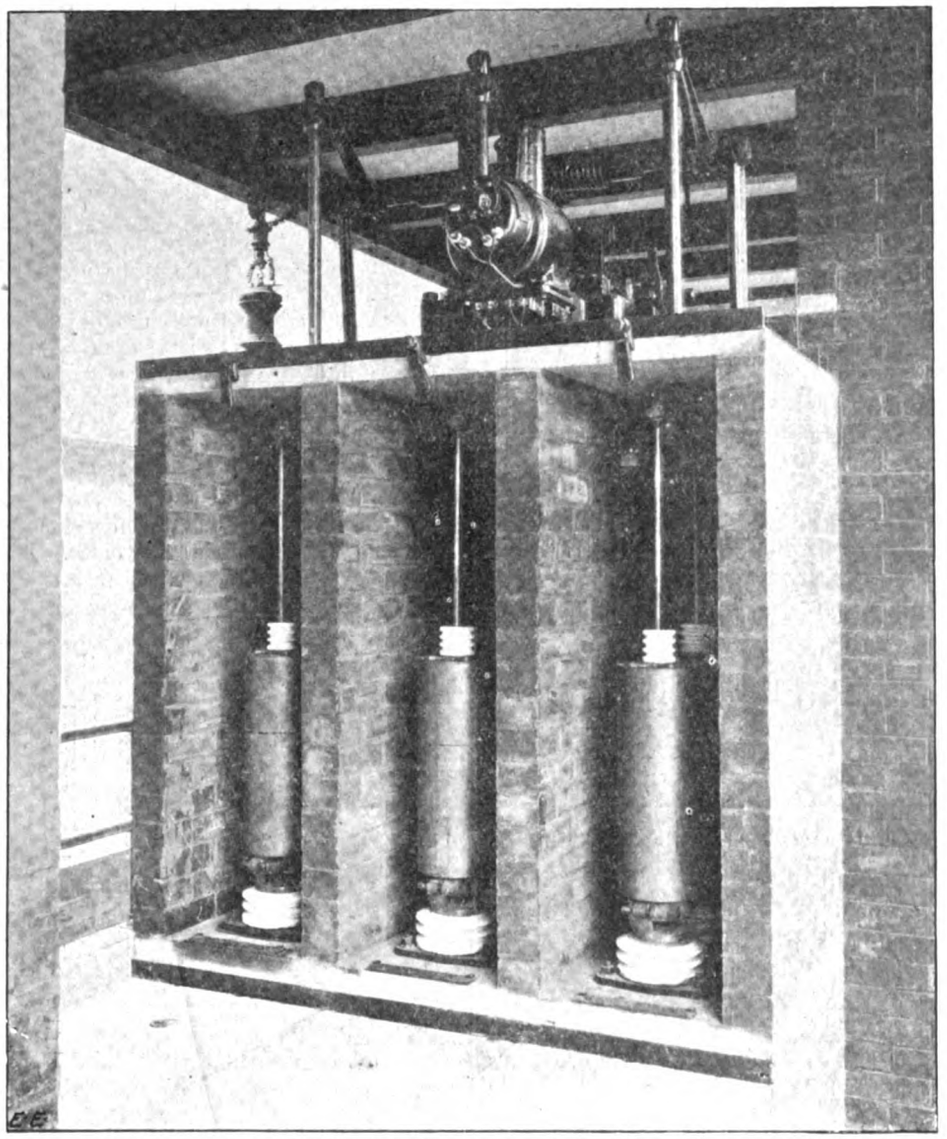

Fig. 8.—Typical B.T.H. Oil Switch with Subsidiary Air Contacts, as used at Lots Road.

These isolating switches serve to disconnect the live parts of the main oil switch from the 'bus bars for inspection, cleaning, etc, and also make it possible to test the mechanism of any oil switch without connecting the corresponding machine or feeder to the live bars. The knife disconnecting switches, together with all other high-tension gear such as main 'bus bars, pilot transformers, main leads, etc., are thoroughly isolated by means of masonry barriers either of brick or artificial stone construction.

### The Switchboard.

The extra high-tension operating and instrument boards are of two types, one made up of the usual vertical panels, the other consisting of an inclined bench-board, or table (Fig. 10), on which are mounted the handles of the control gear, and an instrument section separated from the bench-board by a space through which the operator can

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glance over the station. This bench-board stands in a projecting bay of the second gallery with the vertical panels immediately behind it, so that the operator has the switchboard both before him and behind him, thus greatly shortening the total length of travel required to control all of the gear. All of the machines are controlled and measured on the inclined bench-board facing the station and on the corresponding instrument panels, while all of the outgoing feeders are handled on the vertical panels (Fig. 11); thus, when the operator faces the station he has the control of his machines in front of him and of his feeders behind him. Through the open space between the bench-board and the instrument panels above it the operator can look out over the station.

pole type, is, however, mounted directly on the generator panel in the controlling bench-board. Each generator panel is therefore equipped with: (1) one controlling hand switch for main oil switch; (2) two indicating lamps to show whether the main oil switch is in open or closed position; (3) one field discharge switch; (4) one field rheostat motor controller; (5) one synchronising receptacle; (6) one signal push switch to turbine position; (7) one controlling switch for turbine governor motor. By means of the last device the speed of the turbine may be adjusted in order to bring it into synchronism with the other machines; also when the machines are in parallel the division of the load may be adjusted from the switchboard.

For each generator there are also the following instru-

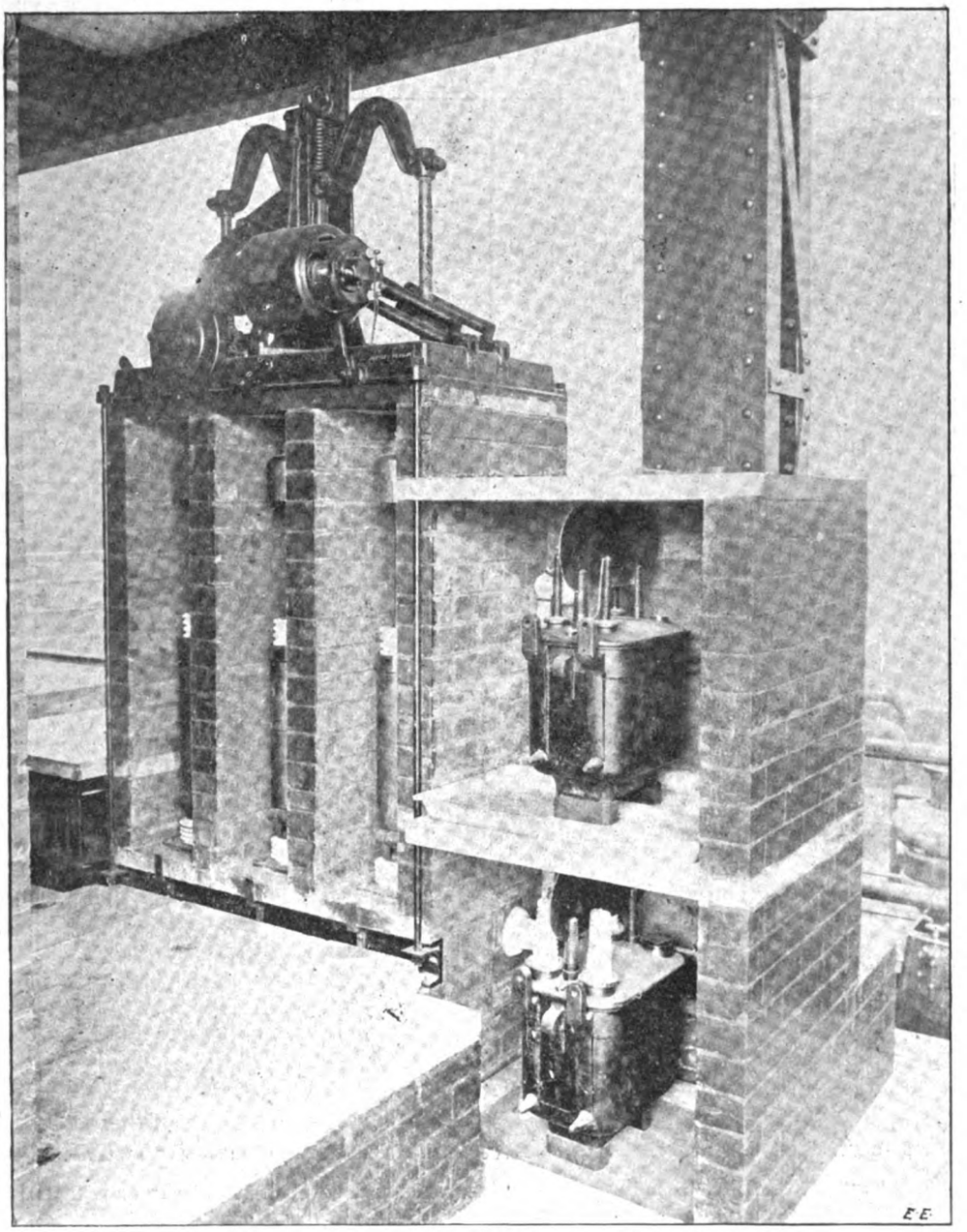

FIG. 9.—View of Motor-Operated Oil Switch and Potential Transformers.

On account of the large size of the field rheostats necessary to handle the excitation of these large machines, and particularly on account of the high temperature at which these rheostats would run run if crowded together, it has been necessary to locate them at some distance from the operating board, for which reason their contact arms are motor driven. A small controller on the bench-board panel for each generator serves to start, stop, or reverse the direct-current motor driving the corresponding field rheostat. Limit stops on the rheostat dial also serve to cut off the current of the motor in case the operator attempts to run the contact arm beyond the limits of the dial. These motor-operated rheostats are placed above the auxiliary switch-board. The main field discharge switch, which is of the single-

ments: three main ammeters, one main voltmeter permanently connected across one phase by means of a potential transformer, one power factor indicator, one field ammeter, one integrating watt-hour meter. The latter is of the single-phase type, with a potential derivation of proper phase relation to give correct readings on one phase of the three-phase circuit. On account of the fact that the load on this system will be almost entirely of a perfectly balanced character, the complications of polyphase watt-hour meters designed to read properly on unbalanced circuits are not considered warranted. Each generator is also equipped with one reverse-current relay designed to light up an alarm lamp, but not to operate the corresponding oil switch automatically. The object of this device is to give

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the switchboard attendant instant notice on the proper panel if any generator fails. Automatic operation of the generator switches is avoided owing to the liability of excessive out-of-phase oscillating cross currents when a heavy fault occurs outside on the network. These momentary rushes of cross current would pull out the generators if equipped with reverse-current automatic release, and suspend the service, a result which is to be avoided on this system except in the very last extremity.

The highest voltage on the switchboard or bench-board is the 125 volts of the exciter and switch operating circuits. All alternating potentials for voltmeters, wattmeters, synchronising, etc, are derived from potential transformers having a ratio of 100 to 1, thus giving 110 volts when the line voltage is 11,000. One terminal of the secondary circuit of each of these potential transformers is earthed on a ground 'bus bar, which circulates through the extra high-tension gear for the purpose. Thus, if a high-potential instrument transformer should by any chance break down between the primary and secondary coils, the breakdown current would be carried off to earth without raising the potential of the secondary circuits supplied from the transformer. Similarly all ammeters, overload relay coils, series coils of wattmeters, etc., are supplied from series or current transformers giving a secondary current at full load of $3\frac{1}{2}$ amperes at a pressure of, roughly, 10 to 12 volts. The secondary circuits of these current transformers are earthed similarly to those of the potential transformers above mentioned. The current transformers are substantially designed with a jointless magnetic circuit requiring negligible magnetising current, thus giving them a very accurate and uniform ratio of secondary to primary amperes throughout their whole load. They are also of ample power to furnish current for either one indicating instrument alone, or two indicating instruments in series with an integrating instrument and relay, without appreciable change of ratio. Thus any 40 to 1 current transformer is interchangeable with any other 40 to 1 current transformer, regardless of the number of instruments for which it furnishes current within the limits reached in this station, and without recalibration of said instruments.

The current and potential transformers are, of course, conveniently located to the extra high-tension leads to which they are connected. To connect these transformers and the oil switches with the central switchboard, a large number of small leads are required. These are all run in extra heavy screwed Simplex pipe, largely of the $1\frac{1}{2}$in. size. These pipes were laid on top of the gallery floor joists before the flat concrete arch floors were put down. Thus the pipes have been buried out of reach of trouble in the concrete. The piping system was very thoroughly worked out to carry each particular pipe as close as possible to the individual device, such as current or potential transformer at one end and the corresponding controlling switch, relay, or instrument which it should reach at the other end. This was done entirely without main cross-over boxes into which it is sometimes customary to bring a large number of pipes, and in which the wires can be generally crossed over to avoid the labour of laying out each pipe accurately from start to finish. The pipes themselves form a number of crosses in the concrete, due largely to the fact that, although a given sub-station is supplied from sections 1, 3, and 5, for example, the three controlling switches, ammeters, and integrating watt-hour meters for the feeders of this particular sub-station are grouped together on one panel at the feeder board. The iron-armoured tubing takes care of all of these crosses of controlling and instrument wiring without any danger of interference between circuits.

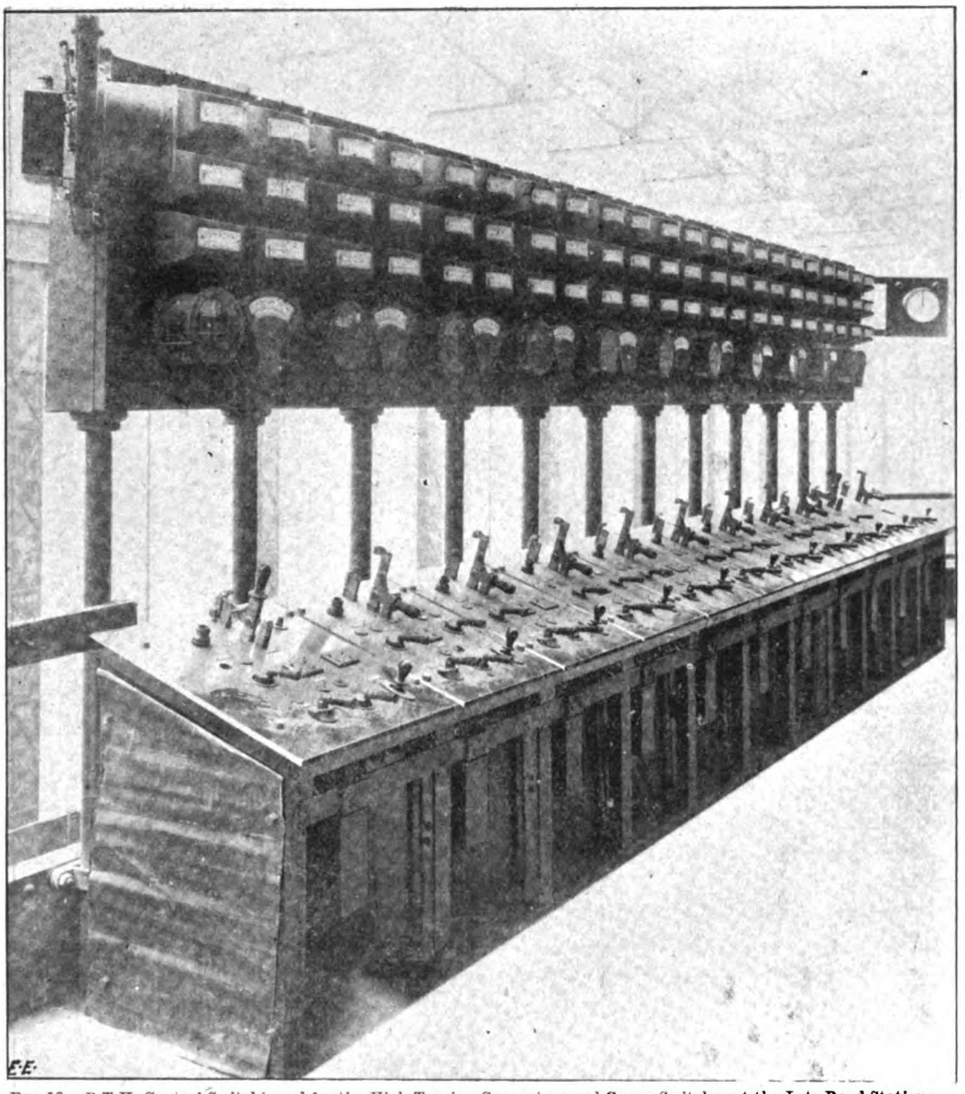

FIG. 10.—B.T.H. Control Switchboard for the High-Tension Generators and Group Switches at the Lots Road Station.

In answer to objections that have been raised to burying such iron-armoured tubing in the concrete, on the score

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that it would be difficult or impossible to get at the wiring in case of severe burn-outs which might injure the pipe, it may be said that considerable experience with this form of construction has shown that burn-outs, when they do occur, do not injure the pipe, and that the burned-out wires can readily be drawn out and new wiring installed, even where the piping is entirely inaccessible. The use of extra high-tension enclosed glass tube fuses in the primary leads of the potential transformers prevents any considerable rush of power through them into the piping in case of a fault. The current transformers cannot, of course, be similarly protected, but the solid earth connection of one secondary terminal takes

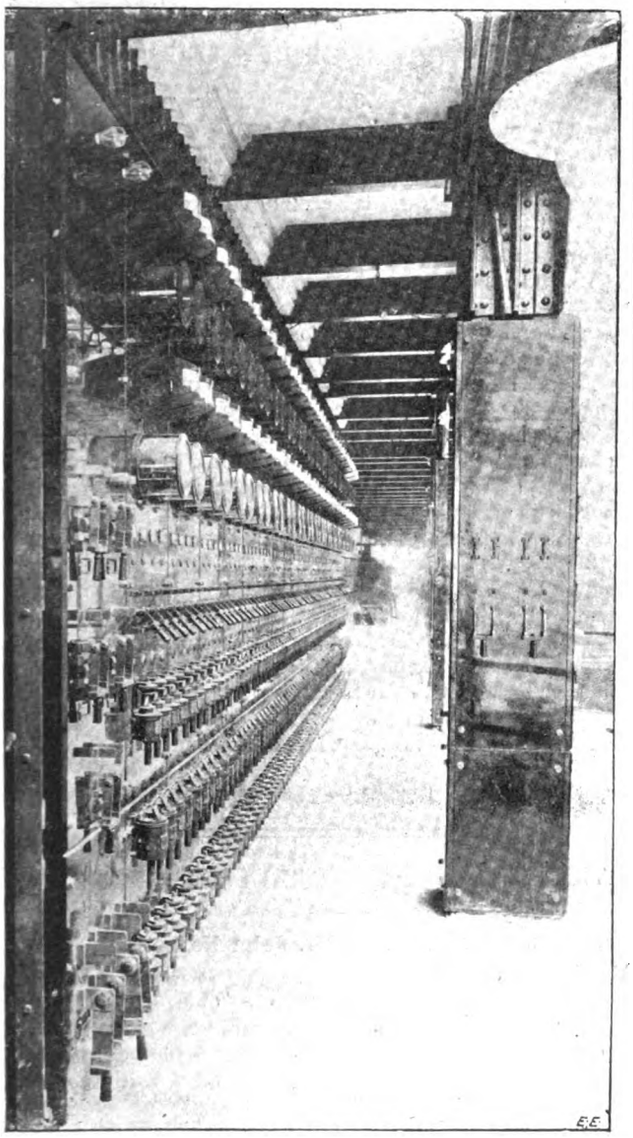

FIG. 11.—B.T.H. High-Tension Feeder Switchboard at Lots Road.

care of any possible transformer breakdown without injury to the piping system carrying the secondary conductors.

### THE AUTOMATIC PROTECTING DEVICES.

As noted above, the main generator oil switches are non-automatic and are closed and opened by hand control only. The 'bus-bar sectionalising switches and the group switches are similarly non-automatic. The individual feeder switches are the only automatic extra high-tension oil switches in the station. These are equipped with overload relays of the adjustable time-limit type, the time feature being obtained by an air dash-pot so designed as to allow the relay contacts to close instantly in case of a short-circuit, while a moderate overload will only close the contacts after an adjustable time limit of several seconds. To provide for operation with the neutral of the extra high-tension generators earthed, and to take care of all possible breakdown between any feeder conductor and the lead sheath, a relay is connected in each of the three phases of each outgoing line, the three relay contacts being connected in parallel to supply the motor of the corresponding oil switch, thus a breakdown to earth on any one of the three phases trips out the whole feeder at the generating station end. The relay contacts for all the feeders are supplied through what might be termed an alarm relay, which in turn rings a gong in case any extra high-tension switch trips out automatically, this alarm relay being inactive when the extra high-tension switches are opened by hand control. To enable the operator to readily find which one of his many feeders has tripped out automatically, the alarm relay also illuminates one of 10 alarm lamps, indicating to which group the faulty feeder is connected.

The oil switchgear is designed in accordance with the modern idea that the power to be broken by any one oil switch cannot be determined by the rating of the corresponding machine or line, but under emergencies may arise to the whole short-circuit output of the station. The idea is such an important one that a little further explanation may be warranted in spite of its obviousness. In the case of a fault upon an extra high-tension feeder which may be rated 2,000 kw. and may never normally carry more than that, the

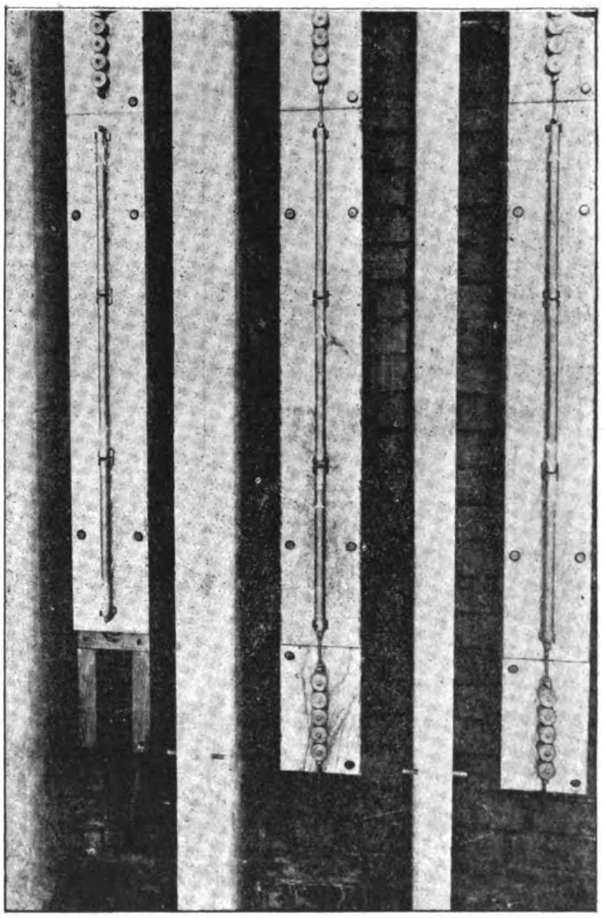

FIG. 12.—Static Discharges at the Chelsea Power Station.

power to be broken by the feeder oil switch will not be limited to 2,000 kw., but will be whatever the whole station can generate on short-circuit, together with considerable power that will be momentarily thrown back from all synchronous machinery on the system by virtue of its inertia and excitation. It is almost needless to say that the extra high-tension oil switches for this station have not been tested on a solid short-circuit of 50,000 kw. of machinery, but similar switches have broken faults on systems nearly as large without damage to the switchgear.

In accordance with modern practice no charging devices have been installed for gradually applying voltage to the extra high-tension three-core cables supplied from this station. It is argued that with oil-break switches no charging devices are necessary, as the harmful effects of throwing a cable directly into circuit are said to be due to the air arc which strikes across between the contacts of an air-break switch for a fraction of a second while the switch is approaching the closed position. These effects are not

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found with an oil-break switch, which apparently does not allow the current to strike across its contacts until these are so close that the current persists without an intermittent make and break at each alternation. The connection of the neutral of the generators to earth is made through a resistance of six ohms, thus limiting the flow of current in case of a solid earth on any phase to about 1,000 amperes. This is ample to pull out the faulty feeder, but will not drop the synchronous machinery out of step as would a solid short-circuit.

### The Auxiliary Switchgear.

For handling the exciters and for supplying power to a large number of motor-driven auxiliaries scattered through the station, which aggregate approximately 100 motors, there is mounted in one gallery at one end of the station a switch-

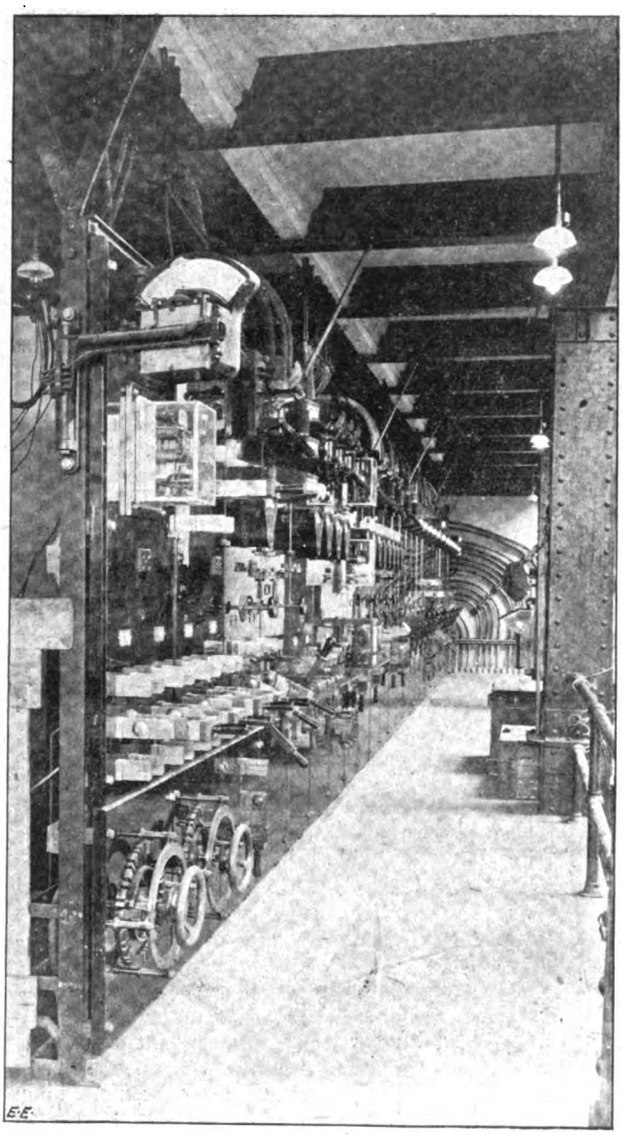

Fig. 13.—Auxiliary Plant Switchboard at Lots Road.

board (Fig. 13) as large as that of the average power-house and capable of handling fully as much power. The exciter system consists of four 125-kw. 125-volt compound-wound engine-driven generators, also of the British Thomson-Houston Company's make. To avoid any chance of short-circuiting across the exciter 'bus bars, the exciter panels are single-pole, the other polarity, together with the equaliser connections, being handled by switches mounted on pedestals adjacent to the exciters; thus only one polarity of the exciter system is carried to the exciter switchboard gallery.

For supplying the direct-current motor-driven oil switches, motor-driven field rheostats, and other switchgear, motors, and control circuits, two 125 volt storage batteries have been installed, the duplication being for the purpose of allowing one storage battery to be carrying the load while the other is charging. These batteries may be charged from a 125-kw. motor-generator set, taking power from the three-phase side. The motor of this set is of the synchronous type, and at the time of writing this machine is being used reversed, taking power from the direct-current side and generating power on the alternating-current side for extra high-potential tests. Suitable end-cell switches are provided to keep up the delivered voltage as the battery discharges. An emergency connection is also provided, so that the storage batteries may be charged from one or more of the exciters in case the synchronous motor-generator set becomes crippled. The auxiliary board also provides for supplying a number of direct-current crane motors from either the motor-generator set or in cases of emergency from the exciters. Like the extra high-tension 'bus, the exciter 'bus is sectionalised into two parts, so that continuous service can be given by the plant, and alterations can be made on either part of the 'bus at times of light load.

For the supply of the 80 odd induction motors driving air and circulating pumps, stokers, conveyors, etc., throughout the station, three banks of air-blast step-down transformers have been installed, each bank consisting of three 500-kw. transformers delivering 220 volts when supplied at 11,000. Two of these banks, aggregating 3,000 kw., will be required at times of heavy load, the third being a reserve. On the extra high-tension side these are supplied from three different sections of the main high-tension 'bus bars through the usual group switches and individual transformer bank switches, the controlling switches of the latter being mounted on the auxiliary board. On the low-tension side these three banks of transformers feed a 220-volt 'bus, which again is not in duplicate, but is sectioned into two parts, so arranged that one bank of transformers feeds each half of the 'bus, and the third bank can be connected to either or both. These low-tension connections are made by means of heavy air-break lever switches. From this 220-volt, low-tension, 'bus lead-covered feeders are supplied through automatic oil switches of the hand-operated type, mounted on the back of the panels, and distribute the current throughout the whole station, with individual motor switches and starters mounted adjacent to the motors. The oil switches in these low-tension feeder circuits are automatic and fitted with overload release without time-limit attachments.

*(To be continued.)*

## THE WORLD'S PROGRESS IN TELEPHONY.

### An Interview with Mr. John Hesketh.

Mr. John Hesketh, electrical engineer in the Postmaster-General's Department of the State of Queensland, being on the eve of his departure for Australia after an extensive tour in the United States and Europe, chiefly devoted to the study of telephone systems, the *Electrical Engineer* decided to obtain the benefit of some of the store of information on telephonic progress which Mr. Hesketh has accumulated during the past few months. Mr. Hesketh was specially deputed by the Postmaster-General of Australia to attend the International Electrical Congress at St. Louis, and to investigate the working of the telegraph and telephone systems in America and Europe for the purpose of preparing an official report for the guidance of the Commonwealth authorities in developing the Australian telegraph and telephone systems.

Mr. Hesketh is well known to many of our readers, and for the sake of those who have not met him personally we may say that he is the typical electrical engineer—alert of demeanour, clear-headed and quick of thought, and with a ready faculty of putting his impressions and opinions in a simple and straightforward manner. Our representative fortunately caught Mr. Hesketh with a free hour among a series of engagements lasting from early morning to late at night, and opened the ball as follows:

"Mr. Hesketh, the *Electrical Engineer* understands that you have devoted several months to a study of telephone work in America and Europe, and wishes, for the benefit of its readers, to know where you have been, what you have

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seen, what you think of it all, and what you are going to do when you get home?"

"Rather a large order, but I will endeavour to fulfil at least a part of it. Landing in America, at San Francisco I investigated the telephone business in the principal American cities from the Pacific to the Atlantic coast, visiting 20 cities in all, including such representative American towns as San Francisco, Salt Lake City, Chicago, St. Louis, Detroit, Cleveland, Buffalo, Grand Rapids, Boston, Rochester, New York, Philadelphia, and Washington. I visited 20 large cities in all and some smaller places, and in every place where there were two competing telephone systems I examined both. In Europe I have spent some time in this country, visiting, besides the Metropolis, Glasgow, Newcastle, Liverpool, and Hull, and in these places also I have visited both telephone systems where two existed. On the Continent I have swung rather a wide circle, taking in Antwerp, Brussels, The Hague, Copenhagen, Stockholm, Berlin, Warsaw, Vienna, Budapest, Munich, Zürich, and Paris."

"You certainly have not wasted much time; and what, may I ask, is your general impression as to the progress of telephony?"

"America undoubtedly leads the world, both in the general development of the telephone business—that is, in the amount of use made of the service by the public—and in the technical development of the industry. The long lead in telephone engineering which America holds over the rest of the world stands out most clearly, and in Europe the best work is being done where American experience is being followed. It seems from the general history of the telephone business in America that the American people, as a whole, take more kindly to the telephone service than the peoples of Europe. They are more ready to avail themselves of improved means of communication, and every improvement in the service and every increase of facilities is readily taken advantage of. As an illustration of the extent to which the use of the telephone is developed in America, I did not sleep in a single hotel in the course of my wanderings where there was not a telephone in my room from which I could use not only the city service, but the suburban and long-distance service as well. It is of enormous convenience to a traveller to be able to talk to any place in the country from his own room in an hotel. In this country, and in Europe generally, hotel managers do not seem to think it worth while to provide their guests with such facilities."

"Then, how about the development of the service among the general public?"

"In American cities the telephone development has already reached a point which seems hardly to be realised as within the bounds of possibility in most European countries. In one place I found a development of 23 telephones to every 100 inhabitants. In large cities, like San Francisco, there is a development of 12 telephones to every 100 inhabitants. In every place the annual increase in number of telephones in use reaches large figures. Apparently there is no limit in sight. It is clearly evident that with a good service and a proper scheme of rates a development of 10 per cent. of telephones to population may easily be attained, and indeed the more general idea of American telephone engineers to-day is that a probable development of 20 per cent. should be provided for."

"These are bold ambitions, Mr. Hesketh? What is the American recipe for obtaining such a general use of the telephone?"

"They do not seem bolder than the established facts warrant. The principal ingredients of the recipe are an efficient service, a graduated tariff, and a thorough education of the public in the value of the telephone service."

"By what method do you find the most efficient service is given?"

"The most interesting result of my investigations is the fact that the common battery system is now accepted by telephone engineers all over the world as the correct principle of telephone exchange working. In America practically the whole telephone service of the country is worked by the common battery method, and in Europe it is being generally introduced, and wherever it is not introduced the reason is merely some question of local or internal expediency, and not because the responsible engineers do not believe in it."

"This makes the prospects of the manufacturers of the system very pleasant?"

"Every telephone manufacturer is making common battery apparatus to-day. The common battery method of working is rather a principle than a particular system. In fact, there is a wide range of systems for a telephone administration to choose from, and although the general method of working and the general results are approximately the same in all systems, the details of the apparatus and the means for accomplishing the results differ very widely. In America there are many large telephone manufacturing concerns who all make common battery systems, some of them having two or three systems differing in details. In Europe the principal large manufacturers of telephone apparatus are also taking up the common battery method, and are introducing systems which follow those of America along their general lines."

"We must take it as proved, then, that common battery working has asserted itself as a general principle?"

"Undoubtedly. No new telephone systems are being designed to-day except with common battery working, and right here in London we see the whole London system gradually being converted to common battery working. The work now being done by the Post Office and by the National Telephone Company will eventually give London a thoroughly modern telephone service. But, of course, London is unique among the large cities of the world, and the magnitude of the work to be accomplished in changing the existing system and in extending a new system to all parts of the enormous area of London will take some time."

"On the Continent generally, did you find the same views held as to the use of the common battery system?"

"Quite unanimously, and the practical proof is to be found in all the new work. Within the last year or two several of the Continental telephone systems have been rebuilt on common battery lines. At The Hague, Brussels, Budapest, and Warsaw I found complete new common battery systems in operation, and giving every satisfaction, and I also ascertained that all new work in practically every country on the Continent is to be done along the same lines."

"That is very interesting. Now, Mr. Hesketh, there has been a good deal of discussion of the telephone question in this country of late, and I should like to ask you what you consider the most important features of the telephone business?"

"I should place, for a proper consideration of the telephone business, the question of efficiency and development first, and the question of rates second. The universal experience is that the public of big cities want an efficient service, and want it widely developed. As to rates, the proper principle undoubtedly is a graduated tariff, under which the user pays according to the amount of his use. It is a great mistake to base the telephone service upon a low flat rate for unlimited use. The independent telephone companies throughout America are now realising the mistake they made in basing all their business upon low flat rates. They have not only found that to give an efficient service and to develop it rapidly costs more than they had anticipated, but they have found that the flat rate is wrong in principle, and that graduated rates are correct, both in theory and practice. As a consequence the independent companies are now generally trying to raise their rates and to introduce message rates; but it is much easier to talk about raising rates than to induce the public to pay a higher rate when once they have become accustomed to a low figure."

"When you speak of graduated rates and paying according to use, do you mean a strictly message rate, a payment for each call?"

"There are various ways of graduating the rates for telephone service, but they all amount much to the same thing—that you vary the supply of service according to the requirements of the user and charge him approximately in proportion to his use. Party-line rates are an accepted method of graduating rates. Message rates on direct lines give the user the best quality of telephone service, and the

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payment is regulated merely by the quantity of service used. The most complete arrangement for supplying telephone service on a large scale is the private branch exchange, which is specially adapted to the requirements of large business concerns and hotels and residential buildings. With a private branch exchange, every user of the service has a telephone on his own desk or in his own room, and the operator at the branch switchboard acts as a distributor of the traffic and all calls go in and out to the right people, so that there is a minimum of delay and friction in the use of the service. In America the private branch exchange method of supplying the service to large users has been very highly developed, and in the cities all large business establishments and all hotels and flat buildings have their branch exchanges, some of them serving several hundred telephones under one roof. One hotel in New York has over a thousand."

"Astounding! Then you are a believer in party lines."

"As a proper means of graduating rates, certainly. You may put it in this way. The party-line telephone station, as a talking machine, is precisely as efficient as a direct-line station, but necessarily where you have several stations on one line, only one can use the station at a given time. Therefore, a subscriber having a party-line station cannot have the unrestricted use that a direct-line subscriber can have. But he does not want it, or rather, he does not feel the restriction. The party line is specially adapted to the small user, and it is practical experience that very little trouble or friction arises from the calls of two party-line subscribers coinciding. I do not believe, however, in trying to make party-line service as attractive as direct-line service. In party-line service you are supplying something at a low price for the customer who is not prepared to pay the full price for the best facilities. If you try to make the party-line service as good as the direct-line service, by introducing selective ringing and lock-out devices, you complicate your apparatus and so increase your cost of maintenance that you lose the benefit of the economy resulting from putting several stations on one line. Some of the devices for party-line working seem to me to carry matters too far in this direction. A reasonable arrangement, in my opinion, is selective ringing on two-party lines and semi-selective ringing on four-party lines. On the two-party line each subscriber would only hear the bell when he was called, and on the four-party line each subscriber would hear a call for one other subscriber as well as his own call."

"How about 10 and 20 party lines?"

"There you give an admittedly cheap service, and you cannot even try to make the service resemble direct-line service. You necessarily have code ringing, and the subscribers must learn to distinguish their own signals. But the advantage of the 10-party line is that it enables you to develop the service among small users who will not pay for direct-line service and would not use the service at all unless they got it at cheap rates. With this class of service an enormous development has been made in the western part of America and in the rural districts. My own view is that 10-party lines should be used only in country districts, not in cities."

"Are we going to do away with the telephone operator, Mr. Hesketh, and make all our calls by playing a tune on a set of buttons or twirling round a dial?"

"The automatic exchange is certainly looming large on the telephonic horizon. There are at least half a dozen automatic systems which have been worked out with great ingenuity. So far, however, only one of these has received any trial in practice. At Grand Rapids, Michigan, I saw an automatic exchange doing steady daily service with over 6,000 lines in service. This exchange has been in use now just about a year. It is giving a good service, and the subscribers seem to like making their own calls by 'twirling a dial.' Whether the automatic exchange will eventually supplant all other methods is more than doubtful, however. The weight of evidence of the great majority of telephone engineers, though all recognise the ingenuity displayed in the automatic systems and the advantages of automatic exchanges under certain conditions, is in favour of the straight common battery system. It must not be forgotten that the common battery system is already largely automatic in its operation, and it will doubtless become more so as further improvements are made. The probable development will be to place more automatic devices in the hands of the operator, and to maintain the subscriber's station in its present state of simplicity, where all the subscriber has to do is to remove and replace the telephone."

"Among all the telephone systems that you have seen, Mr. Hesketh, which should you say is the most complete?"

"Without any question that of New York. The New York telephone system is the finest example of thorough telephone engineering I have seen. All the exchanges are equipped in a uniform manner, all are in fireproof buildings designed specially for telephone purposes, the cable distribution is, for the greater part of the city, so carried out that the lines are in lead-covered cables, practically the entire distance between the exchanges and the subscribers' premises, and the service in all respects is at the very highest point of efficiency. The actual development of the service is not so high as in some of the western towns of America; but, nevertheless, the New York system is by far the largest telephone system in the world, serving actually over 150,000 stations, and is undoubtedly in all respects the best equipped. London will in time have a telephone service similar to that of New York, as the work is being carried out much along the same lines, but the area of London is immensely greater than that of New York, and the work of building a complete distribution system for a city covering over 600 square miles is a task of appalling magnitude and cost. As far as it has gone, the London telephone work is of the highest order."

"There has been a certain amount of discussion on the work done in the municipal telephone systems in England, Mr. Hesketh. Have you had an opportunity of inspecting any of these systems?"

"Yes, I have seen one or two of them in the course of my travels, but I would prefer not to express any opinion."

"That is unfortunate, but an interviewer must be content with what he can get. Do you expect to do much telephone work in Australia, and are you going to buy your telephone material in this country?"

"I expect that in the near future we shall lay our plans for a big telephone development in the Commonwealth. I am quite convinced that in any town or city a development of at least 10 per cent. can be attained in the normal course of affairs, and that a telephone system ought to be planned from the beginning to provide for that development. I hope we shall lay our plans in Australia on those lines. As to buying our material in Britain, we shall hope that British manufacturers will be able to supply what we want at the right prices. I am frank to say, however, that at the present time they hardly seem to have kept up with the procession in the manufacture of telephone apparatus suitable for large telephone systems."

"I suppose you also paid some attention to telegraph matters?"

"Yes. The principal object of my trip was to study the telephone business, but I have naturally paid some attention to telegraphy, and I can sum up my impressions in telegraphy very succinctly. What Britain has to learn from America in telephony, undoubtedly America can learn from Britain in telegraphy. As a Britisher it is very pleasing to me to be able to say this, but I think without any doubt that the telegraph system of Great Britain is, for general efficiency, far in advance of anything else in the world. The Telegraph Department has done some notably fine work in the last few years in laying long underground telegraph lines through the country. When I left this country in 1896 I should not have believed it possible that I should ever see quadruplex working on an underground line between London and Leeds."

"How do you account for the difference in the relative standing of the two countries in telegraphy and in telephony?"

"Well, broadly speaking, telegraphy is a native of Britain and telephony is a native of America. In the early days the telegraph was undoubtedly developed along more scientific lines in Britain than anywhere else. With the rapid extension of land and submarine telegraphy a band of telegraph engineers and inventors arose in this country

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and have made a deep impression on the art of telegraphy. Similarly, the telephone from the beginning has been more rapidly developed, both from a business and from a technical point of view, in America than anywhere else, so in America there has sprung up a band of telephone inventors and engineers who have made a distinct art of telephone engineering. It is only a natural result that with so many minds constantly working on all the problems of a new and progressive art that there should be a rapid and constant development in the scientific branch of the work."

"I suppose you have not entirely neglected wireless telegraphy?"

"I have looked into all the different systems, but that would be too long a story, and I have an appointment now which I really must keep."

With wireless telegraphy, therefore, the interview came to an end, and the interviewer proceeded to make the best he could from an hour's rapid talk and voluminous notes.

## MUNICIPAL PURITY IN SYDNEY.

We have just received from a correspondent in Sydney a long account of a municipal trouble in connection with the Lord Mayor-elect, which reminds us of what happened in Manchester in 1900. From the issue of the Sydney paper called *Truth* for Christmas Day we gather the following particulars, which are of general interest. It seems that at a special meeting of the City Council held on the previous Thursday, counsel's opinion as to the position of Alderman Taylor, the Lord Mayor-elect, was read. We quote from our contemporary:

The case prepared by the city solicitor, and submitted to counsel for opinion, set forth that the firm of Allen Taylor and Co. supplied material to the following firms, contractors to the City Council: Edward Eagar, wood blocks; Lane and Peters, wood blocks; Henley, Limited, timber for troughing electric light cables; H. M'Kenzie, timber for general contract; Stewart and Co., timber for electric light station; Goodlet and Smith, cement.

Counsel was asked to advise whether, on the facts set out, Alderman Taylor had been disqualified at any time during the past two years, or whether he is now disqualified, under Section 24 of the Sydney Corporation Act of 1902, from holding any civic office.

Sir Julian Salomons's opinion was to the effect that at no time was Alderman Taylor disqualified, inasmuch as he was not engaged or interested, in a legal sense, in any of the contracts submitted for consideration.

The opinion having been read, the Lord Mayor moved: "That the opinion of Sir Julian Salomons be received."

After this motion had been seconded a heated debate followed, which we do not propose to refer to even in abstract. The conclusion of the matter, however, was that the Lord Mayor's motion was passed. Some ratepayers have since petitioned for the use of the town hall for a public meeting to consider the bearing of Section 24 of the Sydney Corporation Act, 1902, on the case. This section reads as follows:

Any person who, while holding any civic office under this Act, continues to be or becomes directly or indirectly, by means of partnership with any other person, or otherwise howsoever knowingly engaged or interested in any contract, agreement, or employment, with, on, or behalf of the Council, except as a shareholder, but not being a director in any joint-stock company, shall be liable to a penalty not exceeding £100 nor less than £50, and shall be for three years thereafter disqualified from holding any civic office.

It would be useless for us at this distance to express an opinion which would be at all valuable in the present case. If our readers will refer to our issue of Dec. 13, 1901, on p. 842 they will find a full statement of the laws of England on the matter. In this respect, however, the law is sometimes exceedingly hard on individuals, while lax on shareholders of limited liability companies. Thus, a member of a council may be the largest shareholder in a limited liability company without incurring any liability for actions which as a private individual would disqualify him from his seat. We cannot do better than close this brief reference to the Sydney trouble with a paragraph from our article of 1901: "There must be give and take, live and let live, in all municipal and public life. It is idle to suppose that a man when he gets into a councillor's chair can get rid of all his personal feelings of friendship and divest all prejudices, all sympathies and antipathies, when he takes off his coat and hat to go into the council-room. The idea is ridiculous. We do not want angels, but men of business to conduct our affairs, and so long as they are conducted in a business-like way, and the work is well done, we see no reason why the interests of contractor and of councillor are not perfectly compatible with the public welfare."

## FORTHCOMING EVENTS.

FRIDAY, FEB. 10.

**Olympia.**—Opening of motor exhibition.

**Physical Society.**—At 8 p.m., "Radiation Pressure," by Prof. J. H. Pointing.

**Institution of Civil Engineers (Students' Section).**—"The Reconstruction of the Santa Lucia River Bridge, Uruguay," by Mr. P. J. Risdon.

**Tramways and Light Railways Association.**—At 8 p.m., annual meeting.

**Electrical Contractors' Association.**—At 8 p.m., meeting at Frascati's upon London County Council wiring clause.

SATURDAY, FEB. 11.

**Junior Institution of Engineers.**—At 7 p.m., coming-of-age dinner at the Hotel Cecil.

**Birmingham Electric Club.**—At 7.30 p.m., "Starting and Speed Regulation of Motors," by Mr. E. R. Wood (in substitution for Mr. Whitehouse's paper).

**Institution of Electrical Engineers (Students' Section).**—At 2.45 p.m., visit to the General Post Office Central Telephone Exchange.

MONDAY, FEB. 13.

**Institution of Mechanical Engineers (Graduates' Association).**—Special lecture, by Dr. J. T. Nicolson, on "Results of Force Measurements with Cutting Tools and their Application to Lathe Design."

**Society of Arts.**—At 8 p.m., "Internal-Combustion Engines," by Mr. Dugald Clerk.

**Junior Institution of Engineers.**—At 6.30 p.m., visit to the Brockie-Pell Arc Lamp Works.

TUESDAY, FEB. 14.

**Institution of Civil Engineers.**—At 8 p.m., "Alfreton Second Tunnel," by Mr. E. F. C. Trench; and "The Reconstruction of Monoreiffe Tunnel," by Mr. D. McLellan.

WEDNESDAY, FEB. 15.

**Chemical Society.**—At 5.30 p.m., general meeting.

**Institution of Civil Engineers.**—At 2.30 p.m., students' visit to the electricity generating station of the Underground Electric Railways Company of London, Lots-road, Chelsea.

**Institution of Electrical Engineers (Students' Section).**—At 7.30 p.m., "The Electric Furnace," by Mr. W. J. Williams.

**Royal Meteorological Society.**—At 7.30 p.m., "Report on the Phenological Observations for 1904," by Mr. E. Mawley; "Observations made during a Balloon Ascent at Berlin, Sept. 1, 1904," by Messrs. H. Elias and J. H. Field; and "The Winds of East London, Cape Colony," by Mr. J. R. Sutton.

**Institution of Electrical Engineers (Birmingham Section).**—At 7.30 p.m., "Applications of Electricity in Mines," by Mr. A. C. Anderson.

THURSDAY, FEB. 16.

**Royal Institution.**—At 5 p.m., "Recent Work of the Geological Survey," by Prof. J. J. H. Teall.

FRIDAY, FEB. 17.

**Royal Institution.**—At 9 p.m., "High-Power Microscopy," by Mr. J. W. Gordon.

**Institution of Mechanical Engineers.**—At 8 p.m., discussion on adjourned papers. Prof. W. E. Lilly will read a paper on "The Strength of Columns."

**North-East Coast Institution of Engineers and Shipbuilders.**—General meeting at Newcastle.

**Institution of Electrical Engineers (Manchester Section).**—Messrs. S. L. Pearce and H. C. Gunton will read their paper on "Manchester Tramways Power Supply" on Feb. 21, instead of Feb. 14.

## APPOINTMENTS VACANT.

**City Engineer,** Wakefield.

**Switch-Room Superintendent,** Glasgow Telephone Department. See advertisement.

**Junior Shift Engineer,** Dover. Salary £80 per annum.

**Shift Engineer,** Southend Corporation. Salary £2. 2s. per week. Applications by Feb. 15.

**Chief Assistant Electrical Engineer** Battersea.

**South London Electric Supply Co.**—The directors recommend a dividend on the ordinary shares at the rate of 4 per cent. for the past year.

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THE
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### TO CORRESPONDENTS.

*All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

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## FIRES IN COUNTRY HOUSES.

The cause of fires in country houses is frequently untraceable, and hence such fires are due to electric lighting. This is the argument which is only too frequently used in the daily Press, and even an article by an expert on the editorial staff of the *Daily Telegraph* leaves the same impression in the mind of the reader. This article points out that such "occurrences have become so numerous that, while an isolated instance might not attract more than a passing thought of regret from those with no personal knowledge of or association with the scene of the conflagration, their rapid sequence compels the surmise that some general cause must be responsible for the outbreaks." The author goes on to indicate the invaluable art treasures which have recently been lost or imperilled by fire, and uses these to show that the whole nation is interested. This is so because in nearly every case the public is at certain times admitted to view these art collections and historic heirlooms. He proceeds: "As a rule, the possibility of discovering the cause of a fire is destroyed by the conflagration itself, and 'unknown' is usually found entered under this head in the official report. But with regard to the recent outbreaks in country mansions there is a very strong disposition among those interested to lay the responsibility upon the electric lighting." Again and again charges of this kind have been brought in the daily Press against electric lighting, and frequently a subsequent examination of the scene of the fire has proved that electricity has not been responsible in any way. Unfortunately, however, the first report is widely circulated throughout the Press, while by the time the actual cause of the fire has been discovered, interest in the same has declined, and the true explanation receives a very limited circulation. This was the case in connection with the fire not long ago at Sandringham, which was first stated to be an electric one. This was subsequently proved to be incorrect, and yet quotations from the first report are regularly met with in the daily papers when announcing the probable cause of other fires. This spreading of conjecture is a feature very difficult to prevent with modern systems of news distribution, and it leads to the false conclusion with which we commenced this leader—*i.e.*, that any unknown source of a conflagration must be electric. This conclusion is as unsound logically as an assumption that only one disease is responsible for the death of all country gentlemen. The fire risks in old houses are many, and while we do not object to the dangers of badly-designed electric wiring executed with inferior materials and workmanship being pointed out, we strongly resent any general conclusions which obviously neglect the other fire risks which are more common. The author of the above article was, however, not content with a general conclusion based on unknown causes of fire, but proceeded to give his views on electric wiring as found in country houses. Coming to detail, he naturally must expect criticism, and this was amply provided by letters in the next issue of the *Daily Telegraph*. Thus he condemned wood casing as dangerous, and was promptly met by two of our leading experts in country house work, who gave figures to show the superiority of such wood casing over steel tubing except under special conditions. Into these details we do not propose to go, but trust that in this instance the readers of the article will make a point of reading also the expert criticism on the same. The substance of this criticism is briefly as follows: given a well-designed system of wiring executed with the best materials and workmanship, there is absolutely no fire risk incurred from electric lighting. It is also advisable to have regular inspections made of the wiring to see that all is in order and that no temporary

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additions have been made by incompetent people. The true test of the safety of electric lighting as compared with other illuminants is to be sought in the returns from underwriters, fire offices, and fire brigades, in which there are given the actual number of fires which have been traced to different causes. Thus the fire brigade returns for the last year issued show that in London there were seventy-four fires at which loss of life occurred, but not a single one of these was due to the use of electric light.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### MOTOR 'BUSES—OR WHAT?

SIR,—I think the writer of the leading article in your last issue, entitled "Motor 'Buses—or What?" is altogether wrong in what he says about the London 'buses. I get about the busy parts of the town very much, and only know of the presence of these 'buses by seeing them. I have, I suppose, not seen all types, but those I have seen I can unhesitatingly declare are even less noisy than the horse-drawn 'buses. Since reading your article I have been paying some attention to these latter, and the wheels, the horses' hoofs, and the chain traces all make a noise. For silence I can point to the Road-Car Company's steam 'bus running from Shepherd's Bush to Oxford-circus—so graceful is this 'bus in appearance and running that it always reminds me of a Thames steam-launch—and the bigger 'bus that comes round by Charing Cross and goes up somewhere North. I think it is one of Tilling's. I have, however, had my nerves distracted and my olfactory sense offended by some of the transport motorcars. I remember a particularly bad case in Fenchurch-street recently. A few such would be pandemonium, indeed, and the stink was left for yards behind. I think I could name the company this belongs to, and I met a similar one quite recently somewhere else. I feel sure that many commercial cars are far noisier than the 'buses, and we cannot have a quantity of these soon enough when we consider the life of a 'bus horse. I am not connected with any 'bus company, and my opinion may not be that of other people, but I do feel that your leading article is wrong, and apt to mislead those who do not live in London.—Yours, etc.,

W. F.

Feb. 7, 1905.

### DESTRUCTORS AND ELECTRICITY.

SIR,—Owing partly to the publication of a very instructive paper read by Mr. W. P. Adams before the Institution of Electrical Engineers, public interest in the above question has been considerably stimulated. I think, therefore, that it may not be out of place to point out, with your kind permission, some misconceptions which may arise. There is a tendency in some quarters to estimate the efficiency of any particular destructor by the number of electrical units per ton of refuse which are produced in the works where such destructor is in use.

The number of units which are produced per ton of refuse burnt depends chiefly on the following factors: (1) the calorific value of the refuse; (2) the conditions as to day and night load, which determine whether all the refuse is used for steam raising, or whether the destructor is working at full power, while the electricity plant is practically idle; (3) the efficiency of the electrical generating plant, which may require more or less steam per unit generated; (4) the efficiency of the destructor plant with its boilers and flues; (5) last, but not least, the efficiency of the management.

It is, therefore, absurd to attribute to the destructor either the whole credit for a good result in units per ton or the whole blame for a poor result, and this is demonstrated by the fact that you will find one destructor of a given make giving a very high figure, and another destructor of the same make, but under different conditions, giving a low figure.

One of the most important factors in the efficiency of a destructor—the cost of labour—is usually ignored when using with steam-raising results. In any destructor, increased steam-raising results can usually be obtained by putting on increased labour and "stoking in spoonfuls." From the steam-raising point of view, the all-important question is, what is the cost of a ton of steam produced by the destructor in ordinary everyday work? Under the heading "Steam from Refuse and its Cost," the *Electrical Magazine* published on April 26, 1904, some interesting figures showing the cost of labour per ton of steam, as well as the evaporation per pound of refuse, at a number of combined stations. It was shown that those stations where the highest evaporative results are obtained are not always the most economical, owing to the large expenditure in labour, and it is noteworthy that among those stations where utilisation of steam is complete the best result came from Fulham.

If the destructor produces a supply of steam at a reasonable cost for labour, it is for the electrical department to utilise that steam, and the credit for good results and the blame for bad results belong by rights to the engineers who are responsible for the construction and management of the whole combined works, and not to the maker of any particular part of the installation. I think that if the above facts were more generally recognised it would be in the interest alike of electrical engineers, destructor builders, and the public, and would tend to discount a good deal of humbug.—Yours, etc.,

F. L. WATSON, A.M.I.C.E.

### ALUMINIUM.

SIR,—In reply to the letter of your correspondent, "R. T." Within the ordinary limits of cable insulation, the insulation resistance may be taken as varying directly as the thickness of the dielectric employed. For instance, if a curve is plotted having for abscissæ thickness of insulating medium in millimetres and for ordinates resistance in ohms, the "curve" will be practically a straight line. Taking, now, the relative diameters of copper and aluminium as 1 : 1·3, the leakage areas will also have the same ratio. The periphery of a circle varies directly as its diameter, and the leakage area is represented by the surface of the metallic conductor. Therefore, as the leakage area of aluminium is to the leakage area of copper as 1·3 : 1, the thickness of the insulating medium, for equal leakage, should *not* be 1·3, but $(1·3)^2$.—Yours, etc.,

WILLIAM SMITH.

Birmingham Electric Club, Feb. 4, 1905.

## "IGRANIC" STARTING RHEOSTATS.

The Sturtevant Engineering Company, Limited, of 147, Queen Victoria-street, inform us that they have recently added a number of improvements to their single and double automatic motor-starting rheostats, and are now offering to the market their latest designs under the name of the "Igranic" starting rheostats. To a very great extent the conditions which cover the design of a first-class starting rheostat have altered during the past two or three years, mainly because corporations and supply companies have been raising the voltages of the supply and offering power to consumers at maximum voltages not previously in vogue. These increased voltages have brought about more stringent rules for the protection of their network and their customers. The new conditions necessitate new types of motor starting and controlling apparatus, and it is to meet this necessity that the "Igranic" starting switches have been produced.

Briefly stated, the points which are necessary for the design of a reliable rheostat are as follows: There must be a sufficient number of contacts to ensure an easy acceleration of the motor. The starting rheostat must be provided with automatic releases to protect the motor in the event of failure of the supply, or of overloading. The resistances must be of ample carrying capacity, and must be so arranged that there is a minimum amount of sparking between the moving contact and fixed contacts. The method of assembling the resistance should be such that repairs in

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cases of breakdown can be easily effected. The rheostat should be made of incombustible material throughout. No solder should be used in making the connections. The resistance box should be so arranged that inspection of its interior can be made with little trouble. Ample ventilation should be allowed to prevent any portion of the starting switch overheating, and, above all, the rheostat should be so designed as to give a high insulation resistance between any live part and earth.

The "Igranic" starting rheostats consist of a black enamelled slate front having the contacts, between which

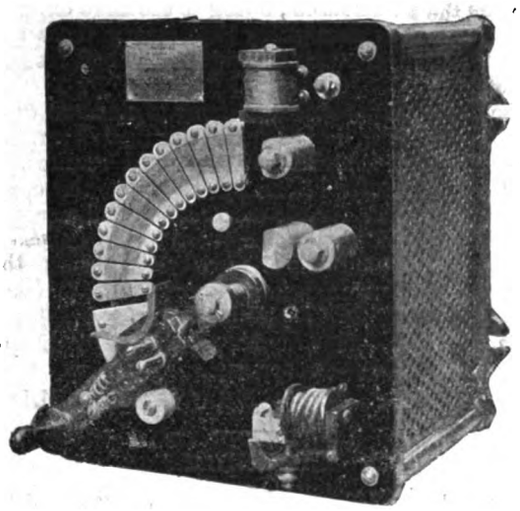

FIG. 1.—Open Type "Igranic" Starting Rheostat.

the sections of resistance are connected, mounted upon it, and a cast-iron ventilated resistance box. The contacts are of two sorts: (1) the button contact, which is used for currents not exceeding 55 amperes; and (2) the renewable contact, which is segmental in shape, used for currents exceeding 55 amperes. It is to be noted that all switches down to the smallest size can be fitted with these renewable segments, if required. The rheostat fronts are made in two patterns, one fitted with automatic no-volt release, which allows the contact arm to return to the off position, in case of failure of supply, and the other fitted with automatic no-voltage release and overload cut-out, the overload coming into effect when the current exceeds a predetermined amount. The front is provided with suitable terminals for taking the main cables, and a terminal is also provided for taking the connection from the shunt, in the case of shunt-wound machines, to the no-voltage release coil.

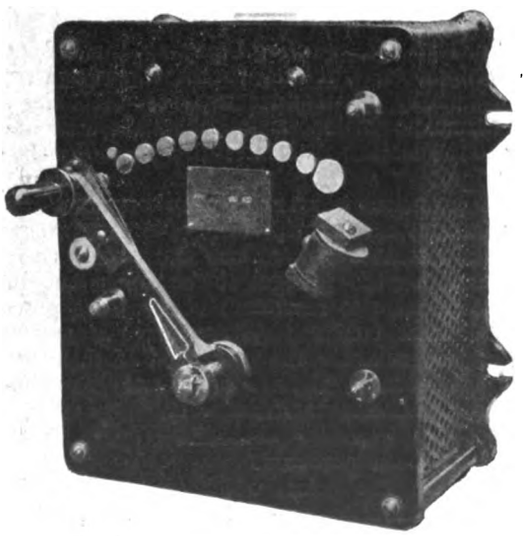

FIG. 2.—Open Type "Igranic" Starting Rheostat.

The principal feature in connection with the "Igranic" starting rheostats is the arrangement of the resistance box. The slate front described above is screwed to a cast-iron box, and insulated therefrom by means of insulating washers and bushes. The resistance material is wound upon asbestos tubes, the asbestos tubes being supported by specially formed porcelain insulators. This method of construction has proved by long experience to be most satisfactory, and provides a non-combustible, well-ventilated, highly insulated resistance. The insulators are held in specially arranged perforated supporting strips, thus ensuring a very high insulation between the resistance material and the metal box. The connections between the contacts on the slate front and the sections of resistance are made by means of specially formed clips, the connections all being made in chambers at either end of the resistance box. It is obvious that this arrangement is a very desirable one, for two reasons: (1) there are no internal connections in the resistance box; (2) every joint can be inspected at a moment's notice. The top, bottom, and sides of the cast-iron resistance box are covered by perforated sheet metal held in position by

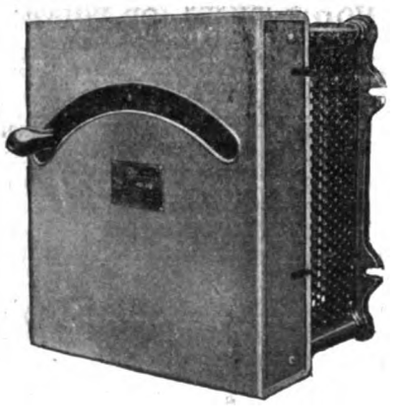

FIG. 3.—Semi-enclosed Type "Igranic" Starting Rheostat.

spring clips at the corners. It is, therefore, possible to open up and inspect the resistance box without removing a single screw, and without requiring any special tools. All that has to be done is to remove the spring clips from the corners, take away the perforated sheet sides, and the whole of the interior is exposed to view.

It will be clear from the above description that the "Igranic" starting rheostats embody simplicity and excellence of design. They are made in three patterns—namely, the open pattern, represented in Figs. 1 and 2 herewith; the semi-enclosed pattern (Fig. 3), provided with a metal cover to protect the operator against contact with any live parts; and the totally enclosed pattern, which is suitable for positions where dust, etc., would interfere with the working of the rheostat. Either can be supplied suitable for series, shunt, or compound wound motors. It remains to add that these rheostats are manufactured throughout at the Sturtevant Engineering Company's London factory, with first-class materials and the best workmanship.

## TRADE NOTICES AND NOVELTIES.

### Lighting Pillars and Transformer Tanks.

We have pleasure in illustrating herewith some useful specialities of up-to-date design and construction manufactured by the British Insulated and Helsby Cables, Limited, of Prescot,

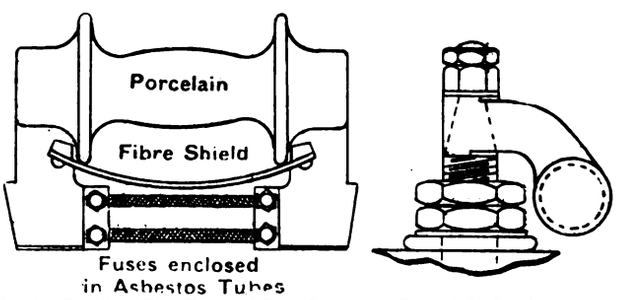


FIG. 1.—Details of Plug Fuse and Cone Connection Type of Feeder Terminal.

Helsby, and Liverpool. Figs. 1 and 2 show the details of a feeder pillar for a low-tension three-wire network. This pillar has a divided sealing base into which all hygroscopic cables enter, terminating into suitable clamps, from which rubber tails are taken to their respective terminals on the switchboard. The switchboard is composed of three enamelled slate panels for a three-wire network, one each for positive,

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negative, and neutral. The positive and negative boards are placed vertically, and each is insulated from the ironwork by

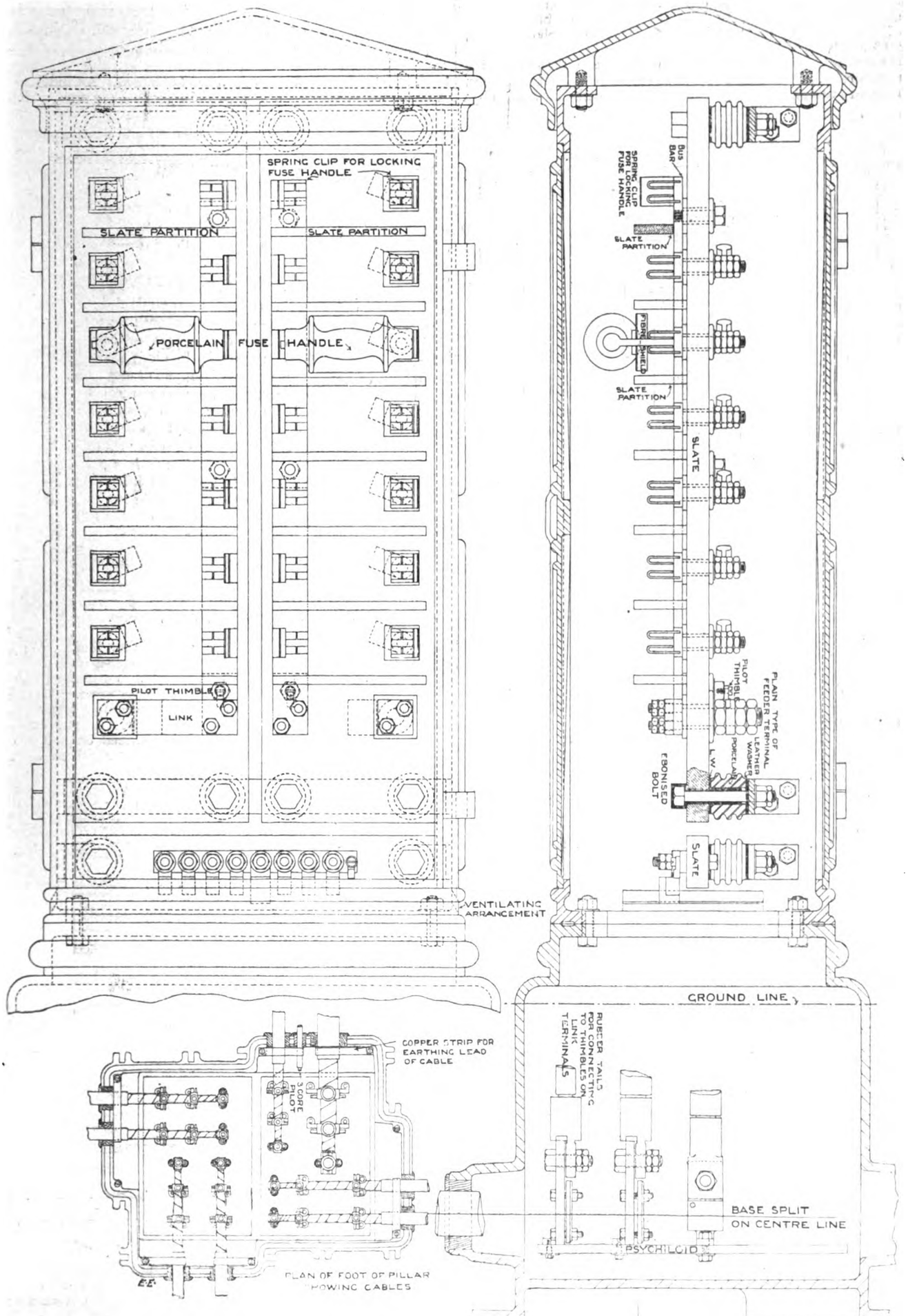


FIG. 2.—Details of Feeder Pillar manufactured by the British Insulated and Helsby Cables, Limited.

porcelain grip-handle type with enclosed fuses. The pillars are well ventilated, having inclined slots all round the base of the

non-inflammable, non-hygroscopic, corrugated insulators and insulated bolts. On each board are mounted plug fuses of the

pillar, and a continuous opening all round the base of the dome. Figs. 3 and 4 show a transformer tank, of which the firm are

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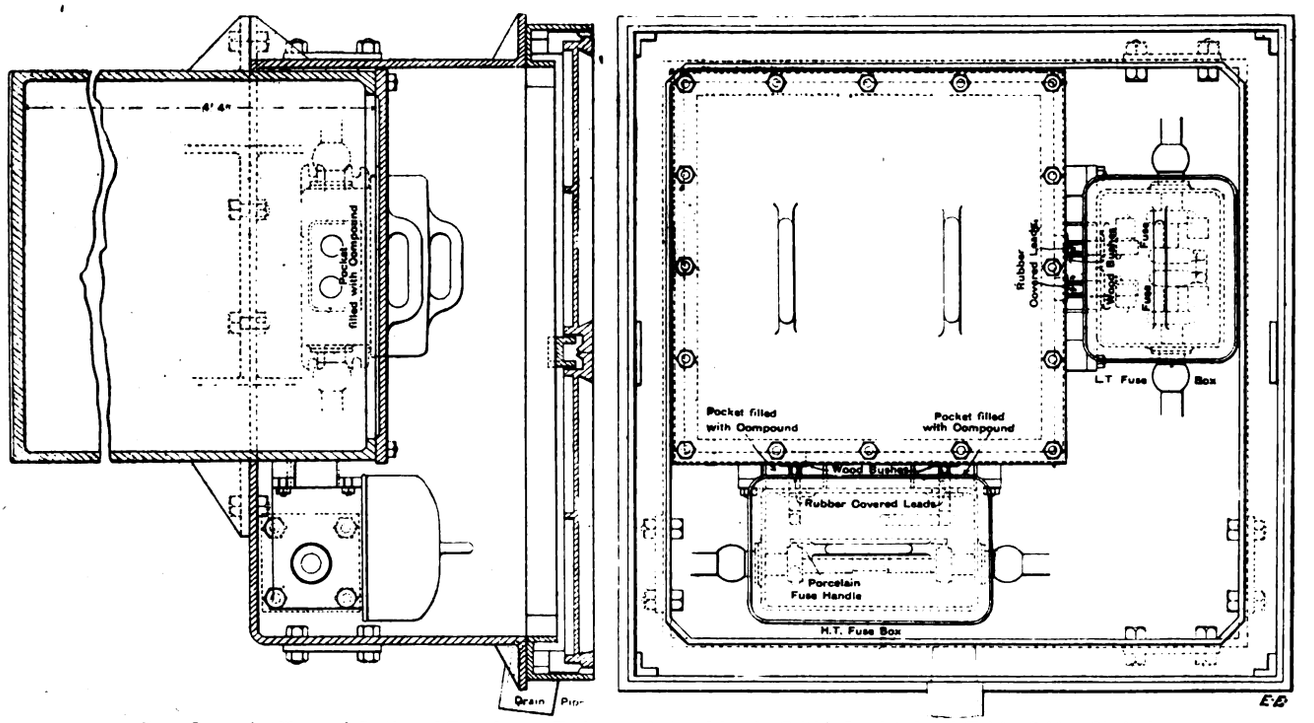
supplying a considerable number at the present time we understand. Owing to the great difficulty in making brick-built transformer chambers watertight, they have directed their attention to the production of a chamber constructed entirely of iron castings; the first being the transformer tank itself, into which the high-tension and low-tension leads are taken through sealed pockets to their respective terminals on the transformer. These leads are taken from watertight boxes, bolted to the side of the tank and provided with suitable clamps and disconnecting links for testing purposes. On the outside of the tank is bolted a chamber which entirely surrounds the upper part of the tank and boxes. The top of this chamber, which is designed as shown, comes nearly level with the ground-line, and the usual pavement frame and cover rest upon it. The whole arrangement is a very convenient one, and all the fittings are easily accessible. For the rest we may well leave the accompanying illustrations to speak for themselves.




FIGS. 3 AND 4.—Plan and Section of Transformer Tank manufactured by the British Insulated and Helsby Cables, Limited.

## The Sinclair Variable Stroke Feed Pump.

Messrs. Hayward-Tyler and Co. have put upon the market a standard line of electrically-driven variable-stroke boiler feed pumps, which they are manufacturing under the Sinclair patent. These pumps, one of which we illustrate in Fig. 1, are designed to secure the highest efficiency with electrical driving. The economy of electrically-driven feed pumps over the old direct-acting steam type has frequently been commented on in our columns. In order, however, to get a wide range of output with the electric drive special devices have been adopted for reducing the speed of the motor. With the pump before us these electrical regulating arrangements are not required, as the stroke of the plungers of the pump can be varied to give different discharges while the pump is at work. The crank-shaft, instead of being fitted with cranks in the ordinary way, is provided with eccentrics, which are so arranged that their axes can be made to coincide with the axis of rotation of the shaft, or they may be removed from the centre a distance corresponding to half the full stroke of the plungers, or any intermediate distance. The change in the throw of the eccentrics is made while the shaft is rotating, simply by holding a lever or hand-wheel in one of two positions, corresponding to an increase or decrease of the stroke, and releasing same when the desired stroke has been obtained. An indicator is added which shows the output of the pump at any time, which is a great convenience when adjusting boiler feeds. With this mechanical construction an ordinary shunt-wound motor can be used, and it always runs at full speed. There are therefore no electrical losses due to regulating resistances. At the same time, there is no increase in the mechanical losses, so that the combination is efficient at all loads. In the curve (Fig. 2) we give particulars which were obtained on a 2,000-gallon pump of the three-throw type. It was driven by a 4-b.h.p. motor, supplied from a 500-volt circuit, and running at a speed of 450 revolutions per minute. The feed pump was working against 160lb. boiler pressure per minute. The over-all efficiency given is the ratio of the power put into the motor to the power represented by the quantity of water delivered against the boiler pressure. The power wasted in overcoming the resistance in the pipework system between the pump and the boilers is all included, so that the efficiency of the pump by itself would be considerably higher. The first of these Sinclair pumps have been working under commercial conditions for nearly two years, and giving great satisfaction.

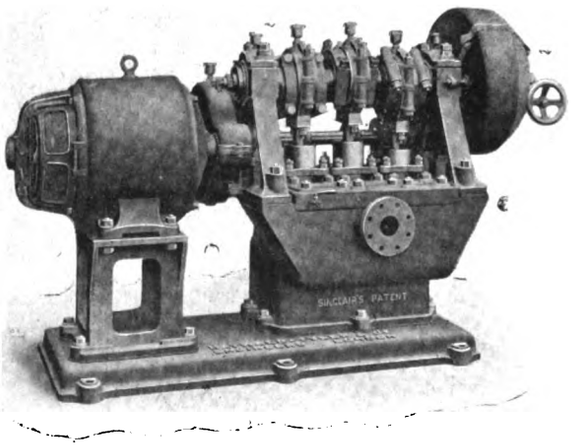
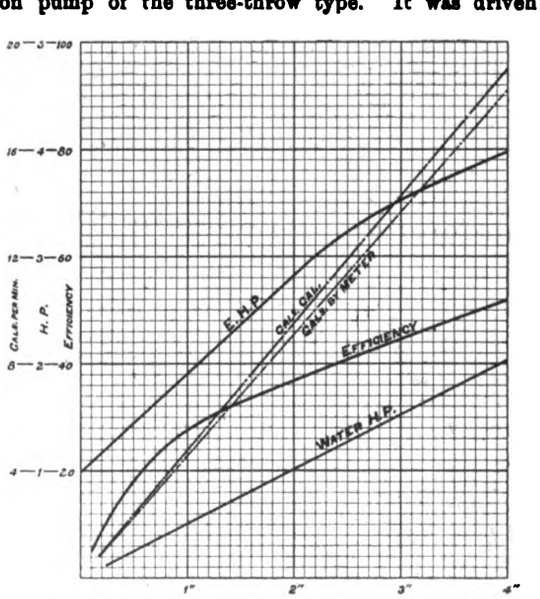



FIG. 1




Output and Efficiency Curves of a Sinclair Electrically-Driven Feed Pump.

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## "Union" Steel Interior Conduit.

The General Electric Company, Limited, 71, Queen Victoria-street, E.C., have just issued a revised edition of their conduit list, which includes particulars of several new departures. Special attention is drawn to the elaboration of their Papristeel conduit system. The paper-insulated tubes have been manufactured for some years, but hitherto no satisfactory means have been found by the company for lining the fittings. However, this difficulty has at last been overcome by using a mineral compound which is spread evenly over the interior of the fittings before enamelling. The same method is adopted

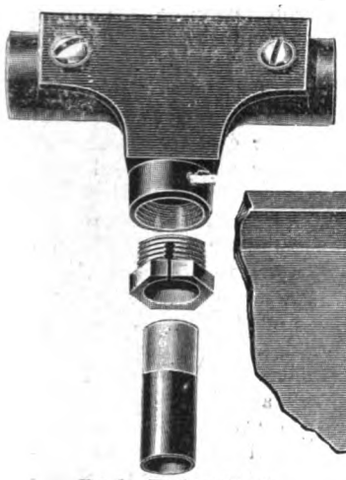


FIG. 1.—Earthing Nipple.

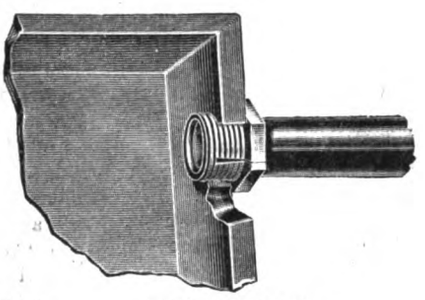


FIG. 2.—Standard Box.

with all types of joint-boxes, thus enabling much better tests to be made. Another great point claimed in favour of these insulated conduits and fittings is their reasonable price, by reason of which it is now possible, we understand, to erect an insulated conduit system for very little more than has previously been paid for ordinary screwed conduits. This result is obtained by using unscrewed Papristeel tube and insulated fittings with the "Union" patent earthing nipple (Fig. 1), which is an improvement on the soft metal nipple introduced by the firm some years ago for a similar purpose. The function of this nipple is to grip the conduit by the pressure exerted in screwing it into the fitting. It will be seen that the nipple is split through part of its length to allow for closing up tightly on the tube. Since it is necessary that these nipples should preserve their conducting properties indefinitely they are made of an alloy similar to type metal. If preferred, the conduits can, of course, be screwed in the ordinary way for watertight installation.s

Another noteworthy departure is the listing of the several sizes of plain steel boxes supplied to contractors at various times for special work. These boxes can be adapted for any number of ways, by either drilling clearing holes in them and using backnuts for clamping screwed tube, or (as shown in Fig. 2) by tapping the holes and using the patent nipples for plain tube described in the foregoing. In this connection it may be men-

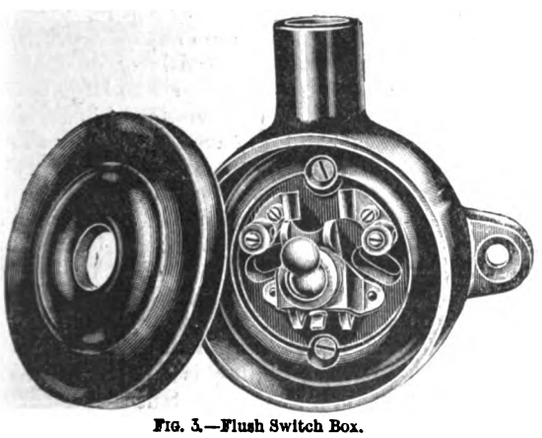


FIG. 3.—Flush Switch Box.

tioned that the company undertake to supply these boxes ready drilled to order at very short notice.

A combination switch and ceiling-rose box also calls for notice. The lugs of this box are drilled so that either the standard switches or ceiling roses can be fixed at will on the job, or transferred if necessary from one to two-way boxes.

Reference may also be made to a new and very neat design in wall-plug conduit boxes. This consists of a malleable iron box containing one of the company's "Midget" wall-plug sockets, and provided with a brass cover mounted flush. But no doubt the cover of insulating material, listed as an alternative, will be generally preferred.

Fig. 3 illustrates a useful type of flush switch box for concealed wiring. It is intended that this box should be fixed so that the edge shall come just level with the surface of the plaster. The lid then screws on to the boss of the switch, and when in position stands out only a very little from the wall.

Oval tube is also given some prominence. Our next illustration (Fig. 4) shows an adaptor by means of which an oval branch can be tapped off from any fitting in the circular main run. This is an entirely new departure, and enables the oval tube to be run direct from the fittings.

Among the accessories listed place is given to Kennedy's patent bending machine, of which an illustration is included, surrounded by bends made in brazed conduit. It is claimed that all kinds of tube can be bent by means of this machine to any required angle without heating. Two sizes are made, the smaller for bending from ½in. to ¾in. tube, and the larger 1in. to 2in. tube. We may add that particulars are included of some watertight fittings particularly adapted for use with conduits, also plain pendants and brackets, made from steel tube, for workshop and similar use. By using Union patent

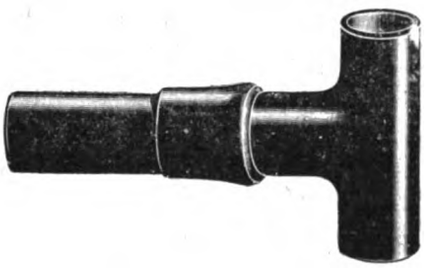
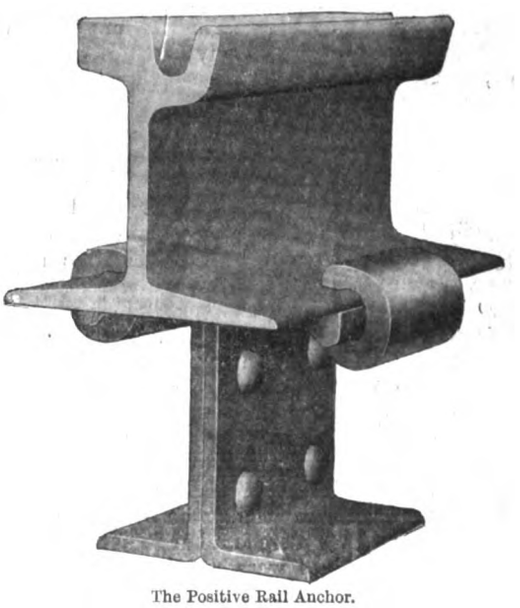


FIG. 4.—Fitting Adaptor.

earthing nipples, these watertight fittings, which are usually screwed ½in. gas, can be immediately adapted for ¾in. ordinary conduit.

## The "Positive" Rail Anchor.

The accompanying illustration shows a new anchor (Walker and Grant's patent) for tramway rails, the rights to manufacture which have been acquired by Messrs. Naylor Bros., Limited, Golborne Ironworks, Golborne, Lancs. The "positive" rail anchor has been designed, we are told, to meet the demand for an anchor which can be fixed without drilling the rail, and is at the same time cheap, strong, and easy to fix. It resembles an "I" section with a "bulb" along each top edge, and is held under the rail by means of heavy clips driven on with a hammer in a direction parallel to the rail. The anchor itself is formed of two rolled-steel plates bent to the proper shape and riveted together; the clips are stamped out of stout steel plate and pressed round a mandril to the exact size required.



The Positive Rail Anchor.

The bulbs are formed to a slight taper, so that the clips enter easily, but grip like a vice when home. The anchor can be made to suit any section of girder rail, and may be added to an existing track with little trouble.

## Catalogues, etc., Received.

THE CAPE ASBESTOS COMPANY, LIMITED, 8, Minories, London, E.C., Kimberley, and Turin.—From the very serviceable combination blotting-pad of this firm, who are manufacturers of blue asbestos removable coverings for boilers, pipes, flanges, etc., we notice that they have a very large number of agencies in all parts of the world.

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## SOME POINTS ON THE SELECTION OF ELECTRIC CABLES.

The above paper was read before the Manchester Section of the Institution of Electrical Engineers on Tuesday. The authors, Mr. L. B. Atkinson and Mr. C. J. Beaver, dealt generally with the types of cables at present in use, and as these were reviewed at considerable length, and from a somewhat technical point of view, this abstract will endeavour to deal with the main features of the paper from the standpoint of the ordinary buyer and user who prefers to note the results of experiments rather than to peruse the details of same, and who possibly considers opinions based on either practical experience or experiments to be of utility to him, even though ungarnished with tabulated data. The paper must be strongly commended for its exposure of the methods indulged in by unscrupulous manufacturers, which, though cheapening the cost or increasing the profits, tend to lower the standard of excellence that is such a feature of most English factories.

The opening paragraph, explaining the paucity of papers upon the subject, gives reasons why there are comparatively so few cablemakers in existence compared with the number of makers of other descriptions of central-station plant: A study of the proceedings of the Institution of Electrical Engineers reveals the fact that of all the important subjects relating to the practice of electrical engineering few have been dealt with to such a small extent as the subject of cables. The reason is, perhaps, not far to seek. In machines, in instruments, in switchboards, there is something which appeals at once to the inventive and constructive mind; known facts and laws may be manipulated to produce novel effects; the results are at once tangible and often striking, and the appliance may be generally readily introduced into the market with perhaps no great outlay of capital, whilst the production of cables with new dielectrics, involving laborious experiment in almost unknown regions of chemistry, requires plant and necessitates large outlay of capital. Their introduction into the market involves considerable expense, and the finding of heavy guarantees for their qualities and permanence. Then, again, electrical enterprises are generally in the hands of mechanical engineers, and the design, manufacture, and use of cables embody so many points of purely electrical and chemical knowledge that, bearing in mind that most mechanical engineers do not study these two sciences, especially the latter, it is not to be wondered at that the tendency is to accept what is given them, rather than make any careful study or enquiry into what they really should demand. Foremost among the papers on this subject which have come before the Institution was the paper on "Insulation on Cables," read in 1901 by Mr. Mervyn O'Gorman in London. This was practically the first paper treating cables from a broadly scientific point of view; and yet there was practically no discussion thereon, and so far many of the important suggestions made in it have been barren of any practical result. It is worth while for a moment to consider why this was so. To some extent it no doubt arose because the paper took so general a view of the whole question. Cablemakers found little to discuss, because their own particular products were simply accepted in the paper as existent, and suggestions, none of which had then been tried, were made for their improvement. Engineers were in the same position; for the questions with which they were familiar in the practical use and deterioration of cables were not brought at all into view. The aim of the authors of the present paper is far less ambitious. They desire to take into consideration the existing types of cable, to consider the purposes to which they are adapted, and to deal with the qualities to be sought for in each type to ensure that it may be the best of its kind.

*The Conductor* is naturally first dealt with, and this commences the series of *exposés* which is such a feature of the paper: The specification of any standard conductor should state the effective sectional area of the whole conductor, *i.e.*, the area of a solid wire having the same conductivity and the number of wires in the strand, or alternatively (as is common in the case of small conductors), the gauge number or diameter in mils of the wire, and the number of wires in the strand. It should further define the minimum conductivity allowable. In the case of tinned wires, it should also state the percentage permissible departure from the standard of conductivity produced by the tinning. Every engineer knows the enormous difference in conductivity between pure copper and copper containing small percentages of impurity. The conductivity of copper produced by ordinary smelting process may be only 50 per cent. to 80 per cent. of that of electrolytically-refined copper. Hence every engineer specifies that conductors shall be of electrolytic copper of 100 per cent. Matthiessen's standard, but in few cases, especially with smaller ones bought commercially, is this tested, and there are copper conductors in the market of not more than 80 per cent. (Matthiesen's standard) conductivity, and these are accepted and used for house wiring and other purposes without discovery.

It cannot be claimed that such wire is bought by the manufacturer as high-conductivity copper, as there is no difficulty in obtaining electrolytic copper of from 99 to 102 per cent., and for many years the only difficulties which the cablemaker has had to contend with, as affecting conductivity, have been mechanical, such as inaccuracy in drawing or imperfections which affect the homogeneity of the wire, but nowadays these are almost negligible. It may be thought that the gain to the manufacturer in making this substitution is too small to be worth considering; but it must always be remembered that the necessary fixed outlay in producing a cable is large, and it is only by variations of small percentages that profit or loss in cablemaking arises; hence a difference of about 3½ per cent. in the price of the copper is appreciable in the case of a large turnover. It is quite arguable that the margins of carrying capacity insisted upon by fire insurances and supply companies' rules are so great that such cables are quite sufficient for all requirements, but if they are the rules should be altered, and either wires admitted which, with lower electrical qualifications, give certain sizes and strength, whilst the purchaser gets them cheaper, or rigid tests should be made to ensure that all tenders are really on a similar basis.

*The Insulation* of a cable is described under three heads: (1) rubber, (2) elastic or plastic materials, (3) fibrous materials impregnated and covered with lead or waterproof material. Regarding rubber-insulated cables, the following may make the reader appreciate the necessity of conscience as an important part of the stock-in-trade of cable factories: Rubber-insulated cables were the first, and in the early days of heavy electrical engineering the only cables used, and their use to-day is still very large for all purposes where high insulation and easy fixing and manipulation are primary considerations. Indeed, except for their cost, they probably would never have been superseded. Speaking generally, there is hardly any article of general commerce in which the buyer places himself so largely in the hands of the seller as he does in the matter of indiarubber; and although large buyers often have facilities for analysis of goods, there are difficulties in the analysis of indiarubber articles which are hardly paralleled in other general analytical work, and to correctly interpret results, and to appreciate the vital points in cable manufacture, it is essential that the analyst should not only be, to some extent, a specialist in rubber, but should have knowledge of the manufacture of cables, and of the various electrical phenomena which affect the life and efficiency of cables. The importance of perfect tinning is insisted on as the best means of separating two substances—rubber and copper—which for chemical reasons should be kept apart. Details of a simple test are given in the appendix for ascertaining the value of the tinning, by immersing wire samples alternately in hydrochloric acid and sodium sulphide for definite periods of time, and then noting the blackening effect.

*Pure Rubber.*—The importance of the purity of this is dealt with, but: It is obvious that such pure rubber must be expensive. With raw rubber in the neighbourhood of 5s. 3d. per pound, the cost to the cablemaker will be about 8s. 6d. per pound. Though at the present time rubber strip, purporting to be pure Para, is being offered at 5s. 9d.

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per pound. There is, therefore, little occasion for surprise to find that in foreign cables, and in cables made by firms with little or no reputation to support, the pure rubber, as above described, is substituted by a lower grade rubber, in which the requisite elasticity and mechanical properties are obtained by vulcanising by what is known as the "cold cure" method. This consists of treating the surface with chloride of sulphur in carbon bisulphide. Apart from the fact that this rubber contains sulphur, contrary to the essentials of its functions in the cable, it nearly always contains traces of hydrochloric acid as an after result of the chemical treatment. The danger of using such rubber hardly needs emphasis, but the temptation to the alien and the small maker lies in the fact that it can be produced at something like 40 per cent. less cost than pure Para strip made by the best method. In some cases of cheap cables the pure rubber may be found to contain a proportion of "rubber substitute," which usually consists of oxidised or vulcanised oil, sometimes with an addition of wax. Such adulteration is not only fraudulent, but almost as harmful as the low-grade chemically-treated rubber referred to above. Where no attempt is made to adulterate, it is sometimes found that makers attempt to imitate the hard non-adhesive surface of correctly "aged" strip by coating with a film of soapy composition. Wires coated with such rubber will blacken before vulcanising if traces of free alkali are present.

*Vulcanising Rubber.*—This compound material as usually applied in two layers of differing colours (generally drab and grey) is also subject to adulteration to a dangerous extent, as here followeth: The addition of rubber substitute, as referred to under "Pure Rubber," should never be allowed; and the expression, "containing no organic matter other than rubber," is in some specifications intended to prohibit such materials. In few cases are analysis made to check this important matter, and even when the specification is framed to bar substitutes large contracts are frequently placed without reference to anything of the kind, and the first-class firm has to be passed and orders given to possibly a foreign competitor, who does not scruple to put in his "mixings" 5 per cent., 10 per cent., or even more of a material costing anything from 4d. to 1s. per pound, in place of the hard fine Para costing from 6s. to 7s. 6d. per pound, according to the state of the market. Such substitutes are invariably prejudicial to the life of rubber cables or any other rubber goods. They increase the liability to oxidation, because they only form mechanical mixtures, and neither combine chemically nor cohere physically; in fact, they sub-divide the particles of rubber when ground up with it, and this means imperfect results as regards durability, from mechanical and from electrical points of view. It is pointed out that specifications are drafted even nowadays with sufficient vagueness to enable the unscrupulous to put in inferior material, and yet to get past the tests. An instance is quoted where a very large contract was recently passed abroad owing to the difference between "fine" Para and "pure" Para being unnoticeable to the eye of the simple foreign tenderer, and to him arranging his insulating materials so as to pass a test after *three* minutes' electrification, instead of after the more searching *one*-minute period, which, though generally understood, *was not specified.* For the prevention of local weaknesses in high-tension rubber cables, the addition of a metallic sheathing is recommended, on the same principle evidently as bonding is used for electrolysis in lead-sheathed cables.

*Fire-Resisting Cables* hardly appear to need much reference as to their suitability for certain situations, and the principles upon which their construction should be based are explained. The main qualities required are: (1) insulation; (2) flexibility; (3) waterproofness; (4) mechanical protection; (5) fireproofness; and either of the three classes of rubber, vulcanised bitumen, or guttapercha are preferred for the insulating medium to be covered by the usual tapes or braids chemically treated, so as to be incapable of supporting flame. Tanned jute is the covering best recommended, and asbestos is stated to be too mechanically weak.

*Vulcanised Bitumen.*—The weak point of this class of cable, its liability to decentralise, is discussed, but the results of tests made on three (incognito) samples of different makes showed that very little fear need be felt on this score. The permanency is, however, brought into question, and this is a point that has hardly been suspected in this class of material: The permanency of such dielectrics is, of course, an important element; it is by many thought that they are absolutely permanent, but they are so only relatively, as they all contain elements affected by various external agencies, and at least it is desirable in considering the use of such dielectrics in various situations to realise how far the possible attacking agencies may have weight. The action of the air gradually tends to oxidise and harden such compounds, particularly if they contain free oils or other oxidisable materials. Acid met with in mines, alkalies in works of various sorts, and some soils acting on other elements of the composition, have other effects. Various sulphates, acids, and alkalies were let loose upon samples of vulcanised bitumen with no effects in some cases, hardening in others, and others still were severely attacked; chromic acid and caustic soda being the most destructive agents: The results of these experiments are full of instruction as to the qualities of and uses to which this class of cable may be properly applied, and show how certain attacking and deteriorating agents not only have a surface action gradually thinning the insulating layer, but may by selective action be penetrating the mass. This latter effect would, of course, be enormously increased with cables carrying continuous currents and having earths on the circuit, on account of osmotic pressure forcing the chemical ions through the dielectric. Such action would be in some degree the equivalent of electrolytic action in lead-covered cables. This is worthy of note, as the freedom from such action is claimed as one of the strongest points in favour of the vulcanised bitumen type of cable. Regarding the whole of the above results broadly, the conclusion forced upon one is that to attain maximum efficiency in every respect vulcanised bitumen compounds must be designed, made, and applied with the greatest possible care. For instance, physical properties (such as resistance to decentralisation) must not be obtained by the sacrifice of chemical inertness. Efforts in this direction usually take the form of stiffening the compound by the addition of mineral loading matter, and, as shown above, this results in not only laying open the material to loss of coherence among its particles (and incidentally rendering it liable to fracture in very cold weather), but also encourages the action of oxidising influences and the selective actions which have been described.

*Fibrous Dielectric Waterproof Sheathed.*—The weak point of this class of cable is that, however well the fibrous material is impregnated, it is always liable to more or less readily take up moisture from the atmosphere, whereby its insulation resistance is reduced. Hence the necessity of covering with a waterproof sheath or metallic or non-metallic composition. A few words as to the protection of the dielectric when the paper is exposed for jointing, or trimmed for connection, may be advisable here. On comparatively small jobs suitable terminal ends are often omitted; pure rubber, or proofed tape, or both being frequently substituted therefor. Even in making joints, materials which are not waterproof for electrical purposes are often used. Care should be taken that only such materials as are non-fibrous and can be made homogeneous should be used. Reference to Glover's guttaroid tape for such purposes is made in a later part of this paper. The fibrous materials generally use are of two classes—viz, paper and fibre, the latter being usually jute or cotton, applied in the form of yarns and afterwards impregnated. The former usually consists of manilla paper, and comprises the great majority of cables which are now made with fibrous materials. The oils used are generally resin oils, or mixtures of resin and resin oils, while Messrs. W. T. Glover and Co. use a compound made from oils called "diatrine." This class of insulation, like its fellows, suffers from the Whitechapel taint, and the word manilla is evidently capable of as many meanings as its sellers choose to give it. In consequence of which: A combination of factors (among which may be included the above stated fact, keen competition, more or less lack of appreciation of the importance of the subject

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on the part of the cablemaker, and on the part of the users or their consulting engineers, and the difficulty of constant checking of the paper manufacturer's products) has resulted in large quantities of paper cable being sold and used in the past containing small proportions of manilla (and in many cases none at all), and large proportions of straw, esparto, chemical wood, and even mechanical wood. Samples of Continental and American cables have been examined in which chemical and mechanical wood papers were used entirely, and some German makers have gone so far as to maintain that chemical wood is preferable to manilla. The chief disadvantages of the introduction of straw, grass, or wood fibres in place of manilla are as follows: (*a*) lower dielectric strength and insulation resistance, and higher capacity; (*b*) deterioration in strength and elasticity of the paper when heated continuously or intermittently, and consequent brittleness; (*c*) danger of rotting in course of time through the action of residual chemicals. Magnified photographs of some classes of manilla paper were shown on the screen, and the characteristics of the poorer classes distinguished from the better material by the differences in the nightmare-like shapes shown. A specification of paper suitable for insulating is given in the appendix. The peculiarities of impregnating compounds were touched on, the consistency recommended being plastic, but not so fluid as to run by gravity within the cable itself.

The lead-sheathing operations are considered: The lead is put on such cables in a plastic state by hydraulic pressure. This is an operation requiring such care to avoid minute cracks or damage from particles of oxide being forced in with the lead that there are engineers who still advocate the older system of drawing the cable into a lead pipe which has already been tested by water pressure, or of putting on double sheaths of lead. Messrs. W. T. Glover and Co., Limited, have, however, met the question by the use of hydraulic pressure up to 100lb. per square inch applied externally after the cable is finished. Such pressure invariably detects a fault if such exist in the lead. The ordinary tank test is practically useless, and it may take many months or even years for water to enter the very fine seams which such faults occasion, but eventually it will do so. No doubt in the past this has been the reason for many unexplained failures, while many more have been due to corrosion in various forms, the effects of which are usually difficult to diagnose, and in most cases the causes are equally difficult to trace. The chief causes of corrosion of lead coverings under working conditions may be summarised as follows: (1) impurities in lead, causing local galvanic action; (2) galvanic action between lead and adjacent metal; (3) corrosion by chemical action; (4) electrolysis.

The causes of the foregoing are reviewed. The most dangerous obviously is the last-named, and while the vagrant tramway and lighting earth currents are duly debited with their share of mischief, another less heard of cause of trouble is commented on. This is the corrosion of lead-covered cables in buildings, etc., due to the existence of a difference of potential between the lead sheathing and its surroundings: The character of the corrosion may vary from small holes which gradually penetrate the lead covering, convert the lead into various oxides of lead, and only make themselves apparent when the rubber dielectric becomes oxidised to a sufficient extent to break down, or the paper dielectric sufficiently exposed to absorb moisture and fail (which may take many months) to very extensive action and a high degree of oxidation (where there is a free and continuous supply of the electrolytic medium and a small difference of potential) or a limited amount of general corrosion, followed soon by fusion (where the supply of the electrolytic medium is small or not continuous, and the difference of potential is comparatively high). . . . In rubber cables the rubber usually fails quickly when the lead is finally penetrated, owing to oxidation; but in the case of paper cables, if undisturbed, the oxides into which the lead is converted will keep out atmospheric moisture for, possibly, years, and the effect of the liberated oxygen in the paper (if made of pure manilla only, and well impregnated) will be negligible. The opinion is expressed that lead-sheathed cables will have but a limited application in connection with heavy current work in the future, and the need for sufficiently bonding and earthing is mentioned.

A class of leadless paper-insulated cable was described as combining the dielectric strength of paper with the waterproof qualities of bitumen, and as being more suitable for heavy currents. It is somewhat disappointing to find that the paper concludes without hazarding a surmise as to the future form or type of electrical cables, but as in the past the question has principally depended upon fashion, so in the future that fickle dame may continue to exercise her control.

The matter in the appendix is really valuable as being specifications compiled by cablemakers for engineers, which is almost one of the signs of the millennium!

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DISCUSSION.

**Mr. C. D. Taite,** from the chair, commented on the amount of original research occasioned by the paper, and on the valuable information thus given to engineers, who, as a rule, possess less information upon cables than upon any other subject. He thought the Cablemakers' Association standards were distinctly useful, and anticipated that there would now be less trouble experienced in preparing suitable specifications.

**Mr. T. L. Miller** congratulated the section upon the paper, and agreed that it added considerably to the very limited amount of information at present available on the subject. The revelations as to the cooking of cables, however, would add a new terror to the consulting engineer. He had imagined that all that was necessary was to specify the insulation resistance and the pressure test, when the cablemakers would guarantee all the rest. It pointed the moral that it was necessary to go to a reliable firm, as if cablemakers wish to "do" one, they can whether or no. He suggested that standard compounds should be devised by an independent analyst, as consultants were yet much in the dark as to the best arrangements for various conditions. He agreed that lead-covered cables had had their best days, and that vulcanised bitumen was a step in the right direction. In Liverpool district lead pipes would not stand any time, owing to the condition of the soil. He referred to a case of failure of lead-covered cable which had been laid solid with cover tiles 1ft. long, where the cable went wrong at 1ft. intervals, and he invited explanations.

**Mr. Pocklington** said that he had been waiting 18 years for this paper. He had laid a lot of cable in Liverpool, but had never found any decentralisation troubles, although his (vulcanised bitumen) cable was often overloaded. He had, however, known some cables give way due to inferior insulation mixtures. He thought that the magnified photos of manilla paper, which showed canals in each quality, almost indicated the cause of hygroscopicity by their presence.

**Mr. S. J. Watson** concurred that the paper was interesting and deserved large attention. He thought that some of the cablemakers must have waxed rich on the amount of adulteration carried on in the past as shown by the paper, but in the future buyers should be better able to get value for their money. He also agreed that lead-sheathed cables should be superseded by a leadless sheath. The past success of vulcanised bitumen, he thought, was largely due to its being generally laid on the solid system, which prevented contact with deleterious matter. He could not explain how rubber cables made by good firms had been so unsuccessful on town networks, and he could find no one else who could explain, makers included.

**Mr. Connelly** explained why separators were used in rubber cables, and gave the following rough tests for examining the quality of a rubber cable: (1) examine tinning for brightness; (2) rubber should be tough and elastic; (3) thicknesses should be up to standard; (4) a variation of between 40deg. and 200deg. should have very little effect upon the insulation.

**Mr. A. G. Cooper** emphasised the need for efficient bonding by wiped gland joints and by earthing at the station. He had found no trouble on account of oil running inside a cable through gravity.

**Mr. Harvey** said vulcanised bitumen cables were risky only when passing over bakers' ovens, and when properly laid they were O.K. His experience showed them to be the best for mining work, where the worst conditions were to be met with.

**Mr. C. C. Atchison** objected to the undue susceptibility of gas and water mains to be damaged by electric currents. His station had been running now for four or five years, and he had yet to experience the emotion of having a faulty cable on his network, but he believed he was in good hands. He was pleased to note that the C.M.A. specifications showed thicker paper and lead than previously was the practice. Considerable discretion should be used in bonding, and joint-boxes should be bonded across by something that would not act as a fuse to an excessive earth current. He thought that cement-jointed ducts caused trouble with lead-covered cables, but had known rubber-covered cables to last 10 years on alternating supply in iron pipes.

**Mr. Berry** thought cement had no effect upon lead-covered cables. The National Telephone Company had had eight years' experience of concrete ducts without a single case of deleterious action through cement. He spoke, as one interested in a new duct lined with lubricating material, of the strains met with when drawing cables into unlubricated ducts.

**Mr. W. W. Lackie** referred to the value of the paper, and to the numerous gathering compared to the Glasgow Section meetings.

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**Mr. W. Taylor** considered that insulation should not be too solid, as it would be liable to be damaged by bending, particularly in cold weather.

**Mr. C. J. Beaver**, replying to the discussion, agreed that bonding and earthing should be considered upon the merits of each scheme, and that it was not advisable to invite current on to the lead sheathing. The seeming canal shapes shown on the magnified manilla paper photos were too minute to be water conductors, and he admitted that there were many peculiar shapes shown which might be likened to anything almost "except torpedo-boats." As to the tests with acids, etc., it should be noted that the severe testing conditions were arranged to the scale of about one day : one year.

**Mr. S. L. Pearce**, in proposing a vote of thanks to the authors, concurred as to the probability of lead-covered cables being used in the future more limitedly than in the past. His own investigations into the matter of bonding practice showed that there was absolutely every method in use, right and wrong, all over the country without the slightest attempt at uniformity.

**Dr. Bowman**, in seconding the vote, said that when he wanted cables he went direct to the makers, and had their experience put at his service, which he thought was the best way.

**Mr. L. B. Atkinson**, in acknowledging the vote, said that Mr. Taite had suggested the paper to him, and had worried him into promising to write it. He, in his turn, had worried Mr. Beaver into writing it, and Mr. Beaver was mainly responsible for the effort.

The **Chairman** announced that the meeting of Feb. 14 was postponed until the 21st, and the annual dinner date was also postponed by one week.

## PERSONAL.

Mr. T. B. Holliday, the engineer and manager of the Brighton Corporation tramways, has resigned that position for a similar one with the Hastings and District Tramways Company.

The recommendation of the Electricity Committee of the Manchester City Council that Mr. S. L. Pearce be appointed chief electrical engineer at a salary of £900, rising to £1,000, as stated in our last issue has been adopted.

The Bradford Electricity Committee have appointed as assistant electrical engineer Mr. Charles William Salt, of Croydon, at a salary of £250 a year.

The Dover Town Council have accepted the resignation of the station superintendent, T. McGill, and have appointed C. H. Lydall at £150 per annum, rising by £25 per annum to £200.

Mr. James Buckley, the chief assistant at the permanent-way engineer's office, Wellington Bridge depot, Leeds city tramways, has had his salary increased to £200 per annum.

We regret to learn of the death of Mr. James Edward Ransome, chairman of Messrs. Ransomes, Sims, and Jefferies, Limited, Orwell Works, Ipswich.

Mr. Frederick Coutts, general manager of the Ayr Corporation tramways, has been appointed manager of the Paisley tramways at a commencing salary of £400 per annum. Mr. Coutts, whose present salary is £250, came to Ayr from Dundee when the tramways were inaugurated in 1901, and his management of the system has been characterised by conspicuous success. His resignation has been accepted with regret.

The salary of Mr. A. P. Dryburgh, assistant engineer at Dewsbury electricity works, has been increased from £150 to £170 per year.

## LEGAL INTELLIGENCE.

### TRAMCAR ACCIDENT.

In the High Sheriff's Court at the Manchester Assizes, before the Hon. John Mansfield and a jury, the case was heard of Wiggins *v.* the Corporation of Manchester.

The plaintiff sought to obtain compensation for personal injuries received in a collision between two Manchester Corporation tramcars at a point near Singleton-road. The accident arose through one of the cars not entering a loop line in sufficient time to allow the other to pass. As a result the cars became interlocked while both were heavily laden with passengers.

The jury awarded £400 compensation.

### MOTOR TRACTION COMPANY.

In the Chancery Division last Friday Mr. Justice Buckley gave his decision in the matter of Mason *v.* the Motor Traction Company, Limited.

The plaintiff, as reported in our last week's issue, sought an injunction to restrain the company from carrying into effect an alleged agreement purported to have been entered into between the company and a Mr. F. G. Hackney, as trustee for an intended new company, or from otherwise carrying into effect a scheme for the reconstruction of the company, intended to be carried out by means of the alleged agreement. Plaintiff's contention was that the articles did not empower the company to sell for partly-paid shares in another company, as it was proposed to do. The company was incorporated in June, 1898, as the London Steam Omnibus Company, and in 1899 the name was changed to the present title.

**His Lordship** said the company had resolved to sell its undertaking for a certain number of partly-paid shares, and the sole question was whether the proposal to sell in this manner was *ultra vires*. The defendants were prepared to undertake not to carry out that part of the scheme relating to the manner of dealing with the purchase consideration without further resolution of the company. According to previous decisions, a sale might be made for partly-paid shares. There was no reason, in the nature of things, why a company, whose objects included the taking over and holding of shares, should be precluded from taking shares partly paid. The defendants, therefore, having given the undertaking stated, there would be no order on the motion, except that the costs be costs of the action.

### ACCIDENTS ON THE MANCHESTER TRAMWAYS.

#### Cross v. the Corporation of Manchester.

The plaintiff, George Cross, a cabowner, claimed compensation for personal injuries which he had sustained through a collision between a cab he was driving and an electric tramcar. Negligence was admitted, and the jury were asked to assess the amount of damages. In crossing the road on his cab he was run into by an electric car, which, counsel said, appeared to have been very negligently managed. The plaintiff, as his cab was crossing the metals, saw two cars approaching, the first of which was one of the heavy bogie cars, which struck the vehicle near the off front wheel with such force that the plaintiff was flung off his seat, falling with his head on the pavement. It appeared that the car was disabled before the accident, and had been towed into Albert-square; and it was on its way to the car-shed, being pushed forward by but not coupled up with the car behind it. Descending the slight incline in Cross-street, the car got out of control, the brakes being rendered temporarily useless by an entanglement with the trolley rope, which prevented the motorman from using them. The plaintiff claimed substantial damages, not only for his own injuries but also for damage to his cab. He was confined to bed for many weeks, under medical care, and suffered great pain.

Counsel for the Corporation having addressed the jury in mitigation of damages, the plaintiff was awarded £500.

## COMPANIES' MEETINGS AND REPORTS

### GREAT NORTHERN AND CITY RAILWAY.

The thirteenth half-yearly meeting of the Great Northern and City Railway Company took place on Tuesday at the Westminster Palace Hotel, the Earl of Lauderdale presiding. Particulars of the report appeared in our last week's issue.

The **Chairman** stated that the traffic receipts were steadily increasing, as the line was gaining in popularity. The ventilation of the tunnels and stations was very satisfactory, and the purity of the air was all that could be desired, while the temperature remained nearly uniform. With regard to working expenses, the matter was in the hands of the contractors, who were responsible for a further period of two years. Since their last meeting they had entered into a supplemental agreement with the contractors, by which the latter undertook to work the line at 60 per cent. of the gross earnings for the first year and at 50 per cent. for the second and third years. In the settlement of the accounts the contractors had met them in an exceedingly fair, liberal, and friendly spirit. The directors believed that in due time the projected extension to Lothbury would be an imperative and profitable addition to the system, but they considered it would be premature to undertake it at present, especially having regard to the condition of the money market.

The report was adopted.

### TYNESIDE TRAMWAYS.

The half-yearly meeting of this Company was held at Newcastle on Monday.

**Lord Armstrong**, who presided, referred to the happy results of the inter-running with the Newcastle Corporation. The delay in giving through traffic facilities on one of the routes arose through difficulties which the Newcastle Corporation were experiencing in the purchase of a house to widen the roadway near the point of junction. On the routes on which through traffic had been begun no hitch, friction, or difficulty of any kind had been experienced. During April—before the running powers were in operation—the number of passengers in Wallsend travelling to or from the junction between the two systems was 28,627, whereas the equivalent figure in September, after through traffic had been introduced, was over 66,000. As the consumption of current was the only item which increased through the additional passengers carried and as their company obtained from the Newcastle Corporation four-fifths of the receipts which the Corporation cars earned on this section of the line, it would be seen that the agreement would far more than justify both the capital cost of securing it and the burden which the efforts in this direction had laid on this year's revenue. Since September the running expenses had been steadily falling, and as a result of a reduction in the rating assessment and the price of current, the total expenses were now below 5½d. per car mile. In the published returns there were only two other tramway companies which showed a lower cost. The receipts had, therefore, exceeded the expenses by a greater amount during the past six months than before.

**Dr. Merz** seconded the adoption of the report, which was carried.

Mr. Summers Hunter and Mr. J. H. B. Noble were re-elected directors, and Mr. Swan, one of the retiring auditors, was re-elected.

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A dividend was declared out of the profits for the half-year at the rate of 2 per cent. per annum.

At an extraordinary meeting consent was given to the promotion of a Bill in Parliament to enable the Company to issue a portion of their capital as preference shares.

## METROPOLITAN ELECTRIC SUPPLY.

An extraordinary general meeting of this Company was held on Tuesday at Winchester House.

**Mr. W. H. Crippe,** who presided, said the object of the meeting was to conform with the Standing Orders of the House of Commons in respect to their Various Powers Bill and the Acton Bill respectively. Situated west of Willesden was a very considerable area, including Uxbridge, Drayton, and other places, where at the present moment the use of electricity was very little developed. The Company had at Willesden a considerable amount of plant now set free which had been used in supplying St. Marylebone, and it was very desirable as far as possible to find use for it, therefore the Company were applying for powers to serve that district. Another scheme was for the supply of the north-west corner of Paddington, formerly part of Chelsea, which could not be supplied without the consent of Parliament. Further, there was before Parliament the Administrative County of London Bill, which applied for powers to supply not only the whole of London, but practically the whole of Middlesex and a good deal of Kent and Surrey. Their directorate felt very strongly that the present companies in London, which between them had invested many millions of money, were not only in a position, but willing and anxious to supply every scrap of power required for the whole of that district, and in the proposed Bill they sought power to do so. Further clauses in the Bill dealt with the reduction of the capital from £1,000,000 to £750,000. The second Bill was for the supply to Acton.

The meeting unanimously adopted the two Bills.

## SOUTH STAFFORDSHIRE MOND-GAS (POWER AND HEATING).

The report for the year ended Dec. 31 states that the central station has been practically completed, and substantial progress has been made in the laying of the trunk mains, which are also very nearly completed through Bilston to Wolverhampton, and through Wednesbury to Walsall. The latter work would have proceeded more rapidly had it not been that considerable delay has been caused in obtaining the sanction of one of the railway companies to the plans for crossing their lines with the trunk main, and also by negotiations with private owners with whom wayleaves have had to be arranged instead of using the public road on various sections of the trunk main route. The gas plant was started at the end of December, under the supervision of the Company's engineer and the Power-Gas Corporation officials, for the purpose of getting the same into good running order before commencing the supply of gas to customers. Various sections of the plant have been tested, and the whole will shortly be tested under actual working conditions. As far as can be ascertained at present, the subscribed capital of the Company will prove sufficient for the completion and setting to work of the central station and the present distribution scheme.

## ST. JAMES'S AND PALL MALL ELECTRIC LIGHT.

The report for the year ending Dec. 31, 1904, states that the supply has been distributed from the Carnaby-street and Mason's-yard stations of this Company on a total of 278,889 8-c.p. lamps, being an increase of 24,421 in the past 12 months. For this purpose 6,488,589 units were generated at these stations and 2,088,347 were purchased from the Central Electric Supply Company, Limited. The price charged on the supply of the Central Company has been considerably reduced, so that it has not been necessary to draw upon the contingency fund. The Central Company has recently declared a dividend of 5 per cent. on the ordinary shares, in respect of which a sum of £2,500 will in due course be payable to this Company.

| | £ | s. | d. |
|---|---|---|---|
| Net profits applicable to dividend on shares for the year 1904 | 36,146 | 12 | 4 |
| Add balance brought forward from 1903 | 2,744 | 16 | 11 |
| | 38,891 | 9 | 3 |
| Less interim dividend, paid in August last, for half-year ending June 30, at rate of 7 per cent. on preference shares, £3,500; 10 per cent. on ordinary shares, £10,000 | 13,500 | 0 | 0 |
| Leaving an amount now to be dealt with of | £25,391 | 9 | 3 |
| The directors propose to divide this amount as follows: | | | |
| By payment of a dividend of 7 per cent. on the preference shares for the second half-year | £ 3,500 | s. 0 | d. 0 |
| By payment of a dividend on the ordinary shares for the second half-year of 7s. 6d. per share, and a bonus of 2s. per share, making, with the interim dividend paid on Aug. 1 last, a total distribution of 14½ per cent. for the year | 19,000 | 0 | 0 |
| Amount to be carried forward | 2,891 | 9 | 3 |
| | £25,391 | 9 | 3 |

## BLACKPOOL AND FLEETWOOD TRAMROAD.

The report of this Company for the half-year ended Dec. 31 last, to be submitted at the meeting on the 23rd inst. at Manchester, states that, including the sum brought forward from last half-year, the balance of profits, after providing for debenture interest, is £10,714, and the directors recommend a dividend at the rate of 9 per cent. per annum for the half-year, which will absorb £6,750, writing off £1,500 to depreciation reserve and £500 to general reserve account, leaving a balance of £1,964 to be carried forward. The number of passengers carried during the half-year was 1,546,617. The receipts from all sources amounted to £21,699.

## SOUTH WALES ELECTRICAL POWER DISTRIBUTION.

At a Wharncliffe meeting of this Company the solicitor read and explained the provisions of the proposed parliamentary Bill, and the following resolution was unanimously passed: "That the Bill, entitled a Bill to transfer to and vest in the South Wales Electrical Power Distribution Company the undertaking of the Carmarthenshire Electrical Power Company, and for other purposes, be, and the same is, hereby approved subject to such alterations and conditions as Parliament may make and may be approved of by the directors and the company."

## CENTRAL ELECTRIC SUPPLY.

The report for the year ending Dec. 31, 1904, states that energy has been supplied to the St. James's and Pall Mall Electric Light Company, Limited, and the Westminster Electric Supply Corporation, Limited, throughout the year, to an amount of 6,214,873 units. This increase of output has materially affected the costs of production, and for the past year the Company have been able to considerably reduce the charge for supply. A Bill for an extension of the Company's powers will be dealt with in the ensuing session of Parliament. Further debenture stock, amounting to £48,014, has been issued during the year, and the premium on the issue, after deducting the expenses, has been carried to the credit of the capital reserve account.

| | £ | s. | d. |
|---|---|---|---|
| After making a full allowance for sinking fund and depreciation, the net balance for the year 1904 is | 604 | 10 | 1 |
| Add balance brought forward from 1903 | 4,402 | 19 | 11 |
| Leaving an amount now to be dealt with of | £5,007 | 10 | 0 |
| The directors propose to divide this amount as follows: | | | |
| By payment of a dividend at the rate of 5 per cent. on the ordinary shares for the year | 5,000 | 0 | 0 |
| Amount to be carried forward | 7 | 10 | 0 |
| | £5,007 | 10 | 0 |

## LIENS REGISTERED.

**Hastings and District Electric Tramways Company, Limited.** A trust deed, dated Nov. 20, 1904, to secure £250,000 debenture stock, has been registered. Property charged: 35,880 shares in the Hastings Tramways Company and the company's other assets and undertaking, present and future. Trustees: Debenture Securities Investment Company, Limited, 12, Moorgate-street, E.C.

**Havana Electricity Company, Limited.**—A trust deed, dated Jan. 19, 1905, to secure £150,000 debentures, created by resolution of even date, has been registered. Property charged: certain bonds of the La Compañia de Electricidad de Cuba for 1,500,000dol. in United States gold, and the company's undertaking and other assets, present and future. Trustees: H. Rüffer, Menival, Sydenham, and Major W. E. E. Gordon, M.P., 4, Chelsea-embankment, S.W.

**Northwich Electric Supply Company, Limited.**—A trust deed, dated Jan. 12, 1905, to secure £11,000, has been registered. Property charged: the company's freehold and leasehold lands and hereditaments and its undertaking and property, present and future. Trustees: Brunner, Mond, and Co., Limited, Winnington, Northwich.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Oporto.**—The Municipal Authorities require tenders for lease of their electric tramways. Tenders by March 15.

**Milan.**—The Mediterranean Railways require tenders for an electric crane to be erected at Gallarate. Tenders by Feb. 10.

**Arenas De San Pedro.**—The Municipality require tenders for public electric lighting for 20 years. Tenders by Feb. 12.

**Ghent.**—The Municipality require tenders for 15 electric cranes for the harbour works. Provisional estimate, £1,200. Tenders by Feb. 20.

**Bury.**—The Electricity Committee invite tenders for the supply and erection of one 500-kw. direct-current high-speed generating set. Tenders by Feb. 14.

**Swindon.**—The Corporation invite tenders for the supply, delivery, and erection of switch panels, etc. Tenders by Feb. 21. See advertisement in last issue.

**Dublin.**—The Corporation invite tenders for the supply of arc lamp carbons to their electricity undertaking. Tenders by Feb. 23. See advertisement in last issue.

**Lirla.**—The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

**Battersea.**—The Council require tenders for the supply for one year from March 31 next of electricity meters, joint-boxes, carbons, coal, and oil stoves. Tenders by Feb. 27.

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**Newport.**—The Visiting (Lunacy) Committee invite tenders for the installation of fire-alarms, telephones, etc., at the county borough asylum. Tenders by Feb. 14. See advertisement in last issue.

**Madrid.**—The Department of Agriculture, etc., invite tenders for installation and working for 60 years of an extension of the electric tramways in the north of the town. Tenders by Feb. 25.

**Laventhem (Belgium).**—The Municipality require tenders for erection of central station, laying of mains, etc. Particulars (3s. 4d.) may be obtained from the Secretary of the Mayor of that place.

**Leith.**—The Corporation invite tenders for the supply and erection of one 600-kw. steam dynamo, one water-tube boiler, and one traction switchboard. Tenders to the Town Clerk by 6 p.m. on Feb. 15.

**Manchester.**—The Tramways Committee invite tenders for the supply and erection of a main switchboard, auxiliary distribution boards, etc., for their car-repairing works. Tenders by Feb. 14. See advertisement in last issue.

**Stockton-on-Tees.**—The District Fund, Gas, Quay, and Electricity Committees invite tenders for the several articles and stores required by them for the year ending March 31, 1906. Tenders by Feb. 10. See advertisement in last issue.

**Rathmines and Rathgar.**—The Urban District Council invite tenders for the supply of coal for electric lighting purposes (about 2,000 tons), cables, etc., arc lamp carbons, and general stores. Tenders by Feb. 20. See advertisement.

**Great Western Railway.**—The directors invite tenders for the supply, delivery, and erection of plant in connection with their electricity generating station at Park Royal and proposed sub-stations and distributing centres at various places. Tenders by March 13. See advertisement.

**Kilkenny.**—The Committee of the District Lunatic Asylum invite tenders for fixing in the asylum an electric installation of tell-tales, consisting of 18 stations, and one recording tell-tale clock. Tenders must be delivered at Asylum before 4 p.m. on Feb. 20. Mr. Joseph Brennan, clerk.

**Switzerland.**—M. R. Vontobel, of Winterthour, and M. Charles Probst, of Lucerne, have obtained a concession for the construction of a narrow-gauge electric railway from Meiringen to Gletsch. The total cost of the enterprise is estimated at £241,600; £19,600 is to be expended on rolling-stock.

**Wimbledon.**—The Urban District Council invite tenders for the supply of (3) engine-room stores, (4) cables, (5) joint-boxes and jointing materials, (6) transformers, (7) meters, (8) oils, (9) incandescent electric lamps, carbons, and accessories, (10) iron castings. Tenders by March 4. See advertisement.

**Islington.**—The Council invite tenders for (Section A) meters, (B) time switches, (C) earthenware pipes, (D) carbons, (E) incandescent lamps, (F) terminal boxes, (G) arc lamp globes, (H) oils and lubricants, (I) waste, etc., (J) belting, (K) rubber and asbestos, (L) engineers' stores, sundries. Tenders by Feb. 23. See advertisement.

**Portsmouth.**—The Corporation invite tenders for 12 months' supply of electrical and other stores, laying cables, etc., and for carting coal from steamer to bunkers at the electric lighting station, Portsmouth. Tenders, by Feb. 15, to the Manager, Electric Light Station, Gunwharf-road, Portsmouth, from whom forms of tender can be obtained.

**Batley.**—The Batley Co operative Society, Limited, Commercial-street, Batley, invite tenders for wiring and fittings in connection with the electric light installation at the new central stores. Copies of the specifications can be had on receipt of 10s. at the offices of Mr. Harry B. Buckley, architect, 85, Commercial-street, Batley, up to Feb. 16, and tenders are to be delivered by 4 p.m. on Feb. 20.

**Manchester.**—The Electricity Committee invite tenders for the supply, delivery, and erection of the following at Dickinson-street station and sub-stations: (a) motor-generators, (b) five-wire balancers. Further information will be given by Mr. S. L. Pearce, chief engineer, Electricity Works, Dickinson-street, Manchester. Tenders to the chairman of the Electricity Committee, Town Hall, by 10 a.m. on Feb. 21.

**Stockport.**—The Gas and Electricity Committee invite tenders for the supply, delivery, and erection complete of one 21-kw. tramway rail return booster. Specification, conditions, and form of tender may be obtained from Mr. A. J. H. Carter, borough electrical engineer, Millgate, Stockport. Tenders, addressed to the Chairman of the Gas and Electricity Committee, Town Clerk's Office, Stockport, by noon on Feb. 15.

**Bournemouth.**—The Town Council invite tenders for the following: Contract No. 1 (Section A) steel grooved girder rails, etc.; (B) permanent-way construction and rail bonding; (C) wood blocks and granite sett edging. Further particulars and drawings, etc., may be obtained at the office of the engineer, Mr. F. W. Lacey, M.I.C.E., Municipal Offices, Bournemouth. Tenders to the town clerk, Mr. Geo. Wm. Bailey, by 10 a.m. on Feb. 15.

**Fulham.**—The Borough Council invite tenders for the supply and erection of (A) condensing plant; (B) boilers; (C) economisers; (D) stokers. Specification, drawings, and form of tender may be obtained from the borough electrical and consulting engineer, Mr. Arthur J. Fuller, on payment of a deposit of £1. 1s., which will be returned on receipt of a bona fide tender. Tender to the Town Clerk by 12 noon on Feb. 22. See advertisement in last issue.

**Shanghai.**—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A *pro forma* contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Pook and Co., 63, Leadenhall-street, E.C. Tenders by March 31, 1905.

**South Shields.**—The Electricity Supply Department invite tenders for the supply, delivery, and erection of the following plant: (Contract No. 67) one multitubular marine-type boiler, with chimney and mountings; (68) two medium-speed open-type vertical engines for two 550-kw. direct-current traction generators; (69) two 550-kw. direct-current traction generators; (70) traction switchboard; tramways department—(Contract No. 4) electric tramcars, complete with "Brill" trucks, for the Corporation. Copies of specifications, conditions, form of tender, also form of contract, can now be obtained from Mr. J. H. Cawthra, M.I.E.E., borough electrical engineer, South Shields, on payment of £2. 2s. for each contract, which sum will be returned on receipt of a bona fide tender for each contract. Tenders to Mr. J. Moore Hayton, town clerk, Court-buildings, South Shields, by noon on March 13.

**Johannesburg.**—The Municipal Council are prepared to receive tenders for 100 electric tramcars, two electric water-cars, one five-ton travelling crane, one electric car traverser, and various workshop tools, including erection at Johannesburg, to Specification No. 10 of their consulting engineers, Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W. Copies of the specification may be seen on and after Jan. 7 at the Council Offices, Johannesburg, and at the Consulting Engineers' Offices in London, and may be obtained on payment of five guineas, which will be returned on receipt of a bona fide tender. Duplicate copies of the specification may be bought for 10s. each (not returnable). Tenders must be addressed to Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W., and must be received by them not later than March 6. The Council will not be responsible for any expenses incurred in tendering.

**South Shields.**—The Corporation invite tenders for the execution of the works and the supply of plant in connection with the laying of proposed electric overhead tramways in the streets of the borough: (Part 1) permanent way and construction of track; (2) copper rail bonds, bonding of tramrails; (3) conduits, cables, and overhead equipment. Specification, etc., can be obtained from Mr. J. Moore Hayton, town clerk, on payment of £5. 5s. for each of Parts (1) and (3), and £2. 2s. for Part (2), which sum will be returned on receipt of a bona fide tender for each part. General and detailed plans of the proposed works can be seen as regards Part (1) at the office of Mr. S. E. Burgess, M.I.C.E., borough engineer, Chapter-row, and as regards Parts (2) and (3) at the office of Mr. J. H. Cawthra, M.I.E.E., the borough electrical engineer, West Holborn, South Shields. Tenders to the Town Clerk, Court-buildings, South Shields, by Feb. 20.

## RESULTS OF TENDERS.

**Middleton.**—The Corporation have accepted the tender of Meldrum Bros., Temperley, Manchester, for a dust destructor; the tender of W. B. Haigh and Co., Limited, Oldham, for the superheater; and that of Tetlow Bros., Hollinwood, Oldham, for boiler at the electricity station.

**Battersea.**—The Council have accepted the tender of C. A. Parsons and Co., at £4,680, to supply and fix one 750-kw. turbo-generator set at the central electric generating station; and the offer of Green and Sons, at £494. 17s., to supply and erect at the central electric generating station a special fuel economiser, consisting of 256 tubes.

**Sydney.**—The City Council have accepted the tender of Henley's Telegraph Works Company for the making of house connections and the laying of electric light cables for six months at the following rates: (A) services under footways up to 5ft. trench length, £2. 3s.; from 5ft. to 10ft., £2. 10s.; 10ft. to 20ft., £3. 1s. (B) under roadways, ordinary paving, £3. 9s.; block paving, £5. 17s. 6d.

**Transformers.**—The Islington Borough Council have placed an order for seven 30-kw. single-phase transformers with Messrs. Ferranti Limited. Messrs. Ferranti have also received orders recently for three-phase and single-phase transformers from the Midland Electric Corporation for Power Distribution, Limited (10 boosters); Bloemfontein Corporation, Eccles Corporation, and Messrs. Bruce Peebles and Co., Limited, etc.

# BUSINESS NOTES.

## TRACTION.

**Rochdale.**—The Corporation traffic returns for Jan. 7 totalled £1,718 against £1,755 last year.

**Halifax.**—The Corporation have decided to proceed with the scheme of tramway extensions, but those outside the borough have been deleted.

**Birkenhead.**—A conference between the respective committees of the Corporation is to be held in regard to running cars or motor 'buses to the ferries.

**Perth.**—It is reported that the plans for the reconstruction of the permanent way have had to be varied, owing to the location of water and other pipes.

**Swansea.**—At last week's meeting of the Tramway Committee it was reported that the new track would probably be completed by the end of the month.

**Grimsby.**—The Light Railway Commissioners have sanctioned the scheme for a line to the new Immingham Dock, of which we gave particulars recently.

**Derby.**—The question of proceeding with the route from Market-place to the borough boundary has been referred back to committee for further particulars as to cost.

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**Keighley.**—The Stockbridge extension is practically complete, and may be opened to-day. A proposal to institute ½d. fares has been referred to committee for a report on the subject.

**Glasgow.**—It is reported that the opposition by the Pollokshaws Town Council to the Corporation tramway provisional order for extending their system will be withdrawn, terms having been agreed upon.

**The Monorail System.**—A working model of the Kearney-Thom electric monorail system, which is to be used on the proposed London and Sussex Railway, was exhibited last week at the exhibition held at the Battersea Town Hall.

**Blackburn.**—The Corporation tramway returns for the nine months ending Dec. 31 show considerable improvement, although there is still an adverse balance. This, however, has been reduced to £601 against £2.144 for the corresponding period of the previous year.

**Western Wagon Property Co.**—For the year ending Dec. 31 this company shows a net revenue of £17,546. A further dividend of £6,650, making 10 per annum, is to be paid, leaving £899 to be written off for old stock, and a sum of £670, which has been carried forward.

**Tipton.**—It is reported that the solicitor to the Council having had an abortive interview with Mr. J. A. Lycett, it has been decided to proceed with the action to compel the tramway company to carry out its obligation to electrically equip the line from Dudley to Wednesbury.

**Stockport.**—The Corporation and the Ashton, Oldham, and Hyde Tramway Company have agreed to compare figures in order to arrive at a fresh agreement regarding through running between Hyde and Bredbury, the company contending that the present arrangement is unfair to them.

**Underground Electric Railways Co.**—It is reported from New York that the profit-sharing notes of the Underground Electric Railways of London underwritten by Messrs. Speyer Bros.' syndicate have all been disposed of to the public and various financial institutions, and the syndicate is now dissolved.

**Batley.**—The Corporation have decided to oppose the Dewsbury Tramway Company's application for an extension of license for 12 months to use steam power on the Bradford-road pending reconstruction. The Corporation are prepared to assent to a six months' extension. The Birkenshaw Council are also opposing.

**Hastings.**—A letter in somewhat conciliatory terms, but adhering to the overhead system for the front, from the solicitors to the promoters was read at last week's meeting of the Corporation. The opposition to the company's Bill is, however, to be continued, though Councillor Boutwood reiterated his plea for a compromise.

**Railway Bills.**—The Great Northern, Piccadilly, and Brompton Railway (No. 2), which was opposed by the Marquis of Salisbury and Sir Walter Phillimore, has complied with Standing Orders. The Hammersmith, City, and North-East London Railway Bill has been referred by the examiner to the Standing Orders Committee, certain formalities not having been complied with.

**Manchester.**—The Tramways Committee have adopted a scale of charges for parcels, fixing "inside" and "outside" rates for the city and its environs respectively. They also decided to run motor 'buses to Cheadle, Northenden, and Chorlton-cum-Hardy. At present horsed omnibuses are run to each of these places, meeting the tramcars at convenient points, and these conveyances are much used, especially in summer.

**Bradford.**—On Wednesday evening a car failed to grip the rails on the Barkerend-road incline, owing to the greasy state of the line, and started to go backwards, although the driver checked the pace by the application of the brakes. Finally it was stopped through colliding with a car bound for the same point. Though the impact was considerable, no injuries were sustained by the passengers beyond a shock, except in the case of two ladies who jumped off.

**Great Northern, Piccadilly, and Brompton Railway Co.**—The capital expenditure during the half-year amounted to £644,896. The estimate for the current half-year is £750,000. The progress of the works during the past half year has been satisfactory. The rent due from the Underground Electric Railways Company of London, Limited, under the terms of the agreement for lease dated Jan. 13, 1903, up to Dec. 31, 1004, permits of a dividend at the rate of 4 per cent. per annum.

**North-Eastern Railway.**—The half yearly report states that during the period under review the company have carried on the Newcastle and Tynemouth suburban lines which are now worked by electricity, 675,000 more passengers between stations on these branches than in the corresponding half of 1903. The directors consider that the results of substituting electricity for steam in working the passenger traffic on these lines have, so far, been satisfactory as regards receipts and expenses.

**Maidstone.**—An enquiry has been held into the application of the Town Council for leave to borrow £60,000 for extending the light railway service. Two new routes are proposed, one from the top of High-street, down Gabriel's-hill, as far as the King's Arms, Loose, and the other from the top of High-street, along Week-street, to Perenden Heath, with a branch along Bexley-road to Holland-road. The Commissioners subsequently inspected the routes, and intimated that a decision would be arrived at shortly.

**Port Elizabeth.**—It is reported that considerable extensions of the tramway network of the Cape Electric Tramways, Limited, are under the consideration of the directors, in addition to which the same company have a Bill before the Cape Parliament for an extension of their Cape Town network into the suburban districts of Woodstock and Maitland. Both schemes will involve large purchases of permanent-way material, while the Cape Town extension will also include the acquisition of rolling-stock and, possibly, sub-station equipment.

**Lancashire and Yorkshire Railway Co.**—At the half-yearly meeting of this company the Chairman, speaking with regard to the Liverpool and Southport line, said that the company could not at present tell the precise cost of working in comparison with steam traction, but reliable accounts were being kept, which would enable this to be done in due course. The increase in the traffic had far exceeded their most sanguine expectations. In the month of December alone, when the dense fogs occurred, they had an increase of 104,000 passengers on that section.

**Highgate-Barnet.**—The electric tramway from Highgate Archway to Barnet, passing through Finchley and Whetstone, is now nearing completion. The rails have been laid for some little time, and the standards to support the wires which will convey the electric current have now been erected. It is hoped that an efficient service of cars may be ready within a few weeks. The short connecting link between the existing horse tramways from the City and Euston to the Archway Tavern and the commencement of the new electric line at the Highgate Archway is not yet sanctioned.

**London County Council.**—The City Corporation have decided to oppose the Council's Embankment scheme, to which we refer in another column. The receipts for the week ending Jan. 28 amounted to £12.048. as against £8,848 last year, and from April 1 the total was £550,061, against £427,754. An enquiry was held last week by the Light Railway Commissioners into the proposal of the County Council to expend an estimated sum of about £250,000 on an extension of the county of Middlesex light railways and tramways in the urban district of Enfield. At the close of the enquiry the Commissioners stated that they would report favourably to the Board of Trade.

**Exeter.**—The Tramways Committee considered on Monday a report on the question of Sunday traffic from the chief officer, who calculated that Sunday traffic would represent at least £780. The committee decided to recommend that the cars be run on the Council's system on Sunday afternoons and evenings from 1.30 to 10. As a result of a conference between the Electric Lighting and Tramway Committees, it is recommended that the price to be charged for electric current to the tramways undertaking be 1¼d. per unit for the first 100,000 units, and 1½d. per unit for any amount taken after the first 100,000; also, that the electrical engineer have charge of the overhead work and the electrical apparatus on the tramway system and in the depôt.

**West Cumberland.**—At a meeting of representatives of the Whitehaven Town Council, Workington Town Council, Maryport Urban Council, and Cleator Moor District Council a letter was considered from the solicitors for the West Cumberland Tramways Company. The letter stated that the engineers of the company (Sir Douglas Fox and Partners) have completed detailed specifications and bills of quantities, and tenders have been received from the Brush Electrical Engineering Company, Limited, and other contractors for carrying out the work. A prospectus inviting public subscriptions will very shortly be issued. After full discussion it was decided to inform the promoters that assent could not be given unless the extension of two years for the commencement of work specified in Clause 3 of the Bill were altered to one year.

**Mansfield and Newark Tramways.**—The delay which has taken place in the commencement of the work of laying down the tramways for which a private company obtained an order in 1901 was the subject of some important and rather strong remarks on Monday at the Notts County Council meeting. At Newark it is proposed to connect the town with the outlying villages of Farndon and Balderton, while the Mansfield scheme is for an extension of the lines and railway sanctioned by the order of 1901. The County Council instructed counsel to represent them at the enquiries to be held by the Light Railway Commissioners, the first of which was held at Newark on Wednesday. The Newark Urban District Council also decided to engage counsel, and to apply for the insertion of clauses relating to widening of streets, term of years for completion, motor power to be used, and terms of purchase.

**Birmingham.**—The Executive Committee of the City Association have prepared a further report upon the tramway scheme of the Birmingham City Council relative to the mode of traction to be adopted. During the last month a demonstration was given in the city at the request of the City Association of the Dolter surface-contact system, and representatives of the association have also inspected the working models of the Waggott surface-contact system. The committee is now completing arrangements with the Lorain Steel Company to take a special party over to Wolverhampton to inspect the whole of the Lorain system of tramways. Shortly afterwards it is hoped to make arrangements for parties to inspect models of the Kingsland surface-contact system and the Waggott surface-contact system. At Tuesday's meeting of the Corporation the agreement with the City of Birmingham Tramways Company in reference to the Balsall Heath route, of which we gave particulars last week, was unanimously confirmed.

**Nottingham.**—The Corporation have considered the Tramway Committee's report as to the Midland Railway Bill, which contains a clause providing for the use by the company of a street service in any district affected by their system. In their report the committee said that the effect of this clause would be to enable the Midland Railway Company to compete with the tramway undertaking of this city. The committee had no desire to oppose a fair system of omnibuses, etc., used only in connection with an extension of the present system of the company, but it appeared to them that the clause went beyond this. The committee were in negotiation with the Midland Railway Company on the matter, and it was hoped that the clause would be modified without going to the expense of opposing the Bill in Parliament. In the meantime, however, it would be necessary to petition against the Bill, and the committee recommended that the Council should direct this to be done. The report was adopted.

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**Sunderland.**—At a meeting of the Tramways Committee, Mr. A. R. Dayson, manager, reported as to the proceedings of the Executive Committee of the Municipal Tramways Association relative to the Bill which railway companies are promoting in Parliament to have power given them to run omnibuses and conveyances in any area to which their lines run. The committee considered that if this Bill became law, it would place too much power in the railway companies' hands, and they therefore decided to call together a full meeting of the association to discuss the matter. The desirability for a loop in West Wear-street was again considered, and it was decided that the matter should stand over for the present. The returns for January, together with the figures for the corresponding period of 1904, are as follows: passengers, 1,170,675 against 1,113,533, being an increase of 37,142; mileage, 123,183 against 118,442, being an increase of 4,741; and receipts, £4,864 against £4,711—an increase of £153. The receipts per car mile amounted to 9½d. in both cases.

**Leith.**—A start was made on Monday with the reconstruction of the tramways. The first section to be electrified is the new line along Pilrig-street and Newhaven-road to Bonnington, and the continuation of that line along the old horse-car line to Newhaven. The whole work of reconstruction will be carried out with the minimum of inconvenience to the public. A gang of men will commence operations at Pilrig and another at Newhaven. The two gangs will meet about Bonnington, and thus complete the line of rails between the two starting points. The section from the foot of Leith Walk to Pilrig does not require relaying, as the rails there are already bonded for electricity, and it is likely that as soon as the car depôt is ready electric cars will be put on this route from the foot of Leith Walk to Newhaven by way of Pilrig, there being at present sufficient plant at the electric station to provide power during the summer load for the propulsion of a number of cars. It is expected that the extension of the electric station and the additions to the plant will be completed before the next winter load is required.

**North Lincolnshire.**—Two light railway schemes, which would open up a portion of the Isle of Axholme and an important section of North Lincolnshire, were the subject of an enquiry by the Light Railway Commissioners on Tuesday. The first scheme is an extension of the Axholme Light Railway, which was opened to develop the peat moss industry, which is already a great factor in the industrial life of Hatfield, Thorne, and Crowle. The necessity of extending the line to Hatfield has forced itself on the attention of the North-Eastern and Lancashire and Yorkshire Railway Companies, by whom it is worked. The other scheme is known as the Blyton and Frodingham Light Railway, and is to be run from Blyton to within two miles of Frodingham Station, where it will join the Great Central Railway, and be worked by them, the cost of this undertaking being £84,661. The Commissioners thought an order might be granted in the first case. Regarding the Frodingham scheme, the chairman said that the Commissioners were prepared to recommend the Board of Trade to grant an order. They had made a note of the various matters brought before them, some of which might require some settlement. As to a bridge at Blyton, the Commissioners thought a level crossing would be sufficient to meet the case at present. As to cattle guards, the Commissioners would specify such roads as they thought required gates, and others that should have cattle guards.

**Metropolitan District Railway.**—The report contains the following passage: "The work of electrification is nearing completion. The directors are assured by their engineers that within two months the whole of the works necessary to operate the railway electrically will be finished. The various electric railway services will then be commenced as rapidly as the car contractors deliver the cars. The important widening of the company's railway between West Kensington and Hammersmith is nearly finished. A new station is being built, and will shortly be opened, at Barons Court. By arrangement with the Metropolitan Company, the High-street, Kensington, Station, is being rebuilt and enlarged. The company's car-shed and depôt at Ealing Common is finished. Extensive sidings are being laid down at Mill Hill Park, at Gloucester-road, and at Parson's Green. The Harrow and Uxbridge Railway has been opened for traffic. The directors have not thought it wise at present to exercise the running powers to which the company is entitled. The directors have given notice, on behalf of the company, of a Bill enabling the company to apply to the general purposes of the company a portion of the capital authorised by the company's Act of 1897 which is not required for the construction of the deep-level railway. Several important schemes will be submitted to Parliament adversely affecting the company. In view of the early adoption of electric traction, and the entire abolition of steam traffic upon the railway, and the changes which will be involved, the directors have made several important alterations in the company's staff."

**Newcastle.**—At the meeting of the Tramways Committee the acting general manager (Mr. T. P. Easton) presented a report relative to the estimates of working for the year ending March 31, 1906. The estimates do not include the amount necessary for the maintenance of the track or the amount necessary for the payment of interest and redemption. Mr. Easton bases his calculations upon the present cost of working—*i.e.*, 6¾d. per car mile—which he acknowledges to be a high rate as compared with other large towns, notwithstanding the economies which have been effected. The average traffic receipts for 45 weeks of the present year equal £3,660 per week, and Mr. Easton estimates the receipts for the ensuing year at £194,737, including amounts payable by the Lighting Committee. The expenses are estimated at £115,265, leaving a balance available of £79,472. The sum of £10,131, representing the estimated expenditure prepared by the city engineer (Mr. Edge) in his report for repairs and renewals to the tramway track, must, however, be added to the estimated expenses referred to above—namely, £115,265—thus making a total of £125,396. This will reduce the balance to £69,341, out of which must be paid the sum of £67,142, being the city treasurer's estimate for the amount necessary for the payment of interest and redemption. This will further reduce the balance to £2,199. The total amount estimated for maintenance work, including the city engineer's estimate for track repairs, amounts to £32,958. A long conversation ensued regarding the estimates, and ultimately it was decided to adopt them, along with the suggestion of the city engineer and the estimate prepared by the city treasurer. The subject will in due course be brought before a meeting of the City Council.

## LIGHTING AND GENERAL.

**London County Council.**—On Tuesday the Hampstead Borough Council received sanction to the borrowing of £4,335 for electric lighting purposes.

**Longton.**—The output of electricity at the Town Council's works during the month was 13,220 units, being an increase as compared with last year of 7 per cent.

**New Issue.**—The Electric Conversion Syndicate, Limited, are issuing 85,000 of the preference shares of the Durham Collieries Electric Power Company.

**South Metropolitan Electric Light and Power Co.**—The preference share register of this company will be closed as from the 15th to the 28th inst. inclusive.

**London Gazette.**—A first and final dividend of 3s. 6d. in the £ has been declared in the estate of Benjamin George Hedges, electrical engineer, 20, St. Luke's-street, Derby.

**St. Andrews.**—Four arc lamps are to be erected in a central position as an experiment in street-lighting. Mr. H. Richardson, electrical engineer, Dundee, is to be consulted in the matter.

**Loughborough.**—The engineer has been asked to make enquiries for manufacturers as to the cost, etc., in connection with his suggestion to letting motors and arc lamps on hire to consumers.

**Huntingdon.**—The Town Council have an application for the provisional order for electric light in the borough, and have asked Mr. Waudle Stephens, of Stamford, to enquire into the matter and report thereon.

**Electrical Exhibition.**—Particulars of the County of London Electric Supply Company's electrical exhibition to be held at 118 to 122, Holborn, E.C., from March 20 to April 5 appear in another column.

**Telegraph Construction and Maintenance Co.**—The directors propose to pay a dividend of 10 per cent. (£1. 4s. per share) in addition to the 5 per cent. already paid, making 15 per cent. for the year 1904.

**Award.**—We learn that Messrs. Brown Bros., Limited, 22-30, Great Eastern-street, E.C., have obtained for their Brown motorcar a silver medal for elegancy over 85 competitors at the Turin Motor Exhibition.

**St. James's and Pall Mall Electric Light Co.**—The share transfer books of the company will be closed from Feb. 8 to 22, both days inclusive, preparatory to the payment of dividends for the half-year ended Dec. 31 last.

**Chelsea Electric Supply Co.**—The directors have decided to recommend, subject to audit, a dividend on the ordinary shares at the rate of 7½ per cent. per annum for the half-year to Dec. 31, 1904, making 6 per cent. for the year, carrying forward about £1,170.

**Wakefield.**—The City Council propose to apply for sanction to borrow a further sum of £18 000 for the purposes of extensions in connection with the electrical undertaking. The appointment of a city electrical engineer in succession to Mr. Shaw has not yet been made.

**Birkenhead.**—The steady increase in the use of electricity in Birkenhead is maintained. The Electricity Committee in their last report show that during the past quarter 272 555 units were consumed by 717 customers, being an increase of 30 335 units and 149 consumers.

**Smithfield Markets Electric Supply Co.**—The directors propose to place £1,500 to the general reserve fund, raising it to £5,740; to add £1,000 to the depreciation fund; and to pay a dividend at the rate of 4 per cent. for the year; carrying forward a sum of £1,659.

**Swansea Telephones.**—There are now 980 subscribers' lines in operation, and 173 orders in hand. Preparations are being made with reference to the proposed action to compel the National Company to grant inter-communication. Once the legal matters had been settled the case would be put down for trial.

**Horsham.**—The Urban District Council have decided to apply for sanction to borrow £4 500 for electric lighting purposes. This amount includes £500 for free wiring purposes and £1,000 for the cost of various extensions which have been already carried out, but which were not included in the previous scheme.

**Kensington and Knightsbridge Electric Lighting Co.**—The directors recommend a dividend on the ordinary shares at the rate of 10 per cent. per annum for the half-year ending Dec. 31, 1904, and a bonus of 2 per cent. for the year, making with the interim dividend paid on Aug. 1 12 per cent. for the year 1904.

**Bishop's Stortford.**—Copies of the objections made by the Bishop's Stortford and District Gas Company to the Council's application for an electric lighting order were laid before the Urban District Council at the last meeting, and it was decided to leave the matter to be settled by their parliamentary agent.

**Electrical Trades Union.**—At a meeting of the Electrical Trades Union, at Aston, on Feb. 2 a resolution was passed recording the meeting's emphatic disapproval and condemnation of the employment of cheap labour upon the electrification of the London railways, considering it a possible source of very grave danger to the travelling public.

**London Branch.**—Messrs. John M. Henderson and Co., of King-street Engineering Works, Aberdeen, have established an office at

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26, Victoria-street, S.W., where, we are informed, an engineer or representative will be available at all times for the transaction of urgent and other business in London and district. The registered address for London telegrams is "Cableways"; telephone No. 431 Victoria.

**National Telephone Co.**—After paying the dividend on the preferred ordinary stock, a distribution at the rate of 5 per cent. per annum for the half-year ended Dec. 31 is declared on the deferred ordinary stock. The sum of £115,000 is placed to reserve and about £10,000 is carried forward. A year ago the dividend was at the same rate, £110,000 was placed to reserve, and £10,500 carried forward.

**Electric Lamp Tests.**—In connection with the independent tests just concluded by the Westminster Electric Testing Laboratory, of York-street, Westminster, we are asked to mention that the A.E.G. make (Electrical Company, Limited), which is a foreign one, comes out almost as well as the best English make, and infinitely better than the average make of the various manufacturers. The company also think that the difference in price should be taken into account when ordering such goods.

**Gravesend.**—At the adjourned meeting of the Gravesend and Northfleet Tradesmen's Association last week the proposition of Mr. Harrington of the previous week—viz., "That in the opinion of this meeting the proposal of the Gravesend Town Council to apply to the Board of Trade for powers to supply Northfleet without the consent of its District Council is inadvisable, and, while certain to involve the borough in heavy law costs, is without a reasonable possibility of success"—was carried.

**Willesden Polytechnic Electrical Engineering Society.**—On Saturday last the third annual dinner of the society was held at the Horseshoe Hotel, under the chairmanship of Mr. Frederic H. Taylor, A.M.I.E.E. At the conclusion of the dinner programme the annual report of the secretary, Mr. H. Drury, was read, and this showed the most successful year the society had known. Many new members have recently been elected, and a lending library for technical works is now being organised by the committee.

**Dance.**—Messrs. Anderson and Munro, electrical engineers, Glasgow and Edinburgh, held their annual gathering and dance in the Masonic-chambers, Glasgow, on Friday last. There was a large company of employés and friends present, and many of the country foremen sent their good wishes for a happy evening. We are glad, in face of the many grumblers who made themselves heard recently, to note that it was remarked that not during the whole 65 years of the firm's existence had there been one so satisfactory in every respect as 1904.

**Derby.**—The Electric Lighting Committee in their report mention the following extras on the undermentioned contracts, and also the amount of architect's commission—viz.: new battery-house contract (Messrs. Radford and Greaves), £24. 15s. 10d.; switchboard platform contract (Mr. H. Vernon), £9. 4s.; turbine bed contract (Mr. E. Morley), £87. 14s. 3d.; architect's commission (Mr. A. Eaton), £163. 6s.—total, £285. 0s. 1d. The above amount of £285. 0s. 1d. is included in the sum of £33,400 granted by the Council in May, 1903.

**Stoke Newington.**—A special meeting of the Council will be held to-night, in pursuance of a requisition, for the following purpose—viz: to consider the desirability of opposing in Parliament the London Building Acts Amendment Bill and the Bills of the Administrative County of London and District Electric Power Company and the Charing Cross and Strand Electricity Supply Corporation (Power Supply), and if thought desirable, to seal petitions in opposition thereto, and to give such directions in connection therewith as the Council may think fit.

**Municipal Telephones.**—The official figures of the National Telephone Company, just issued, show the progress of municipal telephones in 1904. The relative increase in the number of stations or working instruments for the year ended Dec. 31 is as follows: Glasgow—Corporation increase 1,504, National 5,209; Portsmouth—Corporation 553, National increase 981; Swansea—National increase 702; Corporation 488. The grand totals at Glasgow are: National, 17,227; Corporation, 12,136. The totals at Swansea are: National, 2,548; municipal, 1,067.

**Bo'ness.**—The installation of electricity for the lighting of Bo'ness was inaugurated on Feb. 6. The works, which are estimated to cost about £25,000, have been constructed by the National Electric Construction Company, which have already fitted installations in Oban, Musselburgh, and other towns. The power station is situated in the centre of the burgh, near the docks, and cables have been laid throughout the burgh. The light has been running for some months by means of a temporary engine for the lighting of the new library, town hall, and infectious diseases hospital.

**St. Annes.**—Mr. J. H. Clothier, electrical engineer, in his last report, gives the following figures: units sold during December, 51,919; units sold to Dec. 31, 459,820; equivalent to 8-c.p. lamps connected, 16,300; units sold per 8-c.p. lamp connected, 9·5; maximum load, lighting, 173·7 kw.; ditto, traction, 100 kw.; total number of consumers, 305. They had also received three applications for an addition of 100 8-c.p. lamps. Mr. Clothier says that the small total increase for the month is due to a decreased demand by the tramway company, and that the private lighting shows the substantial increase of about 30 per cent.

**Stepney.**—The Borough Council have agreed to order an additional steam-turbine generator from Messrs. Parsons and Co., Newcastle-on-Tyne, at £5,900, being about £877 less than the amount of their previous tender. This reduction is largely due to the fact that a spare armature was supplied with the turbine already delivered. The cost of providing the plant has been included in the estimate of £78,280 approved by the Council on Jan. 6, 1904, in respect of the extension of the system. The Council have also decided to borrow £3,700 for providing further storage tanks, water-softening plant, artesian well, pipes, and pumps at the electric lighting station.

**X-Rays.**—Mr. and Mrs. W. K. Vanderbilt have, it is said, after a successful cure of rheumatism by X-rays, founded and endowed a hospital in the Rue Leonard de Vinci, Paris, at a cost of £40,000. The building, which will be a model institution for treatment by the latest scientific methods and appliances, is practically complete. On the ground floor are the laboratories for the preparation of serum of various kinds and for other services. On the first floor are eight rooms, with 10 beds each. The hospital will be supported entirely by the founders, and the patients will be treated absolutely free of cost. The institution has been placed under the direction of Dr. Georges Gautier.

**Sydney (N.S.W.).**—Mr. Sidney Smith, the Postmaster-General of the Australian Commonwealth, is about to promote the extensive use of telegraph wires for telephone purposes. A test has recently been made in this direction on the line between Geelong and Barwen Heads, thus connecting the latter direct with Melbourne. The first official estimate of the cost of this connection was £400. It was then reduced to £252. Both estimates were conditional upon a payment of £168 by the residents. The distance between the two points is 15 miles. By the utilisation of the telegraph wires the whole work has now been completed at a cost of £5, while the residents will not be asked to contribute one penny.

**Edinburgh.**—The Town Council have adopted a suggestion by Mr. Stevenson, convener of the Electric Lighting Committee, to authorise the committee to undertake the testing of incandescent lamps for use in the city at a charge of 6d. per dozen. He explained that a large number of uneconomical lamps was being used in the city, and thus injustice was being done to the consumers. It was therefore proposed to set up a testing plant where wiring contractors could have their lamps tested and stamped, so that consumers might be satisfied that they were getting lamps sufficient to consume the current for which they were paying. The stamping would be optional. The committee has been empowered to proceed with the painting of the power stations at Dewar-place and M'Donald-road at an estimated cost of £700.

**Stock Exchange.**—The Stock Exchange Committee have appointed Feb. 15 special settling day for Bath Electric Tramways Company's £135,000 4½ per cent. first mortgage debenture stock. The committee have also ordered the undermentioned securities to be quoted in the official list: Bath Electric Tramways Company's £135,000 4½ per cent. first mortgage debenture stock; Birmingham and Midland Tramways, Limited, £200,000 4½ per cent. first debenture stock, redeemable. The committee have been asked to appoint a special settling day in Marconi's Wireless Telegraph Company's further issue of 30,016 shares of £1 each, fully paid, Nos. 196,112 to 196,127 and 221,128 to 251,127; and to allow to be quoted in the official list City of Buenos Ayres Tramways Company's (1904) 248,000 shares of £5 each, fully paid, Nos. 1 to 248,000; and £174,000 4 per cent. debenture stock, in lieu of the shares and debenture stock of the City of Buenos Ayres Tramways Company now quoted.

**Battersea.**—The Council have been in communication with the London and South-Western Railway Company for some time past with reference to the supply of electrical energy for the purpose of their electric installation, particularly for the lighting and supply of power at the Nine Elms goods yard. The company have now stated their willingness to take a supply of electrical energy in the first instance for any purpose on their railway from points in Plough-road, Clapham Junction, Nine Elms, and New-road, and guarantee a consumption for five years of 200,000 units per annum, as per terms agreed upon. The company may at a later date require a much larger quantity to be supplied. The electrical engineer is to prepare a scheme for the lighting by electricity of Nine Elms ward, including provision for the supply of electrical energy to the Nine Elms goods yard of the London and South-Western Railway. In the meantime, however, to cope with the present demand of the company and as a matter of urgency, six double tariff meters are to be procured of the General Electrical Company at a cost of £78.

**Marconi's Wireless Telegraph Co.**—The directors in their annual report, to be presented at the annual ordinary general meeting of the company on Feb. 16, gives some interesting details of the work carried on at their various stations. They consider that as a result of Mr. Marconi's experiments the company is now in possession of all the data necessary for the equipment of stations for good commercial working between England and the continent of America, and a new station embodying the latest improvements equipped on a commercial scale is already nearly completed in Canada. The question of a site for a new station in Great Britain, for which the greater part of the machinery has already been ordered, is still under consideration. Reckoning the total number of words transmitted per year at the rate of only 15 words a minute, for 10 hours a day for 300 days, it is estimated that two wireless stations should earn, after deducting land charges, about £56,000 per annum. The stations already equipped at Poldhu, Cornwall, and Cape Cod, Massachusetts, are being regularly employed for transmission of messages to ships fitted with long-distance receiving apparatus at any point on the Atlantic, and by the results of the working of these stations during the last seven months, the directors are confirmed in their belief that the new stations will afford a satisfactory service between England and the continent of America. Reference is made to the company's agreement with the Post Office, War Office, and Admiralty, and details are given of the company's stations which have been equipped in Canada, Newfoundland, Italy, Holland, and Chili, showing that the company are making satisfactory progress in all parts of the world. The accounts for the year ended Sept. 30, 1904, show an increased profit on the year's working, the net profit for the year ending Sept. 30, 1904, being £12,681. 5s. 3d., as against £10,607. 7s. 8d. for the year ending Sept. 30, 1903. Full particulars of the report and accounts are given in another column.

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**Electrical Exhibition.**—A two weeks' electrical exhibition will be held next month in the new department of Messrs. R. Stephens and Sons' foundry, top of Tucking-mill-hill, by Edmundson's Electric Company, the owners of the Camborne-Redruth electric works. We understand that the company have two travelling exhibitions, one in the North and the other now travelling in Cornwall. The proceeds of this exhibition will be handed to the Miners' Hospital, and Messrs. Stephens and Son have offered to give half of the sum they will receive by way of rent to the Miners' Hospital as well. Concerts and other attractions are being arranged.

**Feed-Water Purifiers.**—The Paterson Engineering Company, Limited, Amberley House, Norfolk-street, W.C., report the following orders recently executed and received by them for Paterson feed-water purifiers for power plants: Babcock and Wilcox, Limited, for H.M. Dockyards, Pembroke, and Gosport and Fareham tramways; Belliss and Morcom, Limited, for their Ledsam-street works; Danks and Co., for H.M. Dockyards, Chatham; Electric Construction Company (two) for H.M. Dockyards, Gibraltar; Mirrlees-Watson Company, for Partick Electricity Works; Crompton and Co., for Ultadunga Station, Calcutta; Earl of Rosslyn's Collieries Company, Limited; Sharp and Sons, Baltic Sawmills, Dartford; Busbridge and Co, paper makers, Kent; and other private firms.

**Dublin.**—The Council have adopted a report of the committee of the whole house upon the reports, etc., in connection with the electric lighting scheme, recommending the Council to retain control over the electric lighting undertaking and the working thereof; also that the committee undertake no further or additional construction works until the consulting engineer has reported that the works covered by his agreement with the Corporation of Sept. 22, 1899, have been finally completed, provided that the Lighting Committee be at liberty to carry out all necessary services' work in connection with the giving of supplies to new consumers, and the extending of the existing distributing mains where necessary within the present area of supply, and where there is statutory obligation to give such supply.

**Football.**—On Feb. 1 a return match was played on the ground of the Reading Football Club, at Elm Park, between the Reading Corporation Tramways and the London United Tramways. There was a good attendance of the public, together with many members of the Corporation, and a well-contested game ended in a win for the Reading men by six goals to nil. Unfortunately, the goalkeeper of the Londoners met with an accident, fracturing his kneecap and necessitating his being taken to the hospital and a substitute put in his place. In the evening both teams were entertained by Mr. Councillor Bull, chairman of the Tramways Committee, and a very successful smoking concert concluded the evening. The above is the fourth match played with the London United Tramways Company, each club previously winning games on their own ground by three goals to two.

**Stretford.**—The additional plant recently installed at the Council station will give the necessary current for electric lighting extensions and for the proposed tramway to Chorlton-cum-Hardy. A large number of houses in the district have already been wired, and a provisional arrangement has been entered into between the Trafford Park Electric Power Company and the District Council of Stretford, by which the electric lighting in the residential portion of Trafford Park is now undertaken by the local authority. Provision has also been made to supply the southern tramway extension to Urmston whenever it comes into operation. The total cost of the additional plant is £6,500, and the Council's installation down to date has cost £42,000. The Electricity Committee have finally recommended the Council to reduce the charge for electric light to private consumers from 6d. to 4½d. per unit.

**Glossop.**—The Guardians have been considering what it would cost to fit up the workhouse buildings with electric light. It appears that for the workhouse proper there would be required 49 8-c.p. lamps, 29 16-c.p. lamps, and 83 switches. For this portion of the work the cost would be £75. 6s. For the tramp ward five lights would be required, and the cost would be £5. 2s. For the infirmary they wanted 32 8-c.p. and 27 16-c.p. lamps, two pulley fittings, 59 switches, etc., the cost of which would be £50. Owing to the distance of the buildings from the nearest underground cable, the Urban Electric Supply Company, Limited, ask the Board to pay a rental of 22s. per quarter for the portion of the underground cable required. The total amount of the estimate for the work is £130. 12s. The question of the desirability of installing the electric light or otherwise has been left in the hands of a committee, consisting of Messrs. Furniss, Rowbottom, Hyde, T. Waterhouse, S. Gregory, J. Malkin, E. Waterhouse, and the chairman.

**Lancaster.**—The Lancaster electricity works were inspected by the members of the Corporation on Friday afternoon in response to an invitation given by the Mayor in his capacity as chairman of the Electricity Committee. Mr. Tester, the electrical engineer, and his assistants conducted the party over the works. Representatives of the British Westinghouse Company, the chief contractors, were also present. The station contains four engines and dynamos, two of 300 kw. and two of 200 kw., each engine capable of running at 300 revolutions per minute. There is a condenser with a 25in. vacuum fed from cold-water tanks outside the station for each engine. A travelling crane capable of lifting 15 tons has been erected for use in case of repairs to the machinery, and as the flywheel of one machine weighs from four to five tons, it is conceivable that some such provision is an absolute necessity. In the evening the members of the Astronomical and Scientific Society, the science classes at the Storey Institute, and a large number of townspeople visited the works.

**Liverpool.**—The accounts of the Corporation electric supply department for the year ending Dec. 31, 1904, show, *inter alia*, the following particulars of expenditure: generation of electricity—coal, including cost of unloading, etc., £36,012; oil, waste, water, and engine-room stores, £5,198; wages at generating stations, £15,082; engines, boilers, dynamos, transformers, etc., £8,896—total, £65,192; distribution of electricity—wages, £1,746; repairs and maintenance of mains, £1,720; repairs and maintenance of meters, £516; repairs of machinery at distributing stations, £769—total, £4,752; rents, £1,990; rates and taxes on buildings, plant, etc., £14,441; management expenses, £11,455, including salaries of engineer's department and clerical staff, £8,275; special charges, £1,967; amount written off for bad debts, £113. The income was as follows: sales of electrical energy for lighting and power, £135,631; sales of electrical energy for public street-lighting, £2,571; sales of electrical energy for electric tramways, £91,674; rental of meters, £2,326; Allerton installation rentals, £29; rents of property, £650; manufacturing account, £3,718.

**Elland.**—The combined refuse destructor and electricity works of the District Council were opened in October, 1903, with 27 consumers, representing an equivalent of 2,191 8-c.p. lamps. By January, 1904, the consumers had increased to 59, representing 2,853 8-c.p. lamps, with 7 h.p. in motors, the units sold during the latter month amounting to 3,641. On Dec. 31, 1904, the consumers had risen to 97, and the units sold during the month to 9,255, there being connected the equivalent of 53·50 8-c.p. lamps and 72 h.p. in motors. The total units sold for the 12 months ended Dec. 31, 1904, was 46,054. In November, 1904, the destructor was shut down owing to there not being sufficient refuse; but in the months from January to November 2,621 loads of refuse were destroyed, together with 679½ loads of sludge from the sewage works. The works' costs show that the only fuel used, except, of course, the refuse and sludge named, up to the time of the destructor being shut down in November, was the small quantity required on the stand-by boiler while the destructor was cleaned out at regular intervals during the 11 months, and the cost of this fuel has only amounted to ·07d. ($\frac{7}{100}$d.) per unit sold. During December the current has been generated from fuel alone by means of the Babcock boiler, but the cost of such fuel has amounted to less than ½d. per unit sold, or ·43d. The oil, waste, and other stores for the 12 months have cost ·06d. per unit sold, while there has been no money expended on repairs. The wages of management and electrical staff have amounted to nearly 1½d., or 1·41d., per unit sold. The cost in men's wages destroying sludge and refuse has been 9½d. per ton. The revenue, at 2d. per unit for power purposes and 4d. per unit for lighting purposes, the price now in force, will amount to about £750, and the expenses of the department only amount to about £290 for the 12 months.

**South Africa.**—We are indebted to the *British South African Export Gazette* for the following particulars of electrical undertakings in South Africa. The Corporation of Pretoria have now completed the purchase of the electric lighting company's property, the shareholders having consented to accept the sum of £115,000 in 5 per cent. bonds, which works out at £1. 2s. for each £1 share. As already announced, considerable extensions are contemplated, for which the necessary funds are to be raised by loan. In the meantime a reduction in the cost of current is announced, lighting being now charged at 1s. per unit and power 5d. and 6d. according to circumstances. No rent is likewise charged for a single meter. The Potchefstroom Consumers' Electric Light and Power Company, Limited, have recently accepted the offer of the Town Council to purchase their undertaking for £6,000, which places the Council in a position to realise their scheme of an installation abreast with the requirements of this progressive town. The company's plant is small and its capacity limited, and it is intended to retain it only as a stand-by, and to erect an entirely new equipment on a scale answering to the town's actual needs An expenditure of £10,000 has been mentioned, but the plans have to be drafted, and when a complete survey is made, and a reckoning taken of future contingencies, it is probable that the outlay of a much larger sum will be decided upon. After having considered a number of offers from various bodies and firms, including that of Messrs. Harris, Lee, and Co., of Johannesburg, the Streets and Public Works Committee of the Mafeking Town Council have recommended that of Mr. J. Addison, of Kimberley, for acceptance, subject to a proper agreement being drawn up. The terms are roughly as follows: Mr. Addison to have the sole right to lay down plant for the supply of electricity and erect lines and appliances, and to supply and erect works and material for a period of seven years, at the end of which the Council to have the right to purchase the undertaking at a valuation plus 15 per cent. If not purchased, an extension is to be granted for a further period of 10 years, at the end of which the Council are to have the same right of purchase plus 5 per cent. It is provided that should the works not be commenced for six months, or the supply within 18 months, the concession is to be considered as lapsed. The Council is to furnish the site for the erection of the power station at a reasonable rent, and also defray the cost of the current for the public lamps, the concessionee bearing the charges of erection and maintenance of the lines, poles, and lamps. The Council will erect the fittings in the town hall, the concessionee supplying the current at the reduced rates for the public lighting. The system is to be a two-wire continuous 200-volt, and the generation by steam or oil, the lines being overhead and bare conductors used. The charges for current are: for lighting, 1s. 6d. per Board of Trade unit, with a meter rental of from 2s. to 7s. per month; for power, heating, cooking, ventilating mills, etc., 25 per cent. less. The minimum charge for current to each consumer is 5s. per month. Orders for the necessary material may be expected to be given out forthwith. The concessionaires of the Boksburg lighting scheme are Messrs. E. H. Gellender and Co., electrical engineers, Germiston, who have, we learn, already placed most of the orders for the plant. These include boilers by Messrs. Davey, Paxman, and Co., Limited, and Messrs. Marshall, Sons, and Co., Limited, and two compound engines by Messrs. Belliss and Morcom, Limited. The General Electric Company supply the two 100-kw. capacity dynamos. The system adopted is the three-wire, direct current, 800 volts pressure across the outers, the voltage to con-

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sumers being 250. Street-lighting will be by 12 arc lamps and 30 incandescent lamps. The cost to the consumer is fixed at 1s. per unit. It is expected that the plant will be in operation by April next.

## PROVISIONAL PATENTS, 1905.

JAN. 30.

**1762. Means for electrically turning on and lighting up gas lamps, particularly those whose burners are beyond reach of hand.** William Pare, 11, Burlington-chambers, New-street, Birmingham.

**1792. Improvements in electric arc lamps.** Joseph Devonport Finney Andrews, 2, Park-avenue, East Sheen, London.

**1820. Improvements in or relating to electro-dynamic traction systems.** Julien Dulait, Constantin Zelenay, and Léon Rosenfeld, 111, Hatton-garden, London. (Complete specification.)

**1837. Improvements in the electrolytic production of metallic sheets, tubes, wire, strip, or the like.** Sherard Osborn Cowper-Coles, 4. South-street, Finsbury, London.

JAN. 31.

**1863. A new or improved method and arrangement for enclosing cables, electric wires, or the like.** Heinrich Rosner, 5, Corporation-street, Birmingham. (Complete specification.)

**1868. Improvements in electric lampholders and the like.** August Eckstein and Albert Julius David Krause, Peel Works, Adelphi, Salford.

**1874. Improvements in apparatus for regulating variable-ratio transformers.** Francis Lydall, Queen Anne's-chambers, Broadway, Westminster, London.

**1876. Improvements in apparatus for controlling the working of electrically-driven cars.** Francis Lydall, Queen Anne's-chambers, Broadway, Westminster, London.

**1878. Telephony.** Edward Alexander Buell, 65, Chancery-lane, London. (Complete specification.)

**1884. Electric system of fog signalling.** Alwyn Bruce Dawson-Moray and John Ffrench Fitzsimons, 3, Marshall-street, Golden-square, London.

**1891. Improvements in contact breakers of induction coils.** Mortimer Arthur Codd, 9, Elliscombe-road, Charlton, London.

**1912. Electric railway system.** Frank Eugene Kinsman, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**1919. Brush-holder for dynamo-electric machines.** James Burke, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**1920. Laminated cores for dynamo-electric machines.** James Burke, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**1921. Dynamo-electric machines.** James Burke, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**1943. An improved suspension device for electric lamps and the like.** August Günther, jun., 6, Lord-street, Liverpool. (Complete specification.)

**1951. A new or improved system of automatic block signalling for electric railways.** Fitzhugh Townsend, 18, Buckingham-street, Strand, London. (Complete specification.)

**29082A/04. Improvements in the means for the mutual electrical control of oppositely rotating members of turbines.** John Hubert Davies and Max Blieden, 1, Queen Victoria-street, London. (Date applied for under Patents Rule 9, Dec. 30, 1904.)

FEB. 1.

**1966. Improvements in or appertaining to mechanically or electrically propelled road vehicles.** Joseph William Allison, Palatine-chambers, Market-street, Halifax.

**1968. An electric carrying lamp.** Frank Greig Bucher, 37, West Nile-street, Glasgow.

**2004. Improvements in or relating to electric vapour lamps or enclosed arc lamps.** Charles Orme Bastian and George Calvert, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**2014. Improvements in or relating to electric distribution systems.** Alfred Julius Boult, 111, Hatton-garden, London. (Justus Bulkley Entz, United States.) (Complete specification.)

**2015. Improvements in or relating to brush-holders for electric dynamos or motors.** Laurence Checkley Barker and John Wesley Burleigh, 111, Hatton-garden, London.

**2022. Improvements relating to electric accumulators or secondary batteries.** Vickers, Sons, and Maxim, Limited, and Robert Frederick Hall, 7, Southampton-buildings, Chancery-lane, London.

**2030. Improved method and means for eliminating or reducing the influence of disturbing currents on telephone circuits.** Charles Mark Jacobs, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**2033. A mechanically operated electric switch.** Stanley Matthews, 4, South-street, Finsbury, London.

**2039. Improvements in electric meters.** The British Thomson-Houston Company, Limited, and Frank Holden, 83, Cannon-street, London.

**2048. Improvements in windings for dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**22326A/04. Improvements in controllers for electric current.** Philip Middleton Justice, 55, Chancery-lane, London. (The Voltage Controller Company, United States.) (Date applied for under Patents Rule 9, Oct. 17, 1904.) (Complete specification.)

**22326B/04. Improvements in electricity transmission systems.** Philip Middleton Justice, 55, Chancery-lane, London. (The Voltage Controller Company, United States.) (Date applied for under Patents Rule 9, Oct. 17, 1904.) (Complete specification.)

FEB. 2.

**2066. Improvements in automatic controlling apparatus for operating electric switches or cut-outs.** Charles Mark Dorman, Reginald Arthur Smith, and Herbert George Bagga, Ordsal Electrical Works, Salford.

**2088. Improvements in brush-holders for dynamo-electric machines.** John Wesley Burleigh, Norfolk House, Norfolk-street, Strand, London.

**2108. Improvements relating to intercommunication telephone systems.** John Young, 322, High Holborn, London.

**2113. Improvements in combined overload and reverse current electric cut-outs.** The British Thomson-Houston Company, Limited, and Edmund Basil Wedmore, 83, Cannon-street, London.

**2116. Improvements in alternating-current motors.** Valere Alfred Fynn, 18, Southampton-buildings, Chancery-lane London.

FEB. 3.

**2159. An automatic electric portable signal.** Henry Wallace, 10, Rosenau-road, Battersea, London.

**2172. Improvements in or relating to electric traction systems.** Wilfrid Swanwick Boult, 111, Hatton-garden, London.

**2189. Improvements in single-phase induction motors.** The Akt.-Ges. Brown, Boveri, und Co., 46, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Feb. 4, 1904, being date of application in Switzerland.) (Complete specification.)

**2183. An improved form of contact breaker for induction coils and the like apparatus.** Alfred Henry Avery, Fulmen Works, Park-street, Tunbridge Wells.

**2199. Improvements in starting switches for electric motors.** Walter Angove Clatworthy, Alfred Holmes, John Henry Holmes, Leonard William Holmes, and Elwood Holmes, 47, Lincoln's-inn-fields, London.

**2194. Improvements in inspection boxes for electric light leads and the like.** James Wenham, 115, Cannon-street, London.

FEB. 4.

**2264. Improvements in and connected with means for generating electricity from heat.** William Anthony Turner, 14, Coleman-street, London.

**2266. Improvements in the construction of spring jacks for telephone switchboards.** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Akt.-Ges.) (Complete specification.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published Feb. 23.*

1904.

**135. Alternating-current generators and motors.** Zani.

**2066. Electric receiving apparatus for telegraphic and other purposes.** Armstrong and Orling.

**2096. Apparatus for use in the distribution of alternating currents.** Berry.

**2277. Electric low-water alarm for boilers and the like.** Sugrue.

**2471. Electric alternating-current machines.** Latour. (Date applied for under International Convention, Feb. 2, 1903.)

**2580. Means for rectifying alternating current.** Weintraub. (Date applied for under International Convention, Feb. 2, 1903.)

**2734. Electric telegraphy.** Gáti.

**3000. Controllers for electric motors and other apparatus.** Laird and Todd.

**3244. Induction transformer for wireless telegraphy receiving stations.** Ducretet.

**3460. Circuit breakers and indicators for use with electric alternating currents.** Andrews.

**4176. Multiplex telegraphy.** Field.

**4512. Generating electricity by the use of moist chemicals which are mechanically pressed upon zinc.** Nehmer.

**6748. Electric switches.** Gore.

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**7827. Electroliers, gas and oil pendants, and the like.** Sanders.

**8714. Electric switches.** Gore.

**12322. Speed control of high-pressure electric motors.** Boult. (De Kandó.)

**12707. Process for the production of electrical resistance bodies from amorphous or crystalline carbide of silicon or boron, or of silicon or other like suitable materials.** Thompson. (Chemische Elektrische Fabrik Prometheus G. m. b. H.)

**12729. Electric railways and motor vehicles therefor.** Sayer.

**13483. Combined electric regulating and measuring apparatus.** Fauvin, Amiot, and Cheneaux. (Date applied for under International Convention, Nov. 28, 1903.)

**15862. Conduits for underground electrical wires or cables.** Stone and Fenwick.

**19432. Electric automatic block signal and safety systems.** Finnigan.

**21138. Electromagnetic therapeutic apparatus.** Bachelet. (Date applied for under International Convention, Oct. 2, 1903.)

**21580. Contact devices for electric clocks.** Gustafson and Carlstedt. (Date applied for under International Convention, Oct. 8, 1903.)

**22171. Electric switchboards to protect persons from injury.** Elektrizitäts Act.-Ges. vorm. W. Lahmeyer und Co. (Date applied for under International Convention, Dec. 31, 1903.)

**23090. Methods of increasing the effective radiation of electromagnetic waves.** Stone. (Date applied for under International Convention, Oct. 30, 1903.)

**24470. Gas or vapour apparatus for electric lighting, rectifying, and other purposes.** Hewitt. (Date applied for under International Convention, Nov. 24, 1903.)

**26887. Apparatus for indicating the presence of faults and the like in three-phase electric circuits.** MacGahan. (Date applied for under International Convention, Jan. 20, 1904.)

**26915. Electrodes for arc lamps.** Dempster. (Date applied for under International Convention, Dec. 10, 1903.)

**26916. Arc lamp electrodes.** Steinmetz (Date applied for under International Convention, Dec. 10, 1903.)

**26918. Arc lamps and electrodes therefor.** Härdén. (Date applied for under International Convention, Dec. 10, 1903.)

**26919. Arc light electrodes.** Härdén. (Date applied for under International Convention, Dec. 10, 1903.)

**28349. Generation and distribution of electricity.** Dixon.

**28467. Electric incandescence lamps.** Thompson. (Deutsche Gasglühlicht Act.-Ges. Auergesellschaft.)

**28543. Electric junction and like boxes.** Manquais.

**28554. Thermoelectric couples.** Boult. (Hoskins.)

**28608. "Electric candle" lamps.** Regnart and Hunter Electric Candle Lamp Company, Limited.

**28629. Drop signals or annunciators for central telephone stations and so forth.** Birnbaum.

**28722. Electric incandescent lighting devices.** Schwabe.

**28723. Electric incandescent lighting devices for shop windows, show-cases, and the like.** Schwabe.

**28724. Electric incandescent lighting devices for billiard tables, exhibition tables, sale counters, and the like.** Schwabe.

**28962. Galvanometers.** Richard. (Date applied for under International Convention, Feb. 3, 1904.)

**29054. Electric incandescent lighting devices for pictures, music desks, writing desks, pianofortes, and the like.** Schwabe.

**29059. Electric ignition plugs for internal-combustion engines.** Renault. (Date applied for under International Convention, May 2, 1904.)

**29233. Low-tension electric ignition devices for internal-combustion motors.** Albion Motorcar Company, Limited, and Murray.

**29310. Electrical dumb-bells and similar appliances for physical exercises.** Loebl.

**29347. Electric transformer.** Stern.

**29423. Automatic photographing telegraphs.** Ribbe.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ⅞-1 |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 15/32-9/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | – | 5-5½ xd |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | – | 5¼-5⅝ |
| —— 4½ per cent. Mortgage Debentures | 100 | – | 101-104 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 101-103 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | – | 2⅛-2⅜ |
| —— 4 per cent. Mortgage Debenture Stock | 100 | – | 86-88 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,751 | 2 | – | ⅞-1 |
| —— Non. Cum., 6 per cent. Pref. | 2 | – | 1 1/16-1 7/16 |
| —— 4½ per cent. 1st Debenture Stock | 100 | – | 93-96 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | – | 75-78 |
| Callender's Cable, Debentures | 100 | – | 105-107 |
| —— Ordinary | 5 | – | 9¼-10 |
| —— 5 per cent. Pref. | 5 | – | 5¼-5½ |
| Crompton and Co. | 3 | – | 2-2⅛ |
| —— 5 per cent. Debentures | 100 | – | 95-98 |
| Edison and Swan United, "A" Shares, 1-99,261 | 5 | – | ⅞-1 |
| —— "A" Shares, 01-017,139 | 5 | – | 1-1⅛ |
| —— 5 per cent. Debentures | 100 | – | 79-84 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 77-82 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | – | 1¼-1½ |
| —— 7 per cent. Cumulative Pref. | 2 | – | 2⅛-2⅜ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | – | 97-99 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | – | 9¼-10 |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | – | 91-96 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | – | 10¼-11 |
| —— 4½ per cent. Preference | 5 | – | 5¼-5⅜ |
| —— 4½ per cent. Debentures | 100 | – | 110-112 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | – | 15-16 |
| —— 4 per cent. Debentures | 100 | – | 99-102 |
| Parker, Thos., Limited, Ordinary | 10 | – | 10-10½ |
| Telegraph Construction and Maintenance | 12 | – | 38-40 |
| —— 5 per cent. Bonds | 100 | – | 101¼-103¼ |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary | 10 | – | 12-12½ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | – | 9¼-10 |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | – | 11-12 |
| —— 4½ per cent. Debenture Stock. Red. | 100 | – | 104-106 |
| Bromley (Kent) Electric Light and Power Co. | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. 1st Debenture Stock, Red. | 100 | – | 101-104 |
| Brompton and Kensington, Ordinary | 5 | – | 10¼-11 |
| —— 7 per cent. Preference | 5 | – | 10¼-10½ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 | 5 | – | 8⅞ 9⅛ |
| —— Nos. 60,001-80,000 | 5 | – | 6¼-6⅜ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | – | 12⅛-12¾ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 105-108 |
| Charing Cross and Strand, Nos. 1-70,000 | 5 | – | 8¼-8⅜ |
| —— 70,001-80,000 | 5 | .. | 8-8¼ |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5⅛-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 4 15/16-5 1/16 |
| —— 40,001-80,000 | 5 | .. | 4 15 16-5 1/16 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | – | 101-103 |
| Chelsea Electricity Supply | 5 | – | 6⅞-7⅛ |
| —— 4½ per cent. Debentures | 100 | – | 108-110 |
| City of London, Ordinary | 10 | – | 12-12½ |
| —— 6 per cent. Cumulative Pref. | 10 | – | 13¼-14 |
| —— 5 per cent. Debenture Stock | 100 | – | 122-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | – | 102-104 |
| County of London Electric Supply, Ordinary | 10 | – | 9 9¼ |
| —— 6 per cent. Cum. Pref. | 10 | – | 12-12½ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 102 104 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. | 100 | .. | 108-111 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | – | 6¼-6½ |
| —— 6 per cent. Cum. Pref. | 5 | – | 6-6⅛ |
| —— 4½ per cent. First Mort. Deb. | 100 | – | 106-108 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 1¼-2⅛ |
| —— 5 per cent. Debenture Stock, Red. | 100 | – | 86-91 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | – | 5¼-6 |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | – | 101-104 xd |
| Havana Electricity, Limited, 1-15,000 | 10 | – | 9¼-10⅛ |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | – | 7⅛ 8 |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 100-102 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 | 1 | – | 9/16-11/16 |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | – | 12⅜-13¼ |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red | 100 | – | 102-104 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅜-10⅛ |
| London Electric, Ordinary | 3 | – | 2⅜-2⅝ |
| —— 6 per cent. Pref. | 5 | – | 5⅜ 5⅞ |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | – | 96 98 |
| Metropolitan Ordinary | 10 | – | 18-18¼ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | – | 110-115 |
| —— 4½ per cent. Cum. Pref. | 5 | .. | 5¼-5⅜ |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | – | 96-98 |
| Midland Electric Power Dis., Ld., 4½ p c. 1st Mort. Deb. | 100 | – | 94-97 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | – | 98-101 |
| —— Preference | 4 | – | 100-102 |
| Notting Hill Electric Lighting | 10 | – | 14¼-15½ |
| —— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.) | 100 | – | 102-104 |
| Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,510 | 5 | – | 6¼-6⅜ |
| —— 4 per cent. Debenture Stock | 100 | – | 98-100 |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures | 100 | – | 100-102 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 | – | 2⅜-3¼ |
| —— 4 per cent. Debenture Stock | 100 | – | 83-87 |
| South London, Ordinary | | – | 4¼-4⅝ |
| South Metropolitan Electric Light and Power Co., Ord. | 1 | .. | ⅞-1 |
| —— 7 per cent. Cum. Pref. | 1 | .. | 1⅛-1 7/16 |
| —— 4½ per cent. 1st Mort. Deb. | 100 | .. | 107-110 |
| —— Ditto, June, 1904 | | .. | |
| St. James's and Pall Mall, Ordinary, 101-20,080 | 5 | – | 13⅜-14¼ |
| —— 7 per cent. Pref. | 5 | – | 8¼-9 |
| —— 3½ per cent. Deb. | 100 | – | 98-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | – | 5-5⅛ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5¼-5⅜ |
| Westminster, Ordinary | 5 | – | 13-13½ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | – | 6¼-6⅜ |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 | 5 | – | 5⅜-5⅝ |
| —— Ord. | 5 | .. | 8⅜-8⅝ |
| —— Permanent 5 per cent. Debenture Stock, 1898 | 100 | – | 140-143 |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 104-105 |
| Barcelona Tramways, Limited, Ord., 1-20,000 | 10 | .. | 11⅜-12¼ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 | 10 | .. | 9¼-10 |
| —— 5 per cent. Deb., Red., 1-600 | 100 | .. | 98-102 xd |
| —— 4½ per cent. Red. Deb. Stock | 100 | .. | 96-100 xd |
| Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606 | 1 | .. | 11/16-13/16 |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 | 1 | .. | 15/16-1 1/16 |
| Belfast Street Tramways, Ord., 1-26,600 | 10 | .. | 10¼-11½ |
| Blackpool and Fleetwood Tramroad | 10 | – | 13⅜-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | – | 1¼-1⅜ |
| —— 5 per cent. Cum. Pref., Nos. 1 75,000 | 5 | – | 3⅜-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 91-98 |
| British Columbia Electric Railway Co., Ord. Def. | 100 | – | 100-103 |
| —— Ord Pref. | 100 | – | 100-103 |
| —— Non. Cum. 5 per cent. Pref. | 10 | – | 10-10¼ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each | 40 | – | 102-104 p a |
| —— 4½ per cent. Vancouver Power Deb. | 100 | – | 97-100 |
| British Electric Traction Ord. 1-300,000 & 50,001-90,000 | 10 | – | 9¼-9⅜ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | – | 11¼-11⅜ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | .. | 119-121 |
| —— 4½ per cent. 2nd Deb. Stock | 100 | | 97-99 |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Buenos Ayres and Belgrano Tram. Ord., 1-100,000 | 5 | 3¾-4¼ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | 6¼-6½ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | 5⅞-6⅛ |
| —— 5 per cent. Deb. Stock, Red. | 100 | 106-108 |
| —— Prov. Cert., all paid | 100 | 102-105 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | 94-97 |
| Calcutta Tramways, Limited, 1-102,268 | 5 | 8¼-9¼ |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | 106-108 |
| Cape Electric Tramways Nos. 1-480,000 | 1 | 1⅛-1⅜ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | 4¾-5¼ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | 101-104 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | 102-104 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | 9½-10 |
| —— 5 per cent. Cum. Pref. | 10 | 11-12 |
| —— 4 per cent. Debentures | 100 | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | 13-14 xd |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 | 15½-16½ xd |
| —— 5½ per cent. Mort. Debs., 1-5,000, Red. | 100 | 94-97 |
| Imperial Tramways Ordinary | all | 18-19 |
| —— 6 per cent. Cum. Pref. | all | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 50,001-60,000 | 5 | 3½-3⅝ |
| —— 4 per cent. Debenture Stock | 100 | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | 8-8½ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | 10⅜-10⅝ |
| —— 4 per cent. 1st Mtg. Db. Stock, Red. | 100 | 104-106 |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016. | 1 | 13/32 15/32 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | 31/32-1 1/32 |
| —— 4½ per cent. Deb. Stock, Red. | 100 | 104-106 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000 | $1,000 | 106-110 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 | 101-104 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 | 102-104 xd |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000 | 5 | ¼-1½ |

| Name. | Amount paid. | Last price |
|---|---|---|
| | £ | £ |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | -12½ |
| —— 5 per cent. Cum. Pref. | 10 | 9½-9⅝ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk. | 100 | 102-105 |
| Potteries Electric Traction, Ordinary 20,001-40,00 | 10 | 8-¼ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | 8¼-9¼ |
| —— 4½ per cent. Debenture Stock | 100 | 99 102 |
| South Lancashire Electric Traction and Power Company —— £250,000 Ordinary | 1 | 1 |
| —— £101,153 5 per cent. Preference | 1 | 1 - |
| —— £528,093 4½ per cent. Debenture Stock | 100 p.c. | 100 p.c. |
| **Electric Railways.—** | | |
| Central London, Ordinary | 100 | 92-94 |
| —— 4 per cent. Pref. | 100 | 101-103 |
| —— ,, ,, deferred | 100 | 86-87 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | 108-110 |
| City and South London, Consolidated Ordinary | 100 | 46¼-47¼ |
| —— 4 per cent. Debenture Stock | 100 | 105-108 |
| —— 5 per cent. Pref. Stock '91 | 100 | 122-125 |
| —— ,, ,, ,, '96 | 100 | 119-122 |
| —— ,, ,, ,, '01 | 100 | 117-120 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | 10-10¼ |
| —— Ordinary, 1-50,000 | 10 | 3¾-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — | 99-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | — | 97¼-98¼ |
| Waterloo and City, Ordinary | 100 | 91-93 |
| **Telephones.—** | | |
| National Telephone, Preferred | 100 | 108½-109½ |
| —— Deferred Stock | 100 | 107-109 |
| —— 6 per cent. Cum. First Pref. | 10 | 13-15 |
| —— 6 per cent. Cum. Second Pref. | 10 | 12-13 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | 5¼-5½ |
| —— 5½ per cent. Deb. Stock, Red. | 100 | 96-98 |
| —— 4 per cent. Deb. Stock, Red. | 100 | 101½-103½ |
| —— 4 per cent. Prov. Cert. | — | 101½-103½ |
| Oriental Telephone and Electric Company | 1 | 1-1½ |
| —— 6 per cent. Cum. Pref. | 1 | 1½-1¾ |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905. | 1904. | Week. | Current year. | 1904. | 1903 | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Car mile. | Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Feb. 4 | 1,033 | 1,072 | + 20 | — h | 19¼ | 19¼ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·14 |
| Ayr Corporation | ,, 4 | 174 | 164 | + 10 | + 533 | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 336,049 | 1·03 | 10·11 | 1,770 | 5 0 |
| Barking Corporation | ,, 4 | 54 | 42 | + 12 | + 191 | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 5 | 1,037 | 1,015 | — 6 | — 770 | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,349,701 | 1·158 | 9·98 | 2,383b | 6·1 |
| Birmingham Corporation | ,, 4 | 354 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | Jan. 20 | 4,585 | 5,083 | — 498 | — | 6¼ | 6¼ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | — | — | — | — | — | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10 94 | — | 4·59 |
| Blackpool Corporation | Feb. 2 | 238 | 289 | + 9 | + 6,057 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 4 | 203 | 219 | — 11 | — 110 | 16½ | 16½ | Dec. 31 | 32,021 | 2,258,984 | 600,757 | 3·34 | 12·75 | 2,001 | 7 05 |
| Bolton Corporation | ,, 5 | 1,662 | 1,616 | + 46 | + 364 | 38 | 38 | March 31 | 94,161 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·8 |
| Bournemouth Corporation | ,, 1 | 840 | 848 | — 8 | + 2,153 | 10·15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | — | — | — | — | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 5 | 724 | 763 | — 39 | + 3,530h | 9 | 7½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 3 | 4,495 | 4,395 | + 100 | — | 51½ | 51½ | Dec. 31g | 253,150 | 44,391,439 | 6,033,528 | — | — | — | — |
| Burnley Corporation | ,, 4 | 1,027 | 836 | + 191 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 5 | 235 | 296 | — 1 | — | 8½ | — | March 31 | 11,574 | 2,556,134 | 282,378 | 1·08 | 9·84 | 1,570 | 7·57 |
| Cardiff Corporation | ,, 4 | 1,810 | 1,847 | — 37 | + 2,084 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 4 | 141 | 166 | — 25 | — 115 | — | — | Dec. 31g | 9,987 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 4 | 7,072 | 6,994 | + 78 | + 877h | 6 | 6 | ,, 31 | 362,471 | 44,953,938 | 1,292,674a | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 5 | 2,905 | 3,239 | — 334 | — 783h | 6¼ | 6⅜ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Colchester Corporation | ,, 1 | 148 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 2 | 404 | 316 | + 8 | — 83 | — | — | ,, 31g | 25,657 | 6,355,323 | 319,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | ,, 3 | 211 | 212 | — 1 | + 95 | 7·23 | 7·23 | March 31g | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 4 | 164 | 165 | — 1 | — | 4½ | 4½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0·94 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | ,, 3 | 95 | 99 | — 4 | — h | 7 | 6⅞ | Dec. 31g | 6,234 | 888,905 | 107,164 | 3·88 | 14·09 | 952 | 7·39 |
| Dublin U. T., electric cars | ,, 3 | 3,679 | 3,704 | — 12 | } — | 47 | 46 | ,, 31g | 134,648 | — | 3,429,356 | — | — | — | — h |
| Dublin S. District, Electric | ,, 3 | 770 | 676 | + 94 | | | | | | | | | | | |
| Dundee City Tramways | ,, 1 | 805 | 804 | + 1 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 4 | 627 | 577 | + 50 | + 1,686 | 10·77 | 10·75 | March 31 | 34,312 | 12,950,259 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 4 | 13,915 | 13,140 | + 855 | +24,205h | 145 | 123 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Gloucester Corporation | ,, 1 | 211 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | Jan. 25 | 2,209 | 2,160 | + 49 | + 4,555 | 33 | 30½ | March 31 | 68,283 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,069 | 8·77 |
| Huddersfield Corporation | Feb. 4 | 1,204 | 1,074 | + 130 | + 3,761 | 35 | 35 | ,, 31 | 65,545 | 11,893,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | ,, 4 | 2,038 | 2,004 | + 55 | +10,919 | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | Jan. 28 | 327 | 305 | + 22 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | Feb. 1 | 103 | 119 | — 16 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 1 | 182 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 4 | 5,360 | 4,797 | +1,562 | +14,287 | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | ,, 4 | 1,724 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | Jan. 28 | 9,560 | 9,334 | + 226 | + 868 | 103 | 103 | Dec. 31g | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | Feb. 5 | 1,447 | 1,532 | — 85 | — 487h | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — e |
| London County Council | Jan. 28 | 11,698 | 8,948 | +2,750 | + 6,236 | 46½ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | Feb. 6 | 126 | 128 | — 2 | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | ,, 2 | 89 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 4 | 11,588 | 10,692 | + 896 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Metropolitan Elec. Tramways | — | — | — | — | — h | 10 | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 4 | 111 | 100 | + 11 | + 5,247 | 2¾ | — | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newcastle-on-Tyne Corpn. | ,, 4 | 3,661 | 3,583 | + 78 | — | 45 | 38½ | ,, 25 | 185,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111b | — |
| Newport (Mon.) Corporation | ,, 4 | 504 | 442 | + 62 | + 1,333 | 15 | — | — | — | — | — | — | — | — | — |
| Oldham Corporation | ,, 5 | 1,393 | 1,078 | + 314 | + 3,759 | 34¾ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | Jan. 28 | 1,294 | 1,237 | + 57 | + 6,426 | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·16 | 12·39 | — | — |
| Rochdale Corporation | Feb. 4 | 420 | 100 | + 320 | + 5,525 | 4½ | 4½ | 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 2 | 383 | 384 | + 4 | — | — | — | ,, 31 | 23,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·68 |
| Salford Corporation | ,, 6 | 3,869 | 3,638 | + 231 | + 8,752 | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 4 | 65 | — | — | — | 7¾ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 5 | 4,444 | 4,201 | + 243 | + 5,387 | 34¼ | — | ,, 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | Jan. 25 | 719 | 705 | + 13 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | Feb. 1 | 222 | 190 | + 32 | + 1,559 | 6¼ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 3 | 425 | 352 | + 73 | + 8,317 | 11¼ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 5 | 1,120 | 1,079 | + 46 | + 1,465 | 19·54 | 18·48 | ,, 31 | 62,506 | 14,348,958 | 1,433,463 | 1·01 | 10·46 | — | 6·08 |
| Swindon Corporation | ,, 1 | 154 | — | — | — | 3¾ | — | — | — | — | — | — | — | — | — |
| Wallasey U.D.C. | ,, 4 | 646 | 583 | + 63 | + 2,190 | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·80 |
| West Ham Corporation | ,, 2 | 1,052 | — | — | — | 8·62 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 1 | 668 | 395 | + 273 | — | 7½ | — | ,, 31g | 20,878 | 4,263,066 | 417,335 | — | 12·006 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
Per mile of single track. e Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.
Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**Electro-Harmonic Society.**—The 24th inst. will be a "ladies' night," and proceedings will, as usual, commence at 8 o'clock. An excellent programme has again been arranged, the vocalists being Mr. Arthur Strugnell and the Misses Mabel Mawson and Carmen Hill, while instrumental music will be provided by Mr. T. E. Gatehouse and the orchestra. To complete the evening's entertainment, variety performances will be given by Messrs. E. Douglas, F. Leedham, and W. Graham.

**Wireless Telegraphy.**—The Pacific Islands Phosphates Company are so impressed with the success of the installation of wireless telegraphy in the Sandwich Islands that they are investigating the problem of connecting their group by the same means. The group of islands over which the company's operations extend is a large one, but no individual island is further than 200 miles from its nearest neighbour. The group is about 1,000 miles distant from the Fijian cable station, and, according to latest advices, there is a talk of endeavouring to also connect the islands with China by means of wireless telegraphy, and thus bring the group into direct communication with the whole world. It is, however, apparent that for such a great distance a very powerful and large installation would be required at both ends.

**Historical Exhibition.**—An historical exhibition of rare and curious objects relating to medicine, chemistry, pharmacy, and the allied sciences is to be held in London shortly, organised by and under the direction of Henry S. Wellcome. The exhibition will be strictly professional and scientific in character, and will not be open to the general public. We notice that part of a special section (Section VII. B) has been set apart for curious magnetic and electrical appliances. Section II. deals with rare and curious manuscripts, incunabula, books, periodicals, pamphlets, and book-plates on and connected with medical, chemical, pharmaceutical, and allied scientific subjects. We understand that Mr. Wellcome will be pleased to receive at Snow-hill-buildings, London, E.C., any curiosities or apparatus of the medical and allied sciences.

**Motor Omnibuses.**—The competition of electric trams has been a sore point with the railway companies, and now the latter are entering on a form of enterprise which the municipal tramway authorities deem it necessary to take certain precautions against. At a conference of 22 of these authorities, held in London on Monday, Councillor Boyle (chairman of the Manchester Corporation Tramways Committee) presiding, it was resolved to oppose the proposals of several railway companies made in private Bills this session to run motor omnibuses, unless the routes were restricted to the railway stations of the company and fixed points in the vicinity. It was also agreed to support the Bill of the Automobile Club and the Cyclists' Touring Club, providing that all vehicles using the highways after dark shall be compelled to carry a white light in front and a red light in the rear.

**Municipal Wiring.**—A special meeting of the Electrical Contractors' Association was held held last Friday at Frascati's Restaurant to protest against Clauses 63 and 64 of the London County Council General Powers Bill, which propose to confer power upon the borough councils of the Metropolis to execute the wiring of consumers' premises. The hon. solicitor, Mr. R. Tweedy Smith, contended that such powers would lead to municipal trading in its worst form. Large sums had been invested by private firms in the electrical contractors' industry, and there was already great competition. If powers were given to the borough councils to carry on the business of electrical contractors, they would practically have a monopoly in the areas of their supply. It was unfair, he concluded, that the ratepayers' money should be utilised for carrying on such private enterprises as wiring and fitting the premises of consumers in competition with the ratepayers themselves. A resolution was carried that the members should use every endeavour to prevent the passage of the clauses in question, and it was decided to approach the President of the Board of Trade on the matter.

**Non-Sparking Poles.**—In the earlier days of dynamo design, when sparking rather than heating was a limit against which the designer had to contend, the introduction of auxiliary poles was frequently discussed, and often tried with and without success. Such poles have been adopted by one large firm in this country in connection with their turbine-driven direct-current generators, where the commutating troubles are exaggerated by the high speed and consequent few turns in the armature. For this purpose auxiliary poles have been quite successful, and they have enabled large turbo-generators to be worked successfully with fixed brushes at any load. We notice in the *Street Railway Journal* a description of this class of non-sparking pole for another object—*i.e.*, to enable a shunt-wound motor to have its speed varied over a wide range. In the machine in question, which is a four-pole one, the main field coils are shunt-wound, and there are four auxiliary series-wound poles in between them. The device is said to be exceedingly serviceable, as the auxiliary poles always give a correct field for commutation. It is claimed that in this motor, with the brushes placed equidistant between the poles, the direction of rotation may be reversed without any sparking taking place. It runs sparklessly with a variable load as well as at variable speed. The motors of this type are being put on the market in the States by the Electro-Dynamic Company of Bayonne, New Jersey.

**The Domestic Uses of Electricity.**—In the issue for Feb. 15 of *The House Beautiful*, Sir David Salomons writes upon "Electricity in the Home." This article deals with the Protean applications of electricity for domestic purposes. After describing its uses for ordinary and ornamental illumination, Sir David enumerates its special functions in the different rooms. For ventilation it is a convenient agency throughout the house. Then there is the electric radiator, which, if somewhat expensive at present for general use, is a great convenience in the bedroom or the bathroom, or for making a cup of coffee. Nor has Sir David omitted its use to the amateur photographer or in the sick-room, where the value of electro-therapeutics is gaining wider recognition. In addition to these, there is the telephone and the electric bell, to say nothing of the apparatus for frustrating the cult of Bill Sikes. Another article, entitled "The Wonders of Broomhill," describes how Sir David has given practical effect to his views at his seat in Kent. Not only is electricity employed in manifold ways for domestic purposes, but there is a power station where energy can be generated up to 100 h.p., a storage battery, and some workshops containing a variety of machinery. The beautiful picture gallery is artistically illuminated by electricity, which also finds its way into the billiard-room for automatically marking the scores. The articles contain a lot of interesting matter, and are admirably illustrated.

**The Lyons-Moutiers 57,000-Volt Transmission.**—An interesting transmission of energy is about to be undertaken between Moutiers, in Tarentaise, and Lyons, a distance of about 113 miles. The actual power to be transmitted is about 4,700 h.p., which, with the distance,

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makes a record, we believe, for Continental practice. The work is to be carried out for the Société Grenobloise de Force et de Lumière by the Compagnie de l'Industrie Electrique et Mécanique de Genève. For the purpose the contractors are about to instal four pairs of dynamos at the generating station at Moutiers, and there will be at the receiving end of the line five groups of double motors with all accessories. It is an interesting fact that under the order for this equipment the plant will work on the continuous-current series system. This system has, however, been largely used in the district in question, and has worked successfully between Saint-Maurice and Lausanne, a distance of 36 miles. In this case, however, the maximum voltage did not exceed 22,000, so that there will be a considerable jump in the present instance, as at full load the voltage at the generating station is calculated to be 56,960. With this voltage the horse-power above mentioned will be transmitted over the distance of 113 miles by means of two copper wires 9mm. in diameter. At the point where the line enters the town of Lyons underground cables are to be used, which will be highly insulated and armoured. Allowing for the loss on the line these cables will still have to stand a voltage of 50,000. While the continuous-current series system greatly simplifies the line construction, it seems to us that the insulation of the generators and of the receiving motors will need very careful attention.

**Electrical Exhibition Scheme.**—Under the auspices of the National Electrical Manufacturers' Association, a meeting of the industry was held at the Hotel Cecil on Wednesday, when a proposal to hold a general electrical exhibition was approved. The attendance was somewhat limited, but Mr. Walter Davenport, the secretary, who was voted to the chair, read numerous letters from metropolitan and provincial firms promising their support. It is proposed to hold the exhibition in October at Olympia or the Crystal Palace, probably the former. A month was spoken of as the duration of the exhibition, but this remains to be finally settled. The arrangements will be carried out by an executive committee of 15, composed of 10 nominees from the exhibitors and four from central-station owners, while a representative of the electrical Press is also to be invited to officiate. Of the 10 members to be selected by the exhibitors, half will be composed of members of the association and the remaining five will be elected from the other exhibitors. The voting for the five members of the executive to be selected from the members of the association resulted in the following houses being nominated to appoint representatives: General Electric Company, Edison and Swan, Verity, Limited, Electric Power Storage Company, and the International Electric Company. Under terms provisionally agreed upon exhibitors will incur no liability beyond the rent for space, so that should the exhibition fail to succeed the loss will be comparatively small; but Mr. Davenport intimated that, with the numerous assurances of support that had been received, there was every prospect of success, and the lines upon which the exhibition was to be run would ensure the exhibitors, and not professional promoters, benefiting by the profits.

**Smoke Prevention.**—In the course of his address the other day to the Society of Experimental Engineers at Dundee upon the economical use of coal, Mr. H. Richardson, the city electrical engineer, dealt largely with the smoke nuisance, and urged the necessity of further investigation into this matter. The first part of the lecture was somewhat reminiscent of the paper lately presented to the Institution of Electrical Engineers by Messrs. Booth and Kershaw. Improperly designed furnaces, Mr. Richardson held, were responsible for a great amount of the smoke nuisance, and they should get away from the present rule-of-thumb method of building these. Smoking chimneys were quite unnecessary, for the smoke was a sign of imperfect combustion, and therefore showed an uneconomical use of fuel. He went on to show that if those old-fashioned methods of designing furnaces were departed from, and the real principles of combustion recognised, more economical results would accrue, besides attaining nearer to the absolutely smokeless chimney shaft. The whole trouble, he said, was due to designers following the old way, although they had kept up-to-date in the design of pressure-resisting machines, boilers, etc. Referring to the waste gases, Mr. Richardson suggested that these should be analysed on their way to the chimney, and records kept, so that engineers and managers of works might know exactly the state of their combustion. One of the chief causes of the smoke trouble, especially in the North Country, was the fact that bituminous coal was used, unconsumed hydrocarbons, due to imperfect combustion, being also responsible for it. Where anthracite coal was used, very much less trouble with smoke was experienced. In conclusion, he stated that investigation into the combustion question would repay trouble more than any other department of steam-plant engineering.

**London Electric Supply Corporation, Limited.**—We have to congratulate this company on the fact that it has at last reached the stage when it is able to pay a dividend upon its ordinary stock. This company was registered in 1887, although it had been in existence under another name since 1885. It was responsible for pioneering work in the transmission and distribution of electrical energy which has been invaluable to other undertakers. In the earlier days Mr. S. Z. de Ferranti was responsible for the undertaking, and under his advice works were laid down at Deptford from which power was transmitted to London. Mr. Ferranti's ideas as to the generation of electricity outside London, where coal can be cheaply obtained and there is ample water for condensation purposes, have proved to be absolutely correct. Unfortunately, at the time when the Deptford works were started, the experience to enable this to be successfully done had to be dearly bought. Cables to stand the high voltage necessary for such transmission had to be specially designed, and the paper-insulated cable, so largely used throughout the world to-day, may be said to have developed from the Ferranti tubular mains manufactured at Deptford. The result of this pioneering work was to hamper the company with a vast amount of unremunerative capital, but those responsible for the management, of whom Mr. R. Stewart Bain must be given the first place, have carried the matter through in spite of discouragement. Lord Crawford and Mr. Partridge, the chief engineer of the company, have also been with the company throughout, and are to be congratulated on the fact that they have so far overcome their financial difficulties as to be able to declare a 3 per cent. dividend on the ordinary shares. The accounts of the company are reproduced elsewhere, and show that during the past year the number of units sold increased from a little over four millions to 10½ millions.

**Tramways and Light Railways Association.**—Continuing its policy of inspecting the power stations of the electric railways and tramways, a considerable party of this association paid a visit last week to the generating station of the London United Tramways Company. At Chiswick the party were received by the managing director, Mr. J. Clifton Robinson, who escorted them round and pointed out the main features of interest. They first saw the car sheds, where 75 out of the 300 cars in regular use are

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housed, and were then taken through the repairing shops. A tour was next made of the boiler-room, with its range of 11 Babcock and Wilcox boilers, each capable of evaporating 11,000lb. of water an hour. Descending below the boilers, the party inspected the steam-pipe connections with the engines, all placed out of sight, yet readily accessible. Finally they emerged into the engine-room, with its five Allis vertical cross-compound engines, three of 500 kw. capacity and two of 1,000 kw., supplying power to the whole of the company's extensive system. The annual meeting was held on Friday at the Society of Arts, Mr. Alfred Baker, the president, in the chair. The following gentlemen were elected to fill vacancies on the council: Mr. Arthur Stanley, M.P., as president; Mr. H. England, Mr. J. B. Hamilton, Mr. J. H. Rider, Mr. S. Sellon, and Lord Vaux of Harrowden. After the chairman had introduced the newly-elected president, Mr. A. Stanley, M.P., the latter took the chair. In the course of his address he expressed the belief that if anybody invented a cheaper mode of traction than that of a metal wheel on a metal rail it would run trams off the road, but it would not be done by motor omnibuses. In conclusion, he stated that a meeting had been arranged with the Association of Municipal Corporations, and the council hoped that one result of it would be a joint representation to the Government, with the view of doing away with some of the obsolete forms and anomalies at present existing.

**Electro-Acoustic Sea-Sounding Device.** — An electro-acoustic method of sea-sounding where it is unnecessary to touch bottom has recently been devised by Mr. H. Berggrof, a Norwegian engineer, and a description of the apparatus is given in the *Scientific American*. The depths are also registered graphically upon a revolving drum. The operation of the device depends upon the time which sound takes to travel to the bottom and return, and the measurement of the time thus gives the depth to which the exploring apparatus is lowered. According to experiments, it is found that sound takes one second to make the double distance of 2,000ft. In the inventor's recent trials, the vessel was equipped with an acoustic tube which could be lowered into the water. By means of an ordinary clock he could take the depth with considerable precision; thus, four seconds shows about 8,000ft. For more exact work he used a registering apparatus, in which the depth is indicated on a band of paper. The apparatus consists of three parts—a transmitter, an acoustic receiver, and a chronometer. The sound is formed at intervals by a revolving disc which turns slowly and carries a projection on the periphery. The latter is made to strike against a fixed point, and thus makes an electric contact at each revolution. The electric circuit has a magnet which operates a vibrating armature, and each time the contact is made a sound is sent toward the bottom of the sea, whence it comes back to the vessel and is received in a microphone. The microphone is specially constructed so that it is only sensitive to sounds for which it is tuned, by means of a resonator. The vibrator is tuned to the same pitch, so that the membrane, upon receiving the sound from the bottom, will vibrate, and this movement is registered in the apparatus, taking account of the time which has elapsed between the closing of the electric contact and the reception of the sound in the microphone. The apparatus is said to have worked very successfully.

**Birmingham Electric Club.**—At a meeting of this club held on Saturday last, a paper was given by Mr. E. R. Wood on "The Starting and Speed Regulation of Electric Motors." Mr. Wood remarked at the outset that to secure a satisfactory performance from a motor a reliable starter was a *sine qua non*. He pointed out that numbers of starters in use could be improved by a better gradation between the stops—*i.e.*, that although the total resistance might be correct in ohmic value, owing to the unsuitable divisions in that resistance, violent sparking occurred while the contact lever passed over the last few stops. The lecturer suggested grading the resistance so that the amounts between the several stops were in a geometrical progression in the case of shunt-wound motors, but this law must be departed from for series-wound motors in order to reduce the sparking voltage to a minimum. This method would be found to give the best all-round results. The difference between the general starting conditions of shunt and series wound motors was then reviewed, and illustrations given of the advantages to be derived by employing the series-parallel control for tramway purposes. Interesting descriptions were given of different methods for obtaining speed variation by alteration of the supply voltage and by shunt regulation. Because starting switches, as a rule, only have current passing through their contacts for but a very short time, these contacts may be made for a comparatively high current density. This, however, is sometimes carried too far, notably in the case of the surface-contact density between the brushes and contact segments in many controllers. Various methods that have been introduced for prevention of overheating of resistance conductors and for the prevention of oxidation were dealt with. The advantages of compounding motors, cumulative series winding to increase the torque, and cases where the series coils are afterwards cut out in order to secure a practically constant speed, were also dealt with. The paper was well discussed.

**Obituary.**—Those members of the Institution of Electrical Engineers who toured the United States last autumn will hear with deep regret of the decease of Mr. Edward H. Mullin, who acted as chairman of the Transportation Committee on the occasion of the International Electrical Congress at St. Louis, and took a prominent part in carrying out the arrangements connected with the visit. From a memoir of Mr. Mullin appearing in the *Electrical World* of New York, we notice that he was born at Castlederg, co. Tyrone, in 1859, so that he has passed away at the comparatively early age of forty-five. He graduated with honours at Queen's College, Belfast, where he took a special interest in physics, and a little later he proceeded to the States. For some time he was associated with the New York *Times* and other prominent dailies, but his sympathies strongly tended towards scientific and technical subjects, and he devoted himself to this branch of journalism with enthusiasm, contributing extensively to periodicals on both sides of the Atlantic. In 1898 his work in this field attracted the attention of President Coffin, of the General Electric Company, who appointed Mr. Mullin head of the company's publication department. Enjoying the confidence of the Press, Mr. Mullin's services were of great value to the company in removing misapprehensions and setting both sides of the case before the public. Under Mr. Mullin's supervision the company's bureau of intelligence reached a high standard of efficiency. Of his interest in technical journalism our contemporary remarks that "it is not saying too much to include him among the potent influences which, during the last 10 or 15 years, have so perceptibly raised the general standard in this field." Mr. Mullin was for many years actively associated with the American Institute of Electrical Engineers, and at the time of his death was a member of the council. He was also connected with several other electrical organisations, and possessed an extensive knowledge of technical matters. He will be missed the more because, to qualifications of an

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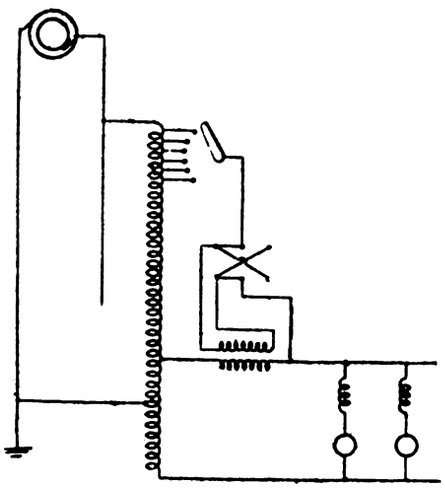
uncommon order, he united a genial personality and a high standard of integrity, which gained him the esteem of all he came in contact with.

**Single-Phase Alternating-Current Distribution.** A patent for a single-phase alternating-current system of distribution has recently been granted in the United States to Mr. P. M. Lincoln, who has assigned it to the Westinghouse Company. From a brief description given in the *Electrical Review* of New York, it appears that the object of the invention is to provide a system in which energy may be transmitted at high voltages and delivered through voltage-regulating apparatus to translating devices at lower voltages, and in which the differences of potential between the grounded conductor from the source of energy and the respective terminals of the translating devices are reduced to safe and limited values. It has been suggested that motors of the commutator type of construction having series-connected armature and field-magnet windings, and being similar in many respects to ordinary direct-current motors, should be operated by alternating current. Various systems have been devised for transmitting energy at high voltages and supplying it at variable low voltages to motors at the points of consumption. The feature of the present invention is that, unlike a previous system, the differences of potential between the respective motor terminals and



the grounded conductor are only one-half that between the motor terminals. With this arrangement the stresses on the insulation and the dangers incident to the operation or repair of the motors are materially reduced.

**New Publications.**—"'N' Rays," by R. Blondlot, translated by J. Garcin. (London: Longmans, Green, and Co. 3s. 6d.) This volume comprises Prof. Blondlot's communications to the Académie des Sciences upon the subject of "N" rays, and is supplemented by instructions for making phosphorescent screens suitable for the observation of the rays.—We have received the January number of the *Proceedings* of the American Institute of Electrical Engineers, which contains papers on "Acyclic (Homopolar) Dynamos," by J. E. Noeggerath; and "Modern Central-Station Design," by J. E. Moultrop; also the discussion on "Problems of Heavy Electric Traction."—A reprint of a paper entitled "The Absorption of Electromagnetic Waves by Living Vegetable Organisms" has been forwarded to us. The author, Major G. O. Squier, of the United States Army Signal Corps, details some experiments in wireless telegraphy carried out by him at the manœuvres held in California last August. It had been noticed in some previous manœuvres that in laying rapid telephone lines in a wooded country for the field exercises of the army, a much better ground could be obtained by attaching the earth side of the instrument to an iron nail driven into the trunk of a tree or shrub than by the ordinary method of burying a conducting plate. Major Squier found that in California, where it was almost impossible to use the ordinary single-wire grounded circuit on account of the extremely dry condition of the soil, a ground connection could be established in a few moments by using a tree. He conducted some simple experiments in wireless telegraphy with vegetable antennæ, and the results prompted him to suggest that the matter was worthy of further investigation in order to see what could be accomplished by the use of more elaborate apparatus than were available when he conducted his tests. There is some talk of such an installation between one of our groups of islands in the Southern Pacific. The idea suggests an interesting field of research, and Major Squier, in concluding his remarks, puts in a plea for the more systematic study of vegetation from a distinctly physical standpoint.—"The Inventors' Guide," by Jas. Roberts (London: John Murray. 2s. 6d). The author has compiled a comprehensive treatise on the patent laws, including the regulations which recently came into force.

**British Association.**—Activity is being evinced at the various centres of the South African Association for the Advancement of Science, in view of the visit of the British Association in August. It is proposed that sub-committees of the local committees shall be formed to deal with the different matters arising out of the tour, and in order to co-ordinate the proceedings a central executive committee, under the chairmanship of Sir David Gill, H.M. Astronomer at the Cape of Good Hope, with whom the secretaries of the local committees will consult in organising the programme, has been constituted. According to the provisional arrangements, the visitors will land at Cape Town on Aug. 15, when the presidential address will be delivered, the remainder of the week being devoted to meetings in the mornings, and lectures, social functions, and excursions in the afternoons and evenings. The Saturday will be entirely devoted to excursions, and in the evening of the same day a special steamer will leave direct for Durban. About two days will be devoted to Durban and Pietermaritzburg, and another couple of days to the Natal battlefields, Johannesburg being reached on Aug. 28. The rest of the week will be spent on the Rand and in Pretoria, the party proceeding thence to Kimberley, *vid* Bloemfontein. A couple of days will be spent at each of the latter places, and then a move will be made for Bulawayo, and finally for the Victoria Falls. If a minimum of 100 members decides in sufficient time to return to England *vid* Beira from Rhodesia, the Union Castle Steamship Company will provide a special steamer sailing by the East Coast and Suez Canal. It is probable that at Cape Town and Johannesburg hospitality will be provided for at least 200 guests, special accommodation being prepared for the secretaries of the sections so as to facilitate their work. Meetings of all the sections will be held both in Cape Town and Johannesburg, and the South African Association are seeing to it that nothing shall be lacking at those places in the way of accommodation for the meetings and facilities for the transaction of business in the most convenient manner. The local committees are also making arrangements for extending private hospitality or providing free hotel accommodation for the visitors, it being understood between the British and South African Associations that only distinguished scientists shall be invited guests.

**The Metropolitan Railway.**—A correspondent to the *Times*, while acknowledging the good points of the new electric service between Baker-street and Uxbridge, has one or two grievances to ventilate. The corridor type of carriage has generally been regarded as an advance in the construction of rolling-stock, but this gentleman evidently does not participate in that view. It is all very well for

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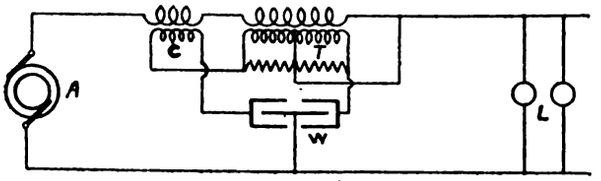
tubes, he says, but when the passenger gets beyond Finchley-road, where the underground section of the Metropolitan Railway ends, he is exposed to a cutting blast, if there is any wind about, every time the doors are opened. The *Times* correspondent considers this not only highly disagreeable, but positively dangerous, and he even indulges in the dismal prediction that to travel on this line will mean a sure journey to the tomb. The older form of carriage is not without its comfortable features, but it really seems as though this gentleman is conjuring up an imaginary bogey when he paints the peril of the corridor train in such a .sombre hue. The American death-rate does not appear to have been accelerated from this cause. The same gentleman urges the following further objection: "Under the old dispensation the man of business had come to look upon his journey to and from the City, if not with pleasure, yet with a chastened affection. It supplied him with two fairly quiet intervals in the day. . . . These oases of comparative peace are now denied him. At intervals of two and three minutes, and with a clang of metal that suggests the bursting of the gates of Hades, the doors fly open and stentorian tones, before and behind, tell him where he is. A half-minute draught and unrest and the doors clang to, and the tones announce with similar and unpleasant emphasis where he will be presently." If the stations could be announced by some improved form of automatic indicator, such a device would probably meet with appreciation, and perhaps railway companies will give this matter fresh consideration. The *Times* correspondent has still another grievance in the abolition of the second-class, stating that it is especially hard on those who cannot afford to travel first-class, but are willing to pay a little extra "to avoid the honest, though rough and emphatic, personalities that pervade many of the trains." These passengers, however, represent a comparatively small section, and scarcely justify the confusion and waste of time consequent upon additional classes, especially as the difference between the first and third class fares on this section of the Metropolitan Railway does not in general, if at all, exceed 50 per cent.

**Electrostatic Wattmeter.**—A patent in connection with an electrostatic wattmeter has recently been granted in the United States to Mr. Miles Walker which substitutes for the resistance, as a source of E M.F. proportional to the load current and in phase therewith, a step-up series transformer. The electrostatic wattmeter has not found an extensive use in commercial work, because the forces which act upon the moving member of the instrument when connected up in accordance with the ordinary method are so small as to necessitate the employment of an instrument which is extremely sensitive and delicate. Under the ordinary practice, the voltage which is applied to the quadrants of the instruments is secured by passing the main current through a non-inductive resistance which necessitates the utilisation of a low voltage in the instrument in order to avoid the large loss of power which would otherwise result in the non-inductive resistance. Mr. Walker's invention, of which a description appears in the *Electrical World*, is designed to eliminate the objections to the use of large voltages. The connections are illustrated in the accompanying diagram. A difficulty in using a plain series transformer in its simplest form is found in the fact that the E M F. measured across the open-circuited secondary coil will be perhaps 40deg. out of phase with the primary current, due to the predominating influence of the magnetising component of the primary current. The inventor, therefore, places a non-inductive resistance across the secondary of the transformer, the effect being that the current which flows through the resistance in phase with the secondary E.M.F. necessitates an opposing component in the primary, and the resultant primary current is caused to be more nearly in phase (opposition) with the secondary E.M.F. In order to shift the phase of the E.M.F. applied to the quadrants so as to bring it directly in opposition to that of the main line current, the inventor uses the compensating transformer shown at C in the illustration.




This transformer has a core provided with a partially short-circuited air-gap so that its secondary E.M.F., which is added vectorily to the secondary E.M.F. of the main series transformer, T, may be in the proper phase position with respect to the primary current to compensate for the lack of exact phase opposition referred to as above.

**Obituary.**—We regret to hear of the death of Mr. C. J. Sutherland, who for many years held the position of city electrical engineer at Worcester. It was only a short time ago that we announced his retirement from that post, and expressed a hope that complete rest would enable him to recover his health. Unfortunately this was not to be.

Mr. Sutherland died on the 30th ult. His experience in electric light distribution went back to the early days of the Eastbourne Company, and he also saw the pioneering work in connection with the first Brompton and Kensington station. After experience at the Stanhope-street station of the St Pancras Vestry, he was appointed assistant engineer to the Hanley Corporation electricity works in October, 1894. In the following June he was appointed joint manager and electrical engineer of those works in conjunction with Mr. C. A Cowell. After holding this post for over three years, he was appointed in November, 1898, city electrical engineer at Worcester. The supply in that city was then being given on the single-phase alternating-current system from works 2½ miles away. With the extension of the supply it was found necessary to put down new works in the city, and these were designed by Mr. Sutherland, and carried out under his supervision. This new station at Hylton-road was completed in 1902, and will serve as a fitting monument to the late engineer for years to come. Mr. Sutherland was highly respected by his committee and staff, and by his colleagues in the electrical profession. He leaves a widow and one little son to mourn his loss.

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## THE LOTS ROAD POWER STATION.

*(Concluded from page 194.)*

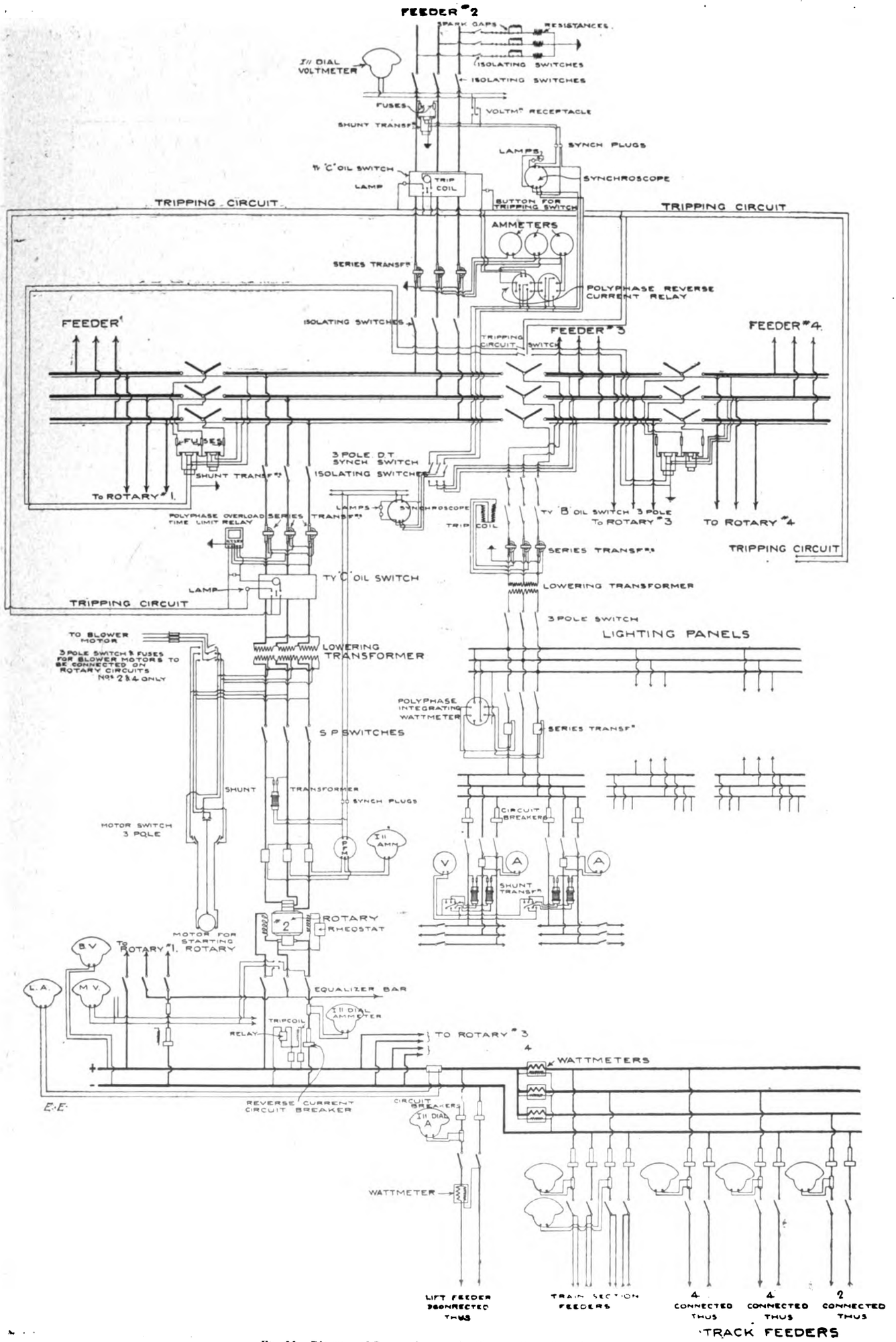


FIG. 14.—Diagram of Connections at the Charing Cross Sub-Station.

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In our last issue we completed the description of the switchboard and auxiliary plant in the above power station. This week we propose to treat of the sub station plant for which the British Westinghouse Company have been the contractors. The sub-stations of the Metropolitan District Railway supply direct current to the southern half of the Inner Circle, and to a very wide area, extending from East Ham to Hounslow and from Sudbury to Wimbledon and Richmond. These points form approximately the bounds of the company, and are all primarily supplied with power from Lots-road. As all the sub-stations are to a great

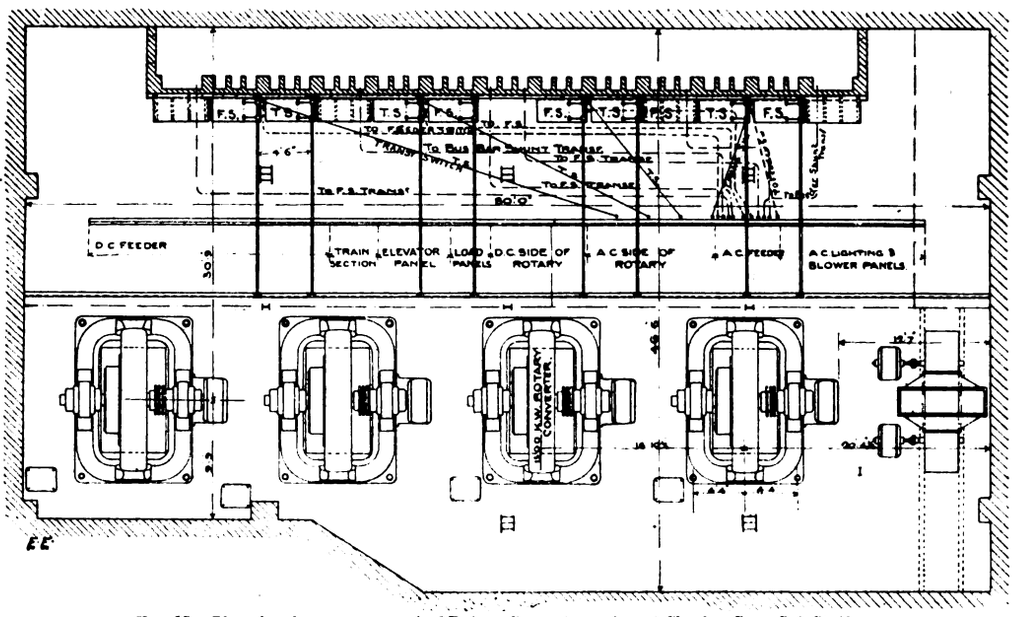


FIG. 15.—Plan showing arrangement of Rotary Converters, etc., at Charing Cross Sub-Station.

degree similar in design and construction, it will suffice to select one of them—viz., that at Charing Cross—for description. Three-phase current at 11,000 volts is supplied to this sub-station from Chelsea by means of four feeders, and, after being converted to direct current at approximately 600 volts, is conveyed by 24 cables to the track rail. In addition, there are direct-current feeders that supply current to the tube stations for operating the lifts, and alternate-current feeders set apart for the lighting of the stations and tunnels.

Fig. 14, which is a diagram of connections at Charing Cross sub-station, shows the system upon which it is

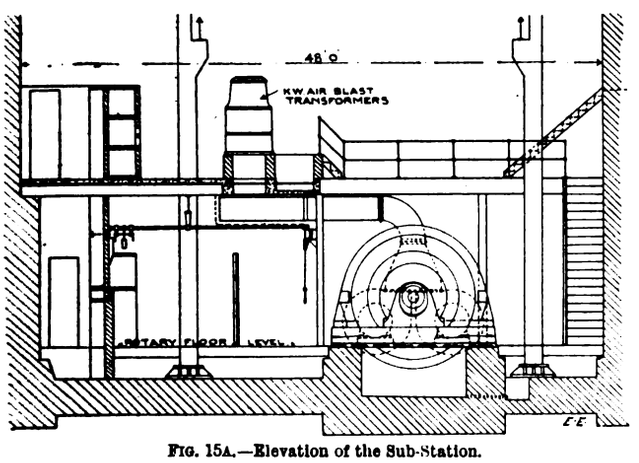


FIG. 15A.—Elevation of the Sub-Station.

operated, and Figs. 15 and 15A give a plan and elevation, from which an idea of the general lay-out of the plant can be obtained. The following details of the equipment are of special interest. Westinghouse spark-gap lightning arresters protect the feeders directly upon their entrance into the building, after which they pass to isolating switches of a single knife pattern, and operated by a long insulating pole fitted with a hook at the end. These switches are, of course, only used upon rare occasions, their function being to cut the pressure off from the oil-break feeder switches when cleaning or repairs are to be undertaken. Like arrangements are made upon the other side of the oil switches—that is, between them and the 'bus bars. Reverse current relays are installed for the protection of the high-tension feeders from the sub-station end, and thus if a short-circuit occurs on any feeder, current will not flow to it from the sub-station 'bus bars. As will be seen from Fig. 14, the main high-tension 'bus bars are divided into four sections, each of which has one feeder and one rotary converter connected to it. By the means of selector switches of the same type and method of operation as the isolating switches, these 'bus-bar sections may be so connected as to use the feeders separately or in parallel as desired, and similar selector switches being included in the rotary circuits, a very flexible and convenient arrangement is secured. The pressure transformers used in connection with the measuring instruments are also provided with selector switches, and thus may be fed from any particular pair of 'bus bars if necessary. The transformers for the alternating-current lighting circuits are connected to the middle set of 'bus-bar selector switches, which arrangement makes it possible to supply the load from either pair of incoming feeders.

The circuit to the primaries of the step-down transformers is completed by isolating and main oil switches in series, and connection is made from the secondaries to the collecting rings of the rotaries through sets of three single-pole knife switches. The main oil switch of each converter is in the ordinary way hand operated, but it is also fitted with an overload time-limit relay, which comes into operation, automatically tripping the switch, if a prolonged short-circuit or overload occurs. In addition, there is a push on the switchboard, the pressing of which will electrically open the main switch. Two knife switches, one for each pole, are provided for the direct-current side of the rotary converter, and there is also a reverse-current circuit breaker in the negative side and the usual equalising switch, which latter, however, is not placed on the switchboard, but on a cast-iron pillar close to the machine. A small induction motor, coupled direct to the shaft, is provided for starting each rotary, and its switch is placed on the alternate-current converter panel of the switchboard.

As direct current is supplied from this sub-station to three railway systems controlled by the Underground Electric Railways, Limited, it has been necessary to split the positive 'bus bar up into three sections on the far side of the main load panel, and in each of these is interposed a suitable direct-current integrating wattmeter. The first and second meter the power in one train section and four track feeders, the third, that in two track feeders. The three other cables that convey the current for operating the lifts are fitted in a like manner.

All lighting is carried out on the three-phase system, each sub-station being responsible for as much as lies halfway between it and the neighbouring ones. By the use of interconnecting switches it is possible, however, to couple up the

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sections, so that the lighting will not be interfered with in the event of a sub-station breaking down or being stopped. A Westinghouse type B triple-pole automatic oil switch is interposed between the main switchboard and the high-

The instruments and controlling gear of the switchboard are mounted upon polished blue Vermont marble panels, which collectively give a total length of 69ft. 4in. Referring to Fig. 16, and beginning from the right-hand side, there

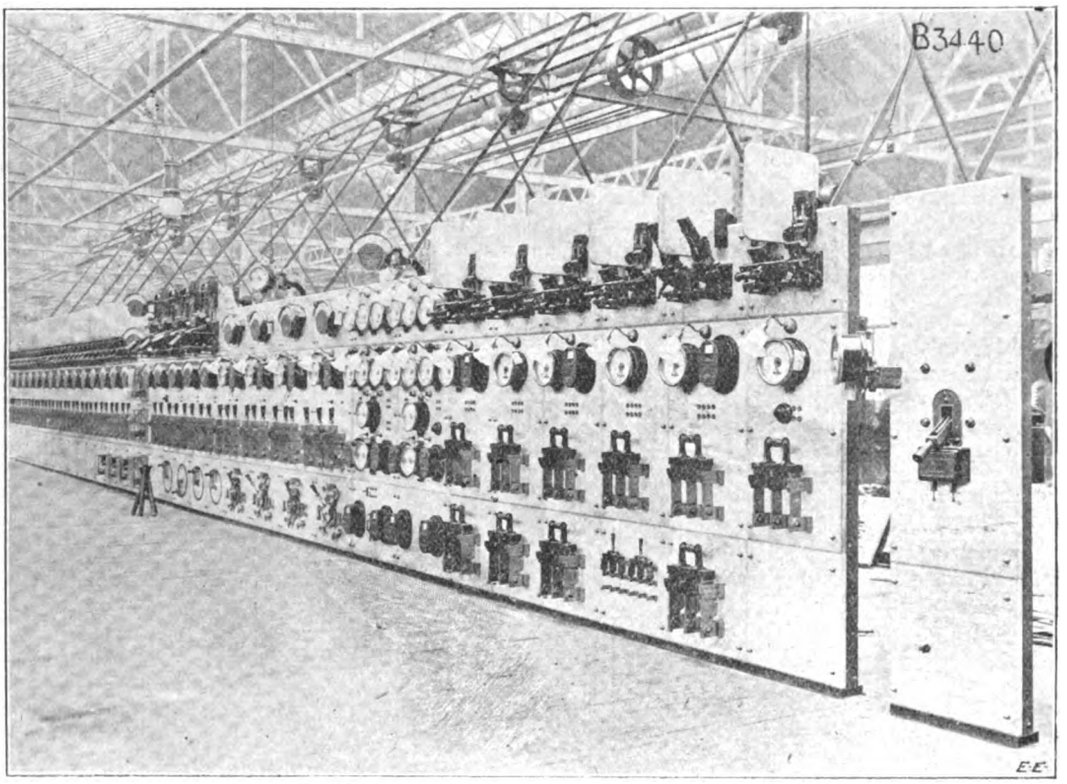


FIG. 16.—View of the Charing Cross Sub-Station Switchboard.

tension lighting panels, which are mounted separately and distinct from the former. The current is transformed down, and then passes through a triple-pole switch and a small separate set of 'bus bars to the low-tension alternate-current 'bus bars, which are divided up into three sections, each

are, firstly, the six alternate-current lighting panels referred to above. Each pair of these contains two double-pole circuit breakers, two ammeters, one integrating wattmeter, two 800-ampere triple-pole knife switches, and one triple pole 1,000-ampere switch for connecting the sub-lighting 'bus

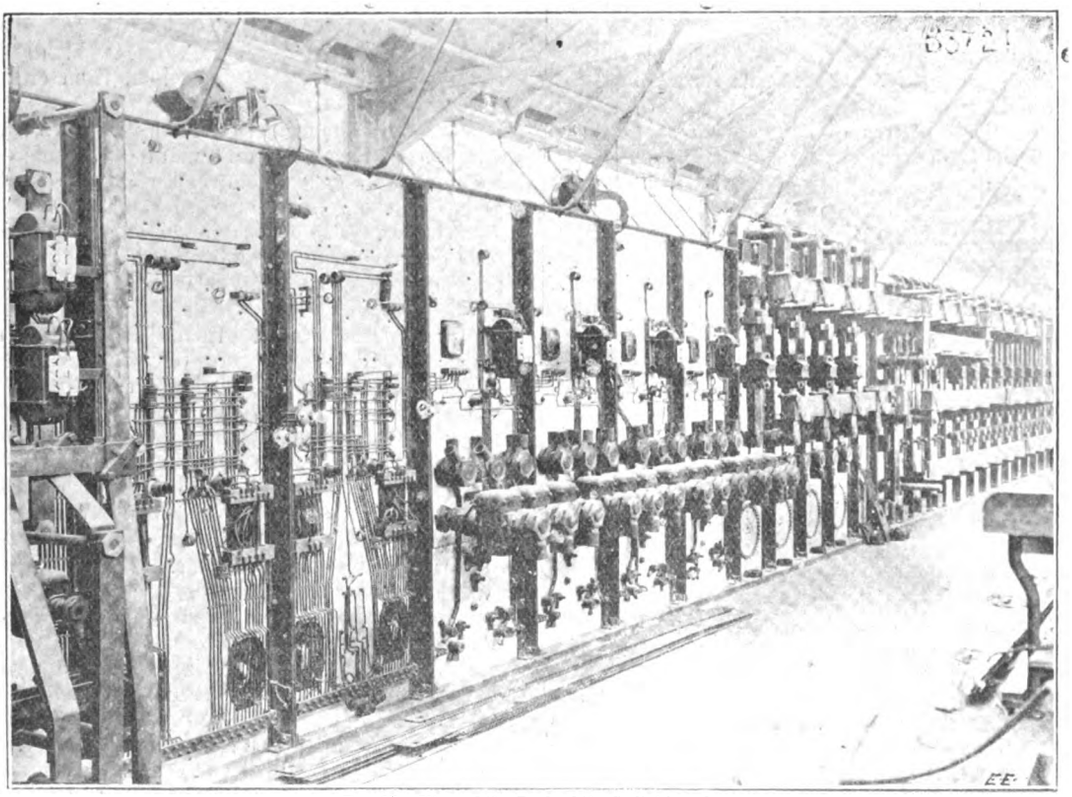

FIG. 17.—View of the Back of the Switchboard.

feeding two lighting circuits. These run in duplicate to the District Railway, the Charing Cross, Euston, and Hampstead Railway, and the Baker-street and Waterloo Railway respectively; and are each provided with integrating wattmeters for measuring their consumption,

bars and the main 'bus bars. There are also two triple-pole two-way 100-ampere switches for starting the fan motors that supply cooling air to the transformers, and one triple-pole main switch for disconnecting the lighting transformer on the low-tension side. The usual swinging arm is

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attached to these panels, in this case carrying a 300-volt instrument, and plugs and sockets are provided that will

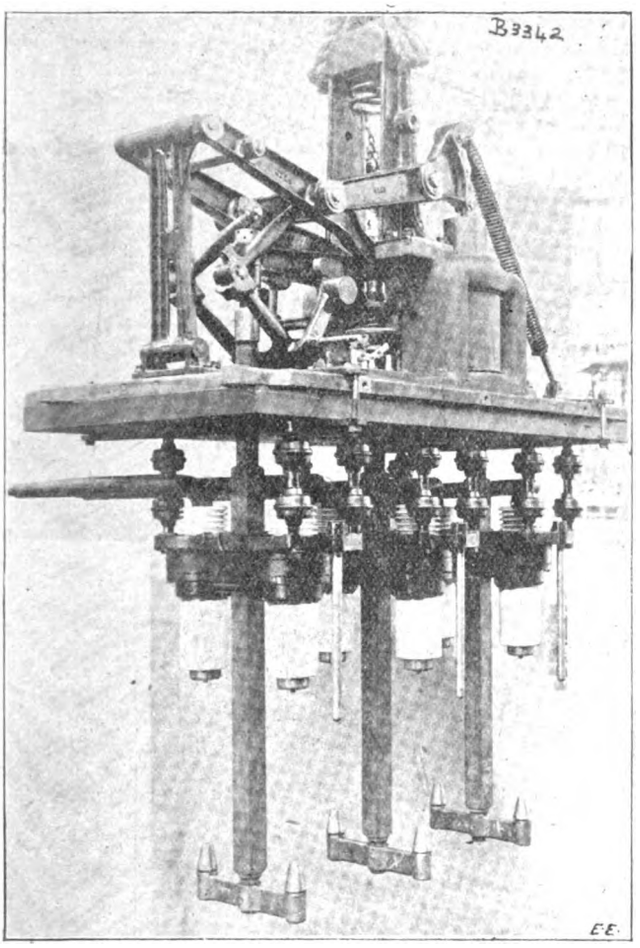


FIG. 18.—The Westinghouse Mechanically-Operated Oil Break Switch for Sub-Station Working.

allow of its connection to any phase and any low-tension feeder for purposes of voltage measurement. The four incoming high-tension feeders are connected, two each, to two instrument panels placed adjacent to the lighting section of the board. These panels are fitted each with six 300-ampere ammeters, two synchroscopes, two integrating wattmeters, and two polyphase reverse-current relays, and adequate illumination of the instruments is obtained by four incandescent bracket fittings. The two red signal lamps below the ammeters are so connected with the two main feeder switches that they will light up, and so warn the attendant, in the event of either of these opening automatically on a fault. These panels also contain two push buttons for tripping the main oil switches and two voltmeter switches, one for each feeder.

Following the feeder section of the board, there are four alternating-current low-tension panels for the rotary converters, each of which contains a large illuminated-dial ammeter, one power factor meter, and one polyphase overload time-limit relay. Red lamps are also fitted and connected with the main switches for the purpose described above. The alternate-current side of the rotary is controlled by three large single-pole knife switches, placed conveniently on the lower portion of the panel, and the sub-base of each contains a starting switch for the induction motor used for starting the converters. Centrally placed above the four panels is a Westinghouse synchroscope, mounted on a double-jointed bracket that enables it to be turned in any direction. The four direct-current panels for the same machines stand next, and contain each, one 4,000-ampere circuit breaker, with a reverse-current relay attachment, one large illuminated-dial ammeter, one voltmeter plug switch, two 4,000-ampere single-pole knife switches, and, on the sub-base, a rheostat dial switch. Then follows the main load panel, upon which are mounted an illuminated-dial voltmeter for the 'bus bars and another similar one for the machines, and an illuminated-dial ammeter that measures the total 'bus-bar current. Next is the wattmeter panel, containing three instruments of 8,000, 6,000, and 4,000 amperes capacity respectively, which are used for metering the power supplied to the three lines before mentioned. The lift panels follow this, three in number, and are each fitted with a suitable wattmeter for measuring the power absorbed by each railway in its lift circuit. After these come 12 train section and track feeder panels, with a capacity each of 3,000 amperes. They are individually fitted as follows: two single-pole. 3,000-ampere circuit breakers, one 4,000-ampere illuminated dial ammeter, and two 3,000-ampere single-pole knife switches; this double-pole arrangement being necessary, as

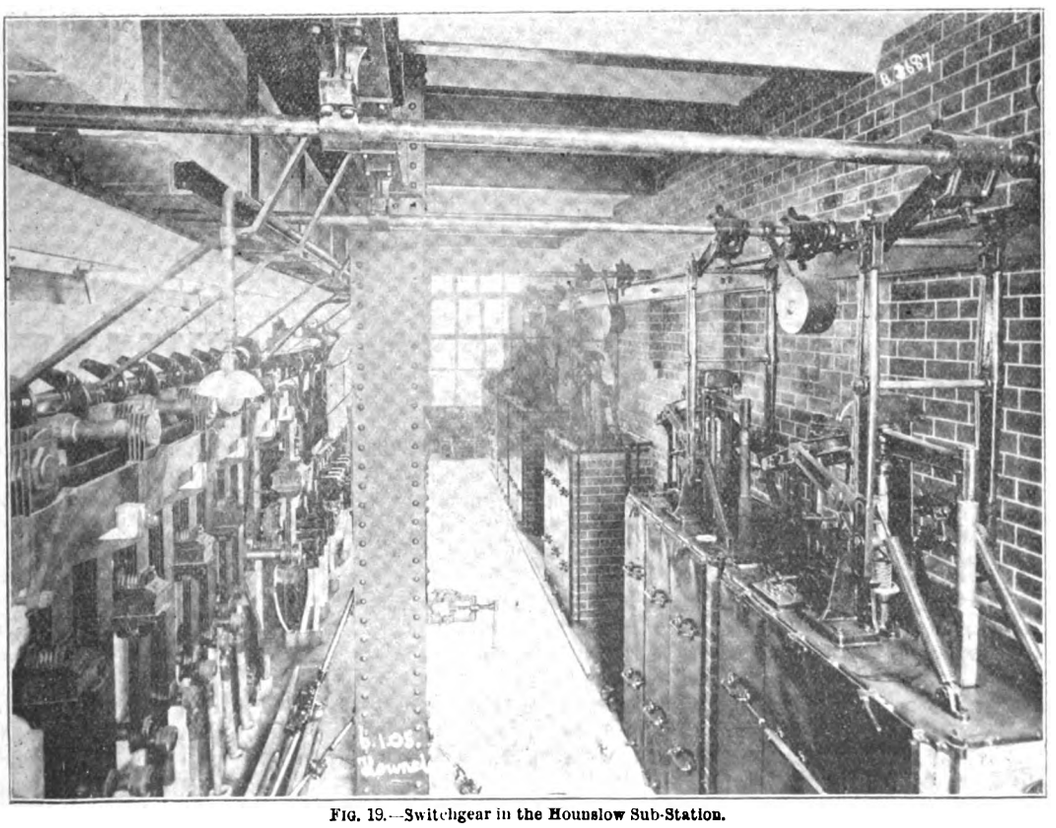

FIG. 19.—Switchgear in the Hounslow Sub-Station.

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both the positive and negative current rails are insulated from earth throughout. The 'bus bars, which are built up of 6in. by ¼in. copper strip, are arranged with a ventilating space between each section instead of being clamped together solid, as is frequent practice. The small wiring of the switchboards, which so often constitutes a danger, has been very carefully carried out, and is neat and at the same time thoroughly mechanical. The low-tension alternate-current ammeters are all operated by small series transformers, which in themselves are decidedly unique. They consist only of a magnetic circuit and a secondary winding, and all that is necessary is to slip them over the switch studs which form the primary, inducing by the virtue of the current flowing in them the secondary current that operates the instrument. By the arrangement of the whole of the high-tension gear, such as cable ends, series transformers, etc., on an incombustible brick wall divided into small cells, fire and life risks are minimised to a great degree. In similar but horizontal cells the high-tension 'bus bars are placed, and the lightning arresters have each a separate cubicle, with a fireproof door completely isolating them but rendering access easy.

Hand operation is used for all the high-tension oil-break switches (Fig. 18) in the sub-station, and this is effected through gearing by large levers. As before mentioned, they are electrically tripped. The switches are erected in a masonry structure with each of their three poles, and the oil-tank in which they are immersed, in a separate fireproof compartment. Two stationary contacts, mounted in large porcelain insulators, are provided for each pole, one being connected to the incoming lead, and the other to the outgoing. The movable contact, as shown in the illustration, consists of a copper bridge-piece mounted on the end of a strong wooden rod, which latter is fastened at the upper end to a cross-bar common to all three poles. In closing, the magnets mounted on top raise the contacts with the assistance, initially, of a pair of balance springs, and through the agency of a system of levers that give a straight-line motion. The switch is kept closed by a toggle joint, which automatically locks the levers, but upon putting the tripping gear into action, the toggle is released, and gravity, assisted by a powerful spring, causes the cross-bar and contacts to drop to the open position. The oil-tanks, which may be readily disengaged from the contacts, are constructed of heavy sheet metal, and lined internally with an insulating cement moulded to fit closely round the terminals and moving contacts. The amount of oil required and fire risk are thus reduced to a minimum, and the wooden rod carrying the contact piece interposes an effectual barrier between the two terminals of each pole. The tank is fitted with a gauge glass that shows the oil-level at sight, and draining and refilling arrangements are provided that allow the oil to be changed without putting the switch out of service. The small double-pole two-way knife switch mounted on the top of each case is connected in the red lamp indicating circuit above mentioned, and is operated by the movement of the main switch levers, changing its position as the switch moves from "on" to "off," or *vice versâ*. The essential features of this oil-break switch may be shortly summarised as follows: a positive and direct action, the maintenance of the open position by gravity, the immersion of all live parts in oil, high insulation and great freedom from fire and shock risks, and accessibility for cleaning and repair.

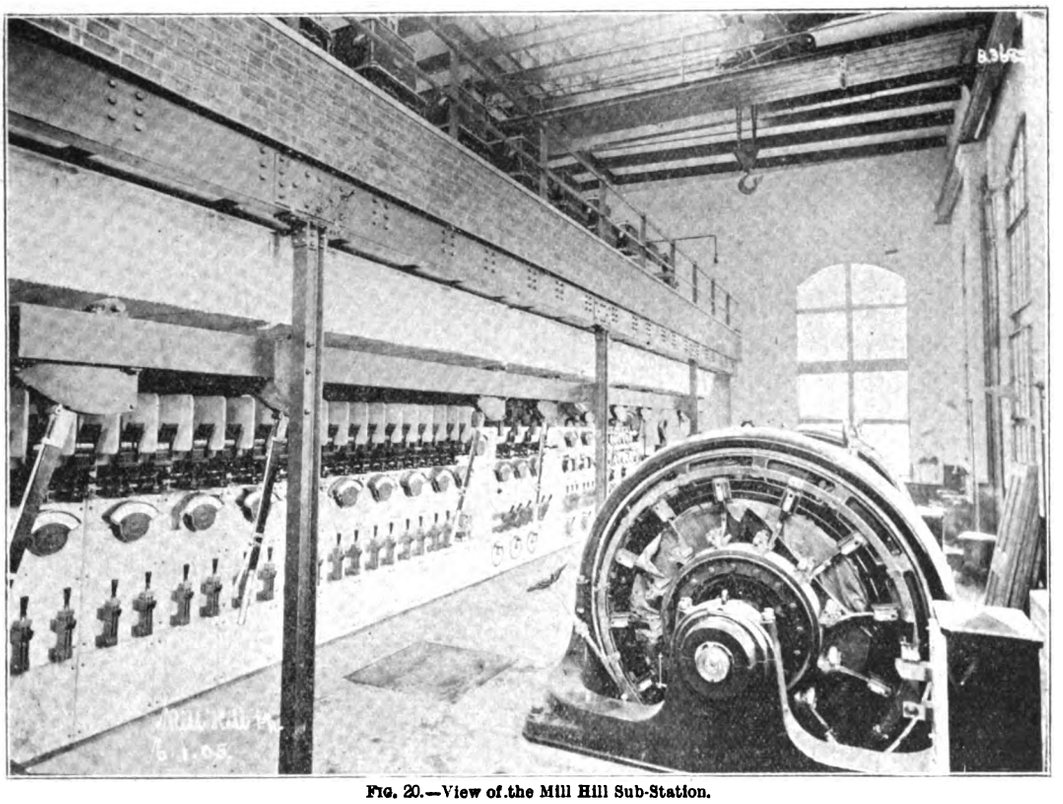

FIG. 20.—View of the Mill Hill Sub-Station.

## AUTOMATIC SIGNALLING ON THE UNDERGROUND.

In anticipation of the more strenuous conditions caused by the shorter headway planned, the District Railway Company has had installed a system of signalling for which great improvements over all earlier systems are claimed. This plant presents features of more than ordinary interest, and is, moreover, the first installation of its kind in this country. The section of line between Hanger-lane Junction and South Harrow has now been worked electrically by the District Railway for over a year, with results that augur well for its success on the more important sections of the line. The length of this trial section is about five miles of double track, and it is divided into block sections varying in length from 1,400ft. to about 3,500ft. On the District Railway generally there are both positive and negative insulated traction rails, the running rails not being used for the traction current. The space between stations is usually divided into two blocks—that is, a "starting" and a "berth" block—and the signalling is on the "normal clear" principle. The signals themselves are of the ordinary mechanical type, and in no way specially adapted for power or automatic working; consequently they are being replaced by special arms with Westinghouse electro-pneumatic signal motors fitted close under them, and the ordinary counterweight abolished for one directly on the signal arm, as shown in Fig. 1. The motors are

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enclosed in cast-iron casings, and being essentially strong and simple are not affected by climatic conditions. They are controlled by small pin valves worked by means of electromagnets in the local signal circuit. Signal cabins are required only at each end of the branch, or where there

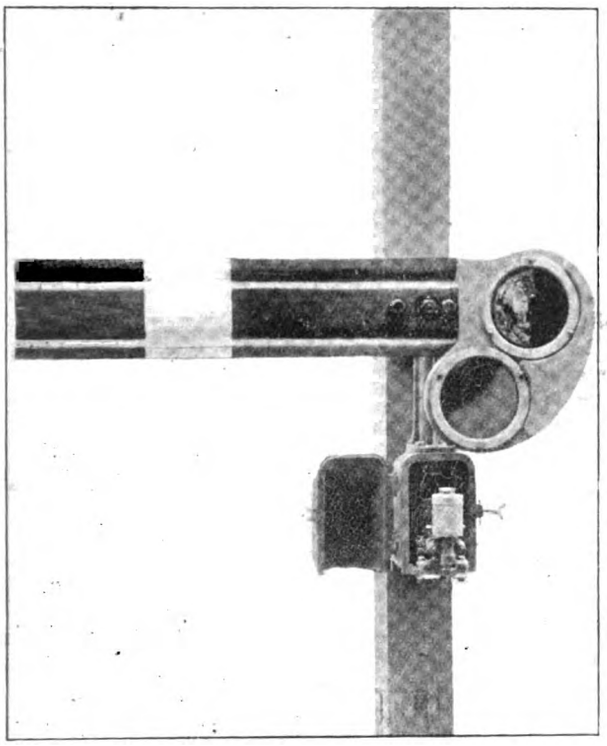

FIG. 1.—An Underground Signal Arm worked on the Westinghouse Electro-Pneumatic System.

is a cross-over road; in the latter case they are normally closed, being opened only when required. An automatic stop (Fig. 2) prevents trains from over-running home signals. This consists of an iron arm between the track rails actuated by a compressed-air motor acting in unison with the adjoining signal motor. When the signal goes to "danger" this arm is elevated to a position in which it engages with a cock on the air-brake system of the train; thus the brakes are instantly and automatically applied if for any reason the driver should run past the signal.

No great saving in first cost need be expected from an automatic installation, as the initial expenditure would probably be quite as great as that incurred in laying down the mechanical system. The working expenses, on the other hand, should be very much reduced, the saving in labour being a most important item, and the cost of renewals and repairs trifling. But, undoubtedly, the greatest advantage of an automatic system is its suitability to the requirements of a very frequent and quick service. The blocks may with facility be made as short as is compatible with the running speed and brake power of the trains. The strain on the signalmen, inseparable from such a service, is abolished, and the safety of passengers is thus independent of the personal equation.

The principles of the system may be best understood by reference to the diagram, Fig. 3. One of the track rails is electrically continuous through the whole length of the plant, and constitutes the positive conductor from the generator to the individual track sections. The other rail is cut up into block sections by means of special rail joints insulated with fibre. All uninsulated rail joints are bonded, to ensure electrical continuity. Power for the operation of the system is generated at 65 volts pressure by motor-generators placed centrally, the negative terminals of which are connected to an insulated negative main running the entire length of the system. This main is connected to each section of the sectionalised track rail at a point near the latter end of the block—*i.e.*, the end at which the train leaves, as distinct from the end at which it enters. It will be seen, then, that there is a potential difference of approximately 65 volts between the continuous positive rail and the insulated negative main. Resistances are interposed in the connections between the negative main and the sectioned rail which reduce the potential difference between the rails to, in the present instance, from three to six volts, according to the length of the block and various local conditions.

Let us now consider the circuit for a single block unoccupied by a train. The current from the positive brush of the dynamo flows along the continuous rail, and thence through the two relays, one at each end of the block, and through the ballast between the rails, all in parallel, to the sectioned rail. From this it flows through a relatively large resistance to the negative main and back to the machine. Now, suppose a train enters the block. Obviously

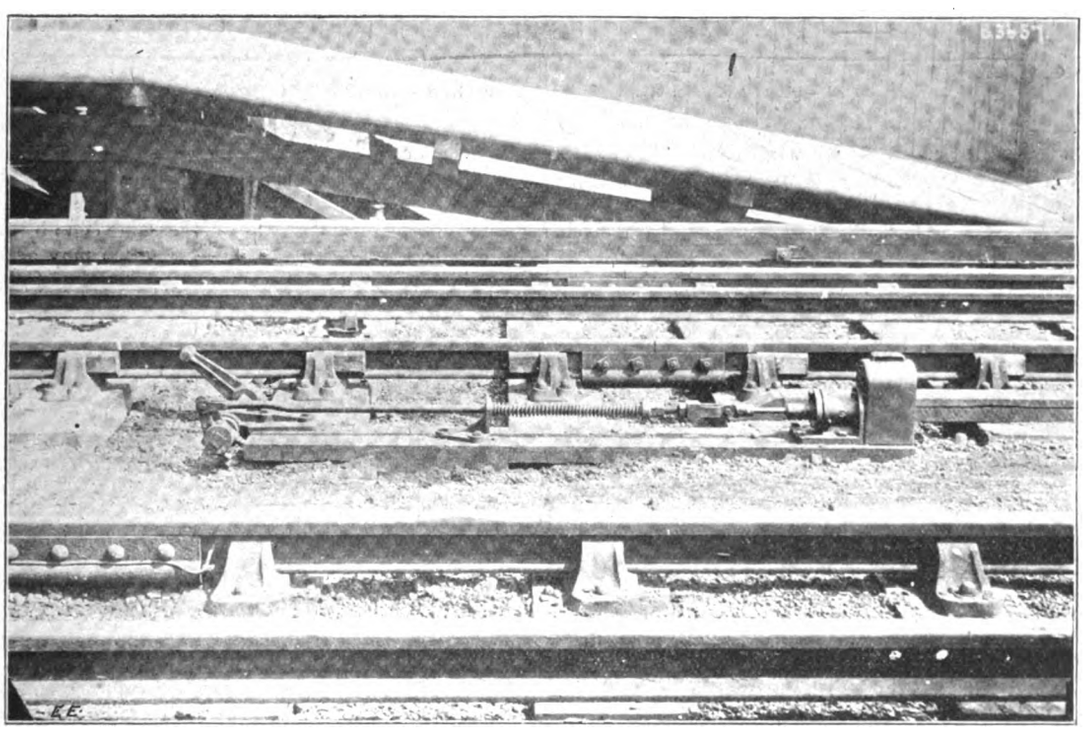

FIG. 2.—Automatic Stop to prevent trains over-running home signals.

the current now flows through the practically negligible resistance of the car wheels and axles from one rail to the other, and the relays are shunted, with the result that the signal is allowed to go to danger. The "track-battery" resistances connected between the negative main and the sections of the sectionalised rail prevent the generator being

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short-circuited when the track circuit is shunted by the axles of the train. In fact, these resistances bear such a relation to the combined resistance of the road bed from rail to rail and the two relays, all in parallel, that the shunting of the track cuts out only a small percentage of the total resistance of the circuit. Thus the current increase in a circuit, when shunted, is not great. This is important, as it is advisable to keep the track potential as nearly as possible constant. An increase of the total current, resulting from the blocks being occupied by trains, affects the potential between the rails of unoccupied sections, increasing the transmission loss in the negative main. The loss in the continuous track rail may generally be neglected on account of its large section Another circumstance directly affecting this track potential is the variation of the resistance of road bed according to weather conditions. Broken stone forms much the best ballast from an electrical point of view, and cinders the worst. It may here be mentioned, however, that though on several occasions recently the track rails on this system have been flooded, the operation of the signals has, we are informed, been in no wise interrupted.

Next we come to the consideration of the circuits of the track relays which control the signal circuits. Fig. 3 is a diagram of the relay and signal magnet circuits for a single block. The track coils of the relays are permanently connected across the rails at that end of the block at which the relay is placed. Between the pole-pieces a polarised armature is suspended from a pivot. This armature bears a winding of considerable resistance, and is connected between the positive rail and the negative main through a contact—operated by the track-coil armature—which is

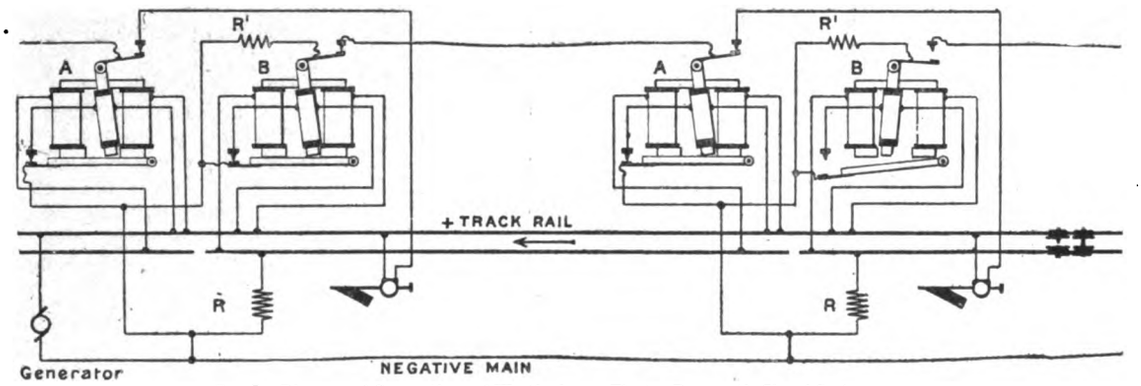


FIG. 3.—Diagram of Connections of Westinghouse Electro-Pneumatic Signal System.

closed when the track coils are energised. To the polarised armature is rigidly connected an arm which actuates a contact, the function of which is to open or close the local circuit controlling the signal motors. The operation of the relays is then as follows: When a difference of potential exists in the normal direction between the rails—*i.e.*, when there is no train on the block—the relay track coils are excited and draw up the armature, which closes the circuit through the polarised armature. The polarised armature is then attracted to one of the poles of the relay, and, swinging over, closes the contact in the local signal circuit. As already mentioned, there are two relays in each block, one at each end. These are duplicates, and operate normally in a precisely similar manner, each working a contact in the local signal circuit. These contacts are in series, as shown clearly in Fig. 3—relays A and B—and unless they are both closed no current can flow through the signal magnet, and the signal will, therefore, remain at "danger" by gravity.

The position of the apparatus when the block is empty has been indicated above: both relays energised, the local signal circuit closed, and the electromagnetic valve operating the pneumatic signal motor consequently open, admitting compressed air to the motor, which holds the signal arm "off." As soon as a train enters the block the relays are short-circuited by the car axles and thereby de-energised, permitting their armatures to drop, and thus breaking the circuit through the polarised armature coils. The polarised armatures then swing back from their position in contact with one of the track-coil pole-pieces, and in doing so break the signal circuit at two points in series. The electromagnet operating the admission and exhaust valves of the pneumatic signal motor is de-energised, and the exhaust is opened, permitting the signal to return to "danger" by gravity. It is, of course, a condition of successful automatic signalling that any interfering influence must, if it has any effect at all, cause the signal arms to go to "danger," and not bring them "off."

So far, so good; but experience has shown that the greatest obstacle to the success of automatic signalling, on electric railways in particular, is the liability of the relays being operated by extraneous currents so as to cause a false "clear" indication when danger should be shown. The particular claim of the system under consideration is that it is impossible for an extraneous current, from whatever source, to bring the signal arm to the "off" position when it should stand at "danger." The main source of extraneous currents affecting the signals is the 500-volt traction power circuit, and when, as is the case at Ealing, the track is not used as a return, the presence on the block sections of current from this source is abnormal. Faulty insulation of the train equipment, positive and negative rails, positive cables, etc., is the most frequent cause of leakage to the track rails. Whether currents other than the signalling current on the track rails are normal, as would be the case were one of the track rails used as a power return, or abnormal, as in the present case, is immaterial; such currents would be equally disastrous to a susceptible system, and are, it is said, impotent to affect the system considered. Faults in the main power circuit occur with sufficient frequency to demand the closest attention on account of the disorganisation of the traffic which they may cause, but even if they were rare, the least liability to give false signal indications of safety would forfeit all claims for consideration.

Although in the present system it is possible for the extraneous currents to energise either one or both relays while the train is in the block, these latter are so interconnected that it is not possible for them both to be energised in the normal direction at the same time by extraneous currents. The various conditions which may occur with a train in the section may be ennumerated as follows: both relays shunted, no extraneous current (normal); one relay shunted, the other energised normally (signal circuit broken at one point); one relay shunted, the other energised reversely (signal circuit broken at two points); both relays energised, one normally and one reversely (signal circuit broken at one point). As will be plainly seen, the circuit through the signal magnet is designed to be always open at one point when a train is in the section, and often at two.

A few words may be added with regard to reliability. The only part of the mechanism which can be described as in any way delicate are the relays, and these are enclosed in weatherproof boxes, where they can readily be examined at intervals. The air pressure used is about 70lb. per square inch, which enables compact motors to be used for signals, points, stops, etc. The air motors employed work, we are told, year in year out without giving the least trouble. The piping is compact, the electrical wires few and small, and the alterations to the track of a trifling nature. The system is applicable where track return is used with either third rail or overhead trolley wire. The signal motors, relays, and other special apparatus were manufactured at the London works of the Westinghouse Brake Company, and supplied direct to the Underground Electric Railways Company of London, Limited, who installed the apparatus themselves.

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## ARMATURE WINDINGS OF THE CLOSED-CIRCUIT TYPE.

BY WM. CRAMP.

*(Continued from page 152.)*

**Examples.**

Following these rules, we have for Fig. 11 :

| | |
|---|---|
| Number of inductors ..... | 64 |
| Forward number-pitch ..... | 17 |
| Backward number-pitch ..... | 13 |

The winding table runs :

1——18——5——22——9, etc.

It is curious to note that inductors of each winding come together in pairs around the armature.

As another example of such a winding :

| | |
|---|---|
| Four-pole machine—number of inductors | 228 |
| forward number-pitch ... | 57 |
| backward number-pitch.. | 53 |

The winding table will run :

1——58——5——62——9——66, etc.

Of course, it is obvious that a single *spiral* may consist of any number of turns, and that in the case of slotted armatures the number of conductors must be equal to, or a multiple of, the number of slots.

But inasmuch as the *raison d'être* of a double winding is the impossibility of always being able to get with a single winding as many commutator sections as are necessary for sparkless commutation, it is rare to find a double-wound armature with more than one turn per section. For it must be remembered that, with a given number of armature inductors in a single winding, the maximum possible number of commutator sections is half the number of inductors, and it is only when this number of sections is not sufficient that a double winding (with double the number of commutator sections) is resorted to. Thus, without losing space in a discussion upon the best arrangements for double and triple windings with more than one turn per section, we may pass immediately to the consideration of those armatures in which the re-entrancy is not the same as the number of windings.

**Re-entrancy Independent of the Number of Windings.**

In all the cases so far discussed the re-entrancy has been equal to the number of windings—a double winding was doubly re-entrant, and so forth. We come next to a class slightly different, in which the re-entrancy is not equal to the number of windings.

Take a Gramme-ring armature and place 16 spirals upon it, somewhat like Fig. 1, but let them be spaced so that the distance between spiral 16 and spiral 1 is half the distance between any other two neighbouring spirals: or, in other words, set out with a distance-pitch equal to $\frac{2}{31}$ of the circumference (instead of $\frac{1}{16}$ as in Fig. 1). Then the distance between spiral 16 and half-way between spirals 1 and 2 is also $\frac{2}{31}$ of the circumference ; so that having arrived at 16 the winding naturally continues with the *same pitch* once more around the armature, and then closes at 1. All this is clearly shown in Fig. 12. If we now connect the spirals regularly down to a commutator (as has been done in the previous cases), we find that we have an arrangement which is very closely allied to Fig. 10. Thus in Fig. 12, where this new construction has been carried out, the spirals in series between the two upper brushes are Nos. 1, 2, 3, and 4, and also as a second series in parallel with these spirals *a*, *b*, and *c*. Closer examination will show a similar state of affairs at each of the other brushes.

Note specially that the spirals 1, 2, 3, and 4 are *not* in series with *a*, *b*, and *c*, but in *parallel* with them. Therefore, considering the upper half of the armature alone, between these two upper brushes we have the sum of the electromotive forces due to an average of about $3\frac{1}{2}$ spirals, but the current is due to *two sets* of about $3\frac{1}{2}$ spirals.

As in Fig. 10, so in this case, the fact of these two sets being always in parallel depends on each brush never touching less than two sections ; so that it is clear that the winding is simply another form of double winding, but this time *it is singly re-entrant* (only closes upon itself once), and has *an odd number of spirals*—viz., 31. The voltage is obviously that of a machine having a single winding and $15\frac{1}{2}$ turns on the armature ; but if the winding is of the same sectional area throughout as such a single winding, the current which the machine will carry will be doubled by the use of 31 spirals, provided that the

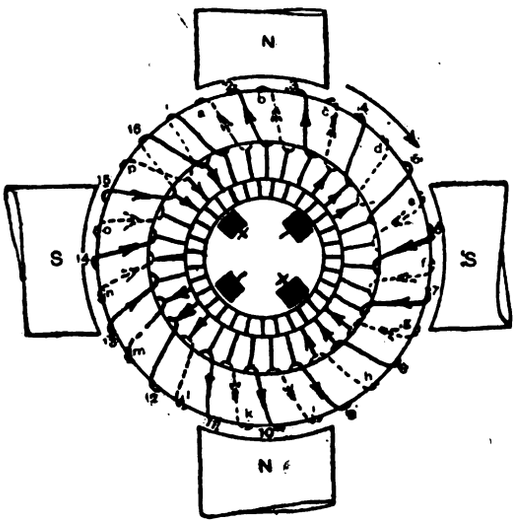


FIG. 12.

brushes are wide enough to make contact with at least two segments of the commutator.

**Reason for the Odd Re-entrancy.**

We may now ask, why it is that this winding is singly re-entrant? It is because *while it has a pitch like a double winding it has also an odd number of spirals*—that is to say, it does not obey in full the first rule of multiplex windings given on page 187. The number of spirals on the armature is *not* a multiple of the number of windings, or, rather, we have a multiplex armature whose windings are not independent ; for a single ring winding with 31 spirals would naturally have a distance-pitch equal to $\frac{1}{31}$ of the circumference, just as the distance-pitch in Fig. 1 is $\frac{1}{16}$ of the circumference. But this 31-spiral winding has a distance-pitch of $\frac{2}{31}$, being, in this respect, similar to Fig. 10, which with 32 spirals has a distance pitch of $\frac{2}{32}$. Like Fig. 10, it has a distance-pitch of a *double* winding, but the number of spirals upon the armature is not divisible by 2.

It thus appears that whether a ring winding is simplex, duplex, or triplex depends simply upon the *pitch chosen* with respect to the *number of spirals*, but the *re-entrancy* is dependent upon the *total number of spirals*. The above winding, for instance, is a double winding, because the distance-pitch is $\frac{2}{31}$, but it is a singly re-entrant winding, because while the distance-pitch is $\frac{2}{31}$, the number of spirals is 31. In the distance-pitch fraction given above—viz., $\frac{2}{31}$—it will be noticed that the numerator gives the number of windings, while the denominator gives the number of spirals.

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Now, if we follow the first rule given on page 187, the number of spirals should be divisible by the number of windings. Thus, in Fig. 10, the number of windings is 2, the number of spirals 32, and because 2 and 32 have the common factor 2, the winding is doubly re-entrant—that is to say, it may be split up into, or considered as, *two separate single windings of sixteen spirals each*, each with a distance-pitch of $\frac{1}{16}$. From this clearly follows the very important rule: *In a ring armature the G.C.F. of the number of windings and the number of spirals gives the re-entrancy.*

So long as the number of windings upon the armature were entirely independent of each other, there could be no mistake about the meaning of the word "winding" in this connection. But now that we find that an armature may have a double winding *without two independent windings*, some confusion is likely to arise as to the exact meaning to be attached to the word.

In a ring armature we take the definition of a "winding" to be: *A set of spirals placed upon the core permanently in series with one another, and forming one complete annular helix, whether closing upon itself or not.*

With this definition the series of spirals marked 1 to 16 in Fig. 12 is just as much a winding as the series dotted in Fig. 10, although in the former case the particular set of spirals does not close upon itself.

*(To be continued.)*

## DISTANCE-CONTROL SWITCHES AND THEIR LAY-OUT IN STATIONS.

BY W. E. WARRILOW, A.M.I.E.E.

(*Continued from page 119.*)

**Another magnet pull switch somewhat similar to that just described is the distance-controlled switch of the British Westinghouse Company. This is illustrated in Fig. 21, which shows back and front views of the arrangement. As compared with the device just mentioned, a marked difference in the disposition of the terminals and contacts will be noticed. In Fig 20 these are below the bridging contacts and subjected to the weight of whatever oil is in the container, while in Fig. 21 the contacts depend from the supporting base, and the switching or bridging piece hangs below them, the oil-tank being also hung below the contacts, the latter dipping down into the oil. This method, though cramping the connections somewhat at the supporting base, has the advantage of removing one of the weakest spots in the oil container—a terminal at the bottom of the tank in an inaccessible position and subject to leakage of oil. There are, of course, many hundreds of the latter switches in use giving entire satisfaction, but whether oil trouble be responsible for the type or not the latest designs of oil switches, large or small, are fitted with terminals depending into the oil. Referring again to Fig. 21, the two pull magnets will be noticed at the top of the switch. The plungers of these, through chain links and a system of levers, operate the main switch rod, a heavy casting coupling the rods of the three bridging contacts together. The switch is held in the closed position by a pair of toggles, the centre of which is broken by a blow from a tripping magnet when opening the switch.**

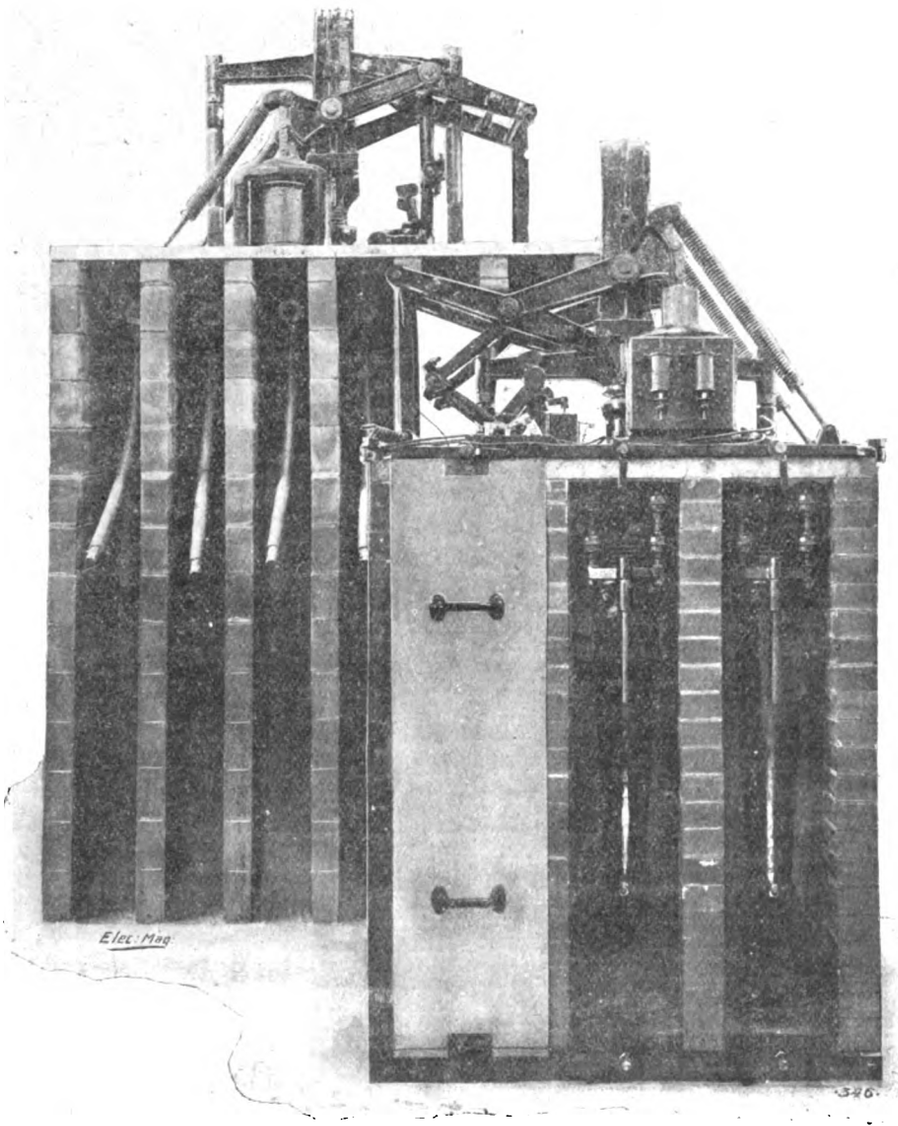


FIG. 21.—Magnet Pull Switch for 33,000 volts (British Westinghouse).

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The weight of the parts assisted by powerful springs carries the cross-bar and contacts sharply to the off position. A D.P. D.T. switch on the main base is operated by the lever motion in such a way that when the main switch is closed the trip coil is placed in circuit, and when the latter operates to open the switch, the small switch closes a signal lamp circuit on the control table, signifying to the attendant that the circuit breaker has been automatically tripped. When

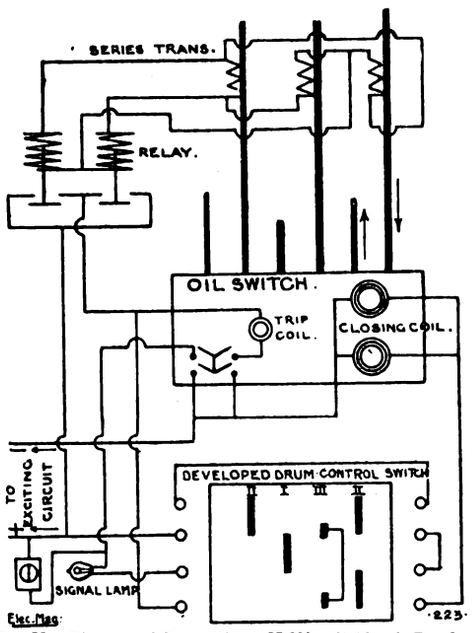


FIG. 22.—Diagram of Connections, 33,000-volt Circuit Breaker.

opened by the attendant the switch does not give this signal. A diagram of the connections is given in Fig. 22. A circuit breaker of the above type is standardised for pressures up to 33,000 volts. Needless to say, the oil-tanks can be lowered to expose the contacts and open up all the vital parts of the switch.

Another design of switch employing pull magnets is illustrated by Fig. 23. It is a type made by Witting, Eborall, and Co., Limited, and will shortly be installed at

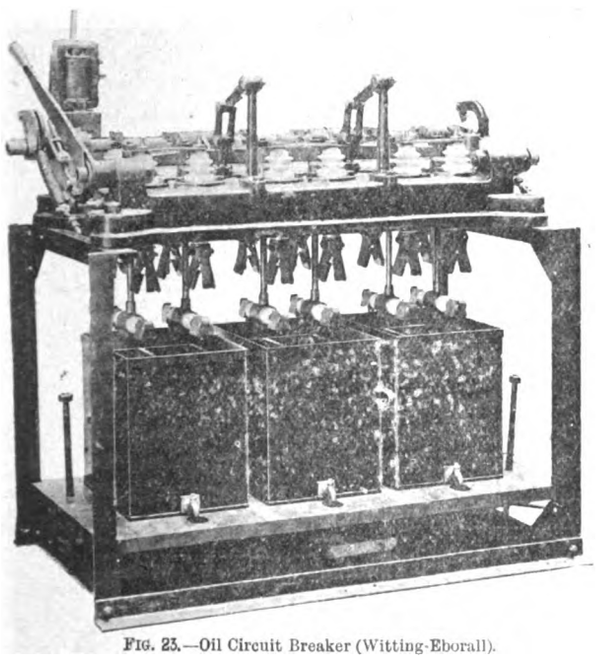

FIG. 23.—Oil Circuit Breaker (Witting-Eborall).

Glasgow and other places. Here, again, the underhung contacts will be noticed and the contact bridges dropping clear into the oil, both fixed and moving contacts being immersed in the oil. The control magnet is mounted at the top of the switch, but is not shown in the illustration, a handle for testing purposes being mounted in its place. There is one tank per phase and two contact bridges per circuit, giving four breaks in series per limb. The switch rods are all coupled to a common cross-head, and at two points equally spaced on this two curved links are pivoted at their centre, their ends being respectively hinged to a swing link fastened to the switch, and a small link and lever fixed to a common crankshaft. The latter runs the length of the complete switch and terminates at one end in a crank suitably connected to the pull magnet. At the other end a smaller crank operates a controller, the functions of which will shortly be referred to. At both ends are powerful springs which assist the action of the switch when being opened. When closed, the shaft is turned and the operating levers are raised, the curved links with swing links drawing up the cross-head and contact bridges. The switch is held in by a catch, which is tripped by an overload or reverse-current device, the solenoid for which can be seen on the left of Fig. 23. The small controller (not shown) performs the following functions: (1) when the switch is closed it breaks the synchronising circuit, thus removing the load of the lamps and synchroscope from the synchronising transformers; (2) it breaks the tripping magnet circuit when the switch is opened, the spark which would otherwise form on the relay contacts thus taking place at the controller; (3) it closes the signal lamp circuits when the switch is closed. For a feeder circuit the controller is, of course, much simpler. A small two-way switch on the operating panel is used to open and close the main circuit breaker. When thrown in one direction it closes the pull-magnet circuit, while in the opposite direction it energises the tripping coil. When released from either position the switch flies to central off position, and thus entirely prevents either circuit being left permanently closed. The oil-tanks of this switch are teak lined, and divided by marble slabs into two parts for the different breaks for each pole, a separate tank per phase being provided. The tanks can be raised and lowered simultaneously for inspection of contacts, oil renewal, etc., and the entire switch is made to slide on rails to render withdrawal easy. Such a switch will control successfully a 3,000-kw. circuit, and break a circuit many times in excess of this if needed. It can be used for the parallel operation of generators of the above size.

*(To be continued.)*

## STUDENTS' WORK IN PLANNING CENTRAL STATIONS.

BY E KILBURN SCOTT, A.M.I.C.E., M.I.E.E.

It occurred to the writer that it would be good exercise for the senior students at the Northampton Institute to plan out a central station. The information given to them was: length and width of engine and boiler house, 100ft. by 50ft. each; approximate size and duty of a Babcock boiler, 16ft. by 23ft.; the number of tubes of a Green's economiser; the output and size of a slow-running single-crank tandem compound engine driving a multipolar traction generator; the internal diameter of a steel chimney, 7ft.; also the information that the coal was to be dumped at one end of the power-house, and carried by a spiral conveyor along the front of the boilers for hand firing.

The students were required to get into the space available as much plant as it could conveniently hold, taking into consideration all questions of lighting, positions of doorways, gangways between the various units, suitable spacing for condensers and other auxiliaries, and proper position for the chimney with a view to shortening the flue, and, in fact, all the various points which must be taken into account when such a station is laid out in an engineer's drawing office. They were also required to fix the relative positions of the dynamos and switchboard, with a view to the easy operation of same, and for economy and convenience in the connecting cables.

Figs. 1 to 3 show the result of about 1½ hour's work by various students, and it is interesting to see how they have arrived at different arrangements, each of which may be said to be a reasonable solution. The spacing of the pieces of machinery was done in the usual manner by cutting out pieces of paper to size and moving them about until the proper distances had been arrived at.

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There are many examples like this which might be set to students in colleges, polytechnics, etc. For example, one very good test would be to give the students a patent specification to draft on some improvement or other detail of, say, a dynamo machine. The question of whether it was a patent or not would not affect the matter so very much, but the practice would be extremely valuable. In the case of colleges or day classes it might include a certain amount of searching and a report on existing patents for a year or so. Of course, in order to enable them to set about the work, the lecturer should first give them a short description of how to properly go about it, and also supply each student with a sample specification of some similar patent.

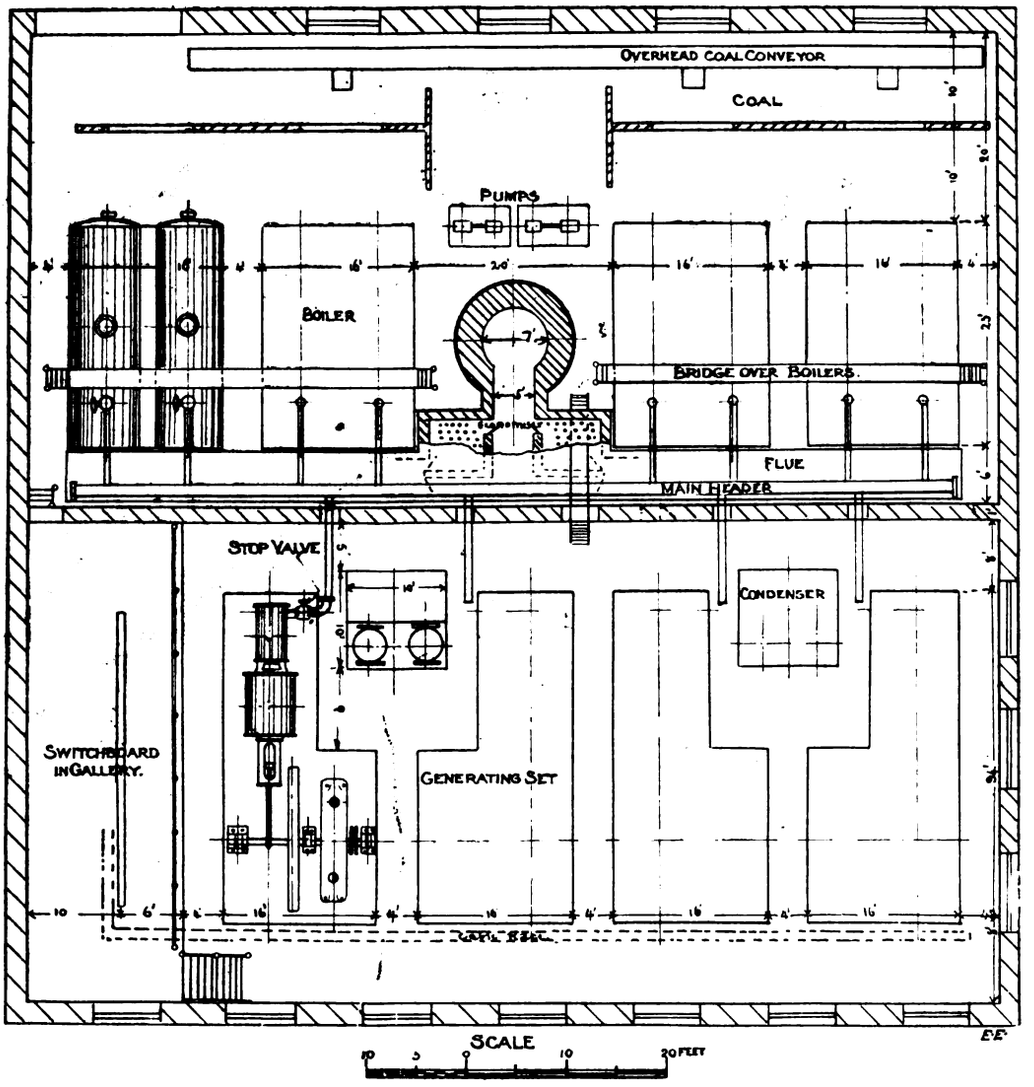


FIG. 1.

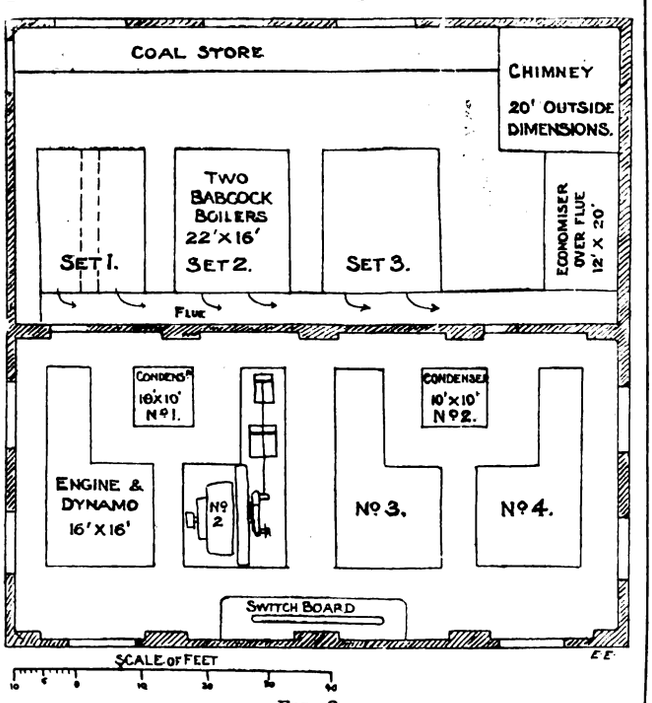


FIG. 2.

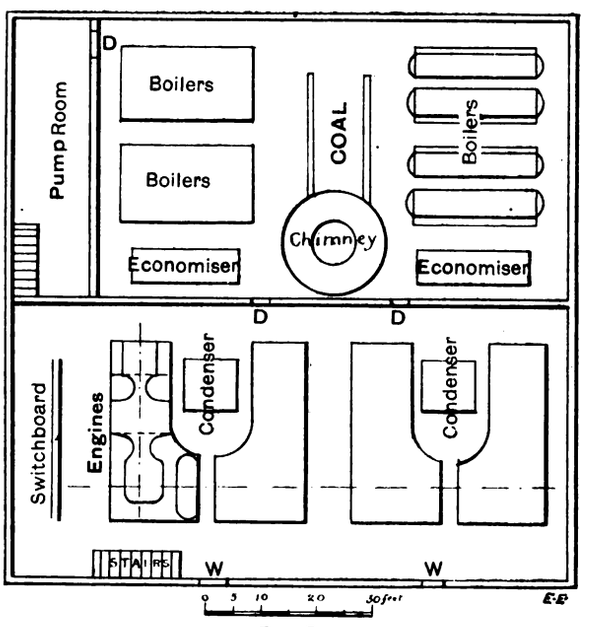


FIG. 3.

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## TIME-LIMIT RELAYS.

There is an increasing demand in an automatic circuit breaker for the introduction of a time element in its operation. Various methods of attaining this end have been tried, nearly all of which fail to conform with all the requirements of such apparatus. The timing device should,

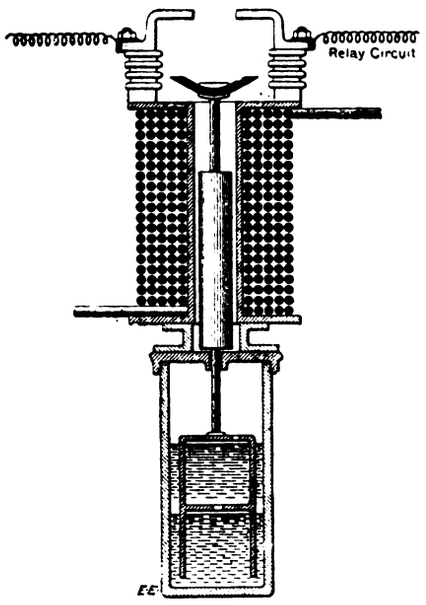


FIG. 1.

as far as possible, fulfil the following conditions: (1) the time element should be adjustable; (2) the time element should vary as nearly as possible inversely as the excess load; (3) the mechanism should return instantly to its zero position when a temporary overload is reduced to the normal load; (4) the relay should instantly trip the breaker upon the occurrence of a dead short (except in special

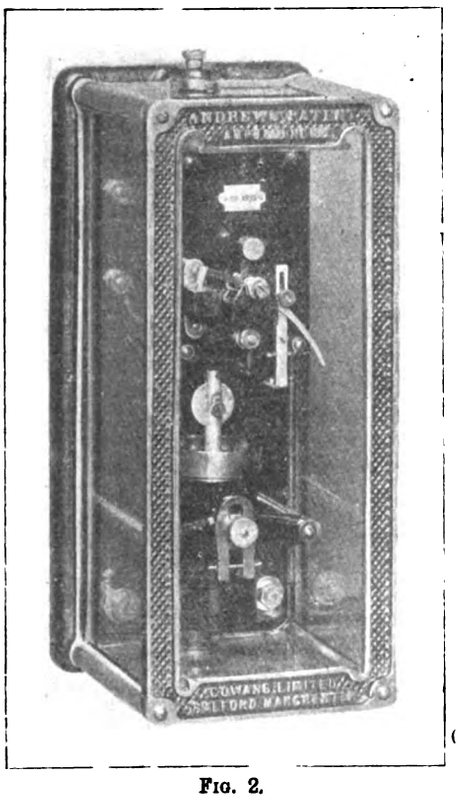

FIG. 2.

cases); (5) it is preferable that the relay shall be so designed that no attention is required for winding mechanism, etc.; (6) it should be simple in its action, and not materially add to the cost of the circuit breaker.

The time-element device illustrated and described below was designed by Mr. L. Andrews, and is manufactured by Messrs. Cowans, Limited, of Salford, Manchester. Mr. Andrews has attempted to conform, in his instrument, to the conditions enumerated above. Its action will be best understood by reference to Fig. 1. The speed at which the core is lifted within the solenoid is controlled by a diving bell immersed in mercury and oil. If the core is subjected to a small pull sufficient only to raise its weight together with the bell, it will rise very slowly, because the tendency for a vacuum to form within the bell will result in the mercury contained in its lower half being lifted. The weight thus added, which checks the upward movement, would, unless special provision were made, bring it to a standstill. The pressure of the atmosphere, however, relieves the vacuum by forcing the oil in the upper half of the bell through the small hole in the middle diaphragm, and the rate at which it does so determines the time taken by the core to travel from its zero position to the position at which it closes a local circuit, and trips the breaker. It will be obvious that the time will approximately depend upon the strength of the pull on the one hand, and the dimensions of the oil inlet on the other. In the event of a dead short-circuit, the mercury contained in the bell is raised bodily, and the action of the instrument is instantaneous.

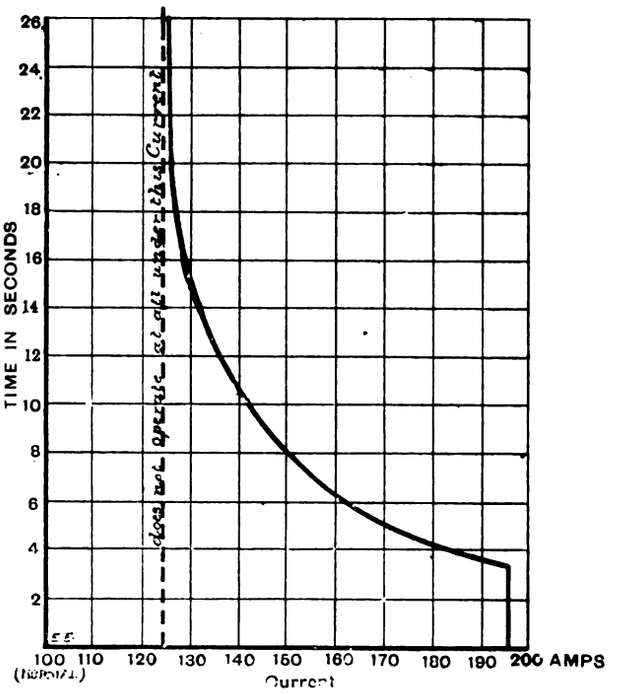


FIG. 3.

Fig. 2 shows one of 70 odd instruments supplied to the Bristol Corporation for their new switchboards. It will be seen that the mechanism is contained in a glass case, which has the advantage of keeping its working parts under easy observation. In these instruments the area of the oil inlet is varied by means of a coned valve, which is easily adjusted by means of an eccentric aluminium disc. A large range of time element can in this way be obtained from a fraction of a section to 20, 30, or more seconds.

Fig. 3 shows a curve which has been plotted from some experiments made upon one of these relays. In this curve the abscissæ denote the currents, and the ordinates the time. It will be seen that when the current reaches a certain maximum the instrument acts instantaneously. In certain cases this feature is not required, a time element being desired under the severest overload. Mr. Andrews has arranged that in these cases an additional disc shall be used which is immersed in the oil, and by its dash-pot action retards the movement under the strongest pull.

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MACHINE-TOOL ACCESSORIES.—Messrs. Edward G. Herbert, Limited, Rosamund-street East, Manchester, have sent us particulars of their Vee cramps and blocks, also of their box jigs. By the use of the latter holes can be drilled or surfaces machined on five different sides of an object at one setting. Besides saving a number of settings, this ensures that all the holes and surfaces are square or parallel to each other.

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## GUERNSEY TELEPHONY.

These are the more or less stormy days of telephony, when nothing is really settled and when everybody wonders what next. A triumvirate pulls the strings—there is a company with a virtual monopoly over nineteen-twentieths of the country; there is the Government on its trial in two or three places; and then there are the half a dozen or so municipalities also on trial. The victor, if victor there is to be, is hidden in the mists of futurity. All that we can do is to try and make the position clear—to indicate each step, whether retrograde or in advance. It is nearly twelve months since we commented upon the annual balance-sheet of the Guernsey telephones—to be exact, in fact, on March 11, 1904. We then rather hinted a challenge, which was accepted, to pick holes in the published accounts. The weak points were suggested, but they seemed such frivolous criticisms that no reply was needed. The system has now passed through its seventh year of working. The accounts of that year are published, and are open to comment. To us they seem as favourable as did the earlier accounts, and the concern seems to be in a flourishing condition. The prime question in every concern is, does it pay? Of course, we assume there is no faking of figures. In the first place, we will follow the method adopted last March. Then the engineer gave the cost per line as $\frac{21,262}{1,217}$ = £17. 9s. 5d. per line. Reckoning in the same manner, at the end of 1904 the figures read $\frac{23,590}{1,375}$ = £17. 3s. 3d. per line. But one critic objected to the method of computation adopted—which was,

$$\frac{\text{cost works completed and under construction}}{\text{total number of lines}}$$

arguing, firstly, that cost of land and buildings should be included in the cost. The argument against this course is forcible, but really the sum—less than £3,000—is so inconsiderable that it might be included, and we get $\frac{26,475}{1,375}$ = £19. 5s. 1d. per line. We take total number of lines, not the lines the critic termed revenue earning. Every line, be it service or sundry, indirectly assists in earning revenue, and has to be paid for to construct, and has to be provided for in depreciation. Oh, this word! Of course, the critic at once hinted that "if the depreciation fund were 7½ per cent. instead of 5 per cent.," the net profit would be turned into a loss. He forgot to say that the 5 per cent. is only one item in the depreciation, and that the real depreciation is much more. In the first place, the item reserve, depreciation, etc., 5 per cent., is exclusive of interest on capital; then amounts are written off tools and furniture accounts; then the balance profit is added to a second reserve account. The capital advanced by the States is £27,587, which, with the reserve (£5,768) and creditors (£68), brings the liabilities to £33,423 (odd shillings left out). The reserve funds increased during the year from £4,227 to £5,768, so that the reserve is over 20 per cent. of the capital. The revenue during the year was £4,546, against £4,064 last year—an increase of nearly £500. The expenditure, including interest and amount written off, tools and furniture accounts, was £3,005, against £2,709 last year—an increase of £300. The revenue per line was, in 1903, £3. 6s. 9½d., but it decreased in 1904 to £3. 6s. 1d. It is extremely interesting to watch these annual balance-sheets, and this decrease per line will need careful attention to find a cause and obtain a remedy. We quite agree with the critic to whom we have referred to above, that real comparison is impossible between what rules at Guernsey and the necessities

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of a British city, but the results of the working can be used to advantage by allowing for the variant conditions.

To jump from Guernsey to America may be permissible when telephony is in question. Last week our interviewer gave Mr. Hesketh's opinions upon American telephony. They were altogether good. On Tuesday the *Globe* says of New York telephony, "It is contended that the service is not only monstrously expensive, but inefficient into the bargain." Where doctors differ, who shall decide?

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### ALUMINIUM.

SIR,—Will you allow me to add a few words to this question, as I fail to understand Mr. W. Smith's explanation. The resistance of a conductor varies directly as its length and indirectly as its cross-section. If we increase the length in a certain ratio, and wish to keep the resistance constant, we must also increase the section in the *same* ratio. In the case under consideration the leakage current flows radially through the insulation. The length is represented by the thickness of the insulation, the cross-section by the cylinder, having as diameter the mean diameter of the insulation. Supposing the thickness to be 1 for copper and 1·3 for aluminium, then the mean insulation diameters (and consequently the circumferences) will have the same ratio, and the insulation resistances will be the same in both cases. Mr. W. Smith in his paper might have been thinking of the quantities of insulation, in which case he would be right, but the thicknesses are certainly in the ratio 1 : 1·3 —Yours, etc., R. T.

### THE METRIC FALLACY.

SIR,—With your permission I should like to refer to two or three points in the letter of Mr. Dale which appeared in your issue of the 3rd inst.

With regard to my statement that in the United States the yard is derived from the metre and the pound from the kilogramme, my authority is the Director of the National Bureau of Standards at Washington. Mr. Dale quotes Lamoitier in connection with the anarchy existing in the textile trade through the confusion of weights and measures. I should like to say that M. Paul Lamoitier is anxious to see the metric count of yarns adopted as an international one. Without professing any technical knowledge of the application of the count, it is certainly not evident that the use of the present, or a metrical, count is in any way regulated by the existing laws in France relating to weights and measures.

One moment's thoughtful consideration would convince any of your readers that the number of threads of silk in a given weight of the twisted material is not a matter which has been brought within the scope of any Weights and Measures Act in any country. The whole of Mr. Dale's contention about the unsuitability of the metric system for textiles is just as wide of the point as if he had claimed that the metric system was unsuitable to the publishers' trade because he had found a number of books where the pages did not number out to an even decimal number, or because the measurements of the books were not precise metric measurements.

The fact that there is a desire to adopt a metric count for yarns show that there is in the yarn trade a number of merchants and manufacturers who think it would be a means of securing international uniformity in the numbering of yarns. Mr. Rowlett's letter of Jan. 20 bearing on this point makes the attitude of the textile trade towards the metric system tolerably clear.

Mr. Dale quotes from John Quincy Adams on the subject of useful proportions in our weights and measures, but as his quotation refers to the American ton of 2,000lb. we lose some of the usefulness. Of course, it is perfectly well known that a relation exists between our weights and measures—it would be impossible to invent a system without one; but it can hardly be argued that the relationship in the British system—viz., a cubic foot of water weighs 1,000oz.—can compare for simplicity of manipulation with the corresponding relationship in the metric system, where one cubic centimetre of water weighs 1 grm.

I am happy to accept Mr. Dale's correction in regard to the size of the American gallon; it will make no difference to the argument.

With regard to the survival of "customary" British standards, I think Mr. Dale misapprehends the point. The survival of old French standards has been adduced by others as an argument against the *merits*, not the *introduction* of the metric system, and I ask if similarly the survival of "customary" measures in this country is to be taken as detracting from the merits of the British system?

Mr. Dale makes light of the chaos that exists at present in our weights and measures, but there is ample evidence that advantage is taken of this confusion by dishonest traders. Mr. S. Wallace, M.P., informed the Select Committee of 1895 that there had been many financial disasters in 1894 to people who bought Canadian hay in tons of 2,000lb., purchasers thinking that they were buying at 2,240lb. to the ton. Within the last few days, a correspondent has informed me that an English firm of pump-makers found their chief competitor to be from America, "which has an old gallon weighing about 8½lb., and *consequently their pumps appear to give* more gallons than ours" We should hardly expect to find the American pump-makers in question anxious to have a similar gallon to ours.

Mr. Dale's concluding sentences are interesting. "America is with you in language, common law, weights and measures." Well, we are not dealing with language, or common law, but his own letter supplies evidence that America is no longer with us in weights and measures. He admits a different bushel and gallon, and I might now instance our stone and hundredweight. And one wonders whether, in the question of coinage, America sold any part of her birthright for what Mr. Dale might call a "mess" of decimal or any other kind of "pottage."—Yours, etc.,

E. JOHNSON, Secretary, Decimal Association.

SIR,—In your issue of Jan. 20, Mr. Rowlett, of the Comité permanent des Congrès internationale de 1900 pour l'unification de numérotage des fils, states that the "chief reason why the metric system in numbering yarns has not been universally adopted, is that Great Britain has refused to agree." In addition to the English system, which is the single standard for linen, and the metric system, which is used to a limited extent for wool, the French use 10 different systems of numbering yarn They are the Roubaix, Fourmies, Elbœuf (three), Reims, Sedan, Vienne, worsted, and cotton methods. All of them originated in France, and have persisted in spite of every effort by the French Government and people for more than a century to eradicate them.

On what theory is Great Britain responsible for this anarchy of French standards? Why has not France abolished these standards and adopted the metric system? The French decree of 1810, making the metric system the standard for linen, hemp, and wool, is still in force. Why do the French not obey it? Is Great Britain to blame for that violation of French law?

Mr. Rowlett says that "one result of the congress of 1900 at Paris has been the adoption by users and makers of raw and thrown silks, including the Silk Association of Great Britain and Ireland, of the metric numbering of silk for international purposes." The French decree of 1866 provided for a gramme-500 metre standard for silk. It has been a dead letter from the date of its passage. The Paris Congress of 1900 adopted the Italian system of numbering silk with a basis of 9 instead of 10, and actually called it decimal and metric. The Comité permanent des Congrès international de 1900, of which Mr. Rowlett is a member, has since repudiated this action of the congress, and adopted a fixed weight system of 1,000m. per kilogramme for silk, in opposition to the universal fixed length method of the silk trade.

Can Mr. Rowlett name a single silk mill in the entire

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world that has changed its *denier-aune* system because of these various resolutions? Can he tell us what the metric system of numbering silk is?

If the French will not obey the law of France, how can we expect the resolutions of the Paris Congress or its Comité permanent to be obeyed by the textile trade of the world?

Mr. Rowlett advocates the metric system "in the interests of the simplification of education," doubtless referring to the well-known claim that the introduction of the metric system would save from one to three years in the school life of every child. I would like him to reconcile that claim with the fact as disclosed by the Board of Education of New York that only 34½ weeks of the eight years of school attendance is occupied with mathematics, and that of this time 20 per cent., or only $6\frac{8}{10}$ weeks, is devoted to compound numbers, weights, and measures.—Yours, etc.,

Boston, Mass., Feb. 4, 1905. SAMUEL S. DALE.

## TELEPHONE RATES.

SIR,—In a spirit of extreme weakness I take up my pen again. Your stern reproofs I admit are not wholly undeserved. Some of my remarks were certainly frivolous. But when people become personal, I have a tendency to become frivolous. If you will blue-pencil the personalities, I will abstain from harmless frivolity. In that way controversy may be shorn of its jagged angles, and the path to truth made easy.

You will pardon my insistence, but I am not content to be contradicted on a question of fact. The third paragraph on p 26 of the *Electrical Engineer* clearly shows that the argument was that a rate of £5. 10s., or between £5 and £6, is the proper thing for this country, and that the whole business must be judged in advance by such a figure. Therefore, £5. 10s. was the pivot of the argument, and was not merely assumed for the sake of illustration. Perhaps you will kindly reprint that part of the paragraph which contains the figures, beginning "The people's part" and ending "compulsorily by arbitration," so that your readers may see clearly who is right on the question of interpretation.

Mr. John Macfee is commendably brief. Wishing to avoid the harsh language apparently inseparable even from a 10-line letter contributed by a municipal telephonist, I can hardly be so brief in reply. Mr. Macfee says that "no rebuilding of plant will be necessary." I have had some little experience of the work required to be done in converting a large telephone system from one method of working to another, and I beg to differ. When Mr. Macfee has got a little further with the work of converting the Glasgow system, he will doubtless find reason to modify his very positive statement. My letter published in your issue of Jan. 20 was based on an official announcement in the Glasgow Press, which stated that the whole Glasgow Corporation telephone system was to be converted to an improved method of working, the method described being what is generally known as the common battery system. As a telephone man of some experience I know that such a conversion can only be carried out effectively by means of a complete rebuilding of the plant, involving new central office and sub-station equipment, and, in the case of Glasgow, probably extensive alterations to the cable plant. Evidently the Glasgow Telephone Committee and Mr. Macfee think differently, and are thinking of grafting relays and lamps on to the present call-wire equipment. I give them a friendly warning that if they proceed on those lines, their last state will be worse than their first.

Mr. Macfee considers my remarks as to the probable cost of an effective conversion and to the telephone muddle at Glasgow to be the outcome of a prejudiced imagination, and too ridiculous for comment. The only prejudices aroused in my imagination by the telephone work at Glasgow are due to the badness of that work, and to the disingenuous arguments and inaccurate statements which have from time to time been made in support of it. There was absolutely no excuse for providing Glasgow, in 1900, with a telephone system which was obsolete in every respect. In spite of the fact that that system was 10 years behind the times in all its essential features, those chiefly interested in it have, up to quite lately, repeatedly claimed that it was all that was modern and up-to-date. Under these circumstances a "prejudiced imagination" in one who knows the real facts is not altogether inexcusable.

Now, what are the facts as to telephone muddle and probable cost of conversion? According to the published descriptions, the Glasgow Corporation telephone system contains 20 exchanges. Of these, five are equipped with flat call-wire switchboards, 14 with vertical magnetic switchboards, and one with a vertical board having signals arranged for push-button calling and clearing. The public stations in the main exchange district are worked from a separate switchboard. At some of the smaller call-wire exchanges ring-off indicators have been added to the equipment, so that calling-off may be done without speaking on the call-wire. The new exchange opened last year is within gunshot of the main exchange, originally designed to serve 10,000 lines, and actually serving only between 5,000 and 6,000. The new exchange is on a totally different system from the main exchange, though it serves part of the same district. There are five different methods of working the service from the subscriber's station in vogue, and the whole service is worked on what is called the "ring-through" system, the subscribers ringing each other up. The subscriber's list contains an appalling number of notices to subscribers, telling them what to do and what not to do in working the service, both generally and in certain districts. The cable plant is laid out for taper distribution, involving a tangled collection, not merely of Y-joints, but of what might be called "octopus" joints, and the complication is increased by the distribution of the call-wire circuits. More than a third of the total length of cable in use is armoured cable, buried solid in the ground.

This is a brief description of a telephone system built all within the past 4½ years. Honestly, I do not think the term "telephone muddle" is too harsh a term to apply. However, if any telephone engineer (British municipal telephone men barred), British, Continental, or American, will state in your columns that it is not a muddle, that the above paragraph describes such work as he himself would have done, starting in 1900 to build a telephone system in a city area of a million population, then I will cheerfully withdraw the word.

Of the advisability of completely reconstructing the Glasgow Corporation telephone plant there can be little doubt. In fact, if the plant is to be put into condition to give a modern service and to be developed along right lines, it is an absolutely necessary step. I offer Mr. Macfee and the Glasgow Telephone Committee that advice free. A detailed report and estimate I should have to charge for, but I should be much surprised if the cost of such an effective reconstruction as is necessary came to much less than the approximate estimate I gave on Jan. 20. In this Mr. Bennett would doubtless agree, as he thinks that the Post Office will have to spend quite as much as they may pay for the National plant in bringing it up to date. Most of the National plant, though some of it is of older date, is more modern in type and more efficient than that of the Glasgow Corporation telephone system.—Yours, etc.,

HERBERT LAWS WEBB.

35, Old Queen-street, S.W., Feb. 6, 1905.

SIR,—I see that Mr. Laws Webb admits in your current issue that he is an employé of the National Telephone Company, with a special mission in connection with municipal telephones. So long as this is publicly admitted I have no objection to his doing his best—that is to say, by *honourable* and straightforward means—to stay the progress of municipal telephones in the interests of his employers, but I do object to anybody in such a position posing as an independent consulting engineer, expert, or critic, and I do object to underhand methods in every shape and form.

The only other point in Mr. Webb's long effusion that I need notice is his statement that while the corporations only gained 4,687 stations in 1904, the National systems in the same places gained 8,074. It is necessary to note that while the correctness of the corporation figures can in every case be checked by any ratepayer who likes to

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take the trouble to inspect the books, there is no guarantee whatever that the National Company's figures are anything but imaginary. For a long time past that company has been claiming an enormous increase in subscribers in Glasgow and other places, but this claim has not been substantiated by their published directories—a fact which has been several times pointed out in Glasgow, where the company has been challenged (of course, in vain) to support its assertions by showing its books. I submit, therefore, that the two sets of figures do not stand on the same basis as regards credibility. It is possible that the National Company has obtained a larger number of additions in Glasgow and elsewhere during the past year than the corporations, but that has only been done by pushing telephones at 25s. a year, party lines, omnibus lines, and other cheap and inefficient odds-and-ends which the municipalities disdain to touch. In every case the corporation exchanges consist mainly of direct exclusive lines, and it is these which constitute the backbone and bulwark of a telephone system. In Glasgow the Corporation have over 2,000 more direct lines than the company. The corporations also adhere strictly to their tariff rates, which are remunerative; the company confessedly elects to run at a loss. Under such circumstances, corporation systems can only subsist by supplying a superior article which it pays people to take at a higher price, and it speaks much for their vitality and recognised usefulness that they continue to expand in the face of such indiscriminate opposition.—Yours, etc.,

A. R. BENNETT.

[We insert these letters, but *here the correspondence must stop*, as it leads to no advance. Just a short reference to each letter. We reprint, as desired by Mr. Webb, the paragraph *re* £5. 10s.*, merely remarking that Mr. Bennett's argument is to establish a basis to guide the Government as to the maximum it should pay in purchasing the telephones. Naturally, he takes rates found to be remunerative, and says, "There's your factor, your guide, the maximum rate you should contemplate in your purchase." Had the remunerative rates been others, he must have used other figures. There is no dispute with Mr. Webb as to a question of fact—the £5. 10s. is a fact—provided by the remunerative rates. What Mr. Webb does not see or does not admit is that supposing the remunerative rates had been others, not £5 to £6, Mr. Bennett would then have used the mean of the other rates to show the factor controlling the limit of purchase money. Everybody uses similar methods in every business transaction throughout the entire world. Do you want to know the price of a cow? You naturally seek to know the prices generally given, and fix your own accordingly. Mr. Webb himself uses similar methods of argument when he says, or implies, all the modern telephone engineers, except Mr. Bennett, prefer the common battery system, and wants us to infer, what is probably correct, that the experience of the majority is a better guide than the experience of the unit.

Mr. Bennett's letter weakens his case. To the general public each telephone installed is a different station, and if a man gets what he wants he does not care a pin whether it is by means of a party line or any other line. The two opponents each hold the opposing system to be inefficient, and have given general or specific reasons for such inefficiency. Surely Mr. Bennett should stick to his guns. He is proud—deservedly so—of Guernsey, but in Guernsey rates stood at 30s., plus 1d. per call. Municipalities must not disdain to touch whatever is found convenient to customers, whether party or omnibus lines.—ED. *E. E.*]

* The people's part is to make quite sure in advance that no foolish contract is entered into. What is wanted are cheap rates, such as are charged by the British corporations who own telephone systems, by the National Telephone Company itself wherever it is face to face with competition, by the Continental telephone administrations, and by the independent telephone companies in the United States. All these show that a rate of between £5 and £6 per annum for an exclusive direct line to the exchange with unlimited calls is remunerative, and that is what must be insisted on in this country. If the Post Office cannot pledge itself to that in advance, then it has no right to buy the telephones. It is no use fixing a price and then discovering too late that, in order to earn interest on it, a rate of £8 to £10 a year must be charged. The business way is to calculate beforehand the maximum sum that is admissible on the basis of, say, a £5. 10s. rate, and if the company will not take it, drop the matter once and for all until the flux of time gives again the right to buy compulsorily by arbitration.

## *RE* QUESTION 755.

SIR,—In the current issue of the *Electrical Engineer*, in the "Questions and Answers" column, the second answer to Question No. 755 contains a slip which has led its writer, "W. T. W.," to an erroneous conclusion. In the course of his explanation, "W. T. W." says, after mentioning that the exhaust steam is taken into the chimney near the base, "this gives us 35ft. per second as the velocity of the steam, and consequently (of?) the hot gases within the chimney." The latter part of the sentence is, of course, incorrect, seeing that before the introduction of the steam the flue gases had a velocity of 16·8ft. per second only. To get an idea of the velocity of the mixed gases we can use the principle of momentum, by which

$$m_1 v_1 + m_2 v_2 = M V,$$

$m_1$ $m_2$ being the respective masses of steam and flue gas, and $v_1$ $v_2$ their respective velocities before impact M is the sum of the masses, and V the velocity after impact. Take the case of a plant exhausting 21lb. of steam per indicated horse-power hour, using 4lb. of fuel with 20lb. of air per pound of fuel. Then the relative masses of steam and flue gas at the base of the chimney will be 21 to $4 + (20 \times 4) = 1$ to 4, or $m_1 = 1$, $m_2 = 4$; and, further, we have $v_1 = 35$, $v_2 = 16{\cdot}8$. Substituting in the above equation $1 \times 35 + 4 \times 16\,8 = 5$ V—*i.e.*, V = 20·4ft. per second. Substituting this value in the equation $V = \frac{8\sqrt{H}(600-62)}{3\,3 \times 600}$ we find H = 88ft., thus gaining 28ft. on a 60ft. stack. In practice the gain is not so great as this, for the following reasons:

1. The value of V is not as great as obtained above, on account of internal losses in the mixture of the gases.

2. After the steam has travelled a few feet above the point of entry, where it has a temperature of about 212deg. F., it abstracts a considerable proportion of the heat in the flue gases, reducing the temperature of the latter, and this reduces the draught.

3. The steam expands with this rise of temperature, and occupies a portion of the volume of the chimney, further reducing the draught by a throttling effect.

These considerations show, what has been found in practice, that turning exhaust steam into a high chimney has very little effect on the draught.—Yours, etc.,

B. W. X.

## FOREIGN LAMPS.

SIR,—With reference to the "flame" arc lamps put up in the vicinity of the Mansion House, and respecting which a notice recently appeared in the technical papers, it has no doubt escaped the notice of the City lighting authorities that the arc lamps which have been fitted up are of German manufacture. In view of the present state of trade it seems rather peculiar that the premier city of the Empire should have to go abroad for arc lamps to light its streets, when there are in this country numbers of manufacturers of *high-class arc lamps*, both "flame" and otherwise, who would be only too pleased to submit most satisfactory lamps for practical tests on the streets, more particularly because in this case, if the trials prove satisfactory, a very large number of lamps will be required.—Yours, etc,

OBSERVER.

## 160-H.P. MOTORS.

SIR,—Though probably too late, I should like to submit an explanation to your Question No. 756, *re* the 160-h.p. 400-volt motor, several answers to which are printed in your last issue. I have had two similar occurrences recently with 450-volt motors. In the first case the brushes had been reversed, but the rocker had not been properly set afterwards. In the second case the brushes had been fitted to face the wrong way round, the spindles in this case being fixed. In both these cases one brush invariably kept most of the sparking and all the flashing over to itself. Now, I take it that the machine in question was installed in its permanent position, and not running on test at the maker's. In this case it is quite conceivable that the machine had been taken apart for packing, and afterwards

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erected by men "on the job." In many machines it would be perfectly easy for the brushes under these conditions to be put on wrong way round. However, when the machine is at rest it is a very simple matter to check this: examine the armature and see which coil is midway between two pole-tips, follow this coil along to its connection on to the commutator, and the bar to which this is connected will be the approximate position for the brush.

I do not think there could be much wrong with either the armature or the field. In the first case the preliminary shop tests (galvo and insulation) pretty well ensure the armature being sound, while the resistance and insulation tests to the field coils should prove these good. I cannot understand that in the event of a field coil being wrongly connected the circuit breaker waits until the third contact is reached before opening. In this last case the ammeter readings would have helped us, but unfortunately these are not given.—Yours, etc., H. M. M.

## THE SINCLAIR VARIABLE-STROKE FEED PUMP.

SIR,—We were pleased to see that you gave such an interesting notice of our variable-stroke boiler feed pumps in your last issue, but there is one small matter to which we should like to draw your attention.

You mention that the curve of test shown refers to 2,000-gallon pump. We should like to point out that although this test was taken from a machine capable of pumping up to the capacity of 2,000 gallons, the actual test was taken at a slower speed, giving a maximum discharge of 1,000 gallons per hour, so that the total efficiency does not show out as well as it would if the machines were fully loaded and working to the maximum capacity.—Yours, etc., HAYWARD-TYLER AND CO.

## GLASGOW LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The monthly meeting of this section was held on Tuesday evening, when the discussion on Mr. Maxwell's paper on street arc lighting was continued.

Mr. W. W. LACKIE (member) read a paper on "Earthing." "An earth," he said, "had been legally defined as follows: 'The earth is an earth, but an earth need not necessarily be the earth.'" After quoting the rules referring to earthing in the rules and regulations recommended for wiring for the supply of electrical energy issued by the Institution of Electrical Engineers and the rules in Glasgow Corporation general rules, he went on to state that during the years 1902, 1903, and 1904 35 fires were reported to the electricity department of the Glasgow Corporation by the fire department as having been due to defective electric light installations. Two of these were, in the opinion of the electricity department, not due to electricity at all. Of the remaining 33, 15 were due to the melting of gas-pipes by a current of electricity, the installation in each case having been carried out with metal-sheathed cables; eight of the fires occurred on installations where the metal piping or metallic sheathing of the cables were not properly earthed; seven were on installations where the iron piping or metal sheathing was earthed. The causes of the remainder have probably no bearing on the subject of earthing, but may be of sufficient interest to be stated here: five were caused by the cables having been chafed, and the insulation consequently damaged by contact with the sharp edges of iron pipe ends; one was due to a piece of hot carbon falling from an arc lamp upon some muslin goods in a shop window; five were due to defective twin flexible conductors; three were due to deterioration and defects in switches; three were due to wooden casing having been saturated with water; and one was caused on a wood casing installation where the conductors were not protected, but were lying against a soft gas-pipe, and the insulation of the conductor failed. Perhaps it might be well to point out in passing that the effect of these fires was much more serious in the 15 cases where soft gas-pipes were melted, and the author begs to express the hope that electrical engineers will do all they can to stop the use of this class of pipe, and, if possible, see that it is removed from any building into which electric lighting or power is being installed. Considering, however, only the first 15 cases, and especially the seven where the metal sheathing was earthed, the fact of current going *viâ* the gas-pipes at all goes to show one of two things—viz., either that the current flowing to earth and back to the generating station divides up between the one, two, or more paths to earth in proportion to the conductivity of these different paths, or that by increasing the earth connections the current going to earth is increased by the increased conductivity to earth of the earth circuits. It is, further, impossible to test an installation after it is completed, with a view to ascertaining whether the metal sheathing is in itself properly electrically continuous throughout its entire length, and whether the continuity of earthing throughout is not due to the sheathing being earthed at one point by the earth-wire run for that purpose, and at another point by means of a gas-pipe or other pipe. It may be that for part of the course a gas or water pipe is the bonding or cross-connecting link between two lengths of sheathing.

With the present system of earthing, if one conductor came in contact with the sheathing, the current that flows momentarily, but long enough to blow branch and main fuses, was frequently 250 to 300 amperes, and was sufficient to interfere with the supply to other consumers. It had often been found that a momentary short-circuit was due to an earth on a three-ampere branch circuit in a consumer's premises. Bearing these facts in mind, the author has come to the conclusion that the present method of earthing at any point and direct is wrong, and it is his opinion (1) that the metal sheathing on installations for connection to public supply mains should be kept clear of all other metal work throughout the entire run of the conductors; (2) that the connection to earth should be through a resistance of such an amount as would allow not more than, say, two or three times the normal current of the installation flowing to earth in the event of one of the conductors coming in contact with the sheathing; and (3) that the metal sheathing on installations for connection to public supply mains should be joined to earth at one point only.

The author then went on to speak on each of these three points. With regard to (1) metal sheathing kept clear of all other cables, he said that in the Glasgow provisional order it was distinctly stated that the Corporation were not, except with consent, to lay their electric lines in contact with any such mains. It followed, therefore, that if it was necessary to keep clear of other pipe work under ground, it was obviously just as necessary to keep clear of pipes and metal work inside buildings. If the sheathing used for electric lighting and power conductors was insulated throughout its entire length, it would be possible to test, after any installation was completed, and to see that the cable sheathing was clear of all other metal work in the building, and also that it was in itself electrically continuous. With regard to (2) a resistance in the earth circuit, if there was such a resistance the rush of current would be reduced so enormously as to make the main fuse strong enough to resist it. It would be even a better arrangement if each set of branch pipes had a proportionate resistance inserted to a separate slightly insulated earth wire and the sheathing of the mains had also a resistance. In using metallic-sheathed conductors it had formerly been common practice to have the main fuses enclosed in cast-iron boxes, these boxes being earthed through connection to the metallic sheathing. It had then been frequently found that when a fuse blew, an arc was formed between a conductor and the case, owing to the distance between the 'bus bar and the side of the case being less than the break of the fuse, and strong enough to keep up an arc. Sometimes this arc had melted a hole in the iron box as well as below the main fuse. As a remedy some engineers insulated these boxes by mounting them on wooden bases and connecting the pipes across the gap by means of a bonding wire, or having the fuses enclosed in a wooden case. A similar course had been adopted where an arc had formed between one of the terminals or blades and the side of the switch box. One good reason for earthing the metallic sheathing covering electric conductors is, of course, the prevention of

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possible dangerous shock to the public, and the insertion of a resistance of the size suggested would not militate against this in any way. Several stations have adopted this course to protect their works from a complete shut-down. To ensure continuity of supply the middle wire of the three-wire system is earthed through a resistance of a tenth of an ohm, or in some cases one ohm.

Mr. A. P. Trotter had constructed a mechanical model to show the difference of pressure between each of the three conductors on a three-wire system, and each with varying leakages or earths. This device was described at length, but as it has been already described in Mr. Raphael's book on "Faults in Electric Mains," Mr. Lackie's description of it is here omitted. The idea of introducing a resistance to the extent suggested on the earth circuit is probably novel, so far as wiring is concerned, but to introduce a resistance of some kind is not new in underground mains work, as the Howard Conduit Company, Trafford Park, Manchester, in a descriptive pamphlet of their asphalt conduits for underground mains, advocate this. If in circuit with or if the earthing resistance on a consumer's premises took the form of an electromagnet, which would close a secondary circuit so as to ring a bell, sound an alarm of some kind, or light a tell-tale lamp, each installation would become self-testing. The winding of the resistance in the form of an electromagnet would also, in cases of dead earths, act momentarily as a choking coil. We are all agreed that a fuse of a certain capacity affords no protection against leakage current, which is, as a rule, leakage to or from earth, so long as that current does not exceed that at which the fuse will blow. The above arrangement would act before the fuse, and even a simple electromagnet in circuit with the earth-wire without the resistance advocated would always be an advance on present practice. It has frequently happened that for some reason or other the fuse on the branch main connected to the neutral wire on a two-wire installation has gone, and the installation has had an earth connection on the same conductor inside the premises beyond the fuse. The installation still continues to have a satisfactory supply through this earth connection and the earth connection at the generating station. If a resistance of the amount suggested was inserted in the earth connection, the chances are that the consumer would very soon see that something was amiss, due to the bad pressure brought about by the supply having to come or go by the earth resistance; and, moreover, if a bell or other device was connected, as indicated, with the resistance, it would immediately show that current was passing by the earth circuit. If earthed at more than one point, several resistances would be required, so that the joint parallel resistance should equal a resistance such that only two, or say, three times the normal current would flow to earth; but further current is diverted over the other metal work of the building if earthed at several points. If several paths are given between the metal sheathing and earth on different floors of a building, there is, as before, current diverted over all the other metal work of the building, and such stray current may cause arcing sufficient to melt pipes—gas and water—and, if gas, fire will result. The resistance of 50 yards of $\frac{5}{8}$in. tubing with joints was ·4 ohm, and the resistance of 50 yards of lead covering of $\frac{3}{20}$ twin lead-covered wire, ·8 ohm. It looked from that, therefore, as if the current to earth would equal a considerable pressure divided by the resistance to earth of each circuit, and that might explain the melting of the gas-pipes and consequent fires in the seven cases of fire referred to.

Faults had occurred on lead-covered conductors due to a broken strand getting in contact with the lead covering. The momentary flow of current in such a case had often been so great as to burn the lead clean off at the point of the broken strand, and the fuse on the circuit had sometimes gone and sometimes stood. Where it had gone it would be replaced, and the installation might seem all right, but trouble would be experienced sooner or later with a conductor in such a state. Might the same reasoning not be used in advocating the introduction of a resistance on the earthing wire from a motor or dynamo? The comparatively enormous damage generally done to a small motor when one of the conductors in it went to earth, in the opinion of the author, justified putting in a resistance to limit the current. By insulating the sheathing throughout its run, earthing it at one point only, and introducing proper sized resistance on the earth circuit, they had (1) made it possible to make a further and important test at all times, even after an installation has been completed; (2) increased the efficiency of the supply; (3) reduced the already small risk of fire from electrical causes; (4) in no way interfered with the precautions for the safety of the public from shock; (5) rendered installations continuously self-testing. The reason for insisting that fittings and lampholders should be insulated was that if the lampholders were not insulated they would most assuredly break down the insulation of the lamp caps in use. Cases were on record where the insulation between the lamp-collar and one of the terminals was nil. All lamp caps on 250-volt lamps would stand 250 volts between the two terminals, but few would stand 250 volts between one of the contacts and the metal collar on metal-collared lamps, or the lampholder on porcelain or vitrite-capped lamps. Besides, it would have been noticed that in the abnormal state of division of pressure between the positive, neutral, and negative conductors and earth—*i.e.*, when the positive or negative main was to earth—it was quite possible that between one lamp contact and earth, if the holders were earthed, there would be at times a difference of pressure of 500 volts. The lamps in general use to-day were not meant for this, and consequently the simplest and the cheapest way was to insulate the lampholders and remove these two dangers.

## AUSTRALIAN TRAMWAY SYSTEMS.

In no part of the world, in proportion to the number of population, are street tramways more extensively used as a means of passenger transit than in the leading Australian State capitals. Although their introduction is of comparatively recent date, their development has been marvellous, and, as in many European and American cities, they have assisted in making riding cheaper than walking, and are causing the omnibuses and other conveyances of a past generation to become forgotten. In Sydney the tramways were originally worked by steam power, the cars being double-decked, like the railway carriages on several of the Paris suburban lines, but subsequently the cable system was introduced, and later on electricity became utilised as the motive power, and with such success that it is only a question of time when the locomotive and cable will be found dispensed with. The various tramlines, which, like the railways, are the property of the State, form a complete network of communication between nearly every part of Sydney and its suburbs, thus assisting in counteracting the tendency to overcrowding, which forms one of the evils associated with large centres of population. The total length of tramlines open on June 30, 1903, was 124½ miles, representing an expenditure of £3,371,587 for construction and equipment, the number of passengers carried during 1903 being 130,405,402. The Melbourne system, embracing a length of 48 miles, 43½ miles of which are worked by cable and 4½ miles by horse power, was constructed by a municipal trust at a cost of £1,705,794, and is leased to a company. It is said to be the largest and best cable system in existence. The number of passengers carried during the year was 47,564,942. There are also several suburban lines worked by limited liability companies, as follows: horse, 8½ miles; electricity, 4 miles; and cable, 2¼ miles. In Brisbane the tramlines were originally worked by horse power, but in 1897 it became replaced by electricity, the tramways being the property of an English company, and covering a total length of 28 miles. As the traffic increases, extensions are effected. At the close of 1902 there were in the State 65 miles of tramways, including those in Brisbane, the number of passengers carried during 1903 being 18,125,302. In Adelaide there are several tramway lines worked by horse power, but an attempt is being made to secure the introduction of the electric system. The lines are owned by private companies, In Western Australia, Perth has a well-organised system of electric tramways, which, like that in the Kalgoorlie municipalities, is the property of a private company.

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Fremantle and Boulder City also will shortly be in possession of electric tramway systems, constructed by private enterprise under municipal supervision. The only State-owned tramway is that running between the port of Roebourne and the town of Cossack, a distance of 8½ miles, in the north-western portion of the State. In Tasmania the Hobart tramways are worked by electricity, and extend a distance of about nine miles. They are owned by a private company, and were opened in 1901, in which year they carried 1,432,176 passengers. There is also a steam tramway in the north-west portion of the State, connecting Zeehan with Williamsford, a distance of 11 miles, its summit being 1,500ft. above sea-level. Compared with other Australian tramway systems, that of Sydney is considerably the most efficient, there being a continuous succession of trams from early morning until midnight, an all-night service being established on several lines. During the earlier hours of the day and in the evening the tram traffic is enormous, the cars, running almost every minute, being densely crowded. It is the same at holiday time, and the greater the amount of accommodation provided by the State Railway Commissioners the denser becomes the crowding. It is as if the whole population desired the use of the tramcars. Yet, with all this heavy traffic, accidents are comparatively few, being in most instances due to the disregard of ordinary precautions on the part of the sufferers. All the Australian electric systems are on the overhead wire principle, which is not found to interfere with the work of fire brigades to anything like the extent originally anticipated. The cost of the New South Wales tramways was defrayed out of loan revenue, and they constitute one of the most valuable assets of the State.

## CATALOGUES, ETC., RECEIVED.

PUMPS.—Messrs. Balcke and Co., condenser specialists, 27, Clement's-lane, London, E.C., have sent us a pamphlet describing some of their electrically-driven and other pumps.

MECHANICAL STOKERS.—A pamphlet, entitled "Cheap Steam," issued by Messrs. Ed. Bennis and Co., Limited, Bolton, describes and illustrates their stoker and compressed-air furnace.

ARC LAMPS AND METERS.—Mr. G. Braulik, 217 and 218, Upper Thames-street, London, has issued a new catalogue and price-list of his London-made arc lamps; also a new list of "Eclipse" electricity meters.

CABLEWAYS, ETC.—Messrs. Graham, Morton, and Co., Limited, Hunslet (Pepper-road), Leeds, have sent us a catalogue describing their cableways, cantilever cranes, electric telpherage, aerial ropeways, etc.

BAILEY'S VALVES.—We have received from Messrs. W. H. Bailey and Co., Limited, Albion Works, Salford, Manchester, a copy of Part 9 of their catalogue, Section 1. This part deals with valves of the firm's latest improved types for power stations and works.

FULL-SIZE SECTIONS.—From Messrs. Hardy and Padmore, Limited, Worcester Foundry, Worcester, we have received three sheets illustrating full-size sections of manholes and inspection pit covers, with particulars attached. The sections represent stock patterns, and should be especially useful to consulting engineers.

WESTERN ELECTRIC SPECIALITIES.—The Western Electric Company, North Woolwich, London, have sent us copies of their latest price-lists, enclosed in a binder. These lists deal respectively with continuous-current fan motors, enclosed arc lamps, continuous-current circuit breakers, sewing-machine motors, and motor-driven grinders.

SWITCHBOARDS.—A pamphlet just issued by Messrs. Johnson and Phillips, Old Charlton, Kent, contains illustrations of a number of switchboards designed and constructed by the firm. The selection has been made, we are told, with a view to showing the variety and scope of their work in this department, and what the different types of board look like when erected.

ELECTRICAL HEATING.—We have received from the Electric Heating Company, 3, Holborn-place, London, W.C., a copy of their list of patent Phœnix heaters and cookers. The great progress recently made in the design and manufacture of this class of apparatus is well illustrated by this list, which includes a great variety of useful types, all, we are told, made in England.

THE METAPHONE.—From the National Telephone Company, Limited, Victoria-embankment, London, E.C., we have a copy of their revised and enlarged catalogue of metaphones. The metaphone, it may be repeated here, is a complete telephone transmitter and receiver for use in connection with existing electric bell wires, bells, etc., and batteries in houses, offices, hotels, etc. Several patterns are illustrated.

AIR-COMPRESSING PLANT.—Air-compressors are dealt with in a new catalogue recently issued by Mr. Peter Brotherhood, Belvedere-road, Westminster Bridge, S.E. These compressors, we are told, have been specially designed to meet in the best manner possible the rapidly growing requirements of users of pneumatic tools and other machinery and appliances worked by compressed air. The illustrations of standard Brotherhood air compressors are excellent, and full particulars are included.

COLLIERY CABLES.—From the St. Helens Cable Company, Limited, Warrington, we have received a copy of their new catalogue of dialite cables for use in collieries. The special features of dialite cables are dealt with at some length, and the reports of independent tests given, while several methods of fixing or laying cables in mines are illustrated. These methods are founded on the many years of experience which the company have had with this particular class of work, and make a useful addition to the catalogue.

PAPER-INSULATED CABLES.—From Messrs. W. T. Henley's Telegraph Works Company, Limited, Bloomfield-street, London-wall, E.C., we have received a copy of their very conveniently arranged new price list of paper-insulated cables for electric lighting, power, and traction, comprising low-tension, single-concentric, triple-concentric, twin, three-core, and high-tension concentric cables. We note that the specification of cables, details of conductors, etc., contained in this list are in accordance with the recently issued report of the Engineering Standards Committee.

## FORTHCOMING EVENTS.

FRIDAY, FEB. 17.

**Royal Institution.**—At 9 p.m., "High-Power Microscopy," by Mr. J. W. Gordon.

**Institution of Mechanical Engineers.**—At 8 p.m., discussion on adjourned papers. Prof. W. E. Lilly will read a paper on "The Strength of Columns."

**North-East Coast Institution of Engineers and Shipbuilders.**—General meeting at Newcastle.

**Electrical Engineers (R.E.V.)**—At 8 p.m., Bohemian concert at the "Horns," Kennington.

SATURDAY, FEB. 18.

**Glasgow Technical College Scientific Society.**—At 7.30 p.m., "High-Speed Tool Steels from the User's Point of View," by Mr. E. H. Robertson.

MONDAY, FEB. 20.

**Society of Arts.**—At 8 p.m., "Internal-Combustion Engines" (Lecture II.), by Mr. Dugald Clerk.

TUESDAY, FEB. 21.

**Institution of Electrical Engineers (Manchester Section).**—At 7.30 p.m., "Manchester Tramways Power Supply," by Messrs. H. C. Gunton and S. L. Pearce.

**Institution of Civil Engineers.**—At 8 p.m., resumed discussion on "Alfreton Second Tunnel" and "The Reconstruction of Moncreiffe Tunnel." Paper, "Surface-Condensing Plants, and the Valve of the Vacuum produced," by Mr. R. W. Allen.

**Institution of Engineers and Shipbuilders in Scotland.**—At 8 p.m., general meeting.

THURSDAY, FEB. 23.

**Institution of Electrical Engineers.**—At 8 p.m., "The Value of Overhead Mains for Electric Distribution in the United Kingdom," by Mr. G. L. Addenbrooke (continuation of discussion).

**Tramways and Light Railways Association.**—At 8 p.m., "Brakes," by Mr. G. A. Trube.

FRIDAY, FEB. 24.

**Physical Society.**—At 5 p.m., "The Curvature Method of Teaching Geometrical Optics," by Dr. C. V. Drysdale; exhibition of Dr. Meisling's colour-patch apparatus, by Mr. R. J. Sowter; and "A Method of Illustrating the Laws of the Simple Pendulum," with an exhibition of string models of optical systems, by Mr. J. Schofield.

**Institution of Electrical Engineers (Manchester Students' Section).**—At 7.30 p.m., "Metallography," by Mr. Buttenshaw.

**Electro-Harmonic Society.**—At 8 p.m., ladies' night.

**Institution of Civil Engineers (Students' Section).**—At 8 p.m., "Morecambe Sewerage: Method of Laying a 15in. Cast-Iron Sewer under the London and North-Western Railway," by Mr. F. D. Flint; and "The Reconstruction of Bow Bridge over the River Lea," by Mr. H. M. Rootham.

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## ELECTRICITY SUPPLY PUBLICITY DEPARTMENTS: A SUGGESTION.

BY B. C. H. J.

As mentioned in this paper of the 3rd inst., the Croydon electricity scheme now possesses a publicity department. This is not quite a novelty, of course, as several of the power companies depend largely upon a similar department for their customers, and in due course all large undertakings will most probably follow suit.

It is in regard to the smaller supply stations, however, that this article is written: those concerns which obviously could not afford to maintain such a department, but at the same time feel the need of it quite as acutely as the larger works. In such towns, in addition to the efforts of local contractors, the resident engineer generally combines to a slight extent the duties of publishing the advantages of electric supply with his own often more pressing work. The chairman of the electricity committee will also often help in the work of conversion by persuasion or personal influence; but he, too, is usually a man with plenty to do and very little time to do it in. In the case of local companies, the secretary takes the committee chairman's place in well-meant but untechnical efforts. In very few instances are the other members of the electricity works staff taken into consideration in the matter. The principal reason is that the local wiring contractors are supposed to do this class of touting to the extent necessary, and in some cases they manage it effectively enough. This is when they have had sufficient experience or technical training to be able to give a possible client the information required, which occasionally is somewhat special and outside the mere room-lighting routine. In a great many instances, however, more mechanical and "moving machinery" knowledge is required in order to answer questions, and here is where the assistant engineers would shine if given the chance.

The scheme that the writer proposes is for the manager of the electricity works to encourage assistant engineers to obtain customers by the payment of a fixed fee per installation secured by them. This would not only help the load curve of the station but the banking account of the assistant, which matter is now become of dwindling dimension, but increasing moment to those concerned. Where several assistants are employed in this way, a bonus might be granted to the one whose consumers had the greatest equivalent numbers of lamps wired, or whose consumer's first quarterly accounts were the largest. The opportunity for this work would be easily found at convenient times during the 16 hours per day off duty, and as such engineers would have opportunities for recommending wiring contractors, there would possibly be another source of income from that part of the scheme to encourage him to do his best. It would have to be understood, however, that the assistant who recommended a contractor was to a certain extent responsible for that contractor's work, to prevent the possible sacrifice of good material and workmanship on account of the bonus. As regards this bonus, it might possibly be a cause of trouble if improperly worked, but there should be no harm done in trying it, and the fact remains that (with most men) the more the metallic incentive the more the exertion.

## OLYMPIA MOTOR EXHIBITION.

The third international motor exhibition, now being held at Olympia under the auspices of the Society of Motor Manufacturers and Traders, Limited, is by far the largest and most important of its kind ever held in this country. It is even doubted by many whether the recent Paris show was its superior. Not having seen the latter, we can't say. So far as we are concerned, the excellence of the arrangements made by the society, the advantages of the new and altered Olympia, its suitable situation for the purpose, and its magnificent new electric lighting installation, are quite in unison with the great progress shown by English exhibitors of motor vehicles for use on land and on water. This progress is mostly visible in the construction of the carriage part proper, the upholstering, improved seating accommodation, and increased leg-room. Petrol seems to rule the day, although there are a few very fine specimens of electric carriages amongst the exhibits. On the whole, there appears to be reduction of prices and a tendency to do with as few cylinders as possible, one and two for the lighter and three and four for the heavier cars. The commercial omnibus and railway motor section is well represented, and British builders more than shine in the boat exhibits. The exhibition will remain open until Feb. 18 inclusive. T.R.H. the Prince and Princess of Wales visited the exhibition both on Friday and Saturday. On the opening day the exhibitors and friends attended a very successful luncheon, at which Mr. Sidney Straker, A.M.I.C.E., presided, the Right Hon. Lord Stanley, C.B., M.P., being the principal speaker. These proceedings have already been very fully reported in the daily Press.

We were specially interested in the electric ambulance van exhibited by the Electromobile Company, Limited, 7, Curzon-street, W. With regard to its equipment, it is complete, and of the latest pattern. It is fitted with two full-length stretchers, which slide into the van from behind, one above the other. A wide passage for the attendant runs down the right-hand side of the van. The carriage is lighted and warmed by electricity, and is completely fitted with all necessary appliances for first aid. The driver's seat is covered, as a protection from weather, and telephone communication is provided between the driver and the attendant. The van is intended entirely for city use. A distance of 25 miles can be covered on a single charge of the battery, and an exhausted battery can be exchanged for a fully charged one in two minutes. It is mounted on the company's latest type of chassis. Several important improvements have been introduced. The front wheels have been set forward 6in., giving a slightly longer wheel base, and the rigid front spring hangers have been replaced by half-springs. The rear suspension has also been improved by the addition of a transverse spring, which supports the weight of the body, and to which the side springs are attached in the usual manner. A new form of magnetic cut-out or current breaker has been introduced, replacing the ordinary form of sliding contact. In practice this has been found to be very efficacious, eliminating all trouble from burnt contacts. The chassis is fitted with a safety device, which prevents the chauffeur from inserting the running plug in its socket except when the controller is on the zero or neutral position. The socket has been removed to a conspicuous position in the front of the car, so that a casual glance will show whether the plug is in position or not. All carriages of the company are now fitted with an efficient mileage recorder. The counter, which can be locked, is fitted to the chassis in a conspicuous position at the rear. It is driven by means of bevel gear and flexible shaft direct from the gearing. The company further show two elegant electromobiles, one with brougham and one with landaulet body.

S. F. Edge, Limited, 14, New Burlington-street, W., show a 30-h.p. chassis, fitted with a six-cylinder Napier engine, electrical Napier patent synchronised ignition, and hydraulic air regulator to the carburettor. The ignition apparatus contains a low-tension commutator and high-tension distributor, both of which are driven simultaneously from the engine by a vertical shaft passing through spiral gear wheels, which mesh with the wheel. It is directly connected with the lubricator, the latter being driven by a chain which passes round a sprocket. A single-trembler coil forms a part of this compact apparatus, with "timing" lever arranged close up to it.

Messrs. W. and F. Thorn, 19, Great Portland-street, Oxford-circus, W., and Ranelagh House, Lower Grosvenor-place, S.W., London, exhibit the "Silvertown" motor and chassis and an electric landaulette of very light construction, to seat three or four inside and two out; suitable for 12-h.p. motor. The chief feature of these carriages is the "Silvertown" patent drive, which, operating on all four wheels, gives a more even tractive effort on the road. It is claimed that the "Silvertown" system of control is practically "fool-proof." A slight movement of the brake pedal breaks the circuit, connection being made again when the pedal is released, provided the pedal is not depressed enough to put on the brake. This arrangement proves very useful in traffic work, and as a safety device when turning corners, etc. Directly, however, the brake pedal is fully depressed, a braking effect takes place and the current is permanently shut off until the controller is brought back to the neutral position, when it is automatically made again. By this arrangement it is impossible for the car to start forward again when the brake pedal is released, after having been brought to rest by the brakes, although the controller handle may have been left in a forward position. The controller handle is placed underneath the steering wheel in front of the driver, and not at the side as is usually the case, and is therefore easily operated in case of any emergency. The battery consists of 44 cells in ebonite trays, contained in teak wood boxes, sufficient for a distance run of 35 miles on one charge on good level roads.

The Kriéger Electrical Syndicate, 38A, Gillingham-street, S.W., have an electric carriage on their already described system, and this practically completes the electrical car section.

Messrs. Clement-Talbot, Limited, Edinburgh-road, Ladbroke-grove, North Kensington, W., amongst their standard 1905-

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models have a "C.T.2.O." two-cylinder 10 h.p. to 12 h.p., with ignition by high-tension magneto. Honeycomb radiator. All organs of the motor, such as carburettor, pump, etc., are carried on the motor itself.

Amongst the commercial exhibits we noted specially a 2½-ton and a five-ton steam motor-wagon, both very serviceable and fitted with attachment for taking a trailer, exhibited by Messrs. E.S. Hindley and Sons, Bourton, Dorset; and two fine three and five-ton tip wagons, shown by the Bristol Wagon and Carriage Works Company, Limited. The Straker Steam Vehicle Company, Limited, 9, Bush-lane, Cannon-street, E.C., make a good show with their specialties in tipping and other wagons. Messrs. Johnson and Phillips, London and Charlton, show a 16-h.p. chassis fitted with the "Newman" variable speed gear, type "R.A. No. 4," and Newman's adjustable universal couplings, showing system of control, emergency clutch, chain drive, etc., in motion, and various types of the "Newman" variable speed gear. Messrs. Peto and Radford, Limited, 55 and 57B, Hatton-garden, E.C., 61, Chandos-street, Strand, W.C., and Greville Works, Ashstead, Surrey, have a very large and varied assortment of electrical apparatus for use in electric ignition and electric lighting on motorcars, comprising accumulators, induction coils, contact breakers, measuring instruments, magnetos, dynamos, and electrical accessories.

In the same section we noticed lubricating and other oils by the Anglo-American Oil Company, Limited, 22, Billiter-street, London, E.C., and the Vacuum Oil Company, Limited, Norfolk-street, London, W.C., and patented oil cans, etc., by Joseph Kaye and Sons, Limited, 93, High Holborn, W.C., and Patent Lock Works, Leeds.

Messrs. Ransomes, Sims, and Jefferies, Limited, Ipswich, show 24-h.p. to 42-h.p. motor lawn mowers of neat construction, the mechanism of which is easily accessible to the attendant walking behind. Messrs. Willans and Robinson, Limited, Victoria Works, Rugby, and Queensferry, have a large exhibit of tube steel, forging steel, and high-tensile vanadium steel castings and motorcar cylinders. Messrs. David Moseley and Sons, Limited, Chapelfield Works, Ardwick, Manchester, show the "Seddon" tyre in red rubber, which is novel in design and simple of attachment, requiring no inner tube or security bolts.

We are asked to draw attention to the Motorcar Company's new system for protection of purchasers, by means of which intending purchasers may have their car selected by a jury composed of W. Worby Beaumont, Esq., M.I.C.E., M.I.Mech.E.; Dugald Clerk, Esq., M.I.E.E., F.C.S.; Colonel Crompton, C.B., R.E.; Robert E. Phillips, Esq., M.I.Mech.E., A.M.I.C.E., A.I.E.E.; and Alfred J. Boult, Esq., M.I.Mech.E. (Messrs. Boult, Wade, and Kilburn, chartered patent agents).

## INSTITUTION OF ELECTRICAL ENGINEERS.

At the ordinary general meeting on Feb. 9 the following candidates were elected:

*Members.*—A. F. Ball, 14, Lansdowne-terrace, Gosforth, Newcastle-on-Tyne; T. Tomlinson, Northumberland House, Beresford-place, Dublin; A. Wyllie, Wolverhampton-street, Walsall.

*Associate Members.*—W. M. H. Butcher, 22, Maple-road, Anerley, S.E; T. A. Cunliffe, 27, Howard's-lane, Putney, S.W.; F. W. Davies, 47, Cleveland-road, Huddersfield; P. J. Hood, C. S. "Electra," Eastern Telegraph Company, Limited, Suez; S. T. Land, Electricity Works, Rathmines, co. Dublin; R. W. McOlay, Messrs. Balmer, Lawrie, and Co., 103, Clive-street, Calcutta, India; A. J. Makower, 37, Maresfield-gardens, N.W.; J. Place, 46, Watling-street, London, E.C.; T. Schontheil, 14, High-street, Cardiff; R. J. Shaw, 36, Lincoln-street, Gateshead-on-Tyne; R. J. Smith, 76, Tollington-road, Holloway, N.; G. B. Williams, 5, Kensington-masions, Earl's Court, S.W.; F. W. Wyand, Elswick Works, Newcastle-on-Tyne.

*Students.*—C. S. Atkinson, Beta Lodge, Padgate, near Warrington; T. M. Barlow, The University, Birmingham; H. F. Barnes, Comer Villa, Bromyard-road, Worcester; R. G. Barrett, 54, Florence-road, Stroud Green, N.; W. F. Birch, 9, Alma-terrace, Kensington, W.; J. B. Blake, Faraday House, Charing Cross-road, W.C.; W. P. Brennan, 164, Coningham-road, Shepherd's Bush, W.; E. J. D. Buckney, 37, Finsbury Park-road, N.; W. C. C. Chappell, 17, Hornsey Rise-gardens, N.; D. P. Dunn, 19, Grafton-road, Bedford; O. Faber, Fiona, Leonard-road, Penge; K. B. Findlay, Faraday House, W.C.; B. S. Fowler, 25, Clarendon-buildings, Balderton-street, W.; C. Harrison, Faraday House, W.C.; W. Lawrence, 28, Steven-street, Stretford, Manchester; C. R. McGowan, Maghera, co. Derry, Ireland; J. H. McMinn, 50, Gibson-street, Hillhead, Glasgow; J. A. Marshall, Westbrook, Glendale-road, Eccles; W. H. S. Mitchell, 25, Alexander-street, Bayswater, W.; V. Muirhead, Faraday House, W.C.; C. T. Pressland, The Croft, Grimwood-road, Twickenham; T. A. Pudan, Faraday House, W.C.; C. P. Richards, 79, Ryland-road, Edgbaston, Birmingham; T. A. Rose, The Schools, Feltham, Middlesex; W. H. Russell, 53, Netherhall-gardens, Hampstead, N.W.; G. Tingley, 61, York-street, Walworth-road, S.E.; F. L. N. Tuck, 37, St. Oswald's-road, Fulham, S.W.; C. Vandermin, Faraday House, W.C.; M. Vela, 4, Sandoft-road, Eastcombe-avenue, Charlton; I. D. Whittall, Stamford Lodge, Bowdon; G. H. Wilson, Eggleseliffe, co. Durham; W. D. Wivell, Keswick Hotel, Keswick.

## JUNIOR INSTITUTION OF ENGINEERS.

A dinner to celebrate the coming of age of the Junior Institution of Engineers was held at the Hotel Cecil on Saturday last, under the presidency of Mr. W. H. Lindley, M.I.C.E., F.G.S. After the loyal toasts had been duly honoured, Prof. W. E. Ayrton, F.R.S., proposed "Legislation and Engineering," referring incidentally to Mr. Lindley's connection with the Frankfort Exhibition of 1891, and the electrical transmission scheme which attracted such universal attention at the time. Mr. James Swinburne, M.I.C.E., and Mr. J. H. Balfour Browne, K.C., responded. Robbed of its witticisms, the latter's speech was to the effect that science and experience led legislation. The President then proposed "The City and Port of London." In the absence of Mr. W. H. Grenfell, M.P., Archdeacon Sinclair responded. While acknowledging the benefit derived from the many great engineering works carried out in the City, he reminded his audience that Wren, engineer though he was as well as architect, never contemplated the possibility of tube railways, therefore thought should be given with sympathy and reverence to the effect on St. Paul's Cathedral when speculators were preparing for further burrowings. Prof. James A. Ewing, F.R.S., proposed "Applied Science," and, in acknowledging this toast, Dr. R. T. Glazebrook, F.R.S., pleaded for a wider application of applied science to trade and industry. The next toast, that of "The Senior Institution," was proposed by Mr. Sidney H. Wells, Wh.Sc., and responded to by Mr. Charles Hawksley, M.I.C.E., and Mr. Alexander Siemens, M.I.C.E. Then Lord Reay, G.C.S.I., G.C.I.E., proposed "The Junior Institution of Engineers" in flattering language, remarking that the members had built up an institution which took a foremost place among the learned societies of the country. The Empire had been largely developed by members of the profession, and a great responsibility rested on the institution to maintain the reputation English engineers had gained in all parts of the world. This was acknowledged by Mr. Samuel Cutler, jun., M.I.Mech.E.

# LEGAL INTELLIGENCE.

## BRIGHTON CORPORATION'S APPEAL.

The appeal of the Corporation in the action brought by Macartney, McElroy, and Co. came before the Court of Appeal on Friday last. The case originally came before Mr. Justice Grantham, and was reported in our issue of May 27 of last year.

**Mr. Moulton, K.C.**, explained that the Corporation in 1900 determined to lay down and work tramways within the borough, and they accepted in 1901 the tender sent in by the plaintiffs, who were contractors. As to the majority of the work there was no dispute, but in one of the sections, which was to be wood-paved, the plaintiffs under the contract were to receive 12s. 7d. per square yard. The contract said nothing about a separate charge for excavating the metal off the road and laying the surface with cement, and his submission would be that as this part of the work must be done before the wood paving could be put down it was understood by all parties that the agreed sum per yard covered this initial expense. The work was finished, and the contractors claimed over and above the sum of 12s. 7d. per square yard 7s. 2d. for preparing the road. The Corporation said they had no power to pay that sum because it was not in the sealed contract, even if, which they denied, the plaintiffs were entitled to make an extra charge under this head. The plaintiffs thereupon brought an action claiming payment at the rate of 7s. 2d. per square yard for getting the road prepared for the wood paving, and they asked, if it were necessary, that the contract should in this respect be rectified. The jury held that the plaintiffs were entitled to this extra charge, which it was said worked out at £14,621, but on the application of the Corporation judgment was postponed until the point of law on which the appeal was based had been argued before Mr. Justice Grantham. After hearing argument the judge made some strong remarks to the effect that the technical defence raised by the Corporation was one that they ought in fairness never to have raised, because it was clear that the plaintiffs, who had done the work, were entitled to be paid. In his opinion the contract did not set forth the intention of the parties, and should be rectified, and he accordingly entered judgment for the amount that should be found due to the plaintiffs on their claim with costs. Counsel proceeded to argue the case on behalf of the Corporation, and submitted that the evidence was that the contract expressed the real agreement.

**Lord Justice Mathew:** There I am against you.

**Mr. Moulton** said he hoped to convince his Lordship from the evidence that his submission was correct.

At this point the case was adjourned until Wednesday, when it was further adjourned.

## TRAMLINES AND MOTOR OMNIBUSES.

In the King's Bench Division on Monday, before Mr. Justice Warrington, Tillings, Limited, sued Dick, Kerr, and Co., the contractors for the electrification of the London County Council's southern system, to recover damages for injuries alleged to have been caused to plaintiffs' 'buses by raised tramrails temporarily laid on the roads by

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defendants in South London while the conversion was being effected. Defendants pleaded statutory powers, but plaintiffs contended that defendants, being independent contractors, were not protected by statute, and if they were they had been negligent in carrying out their statutory powers. Plaintiffs claimed damages in respect of 69 injuries, and in substance their case was that defendants had created a public nuisance without statutory authority. Defendants denied any negligence, and said they had only done what was reasonably necessary to promote the traffic.

After considerable legal argument, **His Lordship** said that as the case was one of some public importance he would take time to consider the matter.

### TELEPHONE SERVICE.

At Tunbridge Wells County Court last week, before his Honour Judge Emden, the National Telephone Company sought to recover from Mr. Ernest Brooker the sum of £4. 5s. 4d. for the use of telephone and party-line fees.

**Sidney Jared Smith**, the National Telephone Company's manager at Maidstone, said he signed an agreement with defendant for a telephone service connection in 1903. The defendant paid his first instalment for use of service in June, 1903. After that defendant became in arrears to the amount of 12s. 8d. in January, 1904, and was disconnected in February, 1904, due notice being given, as defendant had failed to comply with the agreement. He (the manager) had received no letters of complaint from defendant as to any defects in the service.

On behalf of the defendant, it was urged that there had been a defective service. The company had not supplied an automatic box, and there were many cases where the subscriber could not ring up in time in need.

On the part of the company, it was strongly affirmed that there had been no defective service.

After evidence had been tendered on both sides, a lengthy argument ensued as to whether the disconnection of the service by the company terminated a contract between them and customers.

**His Honour** thought that even if no defective service of telephones had been proved, the company, by disconnecting the defendant's service in February, had thus terminated the contract, consequently the claim would be dismissed.

**Mr. Barton**, on behalf of the company, asked for leave to appeal, but **His Honour** declined to grant this unless the company paid the costs.

**Mr. Barton** said he would consult the company, and at the next Court renew the application.

**His Honour** agreed to consider the question of appeal at the March Court, but said he certainly could not allow the company's present claim against Brooker for reasons he had named. The question of costs would be considered when the application for leave to appeal was renewed.

### TRAMWAY FATALITY.

An action was instituted by Mrs. Jane Pollock against the Glasgow Corporation for £1,000 damages in respect of the death of her husband. Deceased was in the act of descending from the top deck of an electric car at Cleland-street, Glasgow, when, it was averred, the car was started forward and he was thrown to the ground, sustaining injuries which led to his death three weeks later. The defenders denied fault, and pleaded contributory negligence, but the matter has been settled by payment of £150.

## COMPANIES' MEETINGS AND REPORTS.

### WATERLOO AND CITY RAILWAY.

The half-yearly general meeting of this Company was held on the 9th inst. at Waterloo Station, Sir Charles Scotter presiding. Particulars of the report were given in our issue of the 3rd inst.

The **Chairman** remarked that the improved dividend had been brought about not only by increased receipts, but also by decreased expenditure. They were proposing that the Company should supply the electric current for lighting Waterloo Station, and whatever margin of profit there was in connection with the work would be so much to the good of their little company. The Company had carried nearly 16,000 more daily passengers, and the season-ticket holders at the end of the year had increased by more than 200. The progress was slow but sure, and so long as it went on there was no question that in course of time their little dividend would also grow.

The advisability of starting a Sunday service having been alluded to by some of the shareholders, the **Chairman**, in reply, intimated that he was disposed to favour such a course, and the matter would be considered at the next Board meeting. The question of fares had often been discussed by the directors, and they thought that they came to the best decision in the interests of the Company in fixing the fares as they were at present—2d. for the single journey and 3d. return. He certainly would not like to face the question of advancing the fares at the present time. Probably the Baker-street and Waterloo Railway would be opened at the end of the summer, and it would no doubt be an element of increased traffic for their own line.

The report was adopted unanimously.

### CENTRAL LONDON RAILWAY.

The nineteenth ordinary general meeting of this Company was held at the Holborn Restaurant on the 8th inst., under the presidency of Sir Henry Oakley (chairman of the Company).

**Sir Henry** reviewed at length the report and accounts for the half-year (of which we gave particulars in our issue of the 3rd inst.). He then outlined the Company's Bill for completing the circular route, which the directors proposed should be brought forward again. The Great Western Railway have designed a short line to the Central London Company's terminus at Shepherd's Bush so as to provide direct connection. It is probable that the Charing Cross, Euston, and Hampstead and the Baker-street and Waterloo Railways, who will have stations in proximity to those of the Central London Company, will agree to the construction of connecting subways, with through booking, each company conveying the passengers of the other upon a reciprocal basis.

The report was adopted, and a subsequent meeting the Company's Bill was unanimously approved.

The retiring directors—namely, Sir Henry Oakley, Lord Knollys, and the Hon. A. H. Mills—were re-elected.

### LIVERPOOL OVERHEAD RAILWAY.

The half-yearly meeting of this Company was held on Tuesday, Sir William Forwood presiding. Particulars of the report appeared in our issue of the 3rd inst.

The **Chairman**, in proposing the adoption of the report and accounts, said that the decreased earnings were due to the reductions they had made in fares, particularly to working-men. Feeling the competition of the Lancashire and Yorkshire Railway at the North-end very keenly, they had endeavoured to win back the working-men by giving them sectional 2d. return fares, and the net result had been that they had carried 40,000 more passengers, at a profit of £99, equal to ·59d. per passenger, but if they had had the same increase of passengers under the old rate they would have shown an increase of £150. They had also tried a 2d. return ticket from the Dingle. In two months they lost £16—that was, they received that amount less than they would have done under their old rate. They were still working the reduced rate. Differential fares would be introduced as soon as they made their connection with the Lancashire and Yorkshire Railway, and the question of contract tickets would be again considered when they had made their working connection with that railway. The Liverpool tramway system had gradually extended until it now competed with them at many points. The directors had endeavoured to combat all the various difficulties which confronted them by accelerating the speed of their trains, by reducing the fares charged to working-men, and by establishing a tramway system to Waterloo and Crosby; but these had not done all that they hoped, though they had helped to maintain their traffic. They were anticipating considerable assistance from their through traffic arrangements with the Lancashire and Yorkshire Railway. He could assure them that the line was well and economically worked. In reply to questions, the chairman stated that in the opinion of the directors to reduce their fares to 1d. would be disastrous to the line. The report was unanimously adopted, and the retiring directors re elected.

### NORTH METROPOLITAN TRAMWAYS.

The report for the half-year ended Dec. 31 last, to be submitted to the meeting on the 22nd inst., states that the gross receipts for the period amount to £319,275 and the total expenditure amounts to £301,517, leaving as net profit £17,757. This sum, together with £222 brought forward from the last account and the amount received from the Metropolitan Electric Tramways, Limited, for debenture interest, is £20,605, and the sum available for division, after providing for debenture interest, is £17,980. It is proposed to appropriate £17,747 to payment of a dividend at the rate of 4 per cent. per annum on the ordinary shares. The balance of £232 will be carried forward. The number of passengers carried during the half-year was 66,372,192, a decrease of 2,082,478, and the receipts therefrom £310,858, a decline of £10 918. For the whole of 1904 the number of passengers carried was 130,673,957, a decrease of 8,482,628, and the receipts therefrom £611,712, a decline of £40,457. The sum of £18,156 has been charged against revenue for maintenance of the permanent way. Referring to the agreement with the West Ham Corporation for the purchase of the Company's lines and depôts within the borough, which was submitted to and approved by the shareholders on Feb. 11, 1903, the purchase of the lines was carried into effect on June 30 of that year, and the directors report that the price to be paid for the depôts has now been agreed with the Corporation at £63,000, and that the sale will be completed at an early date. The negotiations with the Leyton Council have not yet been concluded.

### BAKER STREET AND WATERLOO RAILWAY.

The report states that the capital expenditure during the past half-year amounted to £173,133. For the current half-year the estimated expenditure is £600,000. Satisfactory progress is being made with the works. Between the Elephant and Castle and Baker-street the running tunnels have been driven throughout. All the station tunnels are through except the down tunnel at the Elephant and Castle. The platforms are being constructed, and the underground tiling and other work of completion is being proceeded with. The station buildings have been commenced. Half the permanent way has been laid. Good progress has also been made on the Paddington section. Arrangements for the interchange subway with the Marylebone Station of the Great Central Company have been made. Arrangements for ventilation, secondary lighting, and signalling are well advanced, and the high-tension cables to the sub-stations on this Company's line are now three-quarters complete. Eighteen trains of six cars each, also trucks, motors, and controlling apparatus, are all on order, and delivery of this rolling-stock should commence in May. The Company is promoting a Bill in

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Parliament to obtain power to make certain alterations in the subways at Trafalgar-square and the Elephant and Castle, to extend the time for the completion of the works and purchase of lands, also for power to issue debenture-stock certificates to bearer.

## NORTHAMPTON ELECTRIC LIGHT AND POWER.

The report for 1904, to be presented at a meeting to-morrow, states that the lamps and motors connected during the year were 6,576 (motors being reckoned in the equivalent of 8-c.p. lamps), making a total of 47 431 8-c.p. The motors, reckoned in horse-power, have increased from 251½ to 351½. Of these, 210 h.p. are hired out by the Company. The separate consumers have increased from 704 to 801. Distributing mains have been laid to the extent of 1 mile 1,262 yards, bringing the total up to 14 miles 1,575 yards. Additional feeder mains have also been laid amounting to 1 mile 1,631 yards. The extension to Dallington has been fully justified by the results. In the early part of the year the nominal share capital was increased from £50,000 to £100,000. There are now two classes of shares only—namely, ordinary and 5 per cent. cumulative preference—the founders' shares having been surrendered. As soon as there is a sufficiency of spare revenue, the extra dividends, or compensation, will be paid, but this can hardly be fully effectuated during the present year. An important purchase of land was made during the year, with a view to future needs. Substantial additions have been made to the plant. The provisional order extending the area of supply to the whole of the county borough, as now constituted, and to various parishes has been confirmed by Act of Parliament. The Town Council made an offer to purchase the business, but the terms were considered inadequate. A further sum of £1,750 is now added to the depreciation fund, besides £50 written off motors. A certain amount of old plant has been sold, and the loss has been written off. The accounts show £1,746 available for dividends. It is proposed to pay a dividend at the rate of 5½ per cent. per annum for the half-year on the ordinary shares, making, with the interim dividend, 5 per cent. for the year. This will leave £316 to be carried forward. The directors are now prepared to allot £1,170 5 per cent. preference shares at 1s. 6d. premium per share, also 5,000 ordinary shares, at a premium, by way of tender. The highest tenders will have the first consideration, but regard will also be had to the amount of the applicant's present holding. Members of the company and debenture-holders are at liberty to apply. The premium will then be payable, and 10s. in the £ on the shares allotted; the remainder by equal instalments on June 30 and Sept. 30.

## KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING.

The report for 1904, to be presented at the meeting on the 23rd inst., states that during the year the number of houses and shops connected with the system has increased from 3,210 to 3,451, while the number of lamps, calculated on the usual basis of 8-c.p., has increased from 280,133 to 303,048. The renewal account now stands at £55,932 an increase of £5,502. After providing for the amount placed to renewal account, writing £3,000 off cost of purchase of Kensington Court Company, Limited, in the capital account, and paying the dividends on the 6 per cent. first preference shares to June 30, 1904, on the 5 per cent. second preference shares to Sept. 30, 1904, and an interim dividend at the rate of 10 per cent. per annum on the ordinary shares for the first half of the year, the balance standing to credit of the net revenue account for 1904 is £18,659. Of this sum, £1,500 has been appropriated to the payment of the first preference dividend to the end of the year and £625 has to be set aside to meet the portion of the dividend on the second preference shares accrued to the same date. It is proposed to pay out of the balance of £16,534 a further dividend on the ordinary shares at the rate of 10 per cent. per annum for the past half-year and a bonus of 2 per cent. for the year, making, with the interim dividend paid on Aug. 1, 12 per cent. for the year. This will leave a balance of £9,184 to be carried forward. During the year substantial reductions have been made in the charge for supply, representing a considerable saving to the consumers.

## CHARING CROSS AND STRAND ELECTRICITY SUPPLY.

The report for the year ended Dec. 31, 1904, to be submitted at the meeting on the 22nd inst., states that a new sub-station has been built in the Green Park, under agreement with the Office of Works, for the purpose of supplying the public lamps in the Mall and parks, the Queen Victoria Memorial, and for other purposes. The lamps added during the past year have been 73,722 (8 c.p.), an increase of nearly 25 per cent. on the highest number previously obtained in the West-end areas in any year. The total number now being supplied in the West-end is 409,663. The total mains now laid amount to 325 miles. The regulations of the London County Council require all theatres to be furnished with supplies from two separate sources. The dual or alternative supply which was provided by the directors, under the advice of their engineer, has now been approved as complying with these regulations. The revenue from sales of current for 1904 amounted to £122,877, as against £110,083 in 1903. The balance of net revenue is £55,942, and it is proposed to pay a dividend on the ordinary shares of 3 per cent. for the year, carrying forward £10,223. With reference to the City undertaking, the erection of the first half of the generating station at Bow, which will hold plant of sufficient capacity to supply the equivalent of 800,000 8-c.p. lamps connected, is now completed, and contains plant to supply 600,000 lamps. Further plant of the capacity of 200,000 lamps will shortly be delivered. The four sub-station buildings in the city are now completed, and contain large storage batteries and plant of sufficient capacity to supply 450,000 8-c.p. lamps connected. There is ample space to more than treble this capacity with practically no additional expenditure on buildings. Mains have been laid in all the principal and most of the secondary streets in the City. These are of sufficient capacity to supply upwards of 500,000 8-c.p. lamps. Spare ways have also been provided into which extra mains, capable of increasing the supply to 1,000,000 lamps, can be drawn. There are 265 miles of mains now laid. There have been added during the year the equivalent of 58,968 8-c.p. lamps, bringing up the total now supplied to 301,081. The gross revenue from sales of current during the year amounted to £78,431, or £22,394 in excess of 1903. The net revenue account shows a profit of £15,670, which has been applied towards the payment of the 4½ per cent. preference share dividends to Dec. 31, 1904, and the balance of such dividends has been provided under the guarantee of the West-end undertakings. The directors have thought it advisable, to enable the Corporation to comply with the increasing demand for electrical energy for railway, tramway, and other motive power purposes, to apply to Parliament for an extension of the areas of supply and further powers, and the Bill for conferring such powers was approved by the resolutions passed at the extraordinary general meeting held on Feb. 3, 1905. These resolutions will be submitted for confirmation at the extraordinary general meeting convened to take place immediately after the annual general meeting. At the same meeting the proposed change in the Corporation's name will be submitted for confirmation. The Charing Cross and City Electric Company, Limited, was formed under the authority of resolutions of this Company for the purpose of contracting for and carrying out the works in the city of London. These works are now practically completed, and the directors are proposing to close all accounts between the two companies. Agreements for this purpose have been prepared, and will be submitted to the shareholders for confirmation. Copies of these agreements will be open for inspection by any shareholder at the offices of the Company for two days prior to the date fixed for the meeting.

## WESTMINSTER ELECTRIC SUPPLY.

The report for 1904, to be submitted at the meeting on the 22nd inst., states that the supply of current, which on Dec. 31, 1903, was provided for the equivalent of 662,129 lamps of 8 c.p., has increased to the equivalent of 711,679 lamps, and applications for supply continue to come in at a satisfactory rate. The new transformer station at Duke-street-gardens is not yet completed, but arrangements having been made for part of the space to be available for the engineers, the first section of plant has been erected and came into use on Nov. 25 last. The result of the year's working justifies the directors in once more recommending an increased dividend—namely, 14 per cent. There being a growing demand for current at a low price, the directors consider that any additional profits should for the present be devoted to the development of the Company's business by the reduction in the rates of charge. A reduced scale of charges came into force on Jan. 1, which will naturally affect the receipts for the current year, and it is, therefore, necessary to carry forward a sum of money sufficient to meet the temporary diminution of profits which may result from the reduction in price. After allowing for depreciation, sinking fund, and other charges, the net balance is £56,328. Out of this the Board recommend the payment of a dividend at the rate of 15 per cent. per annum for the past half-year, carrying forward a balance of £13,798.

## NEW COMPANIES REGISTERED.

**Lowden Electric Lamp Company, Limited (83,470).**—Capital, £3,000. Object: to acquire and take over, as a going concern, the business carried on at Watford, Hertfordshire, as the Lowden Electric Lamp Works. Registered office: Granville House, Arundel-street, Strand, W.C.

**Electric Power Development Company.** — Capital, £50,000. Object: to promote a Bill in Parliament to consolidate the sources of electricity supply in Greater London, and afford facilities to borough councils and electric lighting companies to purchase current wholesale, at prices varying from ¾d. to 1½d. per unit. In many cases this arrangement would at once considerably enhance the profits of the distributing authority, as the present average cost of the production is much higher than 1½d. The Bill provides for a share capital of five millions.

**Motorcar Company (1905), Limited.**—Capital, £2,000. Object: to promote and protect the interests of the professions, trades, and industries connected with the design, improvement, manufacture, and supply of motor-carriages, vehicles, cycles, tramcars, etc.

**Bohm Lens Lamp Company, Limited (83,466).**—Capital, £4,000. Object: to acquire and carry on the business at 104 and 105, Great Russell-street, W.C., as Bohm Lens Lamp Company, as lamp manufacturers, glass-blowers, electricians, suppliers of electricity, etc. Registered office: 104, Great Russell-street, Bloomsbury, W.C.

### Liens Registered.

**Bridgwater and District Electric Supply and Traction Company, Limited.**—Particulars of £12,000 debentures, created by resolution of Nov. 11, 1903, have been filed, pursuant to Section 14 (4) of the Companies Act, 1900. Property charged—the company's undertaking and property, present and future, including uncalled capital. No trustees.

### Discharge Registered.

**Kalgoorlie Electric Power and Lighting Corporation, Limited, London, E.C.**—Discharge registered Feb. 3 of mortgage dated July 10, 1902, for a sum not exceeding £10,000.

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## PERSONAL.

Mr. Thomas Browett, M.I.M.E., M.I.E.E., has been appointed manager of the Diesel Engine Company, Limited, 179, Queen Victoria-street, London, E.C.

The Wakefield City Council have appointed Mr. H. Nevill, first electrical engineer, to the position of city electrical engineer at a salary of £300 per annum, with increments of £25 per year to £400.

The Battersea Borough Council have selected three candidates for the post of borough electrical engineer, the appointment for which is to be made next Wednesday.

Mr. H. H. Oxley, of the Lincoln electricity works, has been appointed charge engineer at the Lynn electricity works at a salary of £65 per annum.

## APPOINTMENTS VACANT.

**Switch-Room Superintendent,** Glasgow Telephone Department. See advertisement in last issue.

**Junior Shift Engineer,** Dover. Salary £80 per annum.

**Meter Reader,** Lynn.

**Tramways Manager,** Ayr Corporation. Salary £200 per annum. Applications by 18th inst.

**Assistant Electrical Engineer,** Whitby Urban District Council. Salary £104, rising £4 annually to £120 per annum.

**Electrical Engineer** Great Western Railway. Salary £600 per annum. Applications by Feb. 27. See advertisement.

**Mains Superintendent,** Carlisle, Salary £120 per annum. Applications to Corporation's Electricity Works by Feb. 28.

**Inspector of Telephones,** Brighton Corporation. Applications by March 4.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Oporto.**—The Municipal Authorities require tenders for lease of their electric tramways. Tenders by March 15.

**Swindon.**—The Corporation invite tenders for the supply, delivery, and erection of switch panels, etc. Tenders by Feb. 21.

**Dublin.**—The Corporation invite tenders for the supply of arc lamp carbons to their electricity undertaking. Tenders by Feb. 23.

**Ghent.**—The Municipality require tenders for 15 electric cranes for the harbour works. Provisional estimate, £1,200. Tenders by Feb. 20.

**Sunderland.**—The Corporation invite tenders for the supply of four 250-kw. synchronous three-phase motor-generators. Tenders by 24th inst.

**Fulham.**—The Borough Council invite tenders for the supply of electrical stores for year ending March 31, 1906. Tenders by 4 p.m. on March 15.

**King's Lynn.**—The Corporation invite tenders for one 200-kw. steam dynamo, condenser, steam and other pipes. Tenders by 28th inst. See advertisement.

**Hull.**—The Electric Lighting Committee invite tenders for the supply, etc., of mains and cables for 12 months. Tenders by 12 noon on March 1. See advertisement.

**Stoke Newington.**—The Council invite tenders for the supply, delivery, and erection of sub-station plant and mains. Tenders by 4 p.m. on March 8. See advertisement.

**Lirla.**—The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

**Battersea.**—The Council require tenders for the supply for one year from March 31 next of electricity meters, joint-boxes, carbons, coal, and oil stoves. Tenders by Feb. 27.

**Shoreditch.**—The Council invite tenders for their yearly contracts in the electricity works and other departments. Tenders by March 14. Full particulars in our advertisement columns.

**Madrid.**—The Department of Agriculture, etc., invite tenders for installation and working for 60 years of an extension of the electric tramways in the north of the town. Tenders by Feb. 25.

**Laventhem (Belgium).**—The Municipality require tenders for erection of central station, laying of mains, etc. Particulars (3s. 4d.) may be obtained from the Secretary of the Mayor of that place.

**Lowestoft.**—The Corporation invite tenders for one water-tube boiler with superheater, brickwork settings, and accessories, together with the necessary pipework. Tenders by March 9. See advertisement.

**Dax (France).**—Tenders are required for a concession to erect and work electric lighting of the town for 35 years. Particulars may be obtained from the Secretary to the Municipality of Dax, Province of Landes, France. Tenders by March 6.

**Rathmines and Rathgar.**—The Urban District Council invite tenders for the supply of coal for electric lighting purposes (about 2,000 tons), cables, etc., arc lamp carbons, and general stores. Tenders by Feb. 20. See advertisement in last issue.

**Kilkenny.**—The Committee of the District Lunatic Asylum invite tenders for fixing in the asylum an electric installation of tell-tales, consisting of 18 stations, and one recording tell-tale clock. Tenders must be delivered at Asylum before 4 p.m. on Feb. 20. Mr. Joseph Brennan, clerk.

**Madrid.**—Der Compania Electrica Madrilena de Traccion propose to extend their electric tramways from the Barquillo-street to Olivide-place. The concession for the works will be dealt with by the Public Works Department, Madrid, April 2. Tenderers for same must deposit a guarantee of £96.

**Switzerland.**—M. R. Vontobel, of Winterthour, and M. Charles Probst, of Lucerne, have obtained a concession for the construction of a narrow-gauge electric railway from Meiringen to Gletsch. The total cost of the enterprise is estimated at £241,600; £19,600 is to be expended on rolling-stock.

**Great Western Railway.**—The directors invite tenders for the supply, delivery, and erection of plant in connection with their electricity generating station at Park Royal and proposed sub-stations and distributing centres at various places. Tenders by March 13. See advertisement in last issue.

**Salford.**—The Electricity Committee invite tenders for the supply of the following cables: 1,800 yards of 0·75 square inch lead-covered and paper-insulated cable, 1,200 yards of 1·2 square inch lead-covered and paper-insulated cable, and 1,760 yards of $^{7}/_{16}$ high-tension concentric cable. Tenders by Feb. 18.

**Stockport.**—The Corporation invite tenders for supply and delivery of points, crossings, and special work in connection with the tramways. Specification, conditions, form of tender, and all information may be obtained on application to Mr. John Atkinson, A.M.I.C.E., borough surveyor, Stockport. Tenders by Feb. 20.

**Wimbledon.**—The Urban District Council invite tenders for the supply of (3) engine-room stores, (4) cables, (5) joint-boxes and jointing materials, (6) transformers, (7) meters, (8) oils, (9) incandescent electric lamps, carbons, and accessories, (10) iron castings. Tenders by March 4. See advertisement in last issue.

**Newport (Mon.).**—The Electricity and Tramways Committee invite tenders for 300-kw. continuous-current high-speed tramway generator (engines of enclosed type), 200-kw. continuous-current high-speed steam balancer (engines of enclosed type), boiler, switchboard, stores, etc. Tenders by March 6. See advertisement.

**Islington.**—The Council invite tenders for (Section A) meters, (B) time switches, (C) earthenware pipes, (D) carbons, (E) incandescent lamps, (F) terminal boxes, (G) arc lamp globes, (H) oils and lubricants, (I) waste, etc., (J) belting, (K) rubber and asbestos, (L) engineers' stores, sundries. Tenders by Feb. 23. See advertisement in last issue.

**Batley.**—The Batley Co operative Society, Limited, Commercial-street, Batley, invite tenders for wiring and fittings in connection with the electric light installation at the new central stores. Copies of the specifications can be had on receipt of 10s. at the offices of Mr. Harry B. Buckley, architect, 85, Commercial street, Batley, up to Feb. 16, and tenders are to be delivered by 4 p.m. on Feb. 20.

**East Ham.**—The Borough Council invite tenders for supply and delivery of five double-deck roof-covered tramcars, complete with electrical equipment. Full particulars, form of tender, and specification may be obtained on payment of £1. 1s. (which will be returned upon receipt of a bona fide tender) from Mr. W. C. Ullmann, M.I E.E., M.I.M.E., Nelson-street, East Ham. Tenders by Feb. 21.

**Manchester.**—The Electricity Committee invite tenders for the supply, delivery, and erection of the following at Dickinson-street station and sub-stations: (a) motor-generators, (b) five-wire balancers. Further information will be given by Mr. S. L. Pearce, chief engineer, Electricity Works, Dickinson-street, Manchester. Tenders to the chairman of the Electricity Committee, Town Hall, by 10 a.m. on Feb. 21.

**Fulham.**—The Borough Council invite tenders for the supply and erection of (A) condensing plant; (B) boilers; (C) economisers; (D) stokers. Specification, drawings, and form of tender may be obtained from the borough electrical and consulting engineer, Mr. Arthur J. Fuller, on payment of a deposit of £1. 1s., which will be returned on receipt of a bona fide tender. Tender to the Town Clerk by 12 noon on Feb. 22.

**Erith (Kent).**—The Urban District Council invite tenders for the execution of all work required under the Council's assisted wiring scheme for period ending March 31, 1906. Specifications and forms of tender may be obtained from Mr. Geo. E. Heath, electrical engineer, from whom any further information desired can be obtained on payment of a deposit of £1. 1s. for each copy required, such deposit being returnable on receipt of a bona fide tender. Tenders by Feb. 20.

**Shanghai.**—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Pook and Co., 63, Leadenhall-street, E.C. Tenders by March 31, 1905.

**South Shields.**—The Electricity Supply Department invite tenders for the supply, delivery, and erection of the following plant: (Contract No. 67) one multitubular marine-type boiler, with chimney and mountings; (68) two medium-speed open-type vertical engines for two 550-kw. direct-current traction generators; (69) two 550-kw. direct-current traction generators; (70) traction switchboard; tramways department—(Contract No. 4) electric tramcars, complete with "Brill" trucks, for the Corporation. Copies of specifications, conditions, form of tender, also form of contract, can now be obtained from Mr. J. H. Cawthra, M.I.E.E., borough electrical engineer, South Shields, on payment of £2. 2s. for each contract, which sum will be returned on receipt of a bona fide tender for each contract. Tenders to Mr. J. Moore Hayton, town clerk, Court-buildings, South Shields, by noon on March 13.

**Johannesburg.**—The Municipal Council are prepared to receive tenders for 100 electric tramcars, two electric water-cars, one five-ton travelling crane, one electric car traverser, and various workshop tools, including erection at Johannesburg, to Specification No. 10 of their consulting engineers, Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W. Copies of the specification may be seen on and after Jan. 7 at the Council Offices, Johannesburg, and at the Consult-

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ing Engineers' Offices in London, and may be obtained on payment of five guineas, which will be returned on receipt of a bona fide tender. Duplicate copies of the specification may be bought for 10s. each (not returnable). Tenders must be addressed to Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W., and must be received by them not later than March 6. The Council will not be responsible for any expenses incurred in tendering.

**South Shields.**—The Corporation invite tenders for the execution of the works and the supply of plant in connection with the laying of proposed electric overhead tramways in the streets of the borough: (Part 1) permanent way and construction of track; (2) copper rail bonds, bonding of tramrails; (3) conduits, cables, and overhead equipment. Specification, etc., can be obtained from Mr. J. Moore Hayton, town clerk, on payment of £5. 5s. for each of Parts (1) and (3), and £2. 2s. for Part (2), which sum will be returned on receipt of a bona fide tender for each part. General and detailed plans of the proposed works can be seen as regards Part (1) at the office of Mr. S. E. Burgess, M.I.C.E., borough engineer, Chapter-row, and as regards Parts (2) and (3) at the office of Mr. J. H. Cawthra, M.I.E.E., the borough electrical engineer, West Holborn, South Shields. Tenders to the Town Clerk, Court-buildings, South Shields, by Feb. 20.

## RESULTS OF TENDERS.

**Shildon.**—Messrs. Clark and Co. have obtained the contract for the electrification of Shildon.

**Keighley.**—The Corporation have accepted the tender of the Brush Electrical Engineering Company for two tramcars at £1,080.

**Stockport.**—The Tramways Committee have accepted the tender of Messrs. Blackwell and Co., London, at £4,343. 11s. 3d., for the overhead equipment and copper bonds, and also for the 10 cars required for the Hazel Grove electric tramway route.

**Gravesend.**—The Town Council have accepted the tender of the Western Electric Company for the necessary concrete drawing-in pits with suitable frames and covers, drawing in the cable, the station and boxes, and connecting to their switchboards, at £48. 9s., and that of Messrs. Cowans, Limited, for the switchboard, at £106. 10s.

**Leftwich.**—Messrs. R J. Nicholson and Co., of Manchester, have secured the contract for the electric light installation at the isolation hospital, Leftwich, near Northwich, from the Northwich Rural, Northwich, Middlewich, and Winsford Committee. In addition to the fitting of the various blocks, the contract includes a distribution system of underground mains.

**Diesel Engines.**—The Diesel Engine Company, Limited, 179, Queen Victoria-street, London, E.C., report the following orders: Peruvian Cotton Manufacturing Company, London, 400 b.h.p.; Caleb, Shadbolt, and Co., Uxbridge, 160 b.h.p.; Electric Construction Company, Limited, Wolverhampton, 20 b.h.p.; Linde British Refrigeration Company, Limited, London, 40 b.h.p.

**St. Marylebone.**—The tender of the Electrical Power Storage Company for the supply and erection of the storage battery for the sum of £2,418 was recommended for acceptance last night; and that of C. A. Parsons and Co., of Newcastle-on-Tyne, for the construction of the stairways, flooring, and grating of the engine-room at the new generating station, according to the specification prepared by the engineer, for £2,952.

**Erith.**—The Electricity and Tramways Committee have recommended the following tenders for acceptance: Brush Electrical Engineering Company, overhead equipment, etc., £4,217; Callender's Cable and Construction Company, underground feeder cables, etc., £2 590. 4s., and £51. 16s. for additional two years' maintenance; British Westinghouse Company, rotary converters, etc., £1,545. 5s.; General Electric Company, high and low tension switchboards, etc., £1,169.

**Bradford.**—The Corporation have accepted the following tenders for miscellaneous stores required by the Tramway Department: J. Rushforth and Son, Bradford, timber; H. Barrett and Son, Bradford, iron and steel; Baxendale and Co., Manchester, varnishes; S. Mason, Birmingham, dry colours; R. R. Minton and Co., Bradford, paints and white lead; Stephenson Bros., Bradford, painters' sundries; General Electric Company, Manchester, electrical accessories; Bradford Incorporated Institution for the Blind, cleaning brushes; J. S. Heap and Sons, Bradford, paint-brushes; A. W. Fairless and Co., Bradford, glass; S. Miller, Bradford, oils, grease, etc.; Veritys, Limited, Manchester, lamp fittings; Thornton and Crebbin, Bradford, iron castings; T. Gameson, Walsall, malleable-iron castings; Jonas Wells, Keighley, steel castings; W. F. Dennis and Co., London, cables and wires; Wood and Saberton, Bradford, bolts, nuts, and washers, wood handles and shafts, galvanised iron and tinware, screws, nails, and rivets, and hard tools; S. W. Whaley and Co., Bradford, rope, twine, paper, etc.; Taylor and Parsons, Bradford, lead, tin, etc.; J. W. Rowlands and Co., Birkenhead, pinion wheels; London Transfer Depôt, Snow-hill, London, transfers; S. Dixon and Sons, Leeds, trolley poles; W. Vaux, Bradford, files.

# BUSINESS NOTES.

## TRACTION.

**Keighley.**—The Stockbridge route was opened on Friday last.

**Newark.**—The Light Railway Commissioners have sanctioned the light railway scheme.

**Stalybridge, Hyde, etc.**—The Joint Board have decided to adopt ½d. fares on all routes.

**Halifax.**—The extension from Sowerby Bridge to the Triangle was opened on Friday last.

**Rideford and Hartland.**—A light railway scheme was approved at a meeting of the inhabitants.

**Royton.**—A commencement has been made with the construction of the electric line to Crompton.

**Accrington.**—The Rawtenstall Council have decided to present a petition against the Corporation's Tramway Bill.

**Falkirk.**—It is reported that the company will make an early commencement with the construction of their system.

**Birmingham.**—The Small Heath route, leased to the company, was due to be inspected yesterday, and to be opened to the public if satisfactory.

**Blagdon-Pensford.**—The projected light railway between these Gloucestershire towns is receiving enthusiastic support from the inhabitants.

**Rochdale.**—The Whitworth Urban District Council have decided to ask the Corporation on what terms the latter will run a line to Whitworth.

**Argentina.**—It is reported that the tramway concession granted to Messrs. Otto Bemberg and Co. for an electric line between Buenos Ayres and Conchitas has been transferred to an Argentine company.

**West Hartlepool.**—The differences between the Corporation and the company are likely to be disposed of amicably, and the summonses taken out against the latter have accordingly been adjourned for a month.

**Loughborough.**—The Town Council having received a communication from a local authority on the subject of a municipal tramway service, have decided to reply that it is a matter for private enterprise.

**West Cumberland.**—Referring to the note in our last week's issue, it was reported at last week's meeting of the Whitehaven Town Council that the company have now agreed to commence the work within one year.

**Bath.**—The Rural District Council having been approached by the tramway company for consent to an extension to Newton St. Loe, which the County Council are opposing, the District Council decided to remain neutral.

**Swindon.**—The Tramways Committee are to consider the question of extensions, particularly to Coate. Some of the councillors favour motor-omnibuses, powers for which Parliament refused to grant the Corporation some time ago.

**Paisley.**—It looks as though the company's proposed extension to Killarchan will not be made at present, as the authority not only insist upon paving works, to which the company are agreeable, but also upon double lines throughout.

**Exeter.**—The Bishop of the diocese headed a deputation to the Corporation last week against the proposed Sunday running. The Corporation decided, however, to adopt the Tramway Committee's report recommending a service from 1.30 to 10.

**South-Eastern and Chatham Railway.**—Having experimented with a steam motor carriage between Ramsgate and Margate, it is reported that the company intend to run a service on this section to compete with the Isle of Thanet Tramways Company.

**Mexborough and Swinton.**—It is reported as probable that terms will shortly be arranged between the company and the Rawmarsh Urban District Council, under which the former will begin the construction of their system before the 31st prox. and complete same within two years.

**Derby.**—The extension from Victoria-street to the Market-place has been completed, and on Saturday morning a satisfactory trial was run. The contract has been completed a week before the time allowed, and had it not been for several interruptions by bad weather the work would have been finished earlier.

**Great Northern, Piccadilly, and Brompton Railway.**—A little complication arose owing to the freehold of the site for this company's station at Piccadilly-circus belonging to the Crown, but conditions have now been agreed, and the London County Council have given their approval to the plan submitted by the company.

**Bristol Tramways and Carriage Co., Limited.**—The gross receipts for the year ending Dec. 31 amount to £259,799, while the working and general expenses and renewals total £168,798, leaving a net revenue of £91,000. It is proposed to pay a final dividend for the half-year at the rate of 9 per cent. per annum, carrying £17,769 to reserve.

**Baker-street and Waterloo Railway.**—The London County Council have conditionally approved the company's plan of the station to be erected in Harewood-avenue, Marylebone. The £500,000 4 per cent. perpetual debenture stock of this company, offered at £96 per cent., was all subscribed and the lists closed on Wednesday, the opening day.

**Glasgow.**—It appears that the Corporation's proposed extension to Partick has fallen through, the latter authority holding out for terms to which Glasgow could not agree. It is reported that, as the result of a further reference to Lord Balfour of Burleigh, the Corporation and the Paisley Company are likely to come to terms in a few days, by which the former will run to Paisley Cross.

**London and South-Western Railway Co.**—At the meeting of this company the Chairman referred to the experiment in electric traction which is to be tried on a portion of the South-Western line between Putney Bridge and Wimbledon, worked by the District Company. All the South-Western Company's trains will be carried over this section by electrical working, and also up to Richmond.

**Croydon.**—On the grounds that the proposed extension of the trams to Upper Norwood cannot be expected to pay working expenses, that the debt of the town is over £2,000,000, and that the rates have risen from 5s. to 7s., a petition has been lodged against the scheme by

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owners and frontagers. It will be remembered that a *plébiscite* was taken recently, when the proposal was affirmed by a small majority.

**Edinburgh.**—The authorities adjoining Edinburgh have received a communication from the syndicate to which we referred a few weeks ago. It is proposed to construct an electric tramway through the suburbs, and the letter suggests a conference. A sub-committee has resolved to recommend that powers be sought to construct an electric line on the Gilmore-place route, which is at present worked by animal haulage.

**Manchester.**—The Urmston District Council at its meeting on Tuesday adopted a long report on the tramways question, in which the negotiations with the Manchester Tramways Committee were described in full. The District Council have taken the opinion of Mr. Balfour Browne, and it is probable that terms will be agreed between the two councils for constituting the Manchester Corporation the tramway authority for Urmston.

**Walsall.**—The Corporation have adopted the tramway accounts, of which we gave particulars recently. A discussion occurred on the question of depreciation, one councillor stating that if a suitable amount had been placed aside for this purpose the gross profits would have been reduced from £7,932 to £2,932. The general consensus of opinion, however, was that the undertaking had been eminently successful for its initial year.

**Llanelly.**—At a meeting of the Roads Committee last week, it was reported that the tramways were to be transferred from the local company to the Llanelly and District Electric Lighting and Traction Company, subject to the approval of the Board of Trade, and that any objections or representations with respect to such proposed transfer were to be made to the Board of Trade. It was decided to present to the Board a complaint of the conditions of the tramways.

**Tranent.**—The committee recently appointed at a public meeting to act conjointly with the Burgh Commissioners to further the scheme for the extension of the electric tramway system from Levenhall to Tranent held a meeting last Friday, when the deputation appointed to interview the company presented a report. After consideration of the report, it was unanimously agreed to prepare petitions for presentation to the directors in furtherance of the extension scheme.

**Cleveland and Portishead Light Railway.**—In the Chancery Division on Saturday, the matter of the Weston, Clevedon, and Portishead Light Railway Company and the Railway Companies Act, 1867, came before Mr. Justice Farwell as a petition. On the case being called on, counsel said that the matter was practically settled, and he asked that his lordship would direct that the petition should stand over generally. His lordship assented, and made the order accordingly.

**Pontypridd.**—At a meeting of the District Council on Tuesday evening Mr. Teasdale, the resident engineer, reported that a trial trip of one of the new electric tramcars had been made in the Treforest district, and had been satisfactory. He hoped that the tram service would be inaugurated not later than March 7 where the lines had already been laid, and the electric lighting installed a week later. Colonel Druitt, the Local Government Board inspector, will inspect the system to-day.

**Erith.**—Good progress continues to be made with the construction of the electric tramways. The Urban Council have decided to inform the London County Council of the construction of tramways up to the county of London boundary at Abbey Wood, and to ask the County Council if they will proceed at once with the construction of the tramways authorised in the last session of Parliament from Abbey Wood to Plumstead, so as to form a through connection with this Council's tramways system.

**Newcastle.**—At a meeting of the Tramways Committee last week it was agreed, in dealing with the estimates, that the track should not be anchored except in such places and such times as the track is up for the purpose of repair. Consequently the sum of £4,500 included in the estimates for the purpose of anchoring and welding the joints will stand over for further consideration. It was decided that the chairman should have an interview with the Tyneside Tramways Company, and make arrangements for increasing the service from Newcastle to Wallsend, having a five minutes' service instead of 10 as at present.

**North Staffordshire Railway.**—At the half-yearly meeting of this company the Chairman stated that, in order to cope with tramway competition, the company had ordered two motor-coaches to run upon rails which they intended to experiment with. It was proposed that these coaches should be put upon the rails and run through the populous districts, stopping at various places which were not regular stations, so that they might pick up passengers. The first route on which they intended to experiment was from Silverdale to Trentham, and if they found the experiment was a success they would, no doubt, follow it up.

**Plymouth.**—At the meeting of the Corporation a member criticised the tramway accounts, pointing out that the receipts in the period dealt with had increased by only £1,225, while the expenditure had increased by £2,983, and drawing the deduction that the tramways were less prosperous. It was explained that the expenditure included a considerable sum for the repair of the permanent way. In adopting a report authorising the construction of the line from Pound-street to Pennycomequick, a rider was added to the effect that wood block paving should be used as far as possible, the estimated extra cost to be first approved by the Tramways and Finance Committees.

**London County Council.**—The Council have come to an arrangement with the Metropolitan Water Board under which the latter are to provide a water supply in the event of any portion of the Council's condensing plant temporarily breaking down. The receipts for the week ended Feb. 4 amounted to £12,556, against £9,373 last year, and from April the total was £562,616, against £437,128. The agenda of the Fulham Borough Council for Wednesday contained a recommendation that support should be given to the County Council's scheme for trams along the embankment. The Battersea Borough Council have decided to urge the County Council to proceed more expeditiously with the electrification of the trams in the district.

**Swansea.**—The necessary steps have been taken to promote the Corporation Bill this session, and the company intend offering the strongest opposition to Part II., which seeks powers to acquire the tramways subject to a lease to the company for 21 years. An opening for a possible compromise is to be offered, however, as the tramways directors will be invited to a conference with the Parliamentary Committee of the Corporation. A basis for a working arrangement has been informally suggested, consisting of an arrangement for pooling the receipts for the whole of the tramways, whether owned by the Corporation or the company, and the division of profits for a period of between 30 and 40 years, after which the Corporation would acquire the company's tramways at "their constructed values," without any liability to grant a further lease.

**London Road Car Co.**—At the meeting of this company it was stated that cars were being built for the company with a 36-h.p., which would carry 34 passengers, and which were being exhibited at the present time at Olympia. It was intended that the substitution of mechanical traction for horse power would be carried out gradually, the existing horses and cars being disposed of by degrees, as a charge to revenue, as they were replaced by the rolling-stock. To provide for the difference in the cost of the new motor road cars and the value in the books of the present fully-equipped horse cars, it was proposed to issue the balance of the company's share capital (£116,004), and, in accordance with the terms under which the capital was authorised, the issue was, in the first place, offered to the shareholders. As the substitution of the motorcars for the present cars would be a gradual one, the additional capital would not be required all at once. The response to the Board's circular had provided sufficient capital for present requirements.

**Motor Omnibuses for London.**—Messrs. Hicks, Davis, and Hunt, solicitors to the London Omnibus Owners' Federation, address the editor of the *Times* as follows: "In view of the interest now being taken by the general public in motor omnibuses, the London Omnibus Owners' Federation will be obliged if you will allow them to announce through you the fact that the undermentioned companies and firms already working omnibuses in London have at this moment a very large number of motor omnibuses under construction, and that they will be in actual work during the next few months; and, further, that it is their intention to cover the whole of the roads with motor vehicles at an early date: London General Omnibus Company, Limited; London Road Car Company, Limited; Thomas Tilling, Limited; Associated Omnibus Company, Limited; Birch Bros., Limited; P. Hearn; Atlas and Waterloo Association; Star Omnibus Company, Limited; London Omnibus Carriage Company, Limited; C. W. French and Sons; Philips and Brickland; Camden Town Association; Victoria Omnibus Association."

**District Railway.**—At the meeting of this company last week, Mr. R. W. Perks, M.P., who presided, said he could almost positively assure the stockholders that that would be the last meeting which the company would hold while the line was being worked by steam traction. The Board was confident that before they met in July next the whole of the steam locomotives would have disappeared from the railway, and the whole of the main line and branches would be worked electrically. The reason why they were not working so now was that the foreign and British car builders had not carried out their contracts to time. The two English companies were building 280 cars, and 140 were being made on the Continent, but they were all considerably behindhand in delivery. Trains were now being delivered by the English contractors, and he hoped that within two or three weeks the foreign companies would begin delivery. Mr. Perks has been succeeded as chairman by Mr. Charles Yerkes, who informed the meeting that he intended to give all his time and energy to the District Company, for he wished it to be the crowning success of his life.

**Private Bills.**—The following petitions have been deposited in the Private Bill Office of the House of Commons: Against the Baker-street and Waterloo Railway Bill—Petition of the Pelican and British Empire Life Office and the Phœnix Assurance Company. Against the Central London Railway Bill—Petitions of the trustees and manager of the Stock Exchange, Union Bank of Scotland, Lloyds Bank, Union Discount Company, Commercial Union Assurance Company, Union Bank of Australia, Scottish Widows' Fund, National Discount Company, Mutual Life Insurance of New York, Liverpool, London, and Globe Insurance Company, County Fire Office, and Provident Life Office. Against the Great Northern, Piccadilly, and Brompton Railway (No. 2) Bill—Petitions of Union Bank of Scotland, Lloyds Bank, Union Discount Company, Commercial Union Assurance Company, Union Bank of Australia, Scottish Widows' Fund, National Discount Company, Union Assurance Company, Liverpool, London, and Globe Insurance Company, Mutual Life Insurance of New York. Against the Hammersmith, City, and North-East London Railway Bill—Petition of Bank of British North America.

**Aston.**—At a special meeting of the Town Council held on Friday last the Council adopted a report of the Public Works Committee embracing a scheme which had been prepared by their consulting engineer, Mr. Robert Green, for the reconstruction of the remaining tramways within the borough, including street improvements. The total cost of the work, including the overhead electric equipment, is estimated to cost £63,270. The Council approved the plans and sections of the work prepared by the engineer, and authorised tenders to be obtained. At a special meeting of the Town Council the members considered the report of the Public Works Committee submitted at the last meeting with regard to the reconstruction of tramways in High-street, Six Ways, Birchfield-road, Lozells-road, and

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Witton-road. The committee did not intend curtailing the width of any of the footpaths of the routes affected. It was proposed that the tramway in Lozells-road should be paved with wood, that that portion of the route between Chain-walk and Whitehead-road should be paved with wood, and the remainder with granite setts. The committee also recommended, with regard to the making-up of High-street after the construction of the tramways, that the road should be paved from end to end, and that the portion between Six Ways and Whitehead-road should be paved with wood, and the remainder with granite setts as far as New-street, and from New-street to the city boundary with wood. The report was approved.

**Belfast.**—At the meeting of the Finance Committee on Monday the Lord Mayor reported as to the result of the negotiations carried on in London by the members of the committee to whom the raising of a loan for the tramways and other works had been entrusted. He detailed the terms under which the loan had been guaranteed by the Union of London and Smiths Bank, Limited, these being an issue price of 98, bearing interest at 3½ per cent., with 1 per cent underwriting commission and the usual brokerage charges, the net result of which is that the Corporation will get the money at about 3¾ per cent. The loan will amount in all to £1,000,000, of which £900.000 will be for the tramways, while the remaining £100,000 will be devoted to other purposes. The arbitration proceedings between the Corporation and the company are proceeding, Mr. Macassey acting as umpire. The company's claim totals close upon £400,000. For permanent way the Corporation put the figure at £105,000. Practically all the quantities and such like matters have been agreed, and the main question to be decided is the extent of the depreciation of the undertaking, the company putting the life of the rails at 24 years, and the Corporation insisting that 18 years are ample. The company are represented by Mr. Cripps, K.C., M.P., Mr. Richardson, and Mr. Hutchinson. Counsel for the Corporation are Mr. Balfour Browne, K.C., and Mr. Campbell, K.C., M.P., Solicitor-General for Ireland. Mr. Cutler, the city surveyor, tendered evidence on behalf of the Corporation as to the condition of the permanent way.

**North-Eastern Railway.**—Speaking at the half-yearly meeting of this company, Sir Edward Grey, the chairman, stated that before the electric trains were introduced the first-class passengers only represented 2 per cent. of the whole of the public travelling on that part of the system. Where the proportion of traffic was so small as that, and where a more frequent service was given, it was quite impossible to provide for this small section without some sacrifice of economy in working. But it was very undesirable that there should be a degree of friction and heat which made the working of the railway difficult, or impaired their relations with the public. Where the inconvenience had been proved to be real the Board desired, even by some sacrifice of economy in working, that it should be dealt with. Though they could not revert to the accommodation first provided for first-class passengers, they proposed to devise some method by which at any rate some first-class accommodation should be provided on the ordinary trains. Considering all the difficulties of the change, the Board thought they had met with a certain amount of unreasonableness in the demands made upon them. The financial result had so far been satisfactory. There had been an increase in receipts of £17,000, equivalent to 27 per cent., and after deducting working expenses, interest on capital and depreciation, they considered that there was a certain net profit left on the working of the electric trains. The Board saw no reason why the future of electric train working should not be as satisfactory as hitherto, but they did not propose to found upon the short experience they had so far had further demands on the shareholders for large capital expenditure, though they believed that the results they had got up to now would be confirmed by future experience.

## LIGHTING AND GENERAL.

**Gravesend.**—Application is to be made for sanction to borrow £4,500 for extensions of mains.

**Handsworth.**—The District Council have decided to borrow £45,000 in connection with the electric lighting scheme.

**Rawtenstall.**—The draft of proposed agreement between the Corporation and the Lancashire Electric Power Company has been agreed to.

**Holyhead.**—The Urban District Council are raising £13,700 for electric lighting purposes and £3,300 for the destructor works, at 4 per cent. per annum.

**Irvine.**—At a public meeting on Wednesday a resolution was carried dissenting from the action taken by the Town Council in the matter of installing electric light into the burgh.

**Tiverton.**—At the last Town Council meeting it was proposed that the electric lighting order be rescinded. A desultory discussion ensued, and the Mayor declined to put the motion.

**Hove.**—Hove proposes to follow Brighton in the method of charging for electricity at Aldrington. Sevenpence a unit for the first hour, and 4d. per unit after, are the prices in view.

**Oxford Electric Co.**—The directors recommend a dividend of 7 per cent. for the year ending Dec. 31, free of income tax, including the interim dividend of 2½ per cent. paid in September last.

**National Telephone Co.**—The transfer books of preference shares and preferred and deferred stocks will be closed from Feb. 15 to 28, both days inclusive, for payment of the dividend for the half-year ended Dec. 31.

**Beckenham.**—The Urban District Council have referred to their General Purposes Committee the report on the advisability of being connected with the telephone system, of which, it appears, Bromley is the nearest station.

**Auckland.**—The Cleveland and Durham Electric Power Company have informed the Urban District Council that negotiations for the transfer of the provisional powers have now practically been brought to a satisfactory conclusion.

**Brompton and Kensington Electricity Co.**—The directors have declared a dividend for the half-year ended Dec. 31 last at the rate of 11 per cent. on the ordinary shares, making, with the interim distribution, 10 per cent. for the year.

**Lichfield.**—The City Council are petitioning against the Shropshire and Worcestershire Electric Power Bill, which proposes to include Staffordshire and the boroughs of Lichfield and Tamworth, with the view of getting protective clauses inserted.

**Nelson.**—The sale of the Corporation's old plant, consisting of two engines and dynamos at the old electricity works, has been completed. Alderman Hudson and the electrical engineer are to report on the advisability of fixing superheaters to the boilers at the electricity works.

**Huddersfield.**—Last July the Electricity Committee reduced the electricity rates, and now they have decided that the charges for current be reduced by ½d. per unit. At the same time they are transferring £5,985 from the revenue and contingencies accounts to the borough fund in aid of the rates.

**Coatbridge.**—The Town Council have decided to consent to the granting of the order being promoted by the Scottish House-to-House Electricity Company, Limited, to transfer their undertaking on the County of London Electric Supply Company guaranteeing the carrying out of the transfer on the lines indicated in the draft agreement.

**Farnham.**—The Council's recent resolution giving a conditional consent to the grant of a provisional order to the Farnham and District Electric Supply Company, Limited, has been rescinded, and, subject to an undertaking being given by the company that their works shall be situated within the urban district, the Council will consent to the grant of the proposed order.

**Yarmouth.**—Messrs. Preece and Cardew will act as consulting engineers in regard to the extension of the electric lighting installation, estimated to cost £10,000. The lighting of the Marine-parade South with arc lamps has been agreed to. The annual cost will be £90, and the Electricity Committee have decided to lay the necessary mains and fix the requisite posts at a cost of £420.

**Gillingham.**—A total of 13,321 8-c.p. lamps, with 220 consumers, is now connected to the Corporation's mains. The resident engineer's estimates of the cost of laying down public and private lighting mains in various roads will be considered when the final financial statement, including the loan for £19,754, comes before the committee. The question of free wiring has been adjourned for the same cause.

**New Firm.**—We are informed that Mr. Robert McLaren, who has been engaged for many years in the locomotive department of the Central Argentine Railway, has now joined the firm of Topping and Seavill, engineers, Rosario, and in future the firm will trade as Topping, Seavill, and McLaren, engineers; and agents in the Argentine for J. and H. McLaren, Midland Engine Works, Leeds.

**Stourbridge.**—The Guardians are still undecided whether to light the new workhouse by gas or by electricity. The architect (Mr. A. Marshall) has submitted estimates, and these were £2,700 for electric fittings and £2,139 for gas fittings for the workhouse. The price for electric lighting would be 3d. per Board of Trade unit, and 2s. per 1,000 for gas if a minimum of three million feet were consumed yearly.

**Stock Exchange.**—The Stock Exchange Committee have appointed Feb. 23 special settling day for Marconi's Wireless Telegraph Company's further issue of 30,016 shares of £1 each, fully paid, Nos. 196 112 to 196,127 and 221,128 to 251,127. Application has been made to the committee to appoint a special settling day in and to grant a quotation to Havana Electricity Company's scrip (fully and partly paid) for £150,000 5 per cent. debentures.

**Galashiels.**—The Electric Lighting Committee are satisfied with the recent canvass with regard to prospective consumers for electric light and power. Under advice of Messrs. Handcock and Dykes, it has been agreed that an agreement be entered into with a company to carry out the installation, and otherwise implement the whole obligations of the Corporation under the order, on the basis of the company providing the whole capital required.

**Exeter.**—At the last meeting of the City Council Mr. Munro protested against the proposal to entrust the management of the electrical equipment to the Electric Light Committee and the electrical engineer. He moved the rejection of the recommendation. The electrical engineer (Mr. H. D. Munro), said he desired enquiry. Nine members voted for Mr. Munro's amendment, which was lost. An amendment that the Council hold an enquiry in committee before the question of the management of the electrical equipment of the tramways was decided on was carried.

**St. Marylebone.**—The Electric Supply Committee last night submitted the following statements: (1) Estimated revenue statement to March 31, 1905—Expenditure—interest on loans and accruing due to March 31, 1905, £38,225; expenses of obtaining loans, £2,381; rents, rates, taxes, insurance, and repairs, £1,103; salaries, wages, and general establishment expenses, £821; supply of current, £600; law and parliamentary charges, £98; cost of promotion of Bills of 1901 and 1904 (proportion of), £1,096—total, £44,324. Income—interest from Metropolitan Electric Supply Company, Limited, £37,035; bankers' interest on temporary deposit, £283; rents of various properties, £956; debit balance, £6,050—total, £44,324. (2) Estimated revenue statement, March 31, 1905, to Sept. 30, 1905—Expenditure—interest on No. 1 loan, £24,765; ditto No. 2 loan, £937; ditto No. 3 loan, £469; ditto bank balances, £100; rents, etc., payable (less rents receivable), £200; salaries, wages, etc., £700; general expenses, £200—total, £27,369. Income—interest from Metropolitan Electric Supply Company, Limited, £21,369; ditto balance, £6,000—total, £27,369.

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**Dewsbury.**—The amount of current used for power and lighting during the fortnight previous to Jan. 21 amounted to 27,871 units, or 3,500 units more than last year, while the supply for tramways was greater by 2,800 units. These figures fully justify the reduction which has been made in the charges for electric lighting.

**Change in Dundee Telephones.**—The Town Council have agreed to the National Telephone Company's proposal to put in underground conduits practically the remaining portion of the overhead telephone wires of the city. The work of opening up and reinstating the streets will be carried out by the Town Council at the expense of the company, who will have to remove all overhead wires where they cross tramway lines.

**Louth.**—At the quarterly meeting of the Town Council, the Electric Lighting Committee reported having made enquiries as to the costs of and the results obtained by having producer gas as a motive power, and had resolved to ask the engineers to submit an alternative estimate for the cost of a suitable plant driven by producer gas. It was decided that the minutes be referred back to be presented to the Council in committee.

**Worcester.**—At the last meeting of the City Council, the Electricity Committee reported a loss on the undertaking in the past year of £1,220. Mr. Parker said that it had been the worst year experienced in regard to water power, and instead of receiving £3,500 from the tramway company, the revenue from that source had been only a little over £2,000. It was urged that the water power obtainable at Powick should be exploited to its fullest extent.

**Walsall.**—The report of the Electricity Committee shows a successful year. After paying the interest and sinking fund there remains a profit of £1,060, but the committee have also been able to reduce the price of electricity from 6d. to 4d., and that used by the trams from 2d. to 1½d. Several extensions of the electric mains are now to be carried out at a total cost of some £1,800 to £1,900. The profit of £1,061 will be carried to the reserve fund.

**Heywood.**—The consumption of electricity for the month of December, 1904, was 9,345 units, as against 8,216 units for the corresponding period of last year, showing an increase of 1,129 units. The consumption for the quarter ending December was 24,531 units, as against 21,139 units for the corresponding period of last year, showing an increase of 3,412 units. The chairman and vice-chairman have been authorised to purchase new motors required during the ensuing year.

**Wakefield.**—The City Council have decided to apply for sanction to borrow £18,000 for extensions in connection with the electrical undertaking. The electricity department is paying over this year £900 towards the rates, and £200 towards the expenses of the town hall. The committee also intend to reduce the price for electricity from 4½d. to 4d. per unit, as well as to abolish the meter rent, which would mean a difference of £600. They thus show a profit of £2,200, as they will still hold £500 in hand.

**Dunfermline.**—The Town Council have apparently only just found out that their proposed application for a provisional order anent electric lighting and power must stand over till November. The resolution was passed on Thursday by the Town Council on the assumption that the application would be made in March. Provisional arrangements have been made for a meeting with representatives of the Fife Electric Power Company with the object of ascertaining the lowest terms on which the company will supply electricity in bulk.

**Huddersfield.**—The last accounts of the Corporation's electricity undertaking show a surplus of £3,875. The surplus, together with £2,110, from the depreciation and contingency account, is to be transferred to the borough fund in aid of the rates for 1905-6, by way of reducing the amount received from the borough rates towards deficiencies in the revenue account for the three years 1893-4-5, amounting to £5,985. 16s. 6d. If this proposal is adopted, the depreciation and contingencies fund will be reduced from £11,853. 11s. 7d. to £9,743. 0s. 1d.

**Mexborough.**—An enquiry has been held into an application of the Urban District Council for sanction to borrow a further £4,000 required for necessary extensions in connection with the electric light undertaking. The money is required to meet deficiencies on the former loans, and to complete new work already sanctioned by the Board but not carried out. The expenditure in excess of the previous amounts scheduled includes £1,359, cost of new cables and lamp. Cables had been laid in certain streets not scheduled, absorbing a further £488, making the total excess £1,847. On the other hand, £1,110. 15s., allowed for mains in the first application, has not been spent.

**King's Lynn.**—During the month applications have been received for 93 additional lamps of 8 c.p. (or equivalent), making a total of 20,427 from private consumers, an increase of four. Enquiries whether the Corporation are willing to let out motors on hire or hire purchase are under consideration. The following report has been submitted—viz.: units generated, December, 1904, 61,501 (1903 59,014); total units sold to private consumers (light and power), 29,765 (25,326); units sold at power rates, 10,091 (5,629); cost of fuel, stores, repairs, and wages at stations, £152. 13s. 5d. (£156. 7s. 6d); cost per unit generated, 0·5955d. (0·6356d.); wages of lamplighters and outside staff, £20. 11s. 4d. (£22. 12s. 10d.).

**Hammersmith.**—The premises of 13 additional consumers, representing a maximum of 315 8-c.p. lamps, have been connected to the mains; 10 consumers have been disconnected, the present number of consumers taking current from the mains being 1,537. The Guardians have received a letter from the Local Government Board requesting that the specification and schedules on which the electric lighting tenders for the workhouse and infirmary buildings were based might be submitted to them, together with the plans indicating the position and number of lights proposed to be introduced. At the last meeting directions were given for the necessary papers to be obtained and forwarded to the Local Government Board.

**Swansea.**—The members of the Corporation paid their annual visit to the electric lighting station on Friday. The Chairman (Major Sinclair), in referring to the progress that had been made, said he certainly anticipated they would come out well on the right side, and that as time went on their position would steadily improve. He believed they had got a really good thing in the electrical undertaking, and one which, in spite of the critics, would soon come under the heading of remunerative undertakings. He thoroughly believed, from what he had seen and knew, that the interests of the public were being well looked after.

**City of London Electric Lighting Co.**—The directors have decided to transfer the sum of £45,500 to reserve account, and to recommend to the shareholders the payment of the following final dividends for the year ended Dec. 31, 1904: Preference shares—0s. per share, making with the dividend of 6s. per share paid in July, 1904, a total distribution of 12s. per share, being at the full rate of 6 per cent. per annum, subject to deduction of income tax. Ordinary shares—7s. per share, making with the dividend of 5s. per share paid in July, 1904, a total distribution of 12s. per share, being at the rate of 6 per cent. per annum for the year 1904, subject to deduction of income tax. The above appropriations will leave a balance of about £22,000 to be carried forward.

**London Gazette.**—George Walter Chapman, official receiver, Bankruptcy-buildings, Carey-street, London, W., has been released from trusteeship in the estate of George Neale, electrician, 2, Fulham Palace-road, London, and trading with another at such address as the South-Western Electrical Contracting and Maintenance Company. Thomas Henry Geake, official receiver, 6, Athenæum-terrace, Plymouth, has been released from trusteeship in the estate of David Todd Cameron, mechanical and electrical engineer, 1, Magdala-villas, Saltash, Cornwall. The partnership between William Hampson and Montague Wakefield Wickes, electrical engineers, 8, Harrington-street, Liverpool, trading as the Liverpool Electrical Engineering Company, has been dissolved by mutual consent.

**Dundee.**—At a meeting of the Tramway Committee the question of the erection of a new electrical station for the city was discussed, but no resolution was proposed. The Electrical Engineer said that during the past winter there had been a large increase in the use of electricity for lighting, involving an additional demand of 900 h.p. If this increase continued, the question of a new station would have to be faced. Mr. Brownlee said they had at present plant to supply 5,000 h.p., and there was boiler space for another 4,000 h.p. The coolers for the condensers could be put on the roof. A suitable place would be the esplanade, near Magdalen-green Station. They would then be close to the river for water, and they could have a railway siding for coal. To have a station near the railway and the river would mean a saving of about £3,000 per annum. He doubted if the Harbour Trustees would sell the dock.

**Telegraph Poles.**—The Staffordshire County Council have just concluded a bout with the Post Office with reference to the placing of telegraph poles by the sides of the main roads. From the beginning the Council insisted that a condition of their consent to the erection of the poles should be that the main roads surveyor should approve of the sites. The Post Office superintendent engineer, in declining to furnish the plans, said that "the positions proposed would naturally be those most suitable to the Department's point of view, and I venture to suggest that these would be hardly likely to meet with the approval of your Council's surveyor." In reply to that the clerk said he should advise the Council to decline to issue any consent, and leave the Department to their remedy, or to issue the consent "subject to the position of the poles being to the satisfaction of the Council's surveyor." Thus the Department would run the risk of his objecting to the position and requiring it to be altered. The matter was referred to the Postmaster-General, and he has now agreed to accept the condition that the poles should be erected subject to the Council's surveyor approving of the positions.

**Science on the Stage.**—A pretty and effective application of the thermit process will be utilised next week in the bill of the London Pavilion, when Miss Lu Robinson will demonstrate, by means of various small crucibles, how iron can be manufactured in a few seconds without the aid of a furnace. By the courtesy of Mr. Frank Glenister, the manager of the London Pavilion, Limited, we were enabled, on Wednesday, to witness a private representation of the turn. Miss Robinson commenced by pouring a small quantity of black grain, which, she explained, did not contain one particle of metallic iron, into a 3in. crucible, added a saltspoonful of white powder, applied a match to it, and almost immediately afterwards, by the aid of a magnet, withdrew from it a solid piece of wrought iron. Large quantities were made and turned into moulds, and thus a horseshoe was turned out within a few seconds. Although the heat engendered comes up to that of an electric furnace, the process is so quick that the crucibles have no time to get heated, and, in fact, one experiment was made inside an ordinary silk hat which had been previously filled with sand, and which was not in the least heated by the process. By the same means a hole was burnt into a solid iron plate in about two seconds, and Miss Robinson was careful to inform the audience that also by these means a safe might be burgled. Mr. William Sykes would have to be mighty quick about it, or else he would burn the contents of the safe as well. Various pretty displays of fireworks, amongst which was an artificial arc lamp, produced by the burning of a steel spring inside a glass cylinder.

**Brighton Telephones.**—A report was presented at last night's meeting of the Town Council showing the excess in telephone expenditure, and recommending application for power to borrow the amount required (£11,616) and a further sum for extensions at Hove. The Corporation telephone system is now showing a profit of £80 per

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month. The report of the Telephones Committee is as follows:—The Telephones Committee have received the following report from the engineer and manager with reference to expenditure in excess of the provision made in Mr. Bennett's estimate, and also with reference to the estimated cost of providing additional ducts and cables in the borough of Hove, which are urgently required to meet the requirements of subscribers in Hove: "Corporation Telephone Department, Brighton, Feb. 2, 1905. To the Telephone Committee of the Town Council of Brighton. Gentlemen,—I have to report that the following work has been done in excess of what was intended in Mr. Bennett's estimate: Additional work sanctioned by the Council on April 7, 1904—extension of ducts in Preston-road and Upper Lewes-road, £1,195; extension of cable and laying same, £3,013. 5s. 6d.; building switchroom (Mr. Bennett allowed £550 for adapting a room to exchange requirements, but did not anticipate that such extensive alterations would be necessary; the cost has been £1,137. 16s. 2d.), difference £587. 16s. 2d.; power-room, £94. 7s. 1d.; power plant, £99. 10s.; cable and ducts beyond Clermont-road in Patcham parish, £216. 12s. 6d.; cable and ducts at Portslade, £30; cable at Southwick and Kingston, £60. 18s. 2d.; ducts laid by Hove Corporation in Church-road, Hove (and now used by this department), amount due to the Corporation £394. 2s. 3d.; difference in cost of switchboard between original tender and actual cost, owing to order being given first for 1,000 lines, and afterwards extended to 2,000 lines when prices had gone up, £525—total, £6,216. 11s. 8d. I therefore recommend that you apply to the Local Government Board for sanction to a loan to defray the cost of the extension of the ducts and cable, amounting to £4,208. 5s. 6d., and also £2,008. 6s. 2d., the cost of the other works enumerated above. You have at the present time 1,687 instruments working and 22 junction lines, making a total of 1,709 completed lines. In addition to which you have 1,229 partially completed lines, making a total of 2,938 completed and partially completed lines. I have also to report that in the borough of Hove 259 lines have been provided, and you have 186 instruments working on these lines. There are a number of others in Hove working on the Brighton cables. There is now such a small number of spares that it is imperative that you should supplement the underground cables in Hove at once and in every direction. I have prepared a scheme to provide 312 additional lines in Hove (being for 200 completed lines and 112 spares). The cost I estimate will be £5,399. 11s. 5d. I therefore recommend you to apply to the Local Government Board for sanction to a loan of £5,400 to defray the cost of these extensions. I am pleased to be able to say that although you have not yet got the 2,000 lines working on which your revenue was estimated to yield a profit, the net profit (after allowing for sinking fund and interest on the money borrowed, and all other charges) is now at the rate of £80 per month, and every month it is increasing. The profits thus earned will enable the Council to establish a substantial reserve fund.—I am, gentlemen, your obedient servant, (signed) D. J. BARNES, engineer and manager."

## PROVISIONAL PATENTS, 1905.

FEB. 6.

**2268. Electric working of mine shafts.** James Swinburne, 82, Victoria-street, Westminster, London.

**2299. Improvements in and relating to electroliers and electric wall brackets.** George Shilvock, 67A, Corporation-street, Birmingham.

**2313. Electrical dental furnace.** Luther Lawrence Bosworth, 52, Chancery-lane, London. (Complete specification.)

**2328. Improvements in apparatus for heating water electrically.** Milton Henry Shoenberg, 60, Queen Victoria-street, London. (Complete specification.)

**2339. Improvements in electric machines.** William Asahel Johnson, 4, South-street, Finsbury, London. (Complete specification.)

**2341. Improvements in brush-rocking gear for dynamos.** Henry Leitner and Harry Hill, 4, South-street, Finsbury, London.

**2342. Improvements in electric lighting of trains.** Henry Leitner and Richard Norman Lucas, 4, South-street, Finsbury, London.

**2351. Improvements relating to apparatus for telegraphic purposes.** Joseph Theodor Szek, 22, Southampton-buildings, Chancery-lane, London.

FEB. 7.

**2387. Improvements in electrical switches.** John Alexander Kennedy McGregor, 5, Corporation-street, Birmingham.

**2401. Improvements relating to the starting and control of direct-current electric motors.** William Henry Heath, 18, Southampton-buildings, Chancery-lane, London.

**2426. Improvements in electrical resistances.** H. Ward Leonard, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**2432. Improvements in electric systems.** Horace Dowie, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**2474. A new or improved process for neutralising static electricity.** William Henry Chapman, 18, Buckingham-street, Strand, London. (Complete specification.)

**2475. Improvements in automatic systems of signalling for electric railways.** Samuel Marsh Young, 18, Buckingham-street, Strand, London. (Complete specification.)

**2490. Improvements in methods of insulating the windings of dynamo-electric machines.** The British Thomson-Houston Company, Limited, and Siegfried von Ammon, 83, Cannon-street, London.

**2491. Improvements in thermal cut-outs or fuses.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

FEB. 8.

**2495. Improvements in apparatus for the automatic ignition of gas, gaseous mixtures, or the like by means of an electric current.** George Hill, The Grove, Ashton-on-Mersey. (Complete specification.)

**2506. Improvements in or relating to the trolley pulleys of electric tramcars.** James Nicholas Hicks and Michael Galvin, 55, Market-street, Manchester.

**2529. Improvements in electric stop-motions for drawing, slubbing, intermediate, roving, and like frames.** Edmund Tweedale and Samuel Tweedale, Penny Bank-chambers, Halifax.

**2533. An electric high and low water level indicator for water-tube boilers.** Jens Ernest Schmidt, Solheim, Hill-grove-crescent, Kidderminster.

**2545. Improvements in the electrical regulation of clocks.** Frederick Augustus Chandler and Bahne Bonniksen, 18, Hertford-street, Coventry.

**2554. Improvements in or relating to electrical connections.** Paul Hallot, 78, Fleet-street, London. (Complete specification.)

**2559. Improvements relating to electric ignition apparatus.** Sir Oliver Joseph Lodge and Alexander Marshall Lodge, 18, Southampton-buildings, Chancery-lane, London.

**2579. An improved protector or casing for electric conductors, pipes, or the like.** Otto Wilhelmi, 40, Chancery-lane, London. (Complete specification.)

**2581. Improvements in homopolar dynamos.** Henry Leitner, 4, South-street, Finsbury, London.

**2586. Improvements in electric switches.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

FEB. 9.

**2607. Improvements in fusible cut-outs.** Herbert Henry Berry and Sidney Mark George Teal, 78, Upper Thames-street, London.

**2628. Improvements in electric ignition arrangements for explosion motors.** Alfred Schoeller, 100, Wellington-street, Glasgow. (Complete specification.)

**2632. Improvements in or relating to burnishing tools for use in the electro-deposition of metals.** Joseph Christopher Jobling and Herbert Champion Harrison, 50, Wellington-street, Leeds. (Complete specification.)

**2639. Improvements in electrical lampholders.** Edward Bettridge Boucher, 21, Finsbury-pavement, London.

**2658. Electric lighter.** Arthur Charles Cann, 59, Victoria-grove, Stoke Newington, London.

**2673. Improvements in apparatus for the periodic making and breaking of an electric circuit suitable for use in connection with electric lamps and other electric apparatus, horological instruments, and for other purposes.** Guy Carey Fricker, 46, Lincoln's-inn-fields, London.

**2691. Improvements in electric signalling systems and apparatus therefor.** The British Thomson-Houston Company, Limited, 83 Cannon-street, London. (The General Electric Company, United States.)

**2692. Improvements in and relating to electric arc lamps.** Edwin Rudolph Grote and Milton Victor Ely, trading as Foster and Co., Palace-chambers, 9, Bridge-street, Westminster, London.

**2693. Trolley pole controller.** Stephen Edward Gunyon, 115, Cannon-street, London. (The Magney Manufacturing Company, United States.) (Complete specification.)

FEB. 10.

**2715. Improvements in connection with pendants, brackets, and the like fittings for gas, oil, and electric lighting, and for similar purposes.** Arthur Woodhouse Southgate and Frank Southgate, 104, Colmore-row, Birmingham.

**2723. A new and improved system of running and insulating electrical conductors.** Harold Sheen Martin and George Vose Stavert, 22, Sir Thomas-street, Liverpool.

**2742. New or improved apparatus for distributing electric currents or producing electric pulsations.** Arthur Thomas Milnor Thomson and Glendower Owen Ellis, Norfolk House, Norfolk-street, London.

**2747. Improvements in electric cables.** Charles James Beaver and Ernest Alexander Claremont, 4, Bloomsbury-square, London.

**2749. Time element maximum current thermal device for cut-outs, alarms, or indicators.** Frank Biliotti, 8, John-street, Adelphi, Strand, London.

**2766. Improvements in locks and switches for gates of electrically-controlled lifts.** Charles George Major, Edwin Charles Stevens, and Percy Herbert Stevens, "Janus" Works, Queen's-road, Battersea.

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2789. **Improvements in protective devices for electric circuits.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

FEB. 11.

2816. **Improvements in and relating to the automatic lubrication of trolley wheels for overhead system of electric traction.** Lewis Jonathan Bedford, 2, Thistle-villas, Reading-street, St. Peter's, Kent.

2850. **Improvements in connection with electrostatic watt and watt-hour meters.** Ernest Wilson and William Hamilton Wilson, 64, St. John's-park, Blackheath, London.

2862. **Improvements in protective devices for electric apparatus.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

2864. **Improvements in installations for controlling electrically-propelled trains.** Siemens Bros. and Co., Limited, and Charles Frewen Jenkin, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2871. **Improvements in or relating to hermetically-enclosed arc lamps, such as are known as electric vapour lamps, partly applicable to other electrical purposes.** Charles Orme Bastian and George Calvert, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published March 2.*

1904.

2644. **Clutch coupling or means for detachably securing arc lamps to their hangers or suspending or supporting posts, pillars, or the like.** Donovan.

2939. **Electrical igniting appliance for explosion engines.** Bullock and Roehl.

3072. **Cut-outs for overhead electrical conductors.** Nash and Eschus.

3386. **Electric motor-control systems.** British Thomson-Houston Company, Limited. (General Electric Company.)

3919. **System of speed regulation for electromotor-driven machinery.** Dunn. (Date applied for under International Convention, Aug. 20, 1903.)

7418. **Hydrometer for use with electric storage batteries.** Hutton.

7489. **Metallic conduits for electric light cables and the like.** Waterhouse and Simplex Steel Conduit Company, Limited.

8549. **Electric ships' telegraph.** Houston and Erskine.

8555. **Electric stop-motions for drawing, slubbing, and other similar machines for preparing and spinning cotton and other fibrous materials.** Tweedale, Tweedale, and Smalley.

13927. **System and apparatus for electrically operating bulkhead doors, hatches, or the like.** Jones. (Long-Arm System Company.)

16820. **Electric winding-up device for clocks and other chronometrical instruments with or without striking work.** Sallin.

19168. **Alternating-current electrical machinery.** Thompson (Berliner Maschinenbau Akt.-Ges. vorm. L. Schwartzkopff.)

26948. **Storage batteries.** Mills. (Edison.)

27011. **Vapour electric apparatus for rectifying electric currents and other purposes.** Kruh. (Date applied for under International Convention, Dec. 12, 1903.)

27755. **Counting mechanism, more especially intended for use with electricity meters.** Aron and Runge.

27887. **Vapour electric apparatus for wireless signalling and other purposes.** Weintraub. (Date applied for under International Convention, Dec. 21, 1903.)

28453. **Continuous-current electric motor.** Soc. Anon. pour le Travail Electrique des Metaux. (Date applied for under International Convention, May 10, 1904.)

28628. **Arc lamps.** Rosemeyer.

29307. **Switches for electric incandescent lamps.** Frey.

29386. **Electrical generators having double-shaped armatures.** Gutzmann.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ⅜-¼ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 15/32-9/16 |
| British Insulated and Helsby Cables, Ord., 1-100,000 .... | 5 | – | 5¾-6¼ |
| —— 6 per cent. Cum. Pref., 1-100,000 ..... | 5 | – | 5¼-5¾ |
| —— 4½ per cent. Mortgage Debentures ..... | 100 | – | 101-104 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. ..... | 100 | – | 101-103 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 ..... | 5 | – | 2¼-2⅜ |
| —— 4 per cent. Mortgage Debenture Stock ..... | 100 | – | 87-89 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 .. | 2 | – | ⅜-½ |
| —— Non. Cum., 6 per cent. Pref. ..... | 2 | – | 1 1/16-1 7/16 |
| —— 4½ per cent. 1st Debenture Stock ..... | 100 | – | 93-96 |
| —— 4½ per cent. 2nd Debenture Stock ..... | 100 | – | 75-78 |
| Callender's Cable, Debentures ..... | 100 | – | 105-107 |
| —— Ordinary ..... | 5 | – | 8¼-10 |
| —— 5 per cent. Pref. ..... | 5 | – | 5¼-5¾ |
| Crompton and Co. ..... | 5 | – | 2-2¼ |
| —— 5 per cent. Debentures ..... | 100 | – | 95-98 |
| Edison and Swan United, "A" Shares, 1-99,251 ..... | 5 | – | ⅜-½ |
| —— "A" Shares, 01-017,159 ..... | 5 | – | 1-1¼ |
| —— 5 per cent. Debentures ..... | 100 | – | 79-84 |
| —— 4 per cent. Deb. Stock, Red. ..... | 100 | – | 77-82 |
| Electric Construction, Limited, Nos. 1 to 112,100 ..... | 2 | – | 1¼-1½ |
| —— 7 per cent. Cumulative Pref. ..... | 2 | – | 2¼-2½ |
| —— 4 per cent. Perp. 1st Mort. Deb. ..... | 100 | – | 97-99 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 | – | 9¾-10 |
| —— 4 per cent. 1st Mort. Deb. Stock ..... | 100 | – | 91-96 |
| W. T. Henley's Telegraph Works, Ordinary ..... | 5 | – | 11-11¼ |
| —— 4½ per cent. Preference ..... | 5 | – | 5¼-5½ |
| —— 4½ per cent. Debentures ..... | 100 | – | 111-113 |
| India Rubber, Gutta Percha, and Telegraph Works ..... | 10 | – | 15-16 |
| —— 4 per cent. Debentures ..... | 100 | – | 99-102 |
| Parker, Thos., Limited, Ordinary ..... | 10 | – | 10-10¼ |
| Telegraph Construction and Maintenance ..... | 12 | – | 34-35 |
| —— 5 per cent. Bonds ..... | 100 | – | 101¼-103½ |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary ..... | 10 | – | 12¼-12⅜ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 ..... | 10 | – | 9¾-10 xd |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 .... | 10 | – | 11-12 xd |
| —— 4½ per cent. Debenture Stock. Red. ..... | 100 | – | 104-106 |
| Bromley (Kent) Electric Light and Power Co. ..... | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. 1st Debenture Stock, Red. ..... | 100 | – | 101-104 |
| Brompton and Kensington, Ordinary ..... | 5 | – | 10¾-11 |
| —— 7 per cent. Preference ..... | 5 | – | 10¼-10⅜ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 .. | 5 | – | 9 9¼ |
| —— Nos. 60,001-80,000 ..... | 5 | – | 6¼-7 |
| Cambridge Electric Supply Company, Ltd., £10 Ord. ..... | 8 | – | 12¼-13¼ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 105-108 |
| Charing Cross and Strand, Nos. 1-70,000 ..... | 5 | – | 8¼-8⅜ |
| —— 70,001-80,000 ..... | 5 | .. | 8-8¼ |
| —— 4½ per cent. Cum. Pref. ..... | 5 | – | 5⅜-5½ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 4 15/16 5 1/16 |
| —— 40,001-80,000 ..... | 5 | .. | 4 15 16-5 1/16 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 | – | 102-104 |
| Chelsea Electricity Supply ..... | 5 | – | 6⅜-7¼ |
| —— 4½ per cent. Debentures ..... | 100 | – | 108-110 |
| City of London, Ordinary ..... | 10 | – | 12-12¼ |
| —— 6 per cent. Cumulative Pref. ..... | 10 | – | 13¼-14 |
| —— 5 per cent. Debenture Stock ..... | 100 | – | 122-126 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) .. | 100 | – | 102-104 |
| County of London Electric Supply, Ordinary ..... | 10 | – | 9-9¼ |
| —— 6 per cent. Cum. Pref. ..... | 10 | – | 12-12¼ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 102-104 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. ..... | 100 | .. | 108-111 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000.. | 5 | – | 6¼-6½ |
| —— 6 per cent. Cum. Pref. ..... | 5 | – | 6-6¼ |
| —— 4½ per cent. First Mort. Deb. ..... | 100 | – | 106-108 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 1¼-2¼ |
| —— 5 per cent. Debenture Stock, Red. ..... | 100 | – | 86-91 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000..... | 5 | – | 5¼-6 |
| —— 4½ per cent. First Deb. Stock, Red. ..... | 100 | – | 101-104 xd |
| Havana Electricity, Limited, 1-15,000 ..... | 10 | – | 9¼-10¼ |
| Hove Electric Lighting, Limited, Ord., 1-13,000 ..... | 5 | – | 7¼ 8 |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 100-102 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 ..... | 1 | – | 9/16-11/16 |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | – | 13-13¼ |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red ..... | 100 | – | 102-104 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅜-10¼ |
| London Electric, Ordinary ..... | 5 | – | 2⅜-2⅝ |
| —— 6 per cent. Pref. ..... | 5 | – | 5⅜ 6 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red... | 100 | – | 96 98 |
| Metropolitan Ordinary ..... | 10 | – | 18¼-18⅜ |
| —— 4½ per cent. First Mortgage Debenture Stock .... | 100 | – | 110-115 |
| —— 4½ per cent. Cum. Pref. ..... | 5 | – | 5⅜-5⅝ |
| —— 3½ per cent. Mortgage Debenture, Red. ..... | 100 | – | 96-98 |
| Midland Electric Power Dis., Ld., 4½ p c. 1st Mort. Deb.. | 100 | – | 96-99 |
| Newcastle-upon-Tyne Electric Supply, Ordinary ..... | 5 | – | 98-101 |
| —— Preference ..... | 4 | – | 100-102 |
| Notting Hill Electric Lighting ..... | 10 | – | 14¼-15¼ |
| —— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.) .. | 100 | | 102-104 |
| Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,510..... | 5 | – | 6¼-6⅜ |
| —— 4 per cent. Debenture Stock ..... | 100 | – | 98-100 |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures ..... | 100 | – | 100-102 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000.. | 5 | – | 2⅜-3¼ |
| —— 4 per cent. Debenture Stock ..... | 100 | – | 82-86 xd |
| South London, Ordinary ..... | – | – | 4¼-4½ |
| South Metropolitan Electric Light and Power Co., Ord... | 1 | .. | ¾-1 |
| —— 7 per cent. Cum. Pref. ..... | 1 | .. | 1⅜-1 7/16 |
| —— 4½ per cent. 1st Mort. Deb. ..... | 100 | .. | 107-110 |
| —— Ditto, June, 1904 ..... | | .. | |
| St. James's and Pall Mall, Ordinary, 101-80,080 ..... | 5 | – | 13¾-14¼ |
| —— 7 per cent. Pref. ..... | 5 | – | 8¼-9 |
| —— 3½ per cent. Deb. ..... | 100 | – | 98-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 ..... | 5 | – | 5-5¼ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5¼-5½ |
| Westminster, Ordinary ..... | 5 | – | 13-13¼ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 ..... | 5 | – | 6¼-6⅜ |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 ..... | 5 | – | 5⅛-5¼ |
| —— Ord. ..... | 5 | .. | 8¼-8½ |
| —— Permanent 6 per cent. Debenture Stock. 1888 .. | 100 | – | 140-143 |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 104-105 |
| Barcelona Tramways, Limited, Ord., 1-20,000 ..... | 10 | .. | 11⅜-12¼ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 ..... | 10 | .. | 9¼-10 |
| —— 5 per cent. Deb., Red., 1-600 ..... | 100 | .. | 99-102 |
| —— 4½ per cent. Red. Deb. Stock ..... | 100 | .. | 96-100 |
| Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606.. | 1 | .. | 11/16-13/16 |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 ..... | 1 | .. | 15/16-1 1/16 |
| Belfast Street Tramways, Ord., 1-26,600 ..... | 10 | .. | 10¼-11½ |
| Blackpool and Fleetwood Tramroad ..... | 10 | – | 13⅜-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 ..... | 5 | – | 1¼-1⅜ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000..... | 5 | – | 3¾-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 94-98 |
| British Columbia Electric Railway Co., Ord. Def. ..... | 100 | – | 102-105 |
| —— Ord Pref. ..... | 100 | – | 100-103 |
| —— Non. Cum. 5 per cent. Pref. ..... | 10 | – | 10-10¼ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each | 40 | – | 102-104 p s |
| —— 4½ per cent. Vancouver Power Deb. ..... | 100 | – | 99-102 |
| British Electric Traction Ord. 1-500,000 & 60,001-80,000 | 10 | – | 9¼-9⅜ |
| —— 6 per cent. Cm. Pt., 30,001-60,000 ..... | 10 | – | 11-11¼ xd |
| —— 5 per cent. Perpetual Debenture Stock ..... | 100 | .. | 120-122 |
| —— 4½ per cent. 2nd Deb. Stock ..... | 100 | | 97-99 |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Buenos Ayres and Belgrano Tram. Ord., 1-100,000 | 5 | 3¼-4 |
| —— "A" 5 per cent. Cm. Pf., 1-40,000 | 5 | 6⅜-5⅛ |
| —— "B" 5 per cent. Cm. Pf., 1-27,500 | 5 | 5½-6½ |
| —— 5 per cent. Deb. Stock, Red. | 100 | 106-108 |
| —— Prov. Cert., all paid | 100 | 102-105 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | 94-97 |
| Calcutta Tramways, Limited, 1-102,268 | 5 | 8¼-9½ |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | 106-108 |
| Cape Electric Tramways Nos. 1-480,000 | 1 | 1⅛-1⅜ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | 4⅞-5⅛ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | 101-104 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1s Mortgage Debenture Stock, Red. | 100 | 102-104 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | 9½-10 |
| —— 5 per cent. Cum. Pref. | 10 | 11-12 |
| —— 4 per cent. Debentures | 100 | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | 13-14 |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 | 15½-16½ |
| —— 5½ per cent. Mort. Debs., 1-5,000, Red. | 100 | 94-97 |
| Imperial Tramways Ordinary | all | 18-19 |
| —— 6 per cent. Cum. Pref. | all | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 50,001-60,000 | 5 | 3½-3⅝ |
| —— 4 per cent. Debenture Stock | 100 | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | 8-8½ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | 10⅜-10⅝ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | 103-105 |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016. | 1 | 7/16 ¼ |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | 15/16-1 |
| —— 4½ per cent. Deb. Stock, Red. | 100 | 104-106 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000 | $1,000 | 105-110 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 | 101-103 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 | 102-104 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000 | 5 | ¼-1½ |

| Name. | Amount paid. | Last price |
|---|---|---|
| | £ | £ |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | ·12½ |
| —— 5 per cent Cum. Pref. | 10 | 9⅜-9⅝ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk. | 100 | 102-105 |
| Potteries Electric Traction, Ordinary 20,001-40,00 t | 10 | 8½ 9 |
| —— 5 per cent. Cum. Pref., 1-80,000 | 10 | 8¼-8¾ xd |
| —— 4½ per cent. Debenture Stock | 100 | 99-102 |
| South Lancashire Electric Traction and Power Company | | |
| —— £250,000 Ordinary | 1 | 1 |
| —— £101,152 5 per cent. Preference | 1 | 1 |
| —— £697,170 4½ per cent. Debenture Stock | 100 p.c. | 100 p c. |
| **Electric Railways.—** | | |
| Central London, Ordinary | 100 | 90-92 xd |
| —— 4 per cent. Pref. | 100 | 99-101 xd |
| —— ,, ,, deferred | 100 | 85-87 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | 109 111 |
| City and South London, Consolidated Ordinary | 100 | 44-45 xd |
| —— 4 per cent. Debenture Stock | 100 | 105-108 |
| —— 5 per cent. Pref. Stock '91 | 100 | 120-123 xd |
| —— ,, ,, ,, '96 | 100 | 118-121 xd |
| —— ,, ,, ,, '01 | 100 | 115-118 xd |
| Liverpool Overhead, 5 per cent. Pref. | 10 | 10-10¼ |
| —— Ordinary, 1-60,000 | 10 | 3¾-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700. | — | 99-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | — | 98-99 |
| Waterloo and City, Ordinary | 100 | 91-93 |
| **Telephones.—** | | |
| National Telephone, Preferred | 100 | 109-110 |
| —— Deferred Stock | 100 | 109-111 |
| —— 6 per cent. Cum. First Pref. | 10 | 13-14 |
| —— 6 per cent. Cum. Second Pref. | 10 | 12-13 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | 5¼-5½ |
| —— 5¼ per cent. Deb. Stock, Red. | 100 | 97-99 |
| —— 4 per cent. Deb. Stock, Red. | 100 | 102-104 |
| —— 4 per cent. Prov. Cert. | — | 102-104 |
| Oriental Telephone and Electric Company | 1 | 1 1/16-1 3/16 |
| —— 6 per cent. Cum. Pref. | 1 | 1 3/16-1 5/16 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905. | 1904. | Week. | Current year. | 1904. | 1903 | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Car mile. | Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Feb. 11 | 1,052 | 1,034 | + 41 | + 5,755h | 19¼ | 19¼ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·14 |
| Ayr Corporation | ,, 11 | 176 | 162 | + 14 | + 547 | 8 | 8 | ,, 15 | 14,160 | 3,201,585 | 336,049 | 1·03 | 10·11 | 1,770 | 5 0 |
| Barking Corporation | ,, 11 | 52 | 40 | + 12 | + 203 | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 12 | 943 | 958 | − 15 | − 802 | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,319,701 | 1·158 | 9·98 | 2,383b | 6·1 |
| Birmingham Corporation | ,, 4 | 354 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | Jan. 20 | 4,585 | 5,083 | − 498 | — | 6¼ | 6¼ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | — | — | — | — | — | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10·94 | — | 4·59 |
| Blackpool Corporation | Feb. 9 | 315 | 231 | + 24 | + 6,087 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 11 | 191 | 186 | + 5 | − 106 | 16½ | 16½ | Dec. 31 | 32,021 | 2,253,984 | 600,757 | 3·34 | 12·75 | 2,001 | 7·05 |
| Bolton Corporation | ,, 12 | 1,677 | 1,579 | + 98 | + 453 | 38 | 38 | March 31 | 94,151 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·89 |
| Bournemouth Corporation | ,, 8 | 835 | 862 | − 7 | + 2,146 | 10·15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | — | — | — | — | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 12 | 753 | 709 | + 44 | + 3,573h | 9 | 7½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 10 | 4,520 | 4,6 4 | − 44 | — | 51½ | 51½ | Dec. 31g | 253,150 | 44,391,439 | 6,033,528 | — | — | — | — |
| Burnley Corporation | ,, 11 | 1,034 | 889 | + 145 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 12 | 237 | 252 | − 15 | — | 8¼ | — | March 31j | 11,574 | 2,556,134 | 282,378 | 1·08 | 9·84 | 1,570 | 7·57 |
| Cardiff Corporation | ,, 11 | 1,803 | 1,912 | − 110 | + 1,975 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 11 | 138 | 170 | − 32 | − 147 | — | — | Dec. 31g | 9,937 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 4 | 7,072 | 6,994 | + 78 | + 877h | 6 | 6 | ,, 31 | 362,471 | 44,953,938 | 1,292,674a | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 12 | 2,896 | 3,297 | − 401 | − 1,181h | 6½ | 6⅜ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Colchester Corporation | ,, 8 | 161 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 9 | 414 | 377 | + 37 | — | — | — | ,, 31g | 25,657 | 6,353,323 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | ,, 10 | 203 | 210 | − 1 | − 97 | 7·23 | 7·23 | March 31a | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 4 | 164 | 165 | − 1 | — | 4½ | 4½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0·91 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | ,, 10 | 98 | 95 | + 3 | — h | 7 | 6¾ | Dec. 31g | 6,234 | 888,905 | 107,164 | 3·88 | 14·09 | 952 | 7·39 |
| Dublin U. T., electric cars | ,, 10 | 3,757 | 3,672 | + 85 | — | 47 | 46 | ,, 31g | 134,643 | — | 3,429,356 | — | — | — | — h |
| Dublin S. District, Electric | ,, 10 | 832 | 701 | + 131 | | | | | | | | | | | |
| Dundee City Tramways | ,, 8 | 800 | 800 | — | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 11 | 649 | 598 | + 51 | + 1,737 | 10·77 | 10·75 | March 31 | 34,312 | 12,950,259 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 11 | 13,356 | 12,684 | +1,272 | +25,476h | 145 | 123 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Gloucester Corporation | ,, 8 | 222 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 8 | 2,411 | 2,195 | + 216 | + 4,789 | 33 | 30½ | March 31 | 68,289 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,069 | 8·77 |
| Huddersfield Corporation | ,, 11 | 1,192 | 1,077 | + 115 | + 3,876 | 35 | 35 | ,, 31 | 65,545 | 11,893,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | ,, 11 | 2,026 | 2,039 | − 13 | — | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | ,, 11 | 368 | 338 | + 30 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | ,, 8 | 108 | 126 | − 18 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 8 | 207 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 11 | 5,395 | 4,962 | + 433 | +14,772 | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | ,, 11 | 1,838 | — | — | — | 7¼ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | ,, 11 | 9,817 | 9,648 | + 169 | + 1,212 | 103 | 103 | Dec. 31g | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | ,, 12 | 1,556 | 1,481 | + 75 | — h | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — a |
| London County Council | ,, 4 | 12,077 | 9,373 | +2,704 | — | 46¼ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 13 | 122 | 141 | − 19 | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | ,, 9 | 100 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 11 | 11,604 | 10,556 | +1,048 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Metropolitan Elec. Tramways | — | — | — | — | — h | 10 | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 11 | 104 | 94 | + 10 | + 1,350 | 2¾ | — | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newcastle-on-Tyne Corpn. | ,, 11 | 3,555 | 3,481 | + 74 | — | 45 | 38½ | ,, 25 | 135,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111b | — |
| Newport (Mon.) Corporation | ,, 11 | 485 | 460 | + 25 | + 1,393 | 15 | — | — | — | — | — | — | — | — | — |
| Oldham Corporation | ,, 12 | 1,373 | 1,027 | + 345 | + 4,054 | 34¾ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 11 | 1,414 | 1,373 | + 41 | + 6,447 | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·16 | 12·39 | — | — |
| Rochdale Corporation | ,, 11 | 407 | 100 | + 307 | +10,521 | 4½ | 4½ | 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 9 | 397 | 407 | − 10 | — | — | — | ,, 31 | 20,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·68 |
| Salford Corporation | ,, 13 | 3,819 | 3,568 | + 251 | + 9,002 | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 11 | 65 | — | — | — | 7¾ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 12 | 4,464 | 4,160 | + 304 | + 5,691 | 34¼ | — | ,, 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 8 | 302 | 387 | − 85 | − 2,493 | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 8 | 216 | 205 | + 11 | + 1,575 | 6¼ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 10 | 434 | 380 | + 54 | + 8,372 | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 12 | 1,069 | 1,078 | − 9 | + 1,454 | 19·54 | 18·48 | ,, 31 | 62,505 | 14,348,958 | 1,433,463 | 1·01 | 10·46 | — | 6·08 |
| Swindon Corporation | ,, 8 | 166 | — | — | — | 3¾ | — | — | — | — | — | — | — | — | — |
| Wallasey U.D.C. | ,, 11 | 650 | 571 | + 79 | + 2,269 | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·60 |
| West Ham Corporation | ,, 9 | 1,102 | — | — | — | 8·62 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 1 | 668 | 395 | + 273 | — | 7½ | — | ,, 31g | 20,878 | 4,263,066 | 417,335 | | 12·005 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. c Train mile. Per mile of single track. e Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures. Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**The Institution.**—It has been decided to hold an extra meeting on Thursday next, when Mr. Donald Murray's paper, "Setting Type by Telegraphy," will be discussed.

**Manchester Section.**—This section has decided to hold its annual dinner at the Midland Hotel, Manchester, on Friday, the 10th prox., the charge for tickets being 7s. 6d. It is desired that applications for tickets should be made before the 28th inst., so as to allow time for the necessary arrangements.

**Hull Tramways.**—The recreation club in connection with the electrical engineer's department of the Hull city tramways held their first smoking concert in the Manchester Hotel on Friday last. Mr. J. Wilkinson, tramways manager, was in the chair, supported by Messrs. W. T. Robson (chief assistant engineer), D. Joys, T. Palmer (secretary), and others. In a few well-chosen remarks the chairman said that the future of the tramways in Hull was very bright, and when the proposed extensions were finished would be the means of giving employment to a number of men. The toast of "The Mayor" (Alderman T. Larard), who is president of the club and chairman of the Tramways Committee, was given with musical honours. During the evening the large audience was entertained to a capital variety programme. From the attendance, which numbered some 250, this new club seems likely to be a success.

**New Atlantic Cable.**—It is reported from New York that before many months the Commercial Cable Company will lay its fifth Atlantic cable, the work being undertaken by the Silvertown Company or the Telegraph Construction Company, of London, or by these two companies conjointly. This appears to have caused some discontent in the States, which resulted in Mr. George Ward, vice-chairman of the Commercial Cable Company, paying a high tribute, when interviewed a few days ago, to English cable companies. His company, he stated, were not lacking in patriotism, but the plain truth was that there was no American cable company so well equipped for the task in question as their English rivals, which have complete facilities for the manufacture of cable as well as steamships specially designed and manned for the work of laying cables. The new cable will run from Nova Scotia to Ireland, a distance of 2,300 miles, and is estimated to cost over £450,000.

**Large Gas-Engines.**—Dr. Louis Bell, in his *résumé* of the "Electric Railway Situation" in the *Electrical Review* of New York, refers to a radical innovation about to be made in San Francisco, where the California Gas and Electric Corporation has just ordered three 4,000-kw. three-phase generating sets, each driven by a 6,000-h.p. gas-engine. These are stated to be for operating the street railways of the city. All sorts of reports are current about the performance of the big gas-engines now used in this country, the majority of them rather unfavourable, but the engineers of this large corporation seem to have been convinced that the gas-engine is all right. It has been looming large in the background for some time, and its appearance at the front of the stage will be watched with the greatest interest. In conclusion, the author disclaims the power of prophecy as to whether this new departure will be successful, but if it be so, the battle of the engines, long impending, will be on in deadly earnest.

**Wireless Telegraphy in the Red Sea.**—It is reported that the wireless telegraph station which has been under construction for some time by Lloyd's at the Red Sea extremity of Suez is expected to be in complete working order about the middle of March, when wireless communication will for the first time be practicable with ships in the Red Sea, as well as throughout the entire course of the Suez Canal. This will doubtless prove no small boon to shipping in cases of accident or distress. In regard to the transmission of "Marconigrams"—or, to give them their official designation, "radiograms"—to vessels crossing the Atlantic, it is announced that during the first three or four days after the vessels leave Liverpool the messages will be sent from Poldhu direct to the steamer. During the next three or four days the messages will be forwarded by cable to the North American Continent, and repeated thence to the approaching ship. An extra 1s. per word is charged for messages which have to be repeated from the other side to cover the cost of the cablegram. At present, however, only the Cunard mail steamers are fitted with long-distance apparatus.

**Lighting New York.**—The City Fathers of New York, like those of Paris, have been a good deal exercised in their minds of late as to whether a municipal electric light supply shall be given, the public having expressed a good deal of dissatisfaction with the company's tariff. It is reported that at a conference between the civic leaders the idea of a municipal lighting plant obtained an adverse reception. The project was viewed with favour in the first instance, but the eagerness displayed by Tammany, which is still a factor to be reckoned with, caused visions of a legion of overpaid superintendents, inspectors, engineers, etc., to present themselves to some of the leading citizens. Consequently this measure is likely to be abandoned, or to encounter a good deal of opposition if proceeded with. A section of the American Press, while holding that there is a good deal of room for reform in the public services of New York, recommends caution in entering for a municipal supply, and hints that the local authorities of England have met with very qualified success in such enterprises. It is stated that a compromise may be arrived at by the city obtaining power to purchase current and distributing it over wires which it has authority to lay in the conduits of the Consolidated Telegraph and Subway Company.

**Leeds Section.**—The Leeds Section of the Institution of Electrical Engineers inspected the electric light and power works of the Shipley Urban District Council on Saturday. The visitors were conveyed from Bradford to Shipley and back by special car by courtesy of the Bradford Tramways Committee. Mr. R. Lindley (chairman of the Shipley Electricity Committee) and Mr. Schofield (resident engineer) met the party, and conducted them over the works. The site of the present works was originally intended for sewage outfall and destructor works alone, but it was decided to combine the electricity works and dust destructor, so as to utilise the steam for generating energy. The electricity supply was commenced on July 26, 1899, with only three consumers; for the year 1904 the units generated totalled 985,988, so the great progress of the undertaking can be seen at a glance. It was pointed out to the visitors as a feature of interest that although the design and arrangement of plant exhibited no startling innovations, the undertakers had adopted a definite attitude in regard to three debatable matters: (1) the whole of the generators are driven by steam-turbines; (2) superheating is employed; and (3) the combination of dust destructor with electricity works. After tea the visitors discussed the design and equipment of the Shipley works, which were considered to be of an up-to-date character.

**Water-Tube Boilers.**—It is stated that the German Admiralty has now decided to entirely dispense with cylindrical boilers. They are the last of the first-class Powers to adopt exclusively water-tube steam generators. The tubular type has already been employed in many

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ships, but in combination with the cylindrical boiler. In fact, Germany was among the first to adopt the duplicate system, at one time preferred by the British Navy Boiler Committee, but subsequently departed from in favour of he complete installation of Babcock and Wilcox or Yarrow boilers. The type so far favoured in Germany is the Schultz, now associated with the Thorneycroft, which it closely resembles. It is also reported that the question of retaining the treble-screw propeller, which most of the other Powers have discarded, has been under consideration. The German engineers admit that this propeller confers no economy, and that even if the centre engine gives better thermo-dynamic results under certain conditions, the drag of the side propellers nullifies this gain; but the naval architects regard it as of the highest importance that there should be three separate water-tight compartments for the machinery so as the better to ensure that the vessel will always have one of her engines in action. On this ground all new ships, including the two new battleships and an armoured cruiser soon to be laid down, will have three engines and three screws.

**Chelsea.**—The Chelsea Borough Council, it seems, applied some time ago for sanction to borrow £29,000, the total estimated cost of erecting public baths in King's-road, including the provision of s self-contained electrical installation, mainly for lighting purposes. Having held an enquiry into the matter, the Local Government Board now suggest that it would be more economical if the Council purchased the electricity required from an existing source. No doubt money is often wasted by municipal authorities in needlessly duplicating plant rather than lend support to private enterprise, but in the present case there is at least some excuse for difference of opinion—how much it would be impossible to decide without weighing all the factors. However, assuming the baths to be necessary, boiler power must, of course, be installed. Granted that, the idea of providing a slightly larger heating surface than would be necessary for primary requirements only, and adding a small generating set with storage battery, does not seem extraordinary. But the question to consider is whether the extra capital outlay and increased cost of maintenance would be justified by estimated results—taking the price charged per unit for the available supply of electricity as a basis for comparison. No doubt the Local Government Board have gone pretty carefully into the matter, in which case their reported judgment must be taken as a compliment to the local supply company.

**New Publications.**—"Mechanical Appliances, Mechanical Movements, and Novelties of Construction," by G. D. Hiscox (London: Archibald Constable. 12s. 6d.). This is a useful encyclopædia of mechanics, and should be serviceable to draughtsmen, students, and patent agents. Mr. Hiscox is the author of an earlier volume, entitled "Mechanical Movements," which has passed through 10 editions, but the present treatise is of a somewhat more advanced character.—The February number of the *Electric Club Journal* (Pittsburg, Pa.) contains as its frontispiece an illustration of the 5,500-kw. turbo-generator described in the opening article. There is an article entitled "Armature Winding for Constant-Potential Direct-Current Machinery," and Mr. C. F. Scott deals with "The Induction Motor and the Rotary Converter, and their Relation to the Transmission System." Mr. C. E. Skinner gives "Some Hints about Transformer Oil," and "Cable Splicing" is dealt with by Mr. W. Barnes, jun. Messrs. H. W. Peck, E. H. Dewson, R. E. Workman, and V. Karapetoff continue their respective serial articles on "Modern Practice in Switchboard Design," "Electric Railway Braking," "Factory Testing of Electrical Machinery," and "Applications of Alternating-Current Diagrams."—"Gas and Oil Engines," by W. C. Runciman (London: Percival Marshall and Co. 6d.). The latest addition to this well-known series of interesting little handbooks provides the amateur with a handy guide to the operation of these engines.

**Electrical Engineer Volunteers' Bohemian Concert.**—The Electrical Engineer Volunteer Corps held another of their famous entertainments last Friday at the Horns Assembly Rooms, in the shape of a Bohemian concert, which was probably the most successful the corps has yet achieved. Captain O'Shaughnessy, the president of the Entertainment Committee, presided, and was assisted by Lieut. Shepherd and Sergeant-Major Marshall on behalf of that committee. Among the officers present we noticed Captain Leaf and Lieutenants Merritt and Levin. A very attractive programme was gone through, Mr. Percy C. Taylor presiding at the piano. The vocal performances were exceptionally good, and included songs and duets by Miss H. Jenkins Colyer and Mr. Murray Rundsey, and the Misses Daisy Wiltshire and Florence Maynard. Comic songs, recitations, etc., by Sapper F. H. Shove, Corporal J. H. Brinkworth, and Mr. Charles Wreford were also very much appreciated. During the interval Sergeant-Major Marshall, president of the sergeants' mess, on behalf of that body presented Mr. Edgcumbe, of the headquarter's staff, with an elegant silver tea service on the occasion of his marriage. Corporal Vitty was the recipient of the monthly spoon-shoot prize. The scarlet of the members of the corps, sprinkled here and there with the blue of the various artillery, cavalry, and naval units of the auxiliary forces, together with the lighter-hued costumes of the large number of ladies present, gave the hall, with its broad and lofty vista, unbroken by pillars or roof supports of any kind, and its effective electric cornice lighting, a very brilliant aspect.

**British Association.**—We published some information last week anent the association's programme for the meeting in South Africa next August, which we are able to supplement from an announcement in the Johannesburg *Star*. At the invitation of the British Association, the South African organisation have nominated the following gentlemen as vice-presidents and secretaries of the 11 sections for the meeting in Johannesburg: Section A—Mathematics and Physical Science—vice-president, Dr. Breyer; secretary, R. T. A. Innes. Section B—Chemistry—vice-president, J. R. Williams; secretary, W. A. Caldecott. Section C—Geology—vice-president, Dr. Corstorphine; secretary, Dr. Molengraaff. Section D—Zoology—vice-president, Dr. Gunning; secretary, Dr. Pakes. Section E—Geography—vice-president, E. H. V. Melvill; secretary, F. Flowers. Section F—Economic Science and Statistics—vice-president, S. Evans; secretary, Robert A. Ababrelton. Section G—Engineering—vice-president, S. Jennings; secretary, E. Williams. Section H—Anthropology—vice-president, Dr. Schonland; secretary, A. von Dessauer. Section I—Physiology—vice-president, Sir Kendal Franks; secretary, A. Mackenzie, M.D. Section J—Botany—vice-president, Burtt Davy; secretary, Prof. Pearson. Section K—Educational Science—vice-president, E. B. Sargant; secretary, Prof. Hele-Shaw. In addition to the sectional meetings, the presidential address by Prof. Darwin, president-elect of the British Association, will be delivered in Johannesburg; and a number of public lectures will be delivered during the week by the following gentlemen: Prof. E. B. Poulton, on "Burchell's Work in South Africa"; Prof. J. O. Arnold, on "Compounds of Steel"; Mr. A. R. Hinks, on an astronomical subject; Sir William Crookes, on "Fluorescence"; Mr. F. Soddy, on "Radio-activity"; Mr. A. E. Shipley, on a zoological subject; and

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Mr. C. V. Boys, on physics. The formation of a general reception committee and a number of sub-committees has been decided upon, as stated last week.

**Institution of Mechanical Engineers.** — The annual report of this institution, which was presented at a meeting last Friday, shows that the total number of members at the end of 1904 was 4,477, representing a gain of 266 over the previous year. The revenue for the year was £11,049, while the expenditure was £10,406, leaving a balance of £643, exclusive of entrance fees and life compositions to the amount of £611, carried direct to capital account. The first report, by Prof. David S. Capper, to the Steam-Engine Research Committee, has now been completed, and, together with a preliminary report on progressive speed and pressure trials carried out previous to March, 1896, will be presented at the March meeting. Since the presentation, in January, 1904, of the late Sir William Robert-Austen's last report, the Alloys Research Committee, under the chairmanship of Sir William H. White, has continued its work at the National Physical Laboratory. Dr. Glazebrook, directory of the laboratory, has arranged a series of investigations on specimens of nickel steel presented by Mr. R. A. Hadfield. It is anticipated that a further report will be presented this year by the committee, communicating the results of these researches. Prof. F. W. Burstall reports that the two specially-constructed large gas-engines and a gas-holder erected in the new power-house of the Birmingham University are now available for the Gas-Engine Research Committee's experiments. The series of experiments on initial condensation in steam-cylinders, which Prof. T. Hudson Beare is carrying out with special apparatus, are in active progress, but are as yet incomplete. Allusion is made to the joint meeting with the American Society in Chicago, and to the monthly meetings held throughout the session, at which a number of excellent papers were presented. The graduates also held monthly meetings and paid various visits.

**The Telephone Position** —The speculation so long rife in relation to the acquisition by the Government of the National Telephone Company's undertaking was removed on the evening of the 16th inst., when the Postmaster-General laid on the table of the House of Commons a memorandum embodying the terms of an agreement entered into by him with the company, the text of which we give in another column. Lord Stanley assured the House some time ago that he would not enter into any final arrangement without consulting Parliament, and the memorandum concludes with the statement that "the agreement will become binding when confirmed by a resolution of the House of Commons, or on Aug. 31 if not disapproved by Parliament before that date." It will be seen that the agreement is practically on the same lines as that entered into in 1901 with reference to the London area, the Government acquiring the company's undertaking at the end of 1911, on paying the value of the plant *in situ*—*i.e.*, on what are commonly called "tramway terms" — which represents a tolerably good bargain for the country. There will, however, be an allowance for goodwill in respect of the company's private-wire business, and in the few cases where the company's license has been extended beyond 1911. Presumably the price is to be settled by arbitration if the parties cannot agree, but it is to be hoped that when the time for fixing the amount arrives a figure will be arranged voluntarily, so as to obviate the expense and delay of protracted arbitration proceedings. With the basis of the transaction clearly defined by the agreement, this course should be quite feasible. In the meantime the company are to allow intercommunication without additional charge between the systems of the Postmaster-General and of the company. If, on complaint and after full enquiry, it is proved that the company is giving an inefficient service in any district, the Postmaster-General may take over the company's business in that district at once, without any payment for goodwill. It is notified that the Postmaster-General will probably take into the Government service when the transfer is effected a "considerable proportion" of the company's officers and servants, on terms to be agreed, but the Postmaster-General will not recognise any liability for pension or compensation in respect of service under the company.

**Tramways and Light Railways.**—A Board of Trade return issued on Wednesday as a parliamentary paper, gives some interesting statistics in relation to the growth of tramways and light railways. The return covers the period from 1878 down to Dec. 31, 1903, in the case of companies, and to March 31, 1904, in respect of local authorities. The report deals with three epochs, classified as the periods of animal, steam, and electric traction. The maximum year of the horse period was 1879, and that for the steam period 1898, while the use of electric traction is, of course, still growing. As compared with the year 1878 the length of line open has increased from 269 miles to 1,840 miles in 1903-4; the capital expenditure from £4,207,350 to £46,451,444; the number of passengers carried from 146,000,000 to 1,799,000,000, and the net receipts from £230,956 to £2,912,110. The capital expenditure per mile of single track open on all items was in 1879, the horse period, £9,877; in 1898, the steam period, £10,469; and in 1903-4, the electric period, £16,018. The percentage of net receipts to capital outlay rose from 3·97 in 1879 to 6·38 in 1898, and in 1903-4 was 6·27; the percentage of working expenditure to gross receipts was in 1879, 83·81; in 1898, 76·93; and in 1903-4, 66·15. The number of passengers carried per mile of route open during 1903-4 was 977,951, as against 806,703 in 1898, and 469,641 in 1879. This again illustrates how improved services create new traffic. The average fare per passenger was 1·84d. in 1879, 1·23d. in 1898, and 1·11d. in 1903-4. The length of line open on the London County Council's southern system at March 31, 1904, was 40 miles, and the receipts for the year were £536,239, the working expenditure £443,986, leaving a profit of £92,253; while the number of passengers carried was 133,139,085. The London United Tramways Company in the same period had 30 miles of line open, and the receipts were £280,241, the expenses £176,391, leaving a profit of £103,850; the number of passengers carried was 45,293,473. The North Metropolitan line, leased from the London County Council, had 50 miles of line open; the receipts were £330,821, the expenses £311,818, leaving a profit of £19,003, the number of passengers carried being 68,154,670. In 1898 there were 38,777 horses and 589 steam locomotives employed on the tramways. In 1903-4 there were only 15,353 horses and 249 steam locomotives. The places of those which have gone have been taken by 7,132 electric cars, so that over 1,460 miles of tramway and light railway line are now worked by electric traction, and only 235 under horse and 108 under steam. Of the total of 312 tramway and light railway undertakings in the United Kingdom, 162 are now owned by local authorities, with a total of 1,147 miles of track. A total capital expenditure of £28,060,524 has been incurred by local authorities. From the profits of these municipal undertakings a sum of £207,087 was in 1903-4 handed over to the relief of the rates, prominent among the contributors being Leeds, Manchester, Liverpool, Glasgow, Nottingham, Salford, and Hull.

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**Electricity in Agriculture.**—A method of subjecting the soil, trees, or plants to an electric current for the purpose not only of destroying insects, but at the same time of charging the soil with ozone, is described in the *Western Electrician* of Chicago. With this object a patent has been obtained by Mr. Sigismund Lokuciejewsky, of Odessa. The source of current may be a storage battery or a generator capable of providing either direct or alternating current. In the latter case the generator is mounted upon a wheeled frame as shown in Fig. 1, so that the armature will be rapidly rotated. The current is first led through an interrupter, 5, and after passing the rheostat, 10, enters the transformer or induction coil, 6. The current is directly led back thence to the opposite pole of

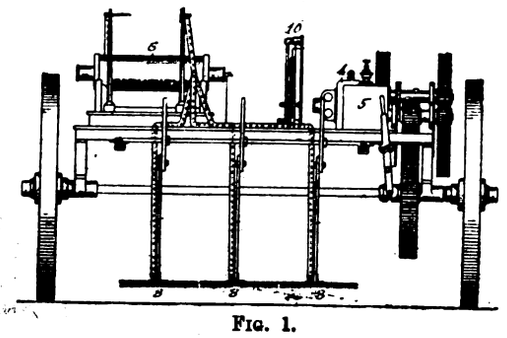


FIG. 1.

the generator, 4. Thus a current of high tension and frequency and low density is produced in the induction coil. One electrode takes the form of an implement arranged to either slide on the surface of the soil or tree or to cut into the soil. As shown in Fig. 2, a circular disc, 7, is employed for this purpose, the disc being attached to the frame of the car so that it will cut into the soil according to the degree of its adjustment. The other electrode consists of brushes, 8, which are fixed to the lower ends of rods or levers, enabling them to be brought in contact with the surface of the soil or tree. The current flows from the transformer through the disc into the soil and through the soil to the other electrode, passing, in the form of sparks or rays, from the soil to the brushes, and then back through

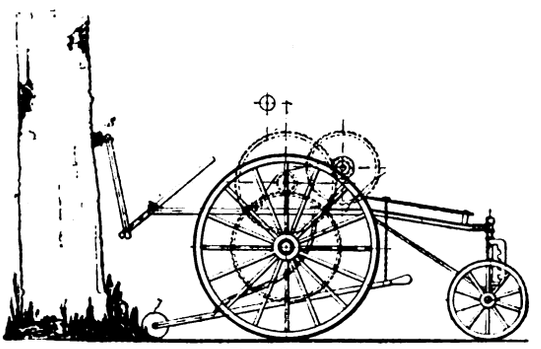

FIG. 2.

conducting wires to the transformer. It is stated that all insects and larvæ in the soil through which the current flows are destroyed, and that the soil becomes "ozonified." To destroy insects on trees the brush electrode is moved by hand along the trunk or branch, and the other electrode is introduced into the soil near the tree, thereby subjecting the insects to the current. The apparatus is intended to be so arranged as to give, at a potential of 500,000 volts, a current of ·0000005 of an ampere. Trials are stated to have proved that these high-potential and low-density currents do not injure the plants, and that they increase the fertility of the soil.

**Electricity and Gas**—The controversy as to the relative merits of these illuminants was renewed last week before the Society of Architects, when Mr. B. R. Tucker, late chief surveyor to the War Office, read a paper on the "Lighting of Buildings, etc., by Electricity and Incandescent Gas." The author prefaced his paper by explaining that its object was to assist in creating an increased interest in this subject, which formed a most important part of an architect's duty. In employing artificial light, it was essential in the first instance to determine the amount that might be required, the mode by which it was to be measured, and the laws that governed its intensity. On a general average, he stated that the amount of light required for reading and writing might be taken as 1 c.p., which sounds a rather moderate estimate; but the lecturer added that the nature and extent of the reflecting surfaces influencing the light were important factors. He prescribed a light of not less than 5 c.p. for work containing a quantity of detail, and this should be doubled for specially fine work, such as engraving. Having remarked upon the necessity of a definite standard of light for comparison, Mr. Tucker described the legal candle standard and dealt with photometry. The author held that the law of inverse squares demonstrated the necessity of a reasonable number of separate lights judiciously separated, instead of a large single light, in order to obtain the highest economy in the illumination of large buildings. As the purpose of lighting was generally to produce a certain intensity at the plane of illumination—usually assumed to be from 3ft. to 4ft. above the floor—the lights should be so located and of such a nature as to produce a minimum illumination of the candle-power at the parts farthest from the source. The best artificial light was that which was soft, steady, well diffused, and approached nearest to the yellowish-white hue of natural light. The author then dealt with the methods of the various types of electric and gas lamps. The former, he said, gave excellent results in such buildings as studios, but lacked the penetrative power of incandescent gas for street-lighting in a fog. Gas did not lack its champions in the discussion which ensued, while electricity found an enthusiastic advocate in Mr. E. T. Ruthven Murray, who eulogised the purity of the light given by the Nernst lamp. As to public lighting, he remarked that some arc lamps were placed too high and others too low. They ought to be about 20ft. from the ground, and then excellent illumination was obtained over the whole street. Regarding enclosed arc lamps, he recommended members desiring to see a model light of this type to inspect those just outside the Central London Railway at the Bank. The exhibitors at the recent Earl's Court Gas Exhibition had paid a high compliment to electricity by making their big lamps resemble arc lamps as far as possible. His experience was that electricity was the more economical illuminant. Mr. Tucker, in replying, said he believed they had not got to the end of incandescent gas lighting, and, on the other hand, the future might witness a great improvement in electric lamps.

**Paralleling a 5,500-kw. Turbo-Alternator.**—The *Electric Club Journal* in its issue of February gives an account of the operation in parallel of the 5,500-kw. 25-cycle Westinghouse turbo-alternator supplied to the Interborough Rapid Transit Company, of New York, and erected in the Seventy-fourth-street power-house. This was the first Westinghouse unit of this size to be put in service, although a number of similar machines are approaching completion. The day after this machine was first put in service it carried loads as high as 8,000 kw., and for considerable periods loads between 7,000 kw. and 8,000 kw. were of common occurrence. This turbo-generator is the largest now in service. Within a few days after the machine was put in service, and while operating in parallel with six of the slow-speed 5,000-kw. machines in the same station, a

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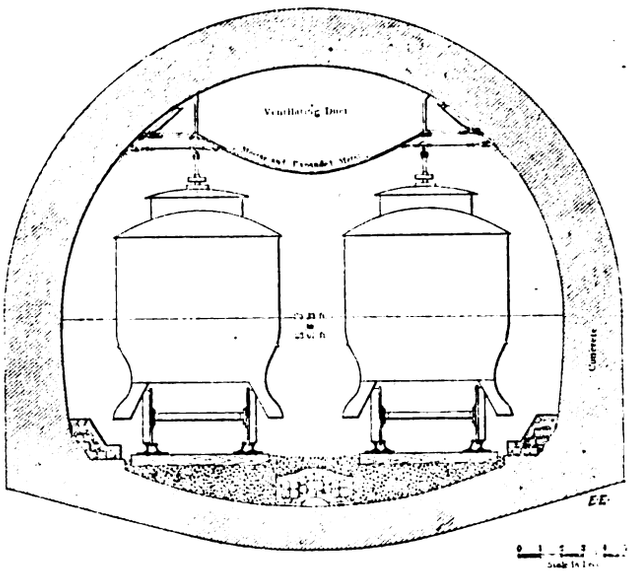
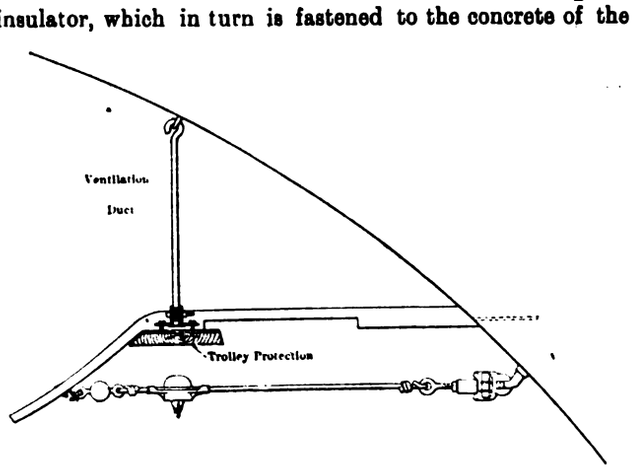
short-circuit occurred among the main leads at a point between the turbo-generator and the switchboard. This was a dead short-circuit, and it tripped the automatic switches on all the slow-speed machines, which were set at almost three times full-load current, but did not trip the safety switches on the turbo-generator on account of the fact that the arc was so violent that it burned off the leads to the safety devices for this particular machine, though these leads were in a separate conduit. It was necessary to cut the turbo circuits off by hand and the short-circuit, therefore, continued on this machine some little time before it was cut out. Careful examination of the generator showed that it was absolutely uninjured in any way, as far as could be determined, and was ready for service immediately afterward, but could not be thrown in with the other machines on account of the main leads to the switchboard being burned off. The machine has been in service with heavy loads since these leads were replaced. The 5,500-kw. turbo-generator is run in parallel with the other machines in the station, and the only notable difference in its operation and that of the slow-speed machines is due to the difference in the speed regulations of the two types of engine. The steam-turbine was adjusted so that it regulated much more closely in speed than the low-speed engines, and, in consequence, the turbo-generator takes the fluctuations in load. It is noted that when the turbo-generator is operating in parallel with the slow-speed machines, the latter carry a much steadier load than when the steam-turbine is cut out, the turbine unit appearing to take all the fluctuations when it is in circuit. This unit, therefore, has something of the effect of a flywheel or a storage battery on the system. This effect, if considered undesirable, can be modified readily by adjusting the speed characteristics of the steam-turbine. On account of its uniform rotative velocity and its relatively large flywheel capacity, the turbo-generator is particularly suitable for operating rotary converter systems such as the Interborough Rapid Transit Company's. Some months ago a series of tests was made to determine the paralleling qualities of turbo-generator units. At full voltage the machines ran perfectly in parallel. Fluctuations in speed were so slight that periods from one to fifteen seconds could be obtained for synchronising. When the voltage was reduced to 60 per cent. of the normal, the machines would carry the full current without any evidence of hunting. The voltage was further reduced and tests were made, until about 15 per cent. of the rated voltage was obtained. Under these conditions the machines still remained in parallel when carrying full-load current, but the conditions of paralleling were not perfectly stable, the load being transferred from one machine to the other at an irregular but not rapid rate. As the synchronising power varies approximately as the square of the voltage, it was extremely low in the last test mentioned. It is evident, therefore, that but small interaction is required between such machines to maintain parallel operation.

**The East Boston Tunnel.**—The East Boston Railroad Tunnel, which was recently completed, presents some features of interest. The system, which is about two miles in extent, consists of a single tunnel with double lines. A ventilating duct extends from one of the termini under the harbour to an intermediate station. The duct, which is seen in the first diagram, has a cross-section of about 38 square feet, and it is divided into two portions by a separating wall located midway between the two ends. On each side of the partition there are 14 openings, each 4ft. by 1ft. 5in. in area, in the flat portion of the duct, and at intervals of about 550ft. there are other groups of openings, diminishing in number as they approach the fan chambers, which are located at the discharge ends of the ducts. A cross-section of the tunnel beneath the harbour is shown in the first illustration. Guard rails are laid throughout. There are three sets of conduits, those in the centre carrying power cables belonging to the railway company, while those on the right and left contain the wires of the Edison Electric Lighting Company and the New England Telegraph and Telephone Company respectively. Considerable interest attaches to the arrangement of the guard rail, of which a description is given by the *Street Railway Journal*. There is a flange space of $1\frac{3}{4}$in. between this rail and the service rail, and the top of the




guard rail is $\frac{9}{16}$in. higher than the top of the running rail. The officials of the company consider that this arrangement practically precludes the possibility of derailment. Another advantage is the facility which the arrangement offers for repairing, as either rail may be taken up without putting the other out of service. Fig. 2 illustrates the method of supporting the trolley wire. A strain insulator is anchored into the concrete of the tunnel by an expansion bolt. The stranded steel span wire is attached to the other end of this insulator. It terminates in a globe insulator, which in turn is fastened to the concrete of the




tunnel ventilation duct. The hanger is attached to the span wire supporting the trolley 13ft. 6in. above the top of the rail. The spans are 20ft. apart. Above the trolley is a fireproof guard-strip, designed to keep the trolley and wire away from the concrete. For lighting the tunnel there are three rows of 16 c.p. 110-volt incandescent lamps spaced 12ft. apart. The supply may be drawn from three sources, this arrangement being adopted to render the illumination secure The lamps can also be fed from the trolley circuit. The lighting of the station and tunnel sections is controlled locally instead of from a central switchboard.

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## SWITCHGEAR FOR THE FISHER STREET SUB-STATION OF THE METROPOLITAN ELECTRIC SUPPLY COMPANY, LIMITED, LONDON.

This gear was designed to the specifications of Mr. J. S. Highfield, chief engineer to the Metropolitan Electric Electric Supply Company, Limited, who was the originator of several of the unique features herein described, such as the remote control from one platform, the protected extra high-tension connections, the depressor method of starting, etc. The gear was designed in detail, constructed, and erected by the British Thomson-Houston Company, Limited, of Rugby, to whom we are indebted for the following particulars.

The sub-station which the Metropolitan company has erected to take up the load formerly carried by the historic Sardinia-street station, is unique in the amount and variety of switchgear required. The high-tension voltage used by this company is, in a sense, the highest to be found in the United Kingdom. Ten thousand volts on each of the two phases, with one end of each phase earthed, gives over 14,000 volts between the unearthed conductors, and a voltage to earth corresponding to 17,000 volts three-phase with earthed neutral. On the other hand, the direct-current voltage is unusually low, the system of distribution being three-wire with 100-volt lamps, calling for a voltage across the outers at the sub-station varying from 220 to 250 volts.

The complete equipment of this sub-station, including the batteries, will easily be able to take care of a peak load of 25,000 amperes at this voltage. Thus, the input is at an unusually high voltage; the output is an unusually large current, while the number of machines and feeders is also unusual, the station being laid out for an eventual capacity of 10 500-kw. motor-generator sets, three three-wire storage batteries, three balancers, six battery boosters, two starting machines, four extra high-tension lines, and 105 direct-current feeders. To control this equipment there has been installed a main low-tension board (Fig. 1), running the whole length of the station—75ft.—a gallery (Figs. 2 and 3) above the same, filled with instrument panels, rheostats, control handles, etc., and a subway the same length filled with extra high-tension gear; in addition to various incoming line equipments, booster panels, balancer starting gear, a station lighting panel, etc., scattered at various points convenient to the corresponding machines or circuits.

The most striking feature of this switchgear as a whole is the arrangement by which both machines constituting a motor-generator set are handled entirely by remote control equipment from one position. Both the extra high-tension switches feeding the synchronous motors and the corresponding direct-current generator panels are mounted approximately opposite their respective machines, the extra high-tension gear being in the basement and the direct-current panel on the floor immediately above. In the gallery immediately above both the extra high and the direct-current equipments, there is mounted a pedestal with operating handles for all of the switches normally used in handling the set, both alternating-current and direct-current, both types of switches being mechanically controlled from this distance by means of gas-pipe and bell-crank connections, in the same way that extra high-tension oil switches have been controlled in the past; this arrangement being unique in its extension to direct-current apparatus. Against the wall in the gallery, immediately behind the above-mentioned pedestal, is a panel carrying all the instruments, both alternating-current and direct-current, and all small switches—such as field switches—synchronising receptacles, relays, etc., but without any extra high-voltage or heavy current leads whatever upon it, all instruments being fed from current transformers, potential transformers, shunts, etc., suitably placed on the panel or in the cells down below, all of the small leads being brought up to the instrument panel through steel piping. This arrangement gives the attendant complete control of one unit from one point. Under his hand he has the direct-current starting switch, the positive and negative main circuit breaking switches, the extra high-tension oil switches, the generator and motor field rheostat hand-wheels, and the corresponding field discharge switches. In front of him are the direct-current voltmeter and ammeter of the corresponding generator, together with an alternating-current voltmeter and two alternating-current ammeters for the two phases respectively of the synchronous motor. On the same panel are two field ammeters, one for the generator and the other for the motor, as well as the synchronising receptacle, alternating-current relays, switch indicating lamps, etc.

Taking up the switchgear more in detail, the extra high-tension power is received in the two-phase form, 60 cycles, 10,000 volts, as generated in the power-house of the company at Willesden. It enters the Fisher-street sub-station *vid* four transmission lines, two from one other sub-station, and the other two from a third sub-station, which in turn is independently supplied, thus linking these various sub-stations in a ring system with duplicate lines each way around the ring. Each such line consists of two concentric cables, one for the red phase and one for the blue phase. The outers of these concentric cables are earthed at Willesden, and are all of practically earth

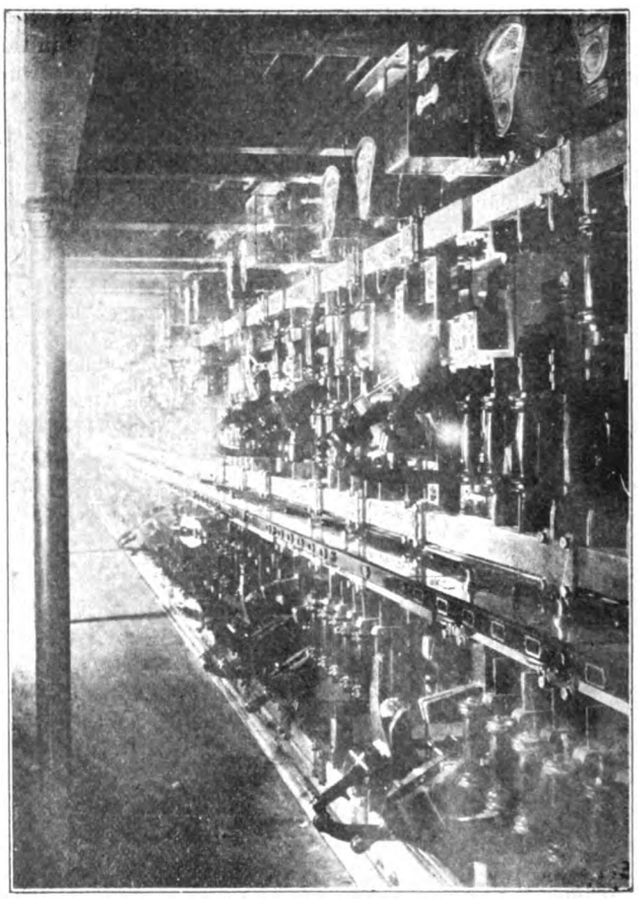

FIG. 1.—View of the Low-Tension Main Switchboard, showing the 'Bus Bars, Switch Fuses, Shelf Barrier, Meters, etc.

potential throughout. They are all, therefore, easily controlled by open-air knife switches of ordinary low-tension types. The inners are, however, controlled by extra high-voltage oil-break switches of the B T.H. single-pole type, one in each phase. These switches are arranged for automatic tripping by means of overload relays energised by current transformers, connected in the outers. Each phase of the incoming lines—*i. e.*, each cable—can be tripped independently of the other. The arrangement of one of these line equipments is shown in Fig. 4.

The extra high-tension gear for the synchronous motors is similar in character—*i e*, it consists of two single-phase oil-break switches in separate masonry cells with knife switches in the outers, these knife switches being mechanically interlocked with the oil switches so that the knife switches cannot be opened when the oil switches are closed or the oil switches closed when the knife switches are open. This is obviously advisable, as otherwise the 10,000-volt circuit could be opened on the outer switches, or a machine could be closed on the inner switches, with the outer switches open, which would give 20,000 volts on the outer

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as soon as the synchronous motor drifted out of phase. In the case of the machines, the current transformers which operate the overload relays are connected in the inners not pass through the outer cables, or any current transformers connected therein. In this way a certain amount of selective operation is obtained between the

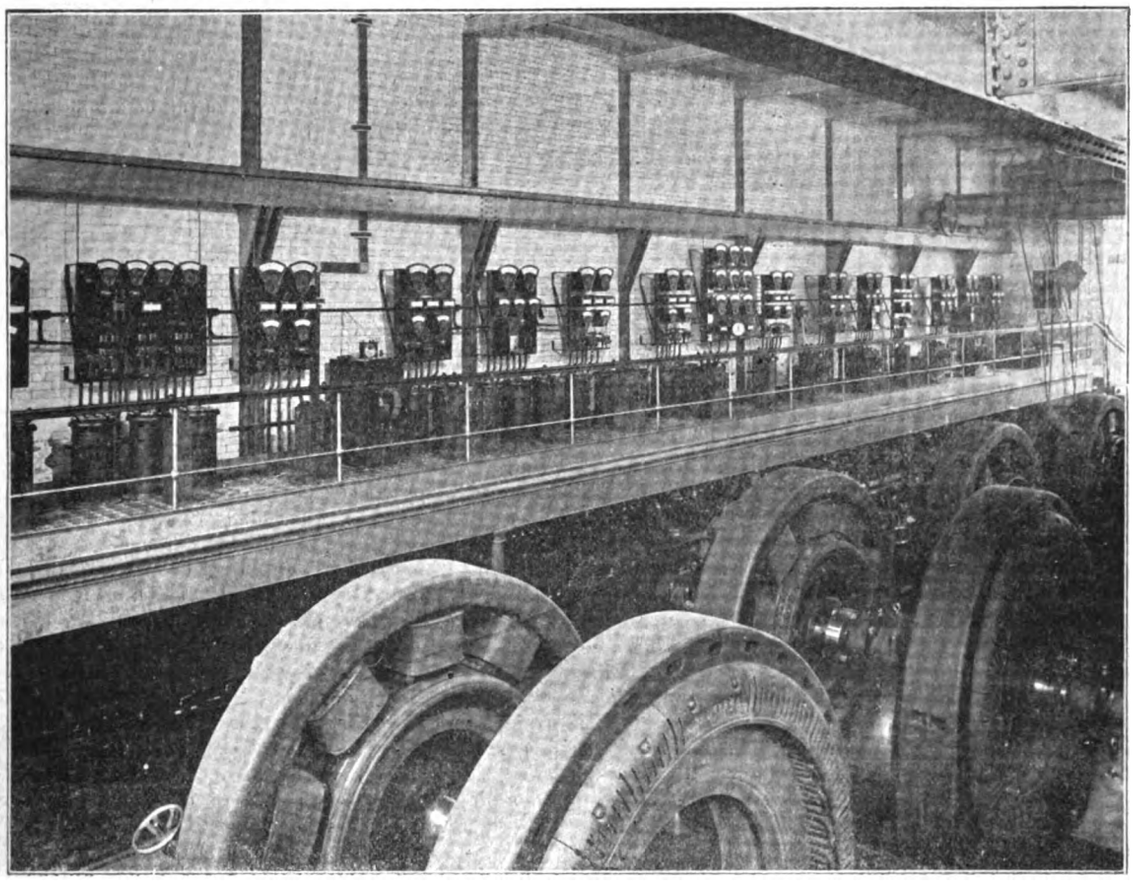

FIG. 2.—General View of the Switchboard Gallery, showing the Main Low-Tension Switchboard beneath same.

between the machine oil switch and the synchronous motor, the idea being that a breakdown of the insulation of the high-tension motor winding to the frame would cause machine oil switches and high-tension feeder oil switches, any machine breakdown tending to operate the corresponding machine switches only, and not to trip out the lines

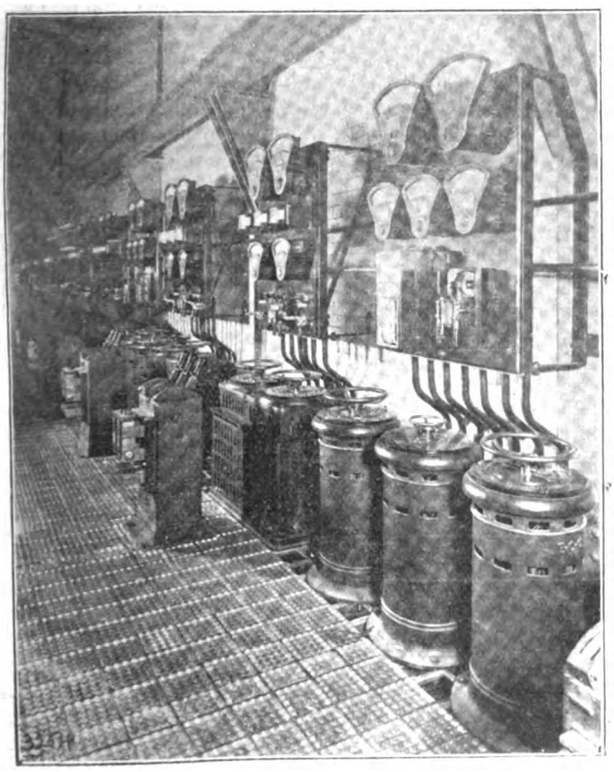

FIG. 3.—View in the Switchboard Gallery, showing a Battery Panel and a set of Balancer and Booster Field Rheostats in the foreground, with Motor-Generator Equipment in the background.

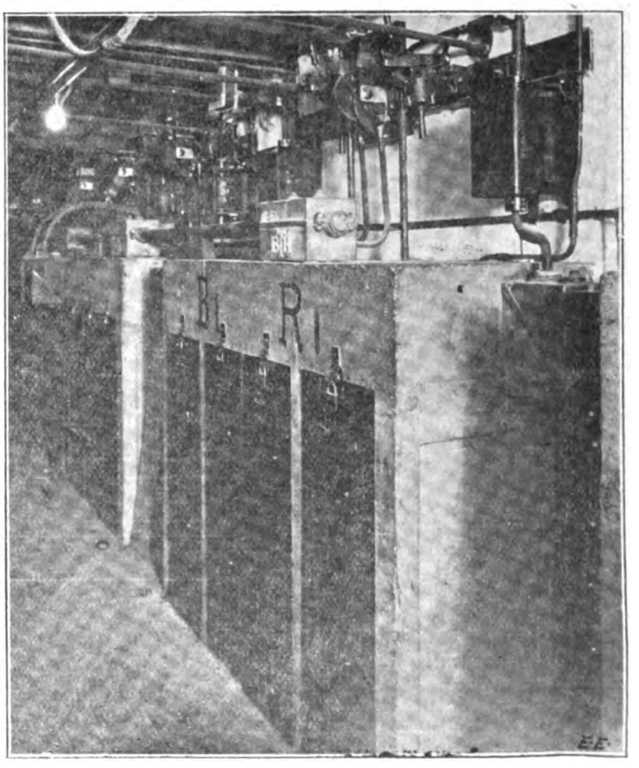

FIG. 4.—Equipment of Oil Switch Cells, Series Transformers, Trip Gear, Outer Knife Switches, and Cable-Dividing Boxes for an Incoming Extra High-Tension Line.

a heavy rush of current from the power station into the said synchronous motor, and thence back to the power station through earth, which current would between the stations, which would only be affected by cable breakdowns between inner and outer conductors.

The machine automatics are so arranged that a fault or

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overload on either phase opens both oil switches on the two phases, differing in this respect from the incoming line automatics which are independent. Each synchronous motor is equipped with one pilot or potential transformer for synchronising, and for properly adjusting the voltage of the synchronous motor when the machine is run up from the direct-current side. Each of the four transmission lines is equipped with two potential transformers, one on each phase, for the supply of voltmeters on each phase, power-factor indicators, and recording watt-hour meters, designed to measure the total station input. The extra high-tension connections throughout the station are unique for their complete enclosure of all high-tension current-carrying parts. The oil switches are in stone chambers or cells, with steel-plate doors, which are normally locked; but even if these doors are opened, access can only be had to the oil-switch tanks, mechanism, etc., all of which are earthed. Access to the live parts of the switch can only be obtained by removing the switch tank.

The high-tension sub-station 'bus bars are made up of concentric cables, the inner core of which is the only dangerous conductor, the outer core being of practically earth potential, and being insulated and surrounded by the usual lead sheath, which in turn is solidly earthed. For branch lines this concentric lead cable 'bus is tapped into the oil switches in large cast metal cable-dividing T boxes mounted on top of the oil-switch cells, the inner being carried down directly through the bases of these boxes into the oil-switch cells through long corrugated porcelain insulators. The boxes are filled with extra high-tension cable compound. No knife disconnecting switches or links of any kind are provided for isolating the oil switches from the sub-station 'bus bars, but the extra high-tension 'bus is divided by three sets of oil (inner) and knife (outer) switches into four sections, any one of which can be shut down when the other three sections are carrying the load, thus allowing cleaning, repairs, adjustments, alterations, or extensions to be made to any part of the gear, without exposure of the extra high-tension inner conductors in the form of knife disconnecting switches, or in any other form of bare copper. Outside the stone cells for oil switches and potential transformers, every inch of any inner or high-tension conductor is either inside a concentric and lead-covered cable, or is surrounded by a compound filled and earthed cast-metal dividing box.

The only points at which the high-tension inner conductors are at all exposed are the terminals of the glass-tube fuses used to protect the potential transformers. These fuses are mounted on their transformers in masonry cells, with doors normally locked. This enclosure of all extra high-tension parts in cable boxes or switch tanks is somewhat novel, as compared with ordinary three-phase work with non-insulated 'bus bars in compartments, and so extreme as to be at times awkward when it is desired, for example, to apply a short-circuit for testing or machine drying, but it has proved most remarkably safe in combined operation and construction; a large amount of work having been done by men in actual contact with the extra high-tension 'bus bars, considering the cables as such, after the station was in continuous service.

The main direct-current low-tension switchboard on the machine-room floor is made up of black enamelled slate panels, solidly bolted to 3in. by 5in. R.S.J. "H" girders, which are framed into the building, and form supports for the gallery, the latter having been designed to suit the switch-gear. The lower half of this board is devoted to the negative side of the system, and the upper half exclusively to the positive side of the system, the two polarities being isolated by means of a slate shelf extending in front of and behind the main panels, throughout the length of the board. Each polarity is fitted with duplicate 'bus bars, which will be used for running at two voltages. Each of these four 'bus bars is divided into three sections by means of eight 'bus sectionalising switches. The feeder panels are distributed between the generator panels, so that there is no great concentration of current in any one section of the 'bus bars, which are each of six square inch cross-section. Each generator panel is equipped with one Thomson recording wattmeter, one 3,000-ampere ammeter shunt, and in each polarity one double-throw B.T.H. 3,000-ampere laminated brush switch, by means of which the machine can be transferred from one set of 'bus bars to the other, this being normally done when the machine is out of service. Each polarity is also equipped with one B.T.H. 3,000-ampere remote-operated switch of a circuit-breaking type, handled from the gallery above. The switch of this type on the positive polarity is equipped with a reversal relay, which is set for about 600 amperes—*i.e.*, just sufficient to act as an overload relay when the machine is being started from the direct-current side.

The 105 direct-current feeders for which provision has been made at this station, consist of concentric or triple-concentric lead-covered cables, varying from one square inch concentric to ·4 square inch triple-concentric. To allow ample room for safely drawing this lead-covered cable up behind the live board, and for fixing the fittings for carrying the currents into their conductors, the main 'bus bars have been fitted on the front of the board. Each feeder is protected by switch fuses, which are made double-throw, so that the feeder can be fed from either the high or the low 'bus. On each polarity of each feeder there is also an ammeter shunt, two ammeters (one positive and one negative) being provided for each five feeders, with suitable swivel switches so that each ammeter can be connected to any one of five shunts. The outer conductors of the triple-concentric feeders are connected through suitable clamp fittings and screw plugs to a neutral 'bus, which runs along the base of the board near the floor.

In the main switchboard there are also three battery panels, each equipped with double-throw laminated brush switches, by means of which the battery can be connected to either the high or the low 'bus on each polarity. The main control of the battery is, however, accomplished at the booster panels, which are located near the boosters. The neutral 'bus is connected to the centre of the battery, enabling the battery to assist the balance of the system, especially in the case of out-of-balance faults. There are no end-cell switches, all variations of battery voltage being obtained from boosters which are driven by the balancers. Each balancer drives two boosters, one for the positive and one for the negative end of the corresponding battery. Adjacent to each booster is a corresponding booster panel, equipped with three main switches, by means of which the battery can be either connected through the boosters to the 'bus bars, or can be connected directly to the 'bus bars, with the booster entirely kept clear. A small centre-zero voltmeter at the top of the panel indicates the amount and direction of the boost.

Each battery equipment is designed for a load of 4,000 amperes—*i.e.*, four square inches of copper have been put in each lead, and each meter, etc., has been designed for the same current. Each battery is equipped with two Thomson recording wattmeters, with ratchets, which prevent them from running backwards, the connections of one meter being reversed, so that one indicates the total charge while the other indicates the total discharge of the battery. Each battery is also equipped with one curve-drawing main ammeter, one curve-drawing neutral, or out-of-balance, ammeter, and one curve-drawing voltmeter connected directly across the cells. The balancers are connected with fields crossed and with one field rheostat, consisting of a fixed resistance between the fields, with a movable tap from the neutral 'bus bar. Each booster is equipped with a series shunt reversing rheostat with contacts so arranged as to connect the booster field across any desired voltage from 125 volts positive to 125 volts negative.

Provision has been made in the switchgear for automatically cutting off the torque of the booster by opening the booster fields in case the booster should tend to run away on the battery current when the balancers are disconnected from the 'bus bars by blowing of their fuses or any other cause. This provision has been made as it is considered inadvisable to put in any automatic circuit-breaking switches in the battery circuits, the idea being to keep the batteries connected to the bars through all emergencies, unless disconnected by hand. To provide for such disconnection, the booster panels are equipped with brush toggle switches with magnetic blow-out auxiliaries, which are capable of clearing the maximum output of a battery on a short-circuit.

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Various provisions have been made for starting the motor-generators. As a rule they are started from the direct-current bars through a starting box, with an induction motor-generator set as a reserve in case the direct-current power fails completely. This induction motor-generator set may be connected on the direct-current side to any generator, entirely independently of the main 'bus bars. An addition to the usual starting equipment is a motor-driven booster, or—to use a somewhat more explicit term, which has been applied to this machine—a depressor. This machine consists of a direct-current motor driving a direct-current generator, which can be connected in place of the starting box. In the use of this machine, the depressor is thrown into circuit with a voltage approximately equal to that across the 'bus bars, after which the depressor voltage is gradually lowered, thus bringing up the voltage on the unit to be started. The advantage claimed for this machine is that a unit can be started from rest with about 100 amperes instead of the 400 or 500 amperes usually required when starting through a dead resistance. The starting current runs up as the depressor voltage is lowered, since the depressor returns less of the starting amperes through its motor as the voltage of its depressing end goes down. As the starting current is much more than the accelerating current, the depressor cuts down considerably the maximum demand for starting.

All of the starting gear has been so designed that current for starting can be taken from any section of the 'bus, either high or low, but no one 'bus or section of a 'bus can be paralleled with any other by any accidental manipulation of the starting switches. Similarly, no one machine at standstill can be thrown in parallel with another up to voltage through mistakes in the manipulation of the starting switches.

In addition to the instrument panels described on the operating gallery, there are others for the batteries; also one 'bus-bar voltmeter panel, and one pilot panel, equipped with six voltmeters and suitable voltmeter switches and pilot wires for measuring the voltage at the centres of distribution of the network supplied.

## NEW LOCOMOTIVES ON THE VALTELLINA RAILWAY.

(*Continued from page 158.*)

### Electrical Equipment.

Continuing his description of the new locomotives for the Valtellina Railway in *Elektrische Bahnen u. Betriebe*, Béla Velatin deals next with the method of collecting current from the trolley wires. It is noteworthy that both the collectors and switchgear are actuated throughout by means of compressed air from one position. The accompanying illustration (Fig. 6) is a diagram of the electrical connections, while Fig. 7 shows the arrangement of the pneumatic system.

Each of the new locomotives is fitted with collectors similar to those which have been in use since the service of electric trains was inaugurated. It will doubtless be remembered by many of our readers that we gave a full illustrated description of the type of locomotive originally constructed for the Valtellina Railway in our issues for April 10 and 17, 1903. Hence it will be unnecessary to recapitulate all the details here. Suffice it to say that the locomotive is provided with duplicate collectors, each being supported at either end by a construction (Figs. 8 and 9) having two arms. The axle pole carries two roller contacts of copper, insulated from each other and revolving upon insulated ball bearings. The current is conducted to carbon blocks, fixed at either end of the roller contacts, and thence by means of insulated cable enclosed within the hollow arms into the locomotive. These collectors are used alternately, according to the direction of travel. The arrangement is very different from the sliding bow, which it resembles, however, in appearance. Referring to Figs. 8 and 9, it will be seen that the bases, of which there are four on each locomotive, differ from those of earlier design. Thus the bearing pressure of the contact rollers on the trolley wires is regulated by means of compressed air acting on a piston connected to the tension springs. A glycerine dash-pot serves to buffer the shocks when the device is raised

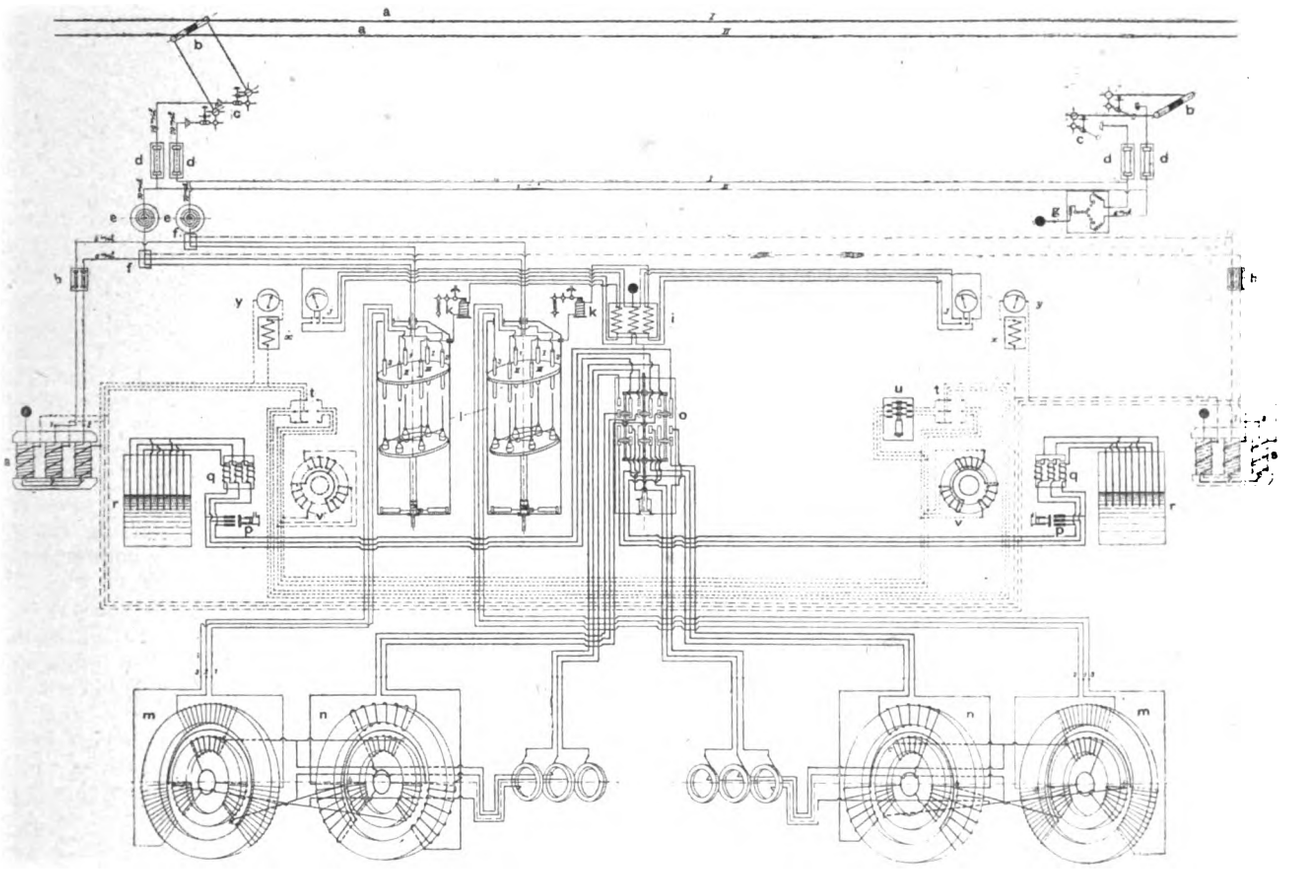

Fig. 6.—Diagram of Electrical Connections, New Locomotive, Valtellina Railway. Reference letters: *a*, trolley wire; *b*, collector; *c*, collector cut-out; *d*, main fuse; *e*, choking coil; *f*, branch box; *g*, lightning arrester; *h*, transformer fuse; *i*, ammeter shunt; *j*, ammeter; *k*, maximum current cut-out; *l*, high-tension switch; *m*, high-tension motor; *n*, low-tension motor; *o*, motor controller; *p*, short-circuiting switch; *q*, resistance regulator; *r*, liquid resistance; *s*, transformer; *t*, air-compressor reversing switch; *u*, automatic air-pressure regulator; *v*, air-compressor motor; *x*, voltmeter resistance; *y*, voltmeter.

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or lowered. Experience has shown in working the Valtellina line that the collectors give the best results when their bearing pressure is properly adjusted to the speed, and advantage has been taken of this fact in the new design. In other words, means are provided whereby the pressure of the roller contacts on the trolley wires is varied to suit the two dominant speeds for which the locomotives are constructed. The air-cylinder is fitted with a double piston. Compressed air is admitted only to the main piston for the lower speed, but when the master controller lever is put over to full speed air is admitted simultaneously to the auxiliary piston through the hollow piston rod, thereby increasing the tension on the springs, and, at the same time, the bearing pressure of the roller contacts on the trolley wires. This pressure amounts to 6½ kg. for the lower speed and 8½ kg. for the higher. A further improvement consists in that when the collectors are lowered a cut-out in circuit with the leads opens automatically, thus breaking the connection with the locomotive and with the contact rollers. Each base rests upon four high-tension insulators, consisting of cast-iron bells provided with wrought-iron bolts, the latter being insulated from the former by means of stabilit and porcelain.

From the above it follows that two valves are provided for regulating the collectors. One of these valves is operated directly through a lever, by means of which air can be admitted to the main piston or released from the same; the other belongs to the auxiliary piston, but in this case the supply of compressed air is governed by the position of the master controller. The lever which operates the first-mentioned valve is fixed in the driver's cabin at a convenient height. This lever enables the two collectors to be raised and lowered, either independently or together.

The high-tension fuses, lightning arrester, choking coils, and branch circuit boxes are fixed overhead in the driver's cabin. Fig. 10 represents one of the high-tension main fuse boxes into which the current from the collectors is first conducted. Single-pole main fuse boxes of this type are provided on each locomotive. The fuses proper consist of several parallel silver wires embedded in porcelain, and the boxes are locked. The leads from the collectors are connected behind the fuses, the high-tension lightning arrester (Fg. 11) being branched off at the junction point. The two main leads are then taken each through a choking coil to two main branch boxes, from each of which four branches are taken. Two of these branches are in turn connected up to the primary switches, and two through double-pole fuses to the step-down transformers which furnish current to the air-compressors, etc. All high-tension leads are enclosed in metal tubes, which are carefully earthed.

The motor controller and switchgear are actuated through pneumatic controllers, of which there are two provided, one at each end of the locomotive. It may be mentioned here that liquid resistances are employed on two of the new locomotives, and metal ones, experimentally, on the third. Each of the pneumatic or master controllers has

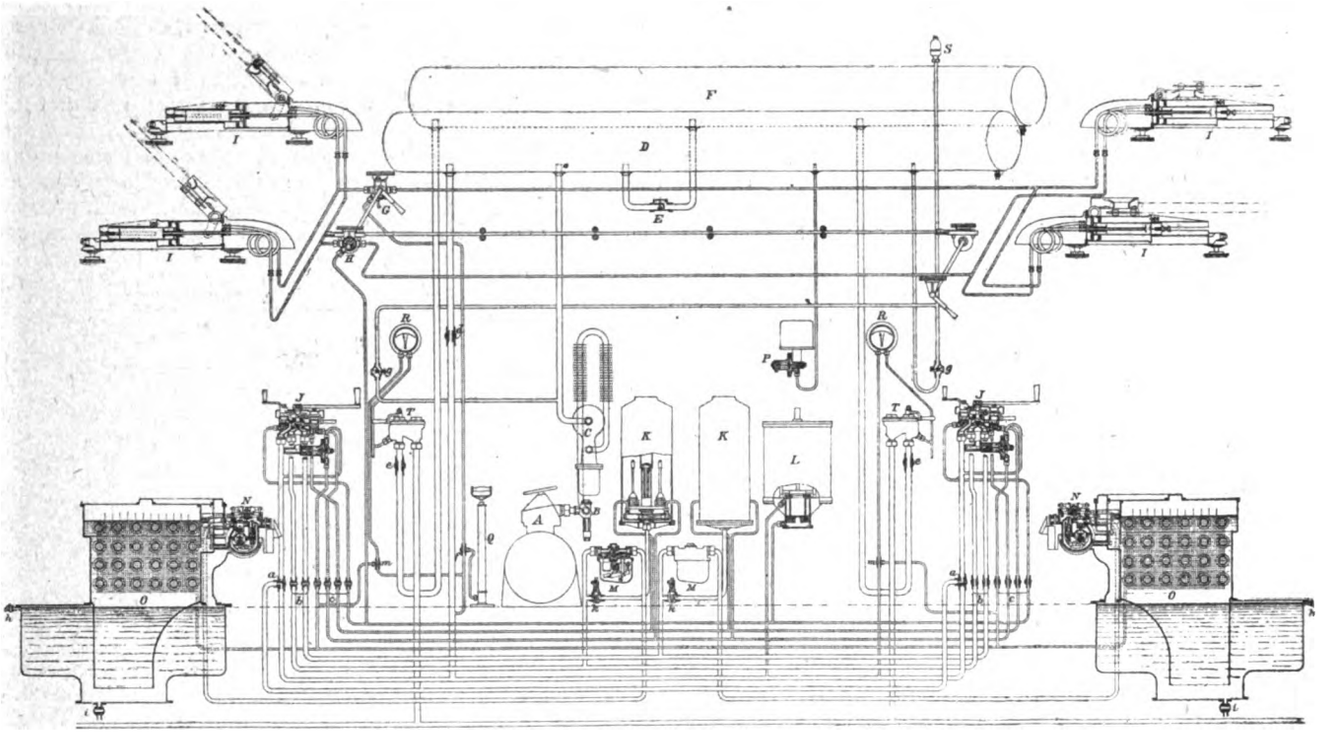

FIG. 7.—Diagram of Connections to Pneumatic Control System, New Locomotive, Valtellina Railway. Reference letters: A, air-pump; B, return valve with oil brake; C, oil separator; D, air-reservoir for electrical apparatus; E, return valve; F, air-reservoir for the Westinghouse brakes; G, collector switch with independent lever; H, collector switch operated from master controller; I, base of collector; J, pneumatic controller; K, high-tension switch; L, motor controller; M, cut-out relay; N, resistance regulator; O, liquid resistance; P, automatic air-pressure regulator; Q, hand air-pump; R, pressure gauge; S, whistle; T, Westinghouse brake valve; *a*, cut-off and safety cock; *b*, cut-off cocks to the two sets of motors; *c*, cut-off cocks; *d*, main cut-off cock; *e*, cut-off cock for the Westinghouse brake valve; *f*, cut-off and cutting-in cock; *g*, whistle valve; *h*, gauge cock; *i*, drain cock; *k*, reversing valve of main switch.

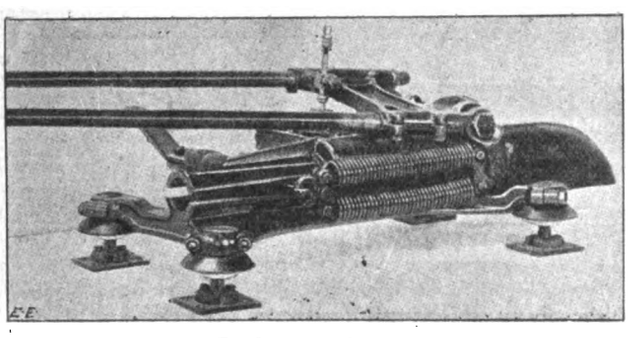

FIG. 8.—Base of Collector.

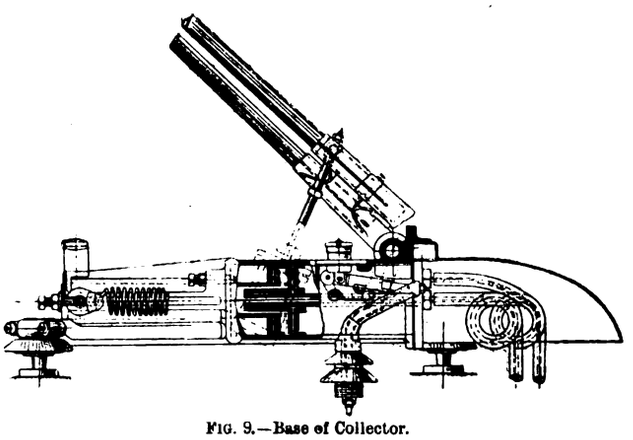

FIG. 9.—Base of Collector.

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three levers corresponding to different functions. The main lever serves to actuate the starting and regulating valves. In starting up, the driver pulls this lever over to the first position, and so opens the starting valve, admitting compressed air to the main switches and rheostats. This closes the main switches and brings the rheostat switches in position for the next step, without actually closing them. He then moves it forward to the second position, at which the regulating valve is operated and the liquid resistance inserted. Attached to the shaft of the starting lever is an eccentric which, upon the lever being

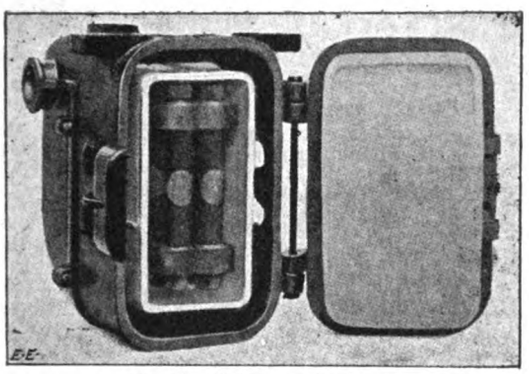

FIG. 10.—High-Tension Fuse Box.

moved further round, compresses a spring which, in its turn, acts upon a diaphragm so as to open a valve through which compressed air is admitted to the corresponding chamber in the top of the rheostat until the accumulated pressure is sufficient to balance the thrust of the spring, thereby causing the diaphragm to return to its original position and the valve to be closed again. In this way a variation in the volume of air admitted to the differential chamber in the top of the rheostat corresponds to an equal variation of the starting current, due to the construction of the rheostat. The further the starting lever is pushed over the greater is the volume of compressed air necessary to force the diaphragm back, and in proportion as

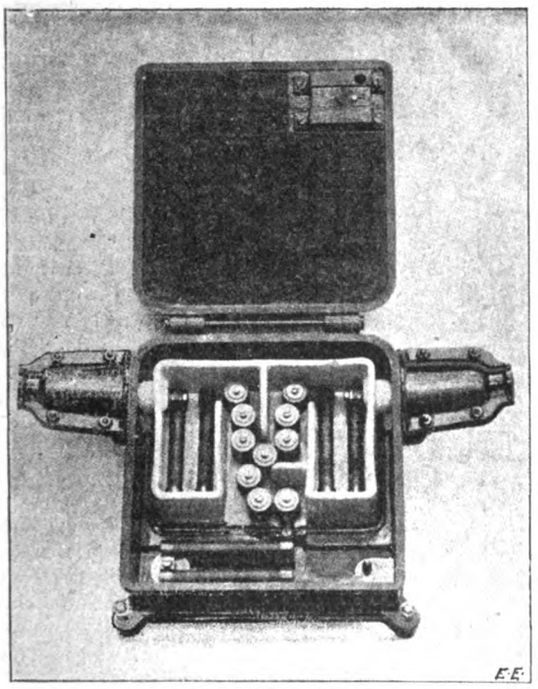

FIG. 11.—Lightning Arrester.

the volume of air admitted to the air-chamber in the top of the rheostat is increased, the greater is the starting current. Each position of the starting lever corresponds, therefore, to a certain constant starting current or tractive effort, which the driver can observe on the ammeter and regulate accordingly. In stopping the sequence is reversed, the return motion of the eccentric causing the diaphragm to be forced by the compressed air behind it in the opposite direction, and a valve to be opened which establishes a connection between the chamber in the top of the rheostat and the atmosphere. The action of setting the lever back to the off position also closes the starting valve, cuts out the water resistance, and opens the primary switches.

The second lever, which is arranged underneath the starting lever, serves to reverse the direction of travel, and operates the corresponding valve. The regulator valve has two ports, which are connected with the corresponding sides of the pistons attached to the main switches. According to the position of the regulator valve, these ports are open either to the compressed-air reservoir or the atmosphere. The third lever is situated on the left of the starting lever, and operates the motor controller. This lever is usually turned inwards when the motors are in cascade. By turning it outwards the motor controller is, through the medium of compressed air, set to the full speed position, only the high-tension motors being then switched in. The speed-regulating valve connected with this lever has, therefore, only two positions: in the one, the pipe to the motor controller is open to the atmosphere, and in the other to the compressed-air reservoir.

The individual levers are so interconnected that the reversing lever and the lever through which the motor controller is operated can only be moved when the starting lever is in the off position, and the main switches, as well as the resistance, consequently cut out. There are two of these pneumatic controllers—one at each end of the locomotive, as already mentioned; and provision is made whereby it is rendered impossible to use both of them simultaneously.

*(To be continued.)*

## AUXILIARY RAILWAY SIGNALLING.

The recent deputation to the Board of Trade has again raised the question of the sufficiency of railway signalling, and particularly that of the auxiliary signalling brought into use to meet conditions not always obtaining. The recent accident at Cudworth on the Midland Railway has also revived interest in the subject for a time. Such revivals are periodical, and coincident with the occurrence of accidents of a sufficiently serious character to attract public attention. Unfortunately, the interest taken is of a superficial and transient character, and is speedily driven from the public mind by other events, and the subject is allowed to lapse until a similar event again stimulates interest. Nothing is done, principally because it is nobody's business to prevent the recurrence of such accidents, and the Board of Trade confines its action to enquiry into the circumstances attending the occurrence and the apportionment of blame, as far as it is possible to do so, for each particular occurrence. It cannot be said at this time of day that there is any novelty in the circumstances attending railway accidents. The arrangements for signalling are such that accidents are mere repetitions, and arise from one or two variations of practically one set of conditions. Under such circumstances the persistent neglect of the lessons taught by successions of accidents seems nearly criminal when looked at from the standpoint of the travelling public, and almost fatuous from that of the railway shareholder. To say nothing of the loss of human life, the mere waste of money involved by such accidents as those at Slough, Cudworth, and numerous other places would seem sufficient to stimulate railway companies to an endeavour to remove the slur that lies upon them, as business men, by the periodical recurrence of disasters of the type of those referred to. In business life an excuse may hold good once, but no more. In such cases as this the possibilities of the present system have been demonstrated times without number, but without stimulating action for the removal of the causes.

If the circumstances attending such accidents are closely examined, it is found that they invariably result from some apparently trivial break in the recognised chain of actions as set forth by official regulations. The rules provided by railway companies for the guidance of their servants are most voluminous, and calculated to provide for every possible emergency of which the official mind can take

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cognisance, and so long as events take place in the order prescribed, the work is carried on with smoothness and dispatch. Railway servants, however, are but human, and consequently their actions and thoughts are not characterised by the machine-like precision which the official regulations desire to promote. Time after time little irregularities, which taken alone were of no consequence, have synchronised and produced terrible results. Momentary aberrations of memory, lack of decision, and the promptitude of action which comes from it, distraction of attention, and want of concentration upon the work in hand, often arising from monotony and sameness of work, and sudden changes in the conditions obtaining, have all played their parts at various times and places. Much, very much, has been done by railway companies to render travelling safe, and to their credit, be it said, that the greater part, or practically all, has been achieved without compulsion. For some years now, however, but little additional work has been done, although the railway service has greatly changed, and the conditions involved by the higher speeds and greater punctuality now insisted upon are much more onerous. The institution of the block system, including the mechanical interlocking of points and signals, upon an almost universal scale something like 30 years ago, has reduced the chances of accident in this country enormously, and all such occurrences as those now being considered may be classed under one head. Practically all railway collisions in this country of such magnitude as to rivet public attention upon them are of the nature of "following collisions." Double lines of rails prevent the "meeting collisions" which are so common on the single lines in the United States, when failure to "side-track" at the appointed place occurs. The mechanical interlocking of the points and signals automatically prevents "fouling collision," and has probably been the greatest safeguard ever provided in railway working; but, as with all preventatives, the difficulty in properly appraising its value, otherwise than by deduction, is extremely great. "Following collisions," as has already been observed, result from human weaknesses. Where mechanical control is absolute, safety of operation is absolute also. The present system of signalling allows unlimited repetition of action, uncontrolled by actual conditions, and the observance of signals depends entirely on concentration of effort upon one class of indication, and the presence of conditions necessary to the proper fulfilment of that effort. Hence the desirability, and even necessity, for some auxiliary methods of signalling, to supplement that already in use, becomes apparent, since, as already stated, concentration upon the work in hand may be unconsciously relaxed, as in the Slough accident, and the conditions for perfect vision do not always exist, and the changes may come so rapidly, as in the Cudworth accident, as to prevent the ordinary arrangements to meet such changes being carried out in sufficient time. It is not intended in this article to deal with checks upon the signalman to prevent repetition of actions not in consonance with the conditions obtaining, and the rules regulating his actions, but to confine attention to methods for ensuring that signals exhibited for the guidance of the driver are really brought under his notice, whatever the conditions of the weather, however rapidly the changes may occur, or however preoccupied his mind may be with other matters.

Of late years numerous suggestions for auxiliary signalling have been put forward, and the most generally approved are those which aim at giving signals on the engine more or less perfectly in accord with the indications afforded by the ordinary semaphore signals. If the characteristics of the latter signals are carefully considered, estimates of the requirements for complete repetition will be more easily made. Whilst the "distant" and the "home" and "advance" signals have, generally speaking, the same appearance, the character of the former differs from that of the two latter in some respects; and the two first-named differ from the last in others. The "distant" signal when "on" is of a cautionary character only, and may be passed by a train, whilst the "home" and "advance" are absolute "stop" signals, unless supplemented by hand signals. On the other hand, the "distant" signal when "off" gives more information than a "stop" signal, inasmuch as the cycle of interlocking is such as to prevent the "distant" from being lowered until both the "home" and the "advance" connected with it are also lowered. Hence a "distant" signal when "off" indicates that all other signals within that signalling range are also "off," and the road is fully prepared to the next block section ahead. There are, of course, certain limitations to such absolute conclusions, and the various signals ahead of the "distant" must be verified for obvious reasons. These, however, do not affect the argument in any way whatever.

The "distant" signal differs from both the "home" and the "advance" in that the two latter are "position" signals—*i.e.*, they indicate positions on the line which must not be passed by a train when these signals are "on." The "distant," however, is a "position signal" of another kind in that it indicates approach to a range of signals. This, of course, is more of the nature of a "localisation of position" at the time, and is not an indication of a position at which a stop must be made.

At junctions, again, the "distant" and "home" signals possess another characteristic, which the "advance" does not possess, in that they are "route" indicators, and by their positions, relatively to other signals of the same character, they indicate to drivers of trains which of the divergent routes has been prepared for the passage of the train. This, of course, is an "operating advantage," and is not connected with any question of safety. Such an operating advantage is, however, of the greatest importance as regards dispatch of traffic, and is only second to safety in railway working.

Hence the characteristic indications of the semaphore signal are greater than would appear at the first glance, and the information conveyed to the driver is correspondingly fuller under normal conditions of weather. Assuming no other cause of error, accident would only result when the indications are disregarded in consequence of preoccupation, etc., as at Slough, or when the weather conditions are such as to render them invisible, as at Cudworth, Northallerton, etc. Under such conditions the detonator system of fog signalling is brought into use, and it is interesting to trace the character of the indications then provided, and compare them with those obtained under normal conditions. Detonators give a sound indication by explosion when passed over by the engine, when the signal to which it applies is "on." The character of detonator employed is the same for all signals, and each signal is repeated separately and independently. There is, therefore, no difference made for the cautionary "distant" or the stop "home" or "advance." It follows, also, that in no case can a "route" indication be given, and also that when approaching a "stop" signal the "position" indication, which has been referred to as a characteristic of such signals, can only be imperfectly conveyed to the driver, and only effectively if he is travelling so slowly as to enable him to stop at any moment. Hence it is evident that all the explosion of a detonator tells the driver is that *a* signal at danger is being passed by him, and he must rely upon his localisation of his position on the line to enable him to judge the character of the signal he is passing.

One of the questions raised at this point is, "Are the explosive signals sufficient notification for the driver's complete information, supplemented by the localisation of position he is able to bring to bear, and which will include his remembrance of his position in the regular cycle of signalling for each block post?" Another question is, "What is the organisation for bringing the detonator system of auxiliary signalling into use? Is it effective, and such as to meet all the conditions that reasoning and experience show to be probable?" Taking the second question first, it may be pointed out that, to go no further back than the Cudworth accident—although it would be possible to point to other cases—the arrangements were not made sufficiently quickly, and that the prime cause of the accident was due to the auxiliary fogman not reaching his position in time to signal the express in accordance with the indications of the semaphore. The necessity for fog signalling arises at most irregular intervals, and, naturally, railway companies utilise, as far as possible, their ordinary men for this special work. This, of course, involves the withdrawal of the men from their ordinary occupations,

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which as a rule they are unable to continue under such circumstances; or if the conditions arise after ordinary working hours, their withdrawal from their homes and equipment. This undoubtedly takes some time, and although signalmen during the interval are instructed to put down detonators, this does not seem to have been done. Hence to these two causes, in themselves independently trivial, the accident at Cudworth was due, and, as already stated, this is not an isolated case.

Turning now to the first question propounded, it remains to be considered whether, in emergency signalling, it is necessary to endeavour to arrange for *complete repetition*. Complete repetition necessarily means a *duplicate* system, and if one is sufficient for the most onerous conditions as well as those ordinarily met with, the other system is superfluous. It may be thought that, having obtained a system which fulfils all conditions, it should, and would, replace the less efficient. From an operative point of view this is incontestable, but it rarely happens that this view is the only one, or even the most important. Railways have now been established for a comparatively long period; sufficiently long in any case to allow of the standardisation of their signalling apparatus, and the amount of money sunk in the provision of the existing apparatus is sufficient to preclude the wholesale scrapping so much favoured by some—theoretically and at other people's expense. Whether engineers like it or not, finance has, and always will have, the last word.

Hence in the case of railway signalling, as in all other practical cases, compromise is necessary. In detonator signalling, as already observed, the driver must use his knowledge of his locality, and his position at any moment in the cycle of signalling, to judge of the character of the signal he is approaching and act accordingly. He knows that the first signal he will meet on approaching a block post is the "distant"; if he get a signal, there he knows perfectly what to do. It is often pointed out, however, that the all-right signal is given by the absence of an explosion, accompanied by a hand-lamp signal, which he may not see. With this combination it is sometimes contended that the driver will lose his bearings in the absence of the landmarks with which he is familiar under normal conditions. The driver, however, has other means of judging his position. Every alteration in the configuration of the road "talks" to him, so to speak. The changes of direction due to curves, the passing over or under bridges, the difference between iron and stone bridges, differences in the character of the road-bed, the passing of stations, cabins, etc., running over crossings and switches, all tell their tale to the driver at their own points on the journey. Hence drivers who are well acquainted with the road are in no danger of mistaking their position.

The next point to be considered is the question of route indication, and on this point no information whatever is vouchsafed to the driver. Whilst this is the case, it must be remembered that in this country the movements of most trains are telegraphed from point to point on the route, and the times at which they leave these points are telegraphed forward. Moreover, the block signalling code provides identification signals, so that signalmen know the character of the trains approaching them. Further, trains run at certain fixed times, and even if not punctual to their booked times their positions are known from the telegrams alluded to above, and the times they will pass any point are known. Hence the signalmen at junctions know perfectly well what trains are approaching, and may set the proper route.

Hence, on the whole, putting aside the most important indication of "on," which is given by the explosion, there is little to object to, from the point of view of safety, in the present arrangement. There are, however, certain operating disadvantages. The chief of these is undoubtedly due to the fact that indications are only obtained at *fixed points*. It is true that these points correspond with the positions of the signals for normal conditions, but it must be remembered that such signals under normal conditions of sight are visible to the driver for some distance before they are reached. Hence there is necessity for much greater promptitude of action in responding to the indications during the abnormal conditions considered than under ordinary conditions. This disadvantage is greater when a train passes a "distant" at danger than at other times. In such a case the driver must get his train into control, so that he may be able to draw up at the succeeding "home" signal, *but he will not know whether it is necessary for him to stop there until he arrives* close to it and the detonator explodes. If, during the time he is passing at the slow speed rendered necessary by the considerations given above between the "distant" and the "home," the cause which necessitated the exhibition of the danger indication at the "distant" has been removed, the "home" signal may be "off" when he gets there, and may have been lowered immediately after he has passed the "distant." As stated, he will not become aware of the fact until his arrival at or near the "home" with his train under control so as to stop immediately, if necessary, and much valuable time will be lost, much more, in fact, than is represented by the time which has elapsed between the lowering of the "home" signal and his arrival there.

The above is a serious working disadvantage. Still another disadvantage is the negative character of the "all right" signal, which has already been alluded to. Could these two defects be eliminated, there would, apart from possible breakdown of the organisation for calling out their men, be but little objection to the present method of emergency signalling. But it must be borne in mind that events have shown that disregard of signals has occurred even under normal conditions, and that auxiliary signalling which would be given under more advantageous conditions would compel attention to what, otherwise, would go unheeded.

The application of these remarks lies in the endeavours made from time to time to provide apparatus with a view to repeat on the engine directly the indications being exhibited from time to time by the semaphores under the control of the signalmen. As has already been stated, there is now a very large number of such designs, and it may be of interest to consider, briefly, some of their chief characteristics, to ascertain, if possible, why so little progress has hitherto been made in applying them to practical work.

Such apparatus may be roughly divided into two heads, mechanical and electrical. In one or two cases, however, the systems are partly mechanical and partly electrical; and the purely electrical systems, again, may be classed under separate heads. It is not intended to give any technical description of such systems here, but to confine attention to their working and compare them with the results obtained from the detonator system previously considered.

Consider, then, first the mechanical systems of which Raven's is an example. Here we have an obstruction on the line, working in conjunction with the signal, which is struck by a lever carried under the engine. Operation of the lever opens a special whistle communicating with the air-brake, and the sounding of the whistle gives the indication required when passing a signal at "danger." The obstruction on the line is placed close to the signal repeated, and consequently the indications are given at fixed points in precisely the same way as with the detonator system. The only difference consists in the character of the indication given and the fact that the system requires no special organisation for bringing it into use, as it is always ready. To complete the parallel, it may be observed that the "all right" indication is also of a negative character, and is given by the absence of any effect when passing the signal.

Turning to the electrical systems, there is, of course, a much greater variety in the means of actuation, and, in some cases, a much greater range in the character of the indications repeated on the engine. Some merely give a "danger" signal by the ringing of a bell when passing a given point; others, again, give both "danger" and "all right" signals. Boult's system of signalling—probably one of the most *complete* systems ever invented—aims at giving all the characteristic indications required, and succeeds in doing so. The "Miller" system of signalling directly upon the engine, which was brought into use at Woodhouse Tunnel a year or two ago, is another example of a class of apparatus which aims ultimately to dispense with other forms of signalling. Some of the systems referred to, such

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as Brierley's and Hoyt's, for example, require mechanical or electrical contact between specially placed apparatus on the line and the engine. Boult's system is independent of contact. The "Miller" system depends upon the operation of circuits upon the engine, when two electrically separate parts of the latter are straddling an insulated point on the track circuit used. In every one of the systems cited it will be seen that signals can only be obtained at fixed points, corresponding to the positions of the semaphores, and so far as the operating advantages, upon which stress has been laid in this article, are concerned, they are in no way superior to the detonator system now in use, and to *this want of the equivalent of the projection of vision*, under normal conditions of operation, is to be ascribed the small progress hitherto made by electrical systems of repetition of signals on engines.

## SURFACE-CONDENSING PLANT DRIVEN BY FYNN REPULSION INDUCTION MOTOR.

In drawing up the designs for the recent extensions at the Burton-upon-Trent Corporation electricity station, it was thought preferable to drive the condensing plant for the new 500-kw. extension set off the alternating-current side of the station instead of the traction continuous side. The Fynn repulsion induction motor, the rights of which are controlled by Messrs. Witting, Eborall, and Co. for Great Britain and the Colonies, was decided on for this purpose, owing to the fact that when starting with a torque equal to that of full load the starting current can be kept down to from three-quarter to full load current. The accompanying illustration (Fig. 1) shows the general arrangement of the plant.

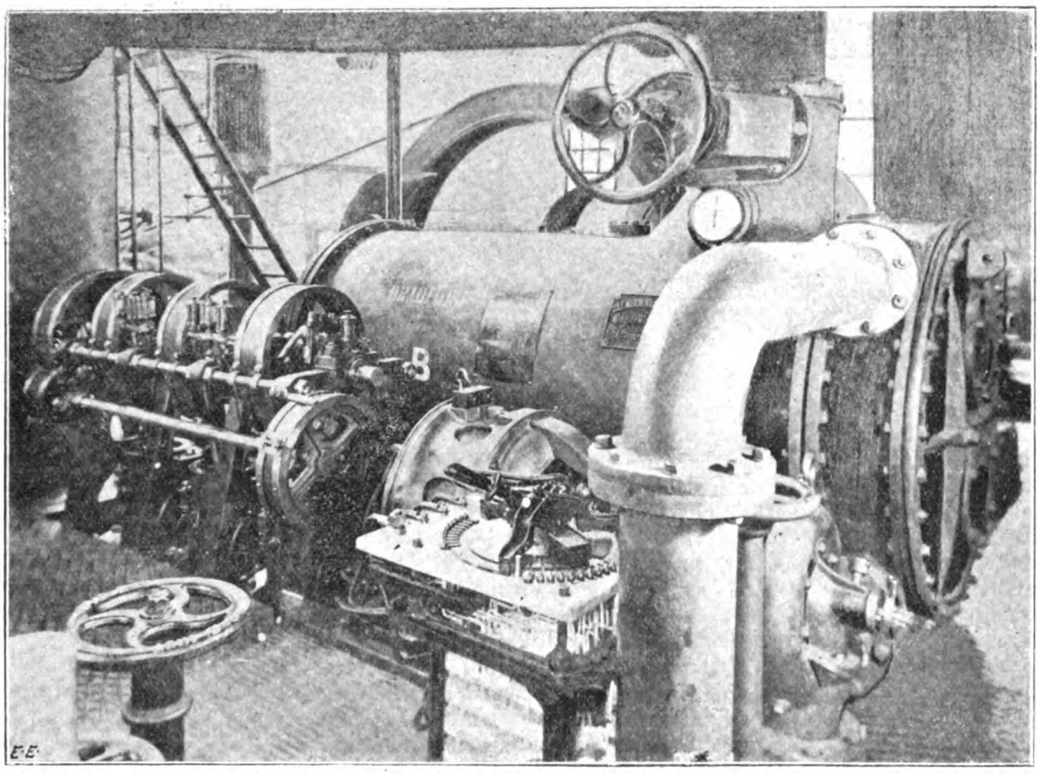

Fig. 1.—Surface Condensing Plant, driven by Fynn Motor, Burton-upon-Trent.

The condensing plant was manufactured by Messrs. Cole, Marchent, and Morley, of Bradford, the motor being supplied through them as well. It consists of the Edwards type of three-throw air-pump and circulating pump by Messrs. Gwynne, the former being driven through gearing by means of a raw-hide spur wheel on the shaft of the motor at a speed of 130 revolutions, and the latter coupled direct to the motor running at a speed of 1,440 revolutions. The air-pump cylinders are 10in. diameter by 10in. stroke, the valves being of the Kinghorn type. The lubrication of all parts is arranged for continuous running. The plant is specified to deal with 13,500lb. of steam with no superheat, and give a vacuum at the condenser of 27in. with circulating water at a temperature of not more than 60deg. F. The plant under test has been found to well fulfil these requirements, and the whole set is a compact arrangement and has dealt with as much as 650 kw. The floor space taken up by the entire set is 14ft. 9ft. by 7ft. 9in., and the condenser stands 4ft. 9in. high above floor level. The large cylinder seen on the extreme left-hand side of the illustration is a grease separator by Messrs. Templer and Ranoe, dealing with the exhaust steam before entering the condenser. The grease and water separated out is automatically discharged, whether the plant is running condensing or to atmosphere, by a Bundy trap.

The motor is of 14 b.h.p., and has an overload capacity of about 40 per cent. On a load of about 15·5 h p for four hours no part of the machine increased in temperature more than 65deg. F. The stator of the motor generally resembles that of an ordinary induction motor, while the rotor is generally similar to the armature of a rotary converter. It has two interconnected windings on it, the free ends of one being connected to slip-rings, while the end of the coils of the other are connected up to a commutator. The operation of starting up the motor is as follows: After closing the main switch putting the current on to the stator windings, the starting switch is put on to the first notch of the resistance in circuit with the brushes on the commutator side of the machine. The motor driving the condensing plant reached a speed on the first notch of 1,060 revolutions in five seconds, which is a performance equal to any continuous-current motor.

There are 13 resistance notches, the speed rising up to full as the switch moves over these. The slip-rings are then short-circuited by pushing in a projecting knob at the spur-wheel end of the motor shaft. The starting switch is then moved back to the first position, and the whole of the brushes bearing on the slip-rings are then raised in one operation by means of a small lever handle. The starting of the motor and carrying out the above operations can be done in 1 to 1¼ minutes. The commutation is absolutely sparkless under all conditions. The starting current is just about full-load current, this being 82 amperes.* The efficiency guaranteed was 83 per cent., but owing to a fairly high power factor being specified, the latter was improved to

* On lower periodicities it becomes easier to reduce the starting current, and this can be kept down to about three-quarters of full-load current with full-load torque.

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80 per cent. with a very slight reduction in the efficiency. It will also be noted from the curves (Figs. 2 and 3) that the efficiency and power factor are almost constant from 10 h.p. to 18 h.p.

This particular motor is not arranged for reversing, as this is not necessary. If it is undesirable to shift the brushes to reverse the motor, this being generally the case, then a second winding is provided in quadrature position on the stator to the first winding, the two being in series; when it is desired to change the direction of rotation all that is necessary is to change over one of the windings. It will be seen, therefore, that both windings are always operative.

In the larger sizes of Fynn motor, from 50 h.p. upwards, which also includes traction motors, the Fynn method of self-excitation is provided. This is a very important feature, and has the great advantage of enabling the motor to work at all loads with a power factor of 100 per cent., the efficiency only being effected to a very trifling extent. The actual power consumption when the condensing plant has been dealing with approximately 13,500lb. of steam, which is the guaranteed performance of same, was 12·9 kw., at a power factor of 80 per cent. Allowing for the efficiency of the motor, this gives a brake horse-power of 13·8 for driving the whole set. The total length of the circulating pipe, which draws from and delivers to the River Trent, is 308ft., and the maximum height above normal river level is 17ft.

This is the first application of a motor of this description driving a condensing plant, and was the second Fynn motor in operation in this country, the first being a 7-h.p. machine. In noting the performance of the motor from the curves, etc., it should be understood that the periodicity at Burton is 75, which is a comparatively high figure.

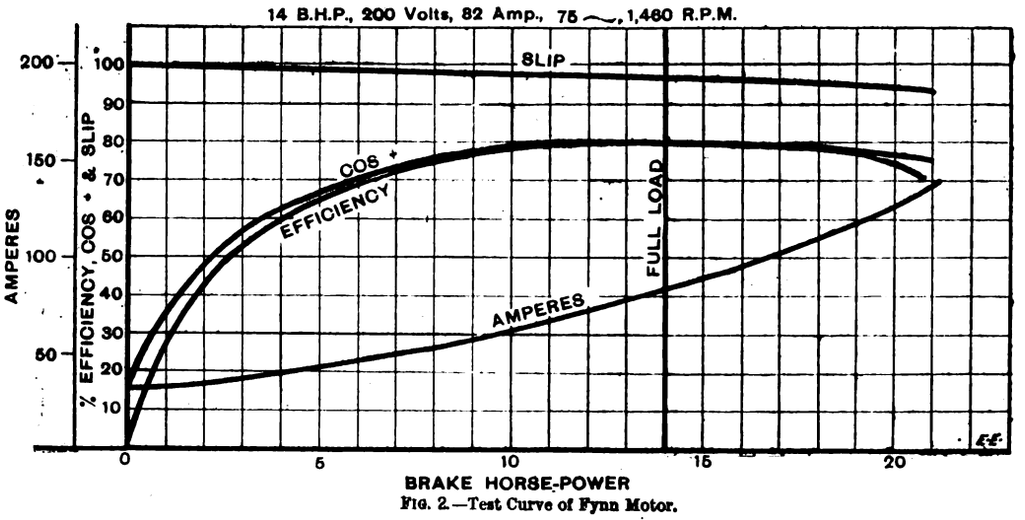


Fig. 2.—Test Curve of Fynn Motor.

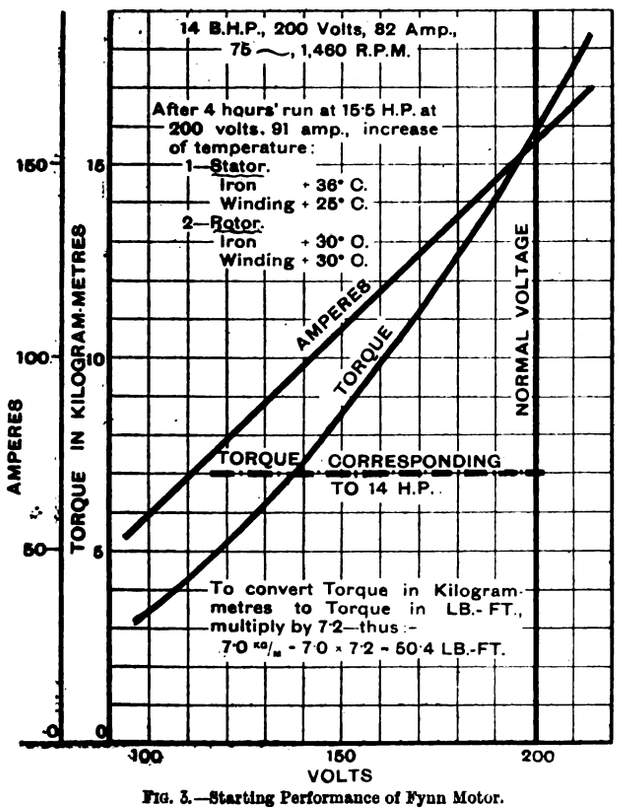


Fig. 3.—Starting Performance of Fynn Motor.

We are indebted to Mr. P. J. Pringle, M.I.E.E, the borough electrical engineer and tramways manager, for the above particulars.

## SOME NOTES ON THE RUNNING OF A PRIVATE LIGHTING AND POWER PLANT.*

BY P. T. BLISSET, ASSOC.MEMB.

In bringing the following notes before you at the request of our local secretary, the object has not been so much to say anything new on the subject of electric driving and lighting as to bring to your notice some points which perhaps deserve more consideration than they have received up to the present at the hands of manufacturers and contractors. Some descriptive notes of a large private three-wire light and power plant may be of interest, in that it shows how electrical driving and lighting has gradually superseded steam driving and gas lighting. The advantages of the extensive use of electricity have long been realised, and the greatest credit is due to those who, in spite of many failures, continued to face the problem of the electrification of factories. It must not be forgotten that the successful application of electricity in works is due more to the firms who experimented on their plants than to the scientists who carried their theories out at the expense of more or less uncomplaining owners, whose prospect of remuneration for their outlay was very remote in the earlier stages of this experimental process.

It may be thought that the carrying out the work of successfully driving and lighting a factory electrically would have been a comparatively easy and simple matter, providing that sufficient funds were available. This was found not to be quite the case some years ago. Neither the engineers arranging the plant or the manufacturers supplying it knew exactly what was required, and consequently there was a good deal done that was not altogether satisfactory, and had not some of the advantages to be derived from the use of electricity been essential in the case under consideration—such as cleanliness and its adaptability to isolated units—the plant about to be described would probably never have been installed, as certainly the old steam-driven arrangements were more reliable. It cannot be expected that electricity will be adopted as a general rule until it is as reliable, at least, as steam or gas; and this condition can only be fulfilled by having all details that go towards the making-up of an electrical plant as substantial and as well designed as the perhaps smaller number of details to be found in a steam-driven plant.

Large generating stations and their component parts have been more discussed than the humbler, though none the less important, details of a lighting or small power plant; but it must be remembered that great efficiency in heavy gear is of no value unless the smaller details are also highly efficient, as in the greater number of cases the losses outside the generating station are much greater than those from within. In the

* Paper read before the Dublin Local Section of the Institution of Electrical Engineers, Feb. 9.

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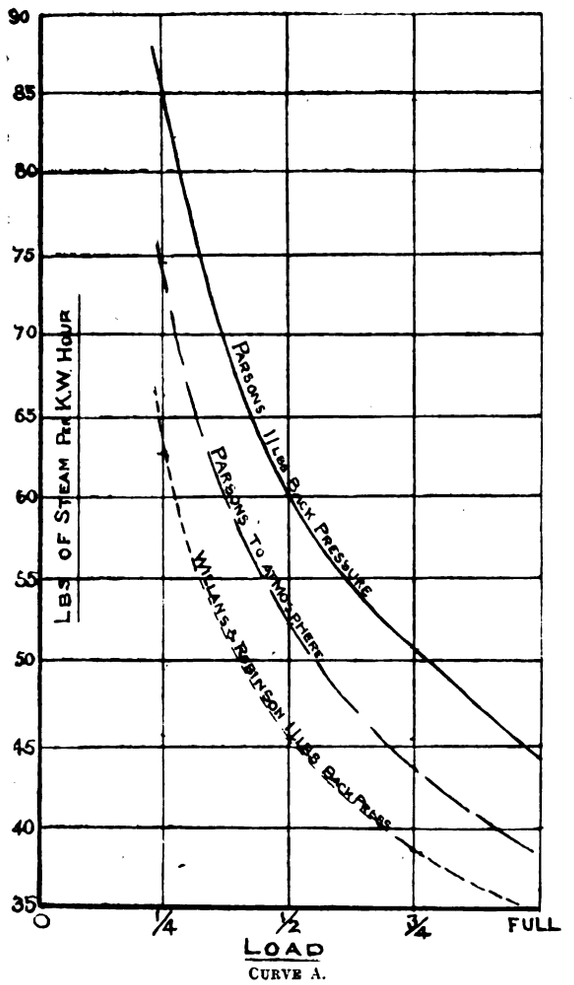
present instance the problem was the electrical driving and lighting of a large number of steam-driven and gas-lighted plants nearly all working in wet and steamy situations, and

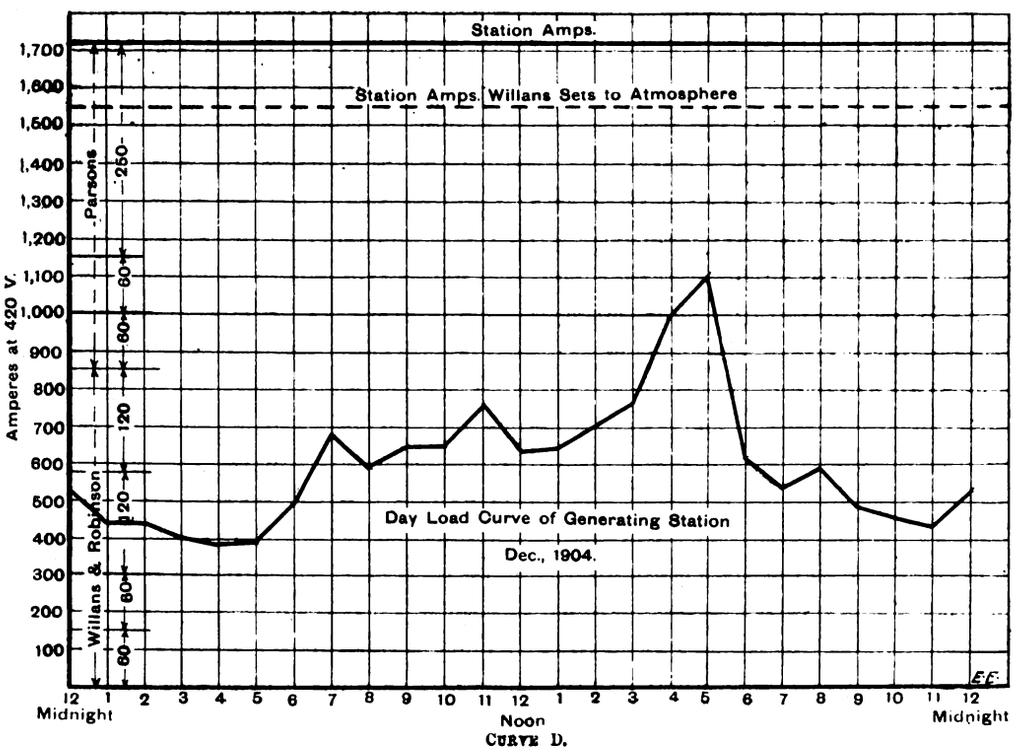



CURVE A.

scattered over an area of about 50 acres. As these conditions were exceedingly adverse to the successful working of the ordinary electrical gear to be obtained 10 years ago, it is very satisfactory to know that most of the original motors and starting gears are still in use and doing good work. The change over from steam and gas to electricity has been going on gradually, the old engines and gas lighting coming in useful as "spares" until sufficient confidence was gained to dispense with their services and depend entirely on electricity. Recently, however, in some large extensions that have been made, electricity is in use exclusively.

A battery of 10 cylindrical multitubular boilers supplies steam to the generating station, each boiler at times generating 72,000lb. of steam at 150lb. pressure per square inch. Induced draught is used, the ingoing air being heated by passing through tubes in the uptake. Sturtevant fans, driven by 11-h.p. or 15-h.p. motors draw the gases from the smokebox, and discharge them through cyclones to take out any dust. These cyclones absorb a large portion of the power of the fan motors, but are necessary, as dust could not be allowed to blow about where there are many open tanks containing water and other liquids. Feed water is pumped by three-throw pumps driven by a 5-h.p. motor through a Royle's heater into each boiler; an injector is also provided as a spare. This range of boilers is fired by three men, and as the load factor of the battery is about 73 per cent., the three men are kept fairly busy. A Vicar's stoker is now being used on one boiler, and gives still better results than firing by hand. The steam is generated at a cost of 12 64d. per 10,000lb., slack coal being used. The generating station at present contains two Willans compound engines coupled to 120-kw. generators, two Willans of 60 kw. each, two old-type Parsons turbo sets of 60 kw. each, and one Parsons turbo of 250 kw. capacity. The large number of small units is accounted for by the gradual growth of the concern. All the generating sets exhaust into a condenser, the atmosphere, or into a main carrying from 10lb. to 15lb. pressure per square inch, the steam being carried round the works and used for heating purposes. As the demand for heating steam varies very considerably, some of the engines are made to exhaust into the condenser, if cooling water is available, or, failing this, into the atmosphere—*i.e.*, when there is more steam going into the back-pressure main than is required. As there is considerable waste at times, due to exhausting into the atmosphere, a new Parsons 250-kw. set is being installed to work at from 10lb. to 15lb. pressure per square inch, exhausting into a separate surface condenser. Under these circumstances, economy of steam is not of the first importance, as the heat wasted by the engines is made use of afterwards.

Willans engines and Parsons turbines are so well known that a description here is not necessary, but as the two types of machines are running in the same station, a comparison between them might be of interest. A curve (A) is shown comparing the test run of the new Parsons 250-kw. set with a test run of a 120-kw. Willans and Mather set. It will be noticed that there is a considerable difference in the steam consumption, the Willans giving a much better result, but losing a little advantage at the smaller loads. In all probability the Parsons set would show a better comparison if both engines were working condensing. A comparison was made from an actual run of both types, extending over several days, and the results are here given in Table B. These tests were very accurately made by taking the strokes of the pumps delivering feed to the boilers, the amount of water delivered per stroke being measured. It will be noticed from the table that there is a marked difference between a test made with the best load for a machine and one made on an actual run, where the load




CURVE D.

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is constantly changing, the steam consumption at its lowest, when the Willans sets only were working, showing about 50lb. of steam per kilowatt.

TABLE B.—Willans and Robinson *v.* Parsons. Parsons exhausting at 11lb. back pressure, Willans to atmosphere.

| Time. | Steam per electric unit. | Ampere-hours. W. & R. | Ampere-hours. P. | % work done by each type. W. & R. | % work done by each type. P. |
|---|---|---|---|---|---|
| 8 a.m.-8 p.m.—30th-31st..... | 59 | 1,990 | 9,984 | 16·6 | 83 4 |
| 6 p.m.-10 a.m.—30th-31st ... | 65·2 | 340 | 6 260 | 5·2 | 94 8 |
| 8 a.m. 8 a.m.—31st-1st ..... | 59·2 | 1,225 | 10 680 | 10 3 | 89 7 |
| 10 a.m.-10 a.m.—1st and 2nd | 52·2 | 10 140 | 1,900 | 84·2 | 15·8 |
| 10 a.m.-10 a.m.—5th and 6th | 57·2 | 12.420 | 610 | 95·3 | 4·7 |
| 10 a.m.-2 p.m. | 49·5 | 3,070 | — | 100 | — |
| 2 p.m.-6 p.m. 5th and 6th | 58·7 | 2 560 | 610 | 80·8 | 19·2 |
| 6 p.m.-10 a.m. | 59·9 | 6,790 | — | 100 | — |

The kind of load that the engines were dealing with is shown by an ordinary day-load curve of the station (see Curve D), from which it will be noticed that the output varies from about 380 amperes at 420 volts at 4 a.m. to 1,100 amperes at 5 p.m. The units being small, several of them have to be kept running to meet any sudden demands which are made on the station, so that they are working for a large part of the time on a small load. If this table is compared with some results given of the running of the City and South London Electric Railway, in which some similar but larger machines were used, it will be seen that on a test of a 300-kw. set with the same steam pressure 25·5lb. of steam per kilowatt-hour was used, the engine working condensing. Allowing for its working non-condensing, the steam consumption would probably be about 28·2lb. per kilowatt-hour. In comparison with the engine given in the table, it is a little better than the 32·2lb. which would be used working against atmospheric pressures. The coal consumption for the City and South London station—9·95lb. per kilowatt-hour—does not, however, compare well with the 5·9lb. of coal consumed in the table. It is possible that the conditions of working in the two cases may be very different. Still, it is satisfactory to know that, with regard to coal consumption, this small plant can compare very favourably with some of the larger ones. I consider that boilers generating steam at the rate of 8 5lb. per pound of slack coal shows rather a high efficiency. Referring to the curve (A), the Willans engines and Parsons turbos appear to increase their steam consumption per kilowatt very much when working with half or quarter load, being as much as 87lb. per kilowatt (with 11lb. back pressure) for quarter load on the Parsons and 63lb. at quarter load for the Willans, so that it would be economical to run them at as near their full load as possible.

Perhaps the question of actual efficiency of the machines is not so important within the scope of this paper as their running. The Willans engines have proved rather troublesome and require a lot of attention, the maintenance charges coming out very high. They frequently required taking down and putting together again, which would take a fitter and his helper two weeks to do, costing about £5. 10s. per engine. Occasionally knocking in the engines occurs, but on being taken down nothing wrong is discovered, and when put together again work perfectly well. The oil consumption is also rather a large item compared with that of some other types of engines, three-quarters of a pint of cylinder oil being used every eight hours in each of the 120-kw. sets, and every month or so about six or eight gallons of crank-chamber oil on account of water from the cylinders coming down and floating off the crank-chamber oil if not noticed.

The Parsons turbines give very little trouble, in the later type the oil being circulated through the bearings by means of a pump. Considering that the speed of the 250-kw. machine is 3,060 revolutions per minute, the system of floating the bearing is remarkably successful, and a great improvement on the older types, in which the apparatus consisted of a worm on the spindle engaging in a wormwheel with 41 to 1 reduction, which drove the air-pump, the working of which caused a considerable knock at each revolution of the wheel. On one occasion, the blades having become jammed, a coupling between the turbo and generator, consisting only of a 1in. square spigot working in a square hole, was sheared off. The inertia of the quickly-rotating armature is naturally capable of doing far greater damage than this.

With Parsons sets the wear of the commutator is very considerable, due to the great speed, and sparking is almost inevitable due to the changes of the load, although the brushes are adjusted to the load as much as possible. An arrangement is being made in the new machine, however, to make the position of the brushes fixed for all loads. As the sparking is due to the distortion of the field by currents flowing in the armature, this distortion will be prevented by taking the current of the machine round a coil inside the pole-faces, so that the current flowing in it will be in the opposite direction to that in the armature, the current in the coil neutralising the action of the armature on the field.

The generators are all coupled on to the two 'bus bars at 420 volts of a Ferranti low-tension switchboard, this switchboard having been recently installed at the back of an old Mather and Platt board, which it has replaced. It was erected and the change made over from the old to the new switchboard practically without stopping any of the plant. The Mather and Platt board, which was designed about 1879, was rather a dangerous arrangement, the feeders being plugged on to the 'bus bars and the cables at the back crossing each other in a very risky manner. Some of the terminals were very near the supporting frames, and arced across on one occasion, causing the cables at the back to catch fire. To make matters worse, some energetic fireman turned the hose on instead of using the sand buckets provided.

The engines in the station are governed by two types of governors, the Willans having "centrifugal" and the old type of Parsons "solenoid." As the solenoid governors were much more sensitive than the centrifugal, the Parsons machines took up practically all the variation in the load of the station. This caused overloading frequently, and consequently the sensitiveness of the governors had to be reduced by shifting the point of suspension of a spring, which resists a core being drawn into the solenoid part of the governor. A better idea of the arrangement may be gathered from the photo shown. There is no difficulty in running the two types of engines in parallel providing that the governing is of the same type. The governor of the 250-kw. Parsons is of the pendulum type. There is also another one running with it, which acts on a trip gear and closes the stop valve in case of the turbo running away. At first the trip gear came out occasionally, but on becoming better acquainted with the machine this never happens, and it runs on continuously, requiring no overhauling. Perhaps a good thing in the new types would be to have a second oil-pump, so that if one pump fail the lubrication would still go on.

*(To be continued.)*

## FORTHCOMING EVENTS.

SATURDAY, FEB. 25.

**Institution of Electrical Engineers (Students' Section).**—At 2.30 p.m., visit to the Great Northern and City Railway; meet at Moorgate Station. At 3 p.m., visit to G.P.O. Central Telephone Exchange.

MONDAY, FEB. 27.

**Municipal and County Club.**—House dinner.

**Society of Arts.**—At 8 p.m., "Internal-Combustion Engines" (Lecture III.) by Mr. Dugald Clerk.

**Institution of Electrical Engineers (Newcastle Section).**—"Some Effects in Three-Phase Working," by Mr. W. M. Thornton.

TUESDAY, FEB. 28.

**Institution of Civil Engineers.**—At 8 p.m., "Surface-Condensing Plants, and the Value of the Vacuum produced," by Mr. R. W. Allen.

**Institution of Electrical Engineers (Manchester Section).**—At 7.30 p.m., "Mechanical Construction of Steam-Turbines," by Mr. W. J. A. London.

WEDNESDAY, MARCH 1.

**Institution of Electrical Engineers (Students' Section).**—At 7.30 p.m., discussion on "The Gas-Engine *v.* the Electric Motor for Small Workshop Driving."

**Institution of Civil Engineers (Students' Section).**—At 2.30 p.m., visit to the works in progress for the widening and enlargement of Victoria Station.

THURSDAY, MARCH 2.

**Institution of Electrical Engineers.**—At 8 p.m., "Type Setting by Telegraph," by Mr. Donald Murray.

**Chemical Society.**—At 8 p.m., general meeting.

**Rontgen Society.**—At 8.15 p.m., general meeting (provisional).

**Civil and Mechanical Engineers' Society.**—At 8 p.m., "Engineering Expert Evidence," by Mr. J. F. Reade.

FRIDAY, MARCH 3.

**North-East Coast Institution of Engineers and Shipbuilders (Newcastle).**—At 7.30 p.m., special meeting to consider the present Board of Trade Regulations for Certificated Marine Engineers, and to suggest certain modifications.

**Royal Institution.**—At 9 p.m., "Recent Advances in Wireless Telegraphy," by the Chevalier G. Marconi.

**Institution of Electrical Engineers (Leeds Section).**—Annual dinner.

**Junior Institution of Engineers.**—At 8 p.m., "Possible Improvements in Locomotive Practice," by Mr. W. Longland.

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**Faraday House.**—On Monday, March 6, Prof. C. A. Carus-Wilson will commence a special course of lectures to the senior students of this institution on "Direct-Current Motor Construction."

**Institution of Civil Engineers.**—On March 22, at 7 p.m., annual dinner at Merchant Taylors' Hall. Sir Guilford Molesworth, president, in the chair.

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THE
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### TO CORRESPONDENTS.

*All Rights Reserved.* *Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

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## TILLING v. DICK, KERR, AND CO.

The decision in this case, unless reversed on appeal, which is extremely doubtful, will have a far-reaching effect. During conversion from horse to electrically-driven systems it has been customary to carry on the work and, as far as possible, continue the service at the same time. The reason for this is perfectly clear and comprehensible. Wherever a tram system has been in operation for some years, be it successful or the opposite, a certain number of people have made business and other arrangements, the due carrying out of which depend upon the tram service. Men select the houses they live in after considering the train and tram services, and have, so to speak, a vested interest in the continued services. The sudden stoppage of a service places them under great difficulties, and the continued stoppage may disarrange their plans altogether, and be the cause of great expense. Hence the slightest consideration of such matters will show how careful an authority or a company is not to interfere with the convenience of its regular customers, and what great pains are taken to keep the service going satisfactorily. The question under consideration has nothing to do with the policy of tramways. For our present purpose we can assume there is no dispute as to their necessity or as to the necessity for conversion. Seeing that these are the ordinary business opinions which must necessarily arise whenever changes in traction take place, it is quite natural to find that the London County Council, when it decided to convert the southern tramways to electricity, held that it was necessary as far as possible to continue the service. As the judge in this case said: "The special Acts of the London Tramways Company and the General Tramways Act provide that the uppermost surface of the rail shall be on a level with the surface of the street, and that the rights of the public to pass over or along the streets shall not be abridged save as in the Acts provided. For the purpose of effecting the conversion of the South London system of tramways, the London County Council made a contract with the defendants, dated Dec. 31, 1902, by which the latter undertook the work described therein, and in a specification annexed, at a certain price. The specification provided, amongst other things, that the contract should include the provision and maintenance of all temporary lines, turn-outs, and cross-over roads to be used during reconstruction, so as to interfere as little as possible with the tramway traffic. The contract and specification also contained provisions casting upon the defendants the duty of observing the provisions of the statutes, and the responsibility for all damage caused by interference with traffic or otherwise. Clause 13 of the specification particularly provided for the continuance of the tramway traffic." It will be seen from these remarks that in their tender the contractors had to consider the things specified, and had also to consider the continuance of the tramway traffic, and whether such continuance in the manner which they adopted would be legal or illegal. We need not labour the question now, for there can be no two opinions in the matter that the methods adopted to continue the traffic necessarily interfered with other traffic using the roads, and interfered detrimentally. It seems from the judge's observations that this interference, necessary for the continuance of the traffic, was at the contractor's risk, as the contractor was responsible for all damage caused by interference with traffic or otherwise. Our object is the moral of all this, and not with the facts. Messrs. Tilling have obtained the legal decision that they are entitled to the relief they ask—which is to recover damages for the accidents caused by the obstructions placed

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on the ordinary road surface by the contractors. What these damages will be, has to be considered—but this is the moral. After this a contractor who undertakes to carry out the conversion of tramways in large towns will know that he is under obligation to pay damages to all and sundry that can prove that they have been in any way damaged by the obstructions used to carry on the ordinary traffic. Unless this decision is reversed on appeal, Messrs. Tilling have set a ball rolling to which there can be no end. Take one of their points, the strain upon the vehicles, or rather the extra strain upon the vehicles, in being hauled over this obstruction. The number of vehicles that any one firm possesses is comparatively small when the total number of vehicles passing along one crowded street of London or any other large town is considered. The owners of each of these vehicles are at liberty to enter an action to obtain damages, and, as we say, if this decision is supported, they must obtain damages. Such damages, although they may in the first instance have to be borne by the contractors, naturally will not be so in the future. If the undertakers insist that the ordinary traffic is to be continued, and the continuance of this traffic necessitates the placing of turn-outs, or cross-overs, or any other impediments in the track of the ordinary, the contractors, in their tender, will undoubtedly put on an extra sum so as to ensure their having a sufficient amount at the end of the job to pay all of their legitimate expenses and to give them the usual profit balance. In a word, the cost, large as it is now, will be increased by this decision, and there seems to be no way out of the difficulty, for it would not be right, if the property of a third person was damaged to any extent, that he should not obtain reparation.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### TELEPHONE PURCHASE.

SIR,—Perusal of the agreement for telephone purchase proposed by the Post Office reveals many things. Especially is indicated the great need which exists for calm enquiry and caution. A question which naturally rises in one's mind is, "What is the nation going to gain?" The answer may be obvious to the Post Office but not to the outsider, even if he, like myself, is not altogether unacquainted with practical telephony. This agreement provides for the purchase on tramway terms of the company's plant, or such part of it as the Post Office may require, in 1911; but the Select Committee of 1898 said in their report: "The Post Office is under no obligation to buy even the plant of the company in 1911, and the Post Office alone could find a use for such plant should all licenses alike be terminated in that year." So it seems that the Post Office is making a special agreement six years in advance to buy something in respect to which it already possesses what is practically an absolute right to take or reject in 1911. Such a proceeding can scarcely be reckoned a benefit to the nation; and after it, what remains? Simply the right of inter-communication between various insignificant country exchanges of the Post Office, which have never been and never can be of any great consequence; the abolition of terminal fees between these same insignificant country exchanges and those of the National Telephone Company; a right, on paper, couched in words which have proved absolutely ineffective for their purpose in the past, to prevent the company giving preferences as between subscriber and subscriber; a right to prescribe the plant to be used by the company (although the company invariably gives a better service than the Post Office wherever they come into competition, so that the inferior is here assuming power to dictate to the superior). The first two advantages, owing to the smallness of the Post Office exchanges affected, may be described as capable of only microscopic good or evil. The third is something which the Post Office has already power to do in all competitive centres under the Act of 1899, but has found itself powerless to enforce; and the last is a very doubtless benefit, as tending to stereotype plant indefinitely, and so restrict invention, progress, and the introduction of improvements. It may also be described as a device for ensuring the placing of practically all orders for future telephone plant in America.

On the other hand, the company's prospective gains are enormous: (1) It preserves the right to maintain its present high rates in non-competitive centres till 1911, and the agreement sayeth not what is to happen thereafter, although the country's unhappy position with regard to trunk lines renders a reasonable forecast easy. (2) It is given a complete monopoly, apart from the present competing centres, until 1911, because it is quite clear that it is not intended to issue any more competing licenses. The right to do so is preserved in words, but a study of the text shows that in no case is it intended to exercise it. (3) It is left with a practically free hand to fight—and, if possible, crush—the existing competing municipalities by charging unremunerative rates and giving preferences. (4) It secures the right to use streets for underground wires without the permission of the local authority, since the Post Office undertakes to lay underground pipes and cables for the company wherever it may want them. Thus the Glasgow and Brighton Corporations, which have always refused the use of their streets to the company, will be obliged to surrender a right hitherto tenaciously retained, and which will certainly be used to compete unfairly with their own undertakings. And this in spite of the fact that Parliament has hitherto most jealously preserved the right of local authorities to control their own streets, except in the case of unreasonable obstruction to Post Office requirements. It is difficult not to conclude that one of the chief aims of the agreement is to place the competing municipalities at the greatest possible disadvantage as compared with the company. It should be remembered that the corporations undertook telephone work at the express invitation of the present Parliament, which gave effect to a strong report from one of its own Select Committees. But the Post Office rises superior to Parliament, and now determines that the corporations are to be discouraged and discriminated against. While stipulating for free inter-communication, and equalisation of rates where it itself competes with the company, and abolition of terminal fees in respect of its own few insignificant country exchanges, it expressly—Clause 9 (3) (*c*)—denies these benefits to the existing municipal exchanges, the subscribers of which number more than ten times all the country subscribers possessed by the Post Office. Are not municipal telephone subscribers British subjects and entitled to equal consideration with those of the Post Office? From the municipalities have come the only effective opposition which the company has ever known—that of the Post Office it can, and always could, afford to laugh at and disregard—and the company in this agreement has apparently insisted upon the municipalities being burdened with disadvantages which will render the company's hard task in fighting them as easy as possible. The design of the Select Committee of 1898 was that the municipalities should rescue the Post Office from the effect of its previous bad bargains with the company, and that municipal competition should render the acquisition in 1911 easier for the nation; the Post Office now appears to be wishful of getting rid of the necessity of ultimately purchasing the municipal systems by making it easy for the company to ruin them. The Post Office likewise agree to pay for goodwill in those centres where the company's license has been prolonged beyond 1911. But this prolongation was given on condition that the company shall not give any favours or preferences whatsoever as between subscribers. It is notorious that this condition has not been adhered to, so that, instead of undertaking to pay extra in these cases, the prolongation ought to be cancelled.

The clause that provides that the agreement becomes binding, if not disapproved by Parliament before Aug. 31 next, opens up certain curious possibilities. If a dissolution and general election should occur, and the new Parliament

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is not able to reach the matter by Aug. 31, the company will get this monumental agreement confirmed without the sanction of Parliament.

It is to be hoped that a Select Committee will sit and take evidence without delay. In addition to safeguarding the municipalities, which I regard as absolutely indispensable and a matter of common justice, future telephone users ought to be protected by defining what rates they are to be charged after 1911, a subject which has been very carefully left out of view altogether, although its importance is paramount, for unless the British telephone-using public is to get substantial advantages there is no call to buy the telephones at all.—Yours, etc.,

A. R. BENNETT.

## ALUMINIUM.

SIR,—On p. 129 of your issue for Jan. 27 last, we have that for equal conductivity the diameter of copper is to the diameter of aluminium as 1 : 1·3. Also "for equal insulation to leakage, as the leakage area is greater, the insulating material must also be thicker in a like ratio." This would appear to be sufficiently explicit.

$$\therefore \frac{\text{Insulation on Cu}}{\text{Insulation on Al}} \propto \frac{1}{1{\cdot}69}.$$

The point is that the quantity of insulating medium required varied as the square of the diameter of the conductor.

The word "thickness" in my last letter should be "quantity," as is evident from the context.—Yours, etc.,

WILLIAM SMITH.

## THE GENERAL ELECTRIC.

The fifteenth annual dinner of the General Electric Company was held at the Trocadero on Saturday evening last. There are too few functions of this kind which we attend without some misgivings as to the pleasure of the evening, but the General Electric's annual function is not one. The evening is recognised as unique, and attention is paid as much to detail to ensure the comfort and the pleasure of the guests as is paid by the firm in the organisation of their immense business. It has been said that in this world nothing succeeds like success, and we must say that this applies particularly to all that concerns the General Electric. Its business has been and is a success, and its entertainments are as great a success as its business.

Four hundred gentlemen sat down to dinner in the Empire Room at the Trocadero, and such as are conversant with Messrs. Lyons' catering will know that, so far as meat and drink was concerned, everything was of the best. While, however, excellent food for the body was provided, there was, at the same time, an excellent food for the mind in the references made by various speakers upon questions which concerned the successful carrying out of a large business. Mr. Max Byng occupied the chair in the absence of his brother (Mr. Gustave Byng), who has been abroad on account of his health, and only that day returned to England. We are glad, however, to say that Mr. Gustave Byng has returned better in health. After the toast of "The King and Queen and the Rest of the Royal Family," the Chairman gave the toast of "The Staff," which he considered *the* toast of the evening.

Most of our readers know somewhat of the rapid expansion of this company, but few, perhaps, realise that it employs some 4,500 workmen and workwomen, and some 1,100 persons which may be called the clerical and managing staff, paying some £300,000 in salaries and wages during the year. Such figures give rise for thought. A wages bill which amounts to practically £1,000 for every working day necessitates and points to an enormous output. Mr. Byng, in the course of his speech, preached a model sermon on the text "Detail," insisting that the success of the business depended upon the constant attention given by every member of the staff to details. Nothing was to be overlooked, nothing shirked; every single detail was to be thoroughly examined and thrashed out, so that work might be carried out in their operations in the most economical manner possible. Mr. Byng paid the highest possible compliment to the staff, testifying to their assiduity and loyalty. The toast was responded to by Messrs. Brooking and Dumas, the latter of whom referred to the expansion in the class of work carried out at Witton. They were dealing with gradually increasing units, and at the time of speaking had under test two machines of 1,000 kw. each. Then we had speeches by Mr. Hirst, by Mr. Gaine, Mr. Bevis, Mr. Medhurst, each exceptionally good—far, indeed, above the ordinary run of after-dinner speeches—appealing both to business and to patriotic instincts. During and previous to the dinner excellent music was discoursed by the band, and various entertainers appeared during the evening, meeting with enthusiastic applause. Altogether the evening was a conspicuous success, and if we had any suggestions to make it would be for every person who reads these lines to qualify for an invitation to these annual festivals, feeling assured that he would feel that the success of these evenings proved unmistakably that the success of the General Electric in all its business is amply warranted.

## THE TELEPHONE QUESTION.

The Postmaster-General laid on the table of the House of Commons on the 16th inst. a memorandum embodying an agreement, dated the 2nd inst., between the Postmaster-General and the National Telephone Company, Limited.

The memorandum recites in the first place the agreement entered into on Nov. 18, 1901, by the Postmaster-General with the National Telephone Company for the purchase of the plant of the company in the London exchange area on the termination of the company's license on Dec. 31, 1911. The plant was to be purchased at its value *in situ*, and no payment was to be made in respect of compulsory purchase, goodwill, or past or future profits; in other words, the purchase was to be made on what are known as "tramway terms." The agreement also provided for inter-communication between the systems of the Postmaster-General and of the company in London during the continuance of the company's license, and for uniformity of rates.

The agreement was in effect approved by the House of Commons, after full discussion, on Jan. 27, 1902.

The document proceeds as follows: An agreement, on similar lines, has now been made in relation to the whole country. On Dec. 31, 1911, the Postmaster-General will take over the whole business carried on up to that date by the company, and will acquire the plant of the company on "tramway terms." No payment will be made in respect of goodwill or profits except in the case of the private-wire business of the company (which can be carried on without the Postmaster-General's license), and in the very few cases where the company's license has, under the provisions of the Telegraph Act, 1899, been extended beyond 1911. At the option of the Government, three-fourths, and, with the consent of the company, the whole, of the purchase money may be paid by way of annuity for a term not exceeding 20 years.

Certain powers of objecting to plant as unsuitable for purchase are reserved to the Postmaster-General, and rules for the construction of plant are laid down.

During the continuance of their license the company are to allow inter-communication without additional charge between the systems of the Postmaster-General and of the company. The company will be precluded from showing favour or preference as between subscribers, and the rates charged by the company will be confined within certain limits. If, on complaint and after full enquiry, it is proved that the company is giving an inefficient service in any district, the Postmaster-General may take over the company's business in that district at once without any payment for goodwill.

Certain provisions of the London agreement which are not of general application remain in force. In other respects the provisions of that agreement have been assimilated to those applicable to the rest of the country.

The memorandum concludes by stating that the agreement will become binding when confirmed by the House of Commons, or on Aug. 31, if not disapproved by Parliament before that date.

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## THE LAW OF ELECTRICAL DISCHARGES THROUGH AIR.*

The results of some interesting tests on the length of discharge path in air at high voltages are given by H Grob in a recent article in the *Elektrotechnische Zeitschrift*. He points out that the Maschinenfabrik Oerlikon have for many years been building artificially-ventilated transformers for extra high tensions, including some for a working voltage of 36,000 volts and a test voltage to earth of 55,000 volts. When applying the test voltages occasional breakdowns were found to occur, in which the length of air-gap jumped across largely exceeded that given by many of the accepted rules. In order to investigate these occurrences more closely, the writer carried out the following series of experiments.

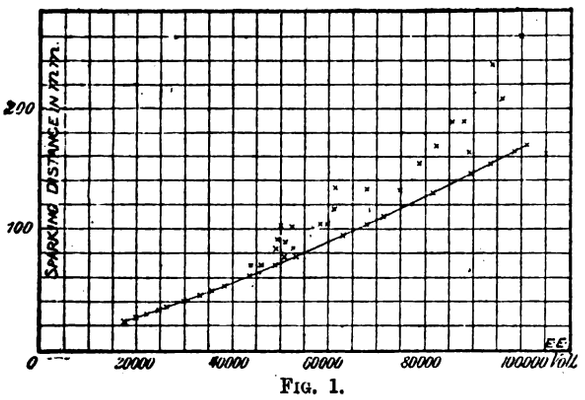


FIG. 1.

Previous experience had shown that the form of the electrodes had a great effect on the results. A smaller radius of electrode, however, by no means always corresponded to a greater sparking distance. In order to avoid change of form, the first experiments were carried out with needle points, new needles being inserted after each discharge. One of the holders was fixed, whilst the other could slide along a groove with scale attached. This needle was gradually moved towards the other until the spark passed. The test voltage was supplied by a generator having a wave of pure sine form, and it was measured by means of a hot-wire voltmeter, so that the values stated below are all effective values. Regulation was effected by means of the generator exciting current, and not by inserting resistances into the main circuit. Up to a voltage of

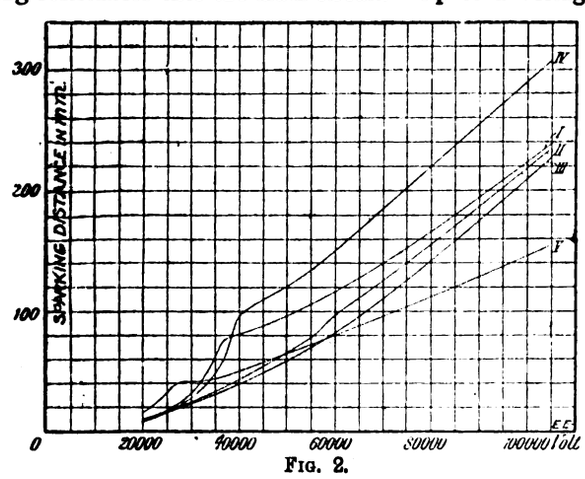


FIG. 2.

about 45,000 the points formed a very satisfactory curve (Fig. 1), but beyond that an unknown influence asserted itself, and entirely upset the results, so that in place of a regular curve a mass of indefinite points was obtained. The lowest points, however, formed an exact continuation of the regular part of the curve. The writer found great difficulty in accounting for this behaviour. Differences in the electrodes could not be the cause, as these would have shown up equally at the lower voltages. Further experiments also negatived the assumption that variations in the quantity of ozone in the air could be the cause.

* Translation from *Elektrotechnische Zeitschrift*, Nov. 11, 1904.

Finally, the needle points were set aside and were replaced by steel spheres of 10mm. diameter. These lead to the absolutely definite curve shown at I. in Fig. 2. This curve showed well what the writer had often previously noticed—viz., that at some point in an otherwise perfectly regular curve a peculiar buckle occurred. He, therefore, determined to investigate this point more closely. On one occasion a series of readings had to be temporarily interrupted to allow a small change in the supply leads to be made. On attempting to continue the experiment, it was found that, with the same spheres and at the same voltage, the sparking distance had unaccountably increased some 40 per cent. The previous arrangement of the conductors was then replaced, and it was found that quite a small variation in the arrangement of the leads sufficed to produce a variation of as much as 50 per cent. in the sparking distance. Further change of the leads in the same sense was found to cause the sparking distance, first, to increase and pass through a maximum and then to diminish and pass through a minimum point. This pointed to the presence of a capacity effect. In order to further test this effect, a pair of metal circular discs of about 10cm diameter were fitted to the supports of the electrode spheres, and arranged to be movable towards or away from one another. It was then found that by suitably adjusting the distance between the discs, the peculiar buckle in the curve could be displaced and diminished (Curve II. in Fig. 2), and could, even within the range of the experiment (20,000 volts to 105,000 volts), be entirely obliterated (see Curve III., Fig. 2). For this last result the discs had to be set several centimetres behind the spheres. There seems, therefore, to be little doubt that a species of resonance is set up in these cases, and this is confirmed by the following experiments, which also show the possibility of other electrical vibrations being present.

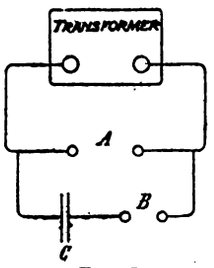


FIG. 3.

The sparking distance can be decidedly influenced by the presence of secondary spark-gaps. In one experiment the arrangement shown in Fig. 3 was employed. A second circuit, consisting of a capacity, C, and a smaller spark-gap, B, was connected in parallel with the main spark-gap, A. The capacity was composed of a sheet of ebonite, having an area of about one square metre and about 10mm. thick, coated on both sides with tinfoil. After each discharge the shunt-gap, B, was slightly increased, whilst the voltage was kept constant. As the distance between the spheres, B (between which a continuous powerful discharge occurred), was increased the discharges at the main gap, A, were influenced in such a way that the distance between these spheres (A) had to be alternately increased and decreased some 10 per cent. as the gap B continuously increased. These results were not absolutely uniform, for at distances of from 1cm. to 3cm. maxima would occur again. Suddenly, with a distance of from 85mm. to 88mm, a new phenomenon was noticed—viz, that the spark-gap at A, for a constant voltage of 60,000, had to be altered from 118mm. to 170mm. when the gap B was altered by an extremely small amount, such as $\frac{1}{100}$mm. It was hardly necessary to touch the micrometer screw carrying one at the B spheres in order to change the sparking distance at A completely. Obviously this indicated the occurrence of accentuated resonance at this point, whilst the previous subordinate maxima were affected by other superposed actions, all varying periodically with the length of the gap at B. The experiment was continued by adjusting the micrometer screw at B once for all so as to give the maximum possible length of spark at A at 60,000 volts, and then taking the complete curve connecting sparking distance at A with the applied voltage, as in the first

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described experiment. This curve showed that the summit of a buckle occurred just at the previously determined value of 60,000 volts. The result of a further experiment is shown by Curve IV. in Fig. 2. Here the main gap was formed by the same spheres as before, but in series with this two quite small additional gaps of about $\frac{1}{2}$mm. each were inserted. It will be seen that this small alteration considerably increased the sparking distance.

A consideration of these various results leads to a simple explanation of the irregularity of the points in Fig. 1. Although the needles were taken from the same packet they differed slightly in length. Since the distance was always measured between the points, it follows that the distance between the needle clamps varied slightly from reading to reading, and as the end surface of these clamps was by no means negligible this variation in distance altered the capacity of the circuit in an irregular manner, and lead to the results found. It further follows that no curve of sparking distances can be of regular form, for there are always two variables present: the distance between the electrodes and the capacity of the system. On this account curves taken with electrodes of different shape may easily cross one another, as is shown by Curve V. in Fig. 2, which represents the results obtained with electrodes formed of two horn-shaped pieces of 12mm. diameter copper wire.

A comparison of the curve for needle points with that for spheres shows that the sparking distances with the former are less than with the latter, in contradiction of the commonly accepted rule that pointed electrodes increase the sparking distance. If the comparatively small values of Curve V. are also taken into account, it would seem probable that the shape of the electrodes is of quite minor importance compared with their capacity and the self-induction of the circuit. It is remarkable that, in spite of this fact, the curves, at least for the higher voltages, and excluding points of resonance, show a close agreement with the well-known equation: $V = a + (b \times d)$, where V is the breakdown voltage, $d$ is the length of gap, and $a$ and $b$ are constants. This equation, of course, represents a straight line, and it will be seen that the upper parts of all the curves are practically straight. It would be interesting to know whether other observers have noticed the occurrence of resonance as described above.

## SOUTH AUSTRALIAN TRAMWAYS.

The Government last December gave notice to the tramway companies of intention to purchase the whole of the tramways and undertakings authorised as follows—viz, Adelaide and Suburban Tramways Act, 1876; Adelaide, Unley, and Mitcham Tramways Act, 1877; Adelaide and Hindmarsh Tramways Act, 1877; Adelaide and Hindmarsh Tramways Extension Act, 1881; Adelaide and Parkside South Tramway Act, 1881; Adelaide and Goodwood Tramway Act, 1881; Adelaide and Suburban Tramways Extension Act, 1881; Adelaide and Hyde Park Tramways Act, 1882; Adelaide and Suburban Tramways Extension Act, 1882; Prospect, Nailsworth, and Enfield Tramway Act, 1882; Adelaide, Payneham, and Paradise Tramways Act, 1882; Adelaide and Parkside Tramway Extension Act, 1883; General Tramways Act, 1884; Adelaide, Unley, and Mitcham Tramways Act, 1877, Amendment and Tramways Enlargement Act, 1891; Adelaide and Parkside Tramway Enlargement Act, 1896; Adelaide Payneham, and Paradise Tramways Act, 1892, Amendment and Tramways Extension Act, 1889. In accordance with the Act, of which we give extracts below, the Government asked the tramway companies at what price they would sell the undertakings to them. There being little probability of any arrangement being arrived at by mutual agreement, the Government have now invited the companies to appoint one arbitrator to act for the whole of the companies.

Our readers will be interested in the following provisions of the current Tramways Act, 1904, as they are an important consideration to any person tendering to effect the conversion of the lines into a system of electric traction under the conditions contained in the same. The tramways in question are comparatively very old, and little or nothing has been done in late years for their improvement, because the private companies knew that under the Act the Government was bound to buy them out. The tracks in Adelaide are laid at the sides of the streets, the up line on one side and the down line on the other. These will be entirely useless, and will have to be taken up, and it is an acknowledged fact that the conversion will cost as large a sum as the installation of an entirely new system. There is also a feeling in the town in favour of motor 'buses, but apart from the principle of dispossessment of vested interests, which would not for a moment be permitted in the colony, the Government are bound by the Act to purchase.

The Tramways Electric Traction Act, 1904, was assented to on Nov. 24 of that year, and Section 7 (1) states the Government may at any time, after one month's notice in writing to the company of its intention so to do, purchase the whole of the tramways and undertakings referred to in the Acts mentioned in the first schedule at a price to be determined, in default of agreement, as hereinafter mentioned, provided that such notice be given within two years from the date when this Act shall come into force. Section 3 provides that failing agreement in writing as to price within one month after the expiry of the said notice, one arbitrator shall be appointed by the Government and one by the company, and all matters relating to such purchase shall be submitted to the decision of such arbitrators, and such arbitrators shall state the value of the movable plant of such tramways and undertakings. Power is also given to apply to a judge of the Supreme Court to settle the principle upon which the purchase money is to be estimated. It is further laid down that the Government shall not carry out the purchase unless within 12 months after such awards or any agreement in writing as to price entered into between the Government and the company a tender shall have been accepted under Section 10, and that the Government shall grant a lease of the tramways and undertakings as acquired to the person who shall tender for the shortest term in consideration of such person agreeing to effect the conversion of the system of horse traction of the tramways and undertakings so acquired into a system of electric traction. Section 10 provides that each tender shall state the number of years' lease of the tramways and undertakings required by the tenderer in consideration of effecting the conversion and constructing the works specified in the conditions of tender and in plans and specifications to be prepared by the Government. Also that the tenderer shall purchase, at the same price as that paid by the Government, all the tramways and undertakings bought by them; and that the work of conversion shall commence within six months from the date of acceptance of tender, and as regards the tramways mentioned in the second schedule shall be completed as to 20 miles of tramways within one year from such date, and as to the remaining portions of such last-mentioned tramways within two years from such date.

The second schedule contains the following portions of the tramways constructed under the Acts mentioned in the first schedule—that is to say, all the tramways between their present termini in the city of Adelaide and (*a*) the corner of Barton-terrace and O'Connell-street in North Adelaide; (*b*) the terminus of the Walkerville tramway; (*c*) the Payneham tramsheds; (*d*) the Maylands tramsheds; (*e*) the Kensington terminus; (*f*) the Parkside tramsheds; (*g*) the cross roads between Unley and Mitcham; (*h*) the Henley Beach terminus.

The Government is specially empowered with reference to all tramways which they purchase to convert the system of horse traction into a system of electric traction, with or without overhead trolleys, etc., and the following details are laid down with regard to the manner of construction: (1) the tramways shall be constructed and maintained with two rails, the running surface of which shall be laid not less than 4ft. 8in. apart; (2) the uppermost surface of every rail shall be and be maintained on a level with the surface of the road; (3) the rails shall be of iron or steel, and shall weigh not less than 90lb. to the yard; (4) the rails shall be grooved, and the groove shall not exceed $1\frac{1}{4}$in. in width; (5) the rails shall be suitably and properly bonded, and the return circuit shall be of such a character as to comply

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with the regulations of the British Board of Trade, and the whole of the work shall be carried out to the satisfaction of the South Australian Railways Commissioner. Other clauses refer to the protection of the Submarine Cable Company's cables to the city, 1d. fares, etc.

A copy of the Act may be inspected at the offices of the Agent-General for South Australia, 1, Crosby-square, London, E C.

## INSTITUTION OF ELECTRICAL ENGINEERS.

We give the following points from the resumed discussion on Messrs. Booth and Kershaw's paper entitled "Fuel Economy in Steam Power Plants."

**Mr. Druitt Halpin**, continuing his remarks, intimated that he was favourably disposed towards the controllable superheater, but feared that the complication of joints and the deposit of lime in the pipes, if the water were not properly purified, formed objections to it. Regarding steam production he agreed with the authors, but thought much higher furnace temperatures than those stated by the authors were possible.

**Mr. J. H. Rosenthal**, said that, unlike Colonel Crompton, he could see nothing mysterious in thermal storage; the results obtained at Kensington only demonstrated what seemed theoretically possible. He did not consider specially-trained men necessary for fuel, water, or gas analyses. Twenty-five years' experience had convinced him that mechanical stoking was the only remedy for smoke. More trouble resulted from excess of air with hand firing than with mechanical stokers, which were now provided with devices ensuring the production of from 10 to 25 per cent. of $CO_2$. He dissented from the author's view that there was no thermo-dynamic gain from superheat. At Hampstead the minimum saving of fuel through superheat was 10 per cent.

**Mr. H. N. Holland** agreed with the preceding speaker, that experts were not needed for fuel and water analyses. Regarding the use of express boilers, these required special firing, and he considered that ordinary water-tube boilers were sufficient for general purposes. Air leakage through the brick setting of water-tube boilers was attributable to the great heat produced. His company had tried building up the firebrick line apart from the outer brickwork, and although the lining did not last so long it greatly facilitated repairs. He recommended a second brickwork shell round the boiler, so as to provide an efficient air insulation. His company had found chain grates quite smokeless, and it was sufficient to clean them weekly. The Mersey Railway Company, who used the Roney stoker, were constantly being prosecuted for smoke nuisance. He concurred with the authors as to the value of the Ados recorder.

**Mr. L. Gaster** remarked that the authors had omitted to deal with the advantages of liquid fuel.

**Mr. W. M. Mordey** stated that as the result of his investigations into heat radiation losses he had ascertained that the radiation loss on a transformer case, at a temperature of 40deg. F., was equal to one watt per three square inches.

**Mr. W. H. Molesworth** adverted to the fact that the authors did not deal with the use of pulverised coal, which he had found by tests yielded a material gain in efficiency.

**Mr. W. C. Thomson** contended that smoke could not be prevented when starting or taking off large banks of boilers, even if chain-grate stokers were used.

**Mr. Ruthven Murray**, dealing with one of the points mentioned by the authors, remarked that engineers could not afford to experiment when putting down new plant. In regard to glazed brick casing for boilers, this entailed an extra cost of 12 per cent. as compared with ordinary brickwork, but it prevented leakage to a large extent, and also gave good heat insulation. His experience had been that chain-grate stokers did not prevent smoke.

**Mr. Booth**, in his reply, said that Colonel Crompton was incorrect in implying that the authors had "come round" to the water-tube boiler; it was rather the reverse. He had never been opposed to the water-tube boiler, though he disagreed with the form it took when the Babcock and Wilcox boiler was introduced into this country some 20 years ago. Regarding mechanical stokers, he declared, after extensive experience of them, that they did prevent smoke. He certainly did not deprecate the use of batteries, which had great possibilities; he had simply pointed out some defects in the present method of construction. Regarding superheating, he remarked that the controllable superheater gave a much steadier and a higher mean temperature, as extreme fluctuations were practically damped out by the water control. Having regard to the hour, Mr. Booth intimated that he would communicate the remainder of his reply in writing.

## GLASGOW LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

Prior to the reading of Mr. Lackie's paper on "Earthing" at the monthly meeting of this section held on Tuesday week, the discussion on Mr. Maxwell's paper on "Street Arc Lighting" was continued. We published an abstract of this paper in our issue for Jan. 20 last, together with a report of the discussion which followed it immediately.

**Mr. W. A. Chamen** (Glasgow), in the course of a lengthy communication, said that while it might often be most convenient to stagger arc lamps, he did not think it the best way of lighting a street. Some of the best street-lighting he had seen was in Berlin, where the lamps were suspended along the middle of the road. He was of opinion that for lighting the by-streets of a city laid out in chessboard fashion, lamps either erected on pillars standing in the middle of the road at the points of intersection, and at a considerable height above the ground, or on long overhanging brackets from one of the corners would give a most excellent result. He did not think that lowering gear should be passed by as useless, although perhaps no very satisfactory lowering gear had so far been devised. He did not agree with Mr. Maxwell's separate feeder arrangement, as, however convenient it might be, it was not practicable within reasonable bounds of cost in a large city. Neither did he agree that the only other alternatives—viz., time switches or remote-control switches—were both unsatisfactory. He was experimenting with both time and remote-control switches, and had good grounds for hoping for success in one direction or the other, if not in both. With regard to price charged for current, it was no secret that in Glasgow the current consumed for arc lighting was charged at 1d., which, however, did not include all wages, interest, sinking fund, and depreciation. He considered that 1d. per unit was a fair price in the case of Glasgow for a supply with nearly 50 per cent. load factor, particularly when it was remembered that the total quantity consumed per annum was 1,460,780 units, that there were no meters registered, that there were no bad debts, and no cost of collection of revenue. Mr. Maxwell had said that a negative carbon dropped through the holder was sufficient to cause an earth. That doubtless arose from the fact that the globe rod was attached directly to the pillar in the form of carrier used in most cases where the lamp was fixed directly above the top of the pillar. In hanging lamps, however, that particular mishap could never occur. It was only to be expected that they should come into sharp conflict with their friends the gas engineers over the matter of street-lighting. Gas engineers had said a few years ago that street-lighting was a very poor business, but now they fought inch by inch the progress of street arc lighting. Mr. Wilson had repeated the usual argument that the arc lamp gave intense illumination within a certain area, but left patches of darkness in between. It was worth noting that though the patchy nature of arc lighting was complained of by Mr. Wilson, they found gas engineers doing all in their power to introduce lamps of high candle-power, as, for instance, in Whitehall, London, and in the new thoroughfare between the Strand and Holborn. Mr. Wilson had referred to Brighton, but it should be remembered that in that town flat-flame gas-burners were replaced in by-streets by ordinary incandescent electric lamps before the incandescent gas mantle fairy had cast her magic spell upon so many moths. The main streets and promenade of Brighton were lighted by arc lamps, and splendidly lighted, too. There was the old argument about fog. He did not see that the gas mantle could pierce a fog any better than an arc lamp. If they lived in perpetual fog, flaming coal fires or Lucigen or Wells oil lights would be the only things to do much good.

**Mr. W. T. Calderwood** (Glasgow)—*communicated*: Mr. Maxwell's arrangement for switching in arc lamps from the station from independent 'bus bars and feeders, using separate machines from the ordinary supply till the lamps are lit up, then paralleling in, is rather impracticable for large towns with extensive street-lighting systems. Time switches controlled from the station is, I think, the ideal arrangement. The time switches must, of course, be thoroughly reliable, not too expensive, and give a sufficient time interval between the switching in of the various arc lamp circuits to minimise flickering at the general consumers' lamps. A time switch for this work is being tried in Glasgow arc lamp street-lighting operated as follows: The time switches are placed one into the base of lamp-post of the first of each circuit of 10 arc lamps. In the station there is an arc lighting board containing two small tumbler switches, one open-reading ammeter, and two incandescent lamps. By closing one of these tumbler switches the first time switch in the street is closed, thus lighting up the first 10 lamps. The closing of the time switch operates a time element, which after a predetermined interval closes the next time switch, thus lighting the second circuit of 10 lamps, and so on. On the station board the ammeter is graduated 1, 2, 3, etc., to show the number of time switches that have been closed, and on the last switch being closed one of the incandescent lamps lights up, thus showing that all the circuits have been completed. In switching out the arc lamps all the switches must be opened before the other incandescent lamp lights up, so that the station engineer can tell how matters stand outside, both for switching in and out. The difficulty about arcing at the switches has been got over. The time switches, or arc starters, as they are called, are operated from the station through a three-core $^3/_{20}$ cable, and this cable is dead unless at the time of switching in or out of the lamps. By using arc starters there is a large saving in men's time, and also in current.

**Mr. McWhirter** (Glasgow) said he regretted that Mr. Maxwell had not put before them any figures relative to the use of enclosed arc lamps for street-lighting. He was assured that in America open arcs were rapidly being displaced in favour of lamps of the enclosed type. The circuits were arranged with constant current up to 100 lamps in series, and as the average life of a pair of carbons was over 80 hours, much saving must result; and as no steadying resistance coils were required, the efficiency of the whole system must be high. These lamps were mostly lowered to the ground for trimming, and that also saved labour. He had paid special attention to the gas lighting in the neighbourhood of the place of meeting after Mr. Wilson's eloquent praises of the superiority of the incandescent gas mantle, and it was almost impossible for any form of light to make a worse display. Ten out of 50 lamps were not giving their normal candle-power. About 30 of the mantles were broken, and the remainder were blackened up.

**Mr. Maxwell's** reply was mostly devoted to a vigorous criticism of Mr. Wilson's remarks.

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## TRADE NOTICES AND NOVELTIES.

### Kramos Resistance Pieces.

The accompanying illustration (Fig. 1) is a full-size representation of a convenient type of resistance piece manufactured by Messrs. Kramos, Limited, Locksbrook Engineering Works, Bath. We understand that the resistance material is an electro-ceramic product, quite original in its composition, structure, and method of production. At the same time, it is claimed to be infusible, non-inductive, and incorrodible. The piece may be described as a compressed cylinder, covered with mica, and further protected at each end by a non-metallic cap, from which protrudes a brass bolt, these bolts forming the terminals for connecting up the pieces. Each piece can be made with any resistance between 0·5 ohm and 300 ohms. They are all of one standard size, thus a 300-ohm piece is no larger than a 0·5-ohm piece. The radiating surface being the same for all, it is clear that they can all carry the same load in watts. Thus an eight-ohm piece will carry seven amperes for the same time as an 80-ohm piece will carry 2·2 amperes. It is pointed out that "Kramos" resistance pieces are especially suitable for heavy intermittent loads, since each piece will carry only 40 watts continuously, while it will convert an electrical horse-power into heat if the load is applied for a few seconds only at a time, with intervals of rest to allow the heat to be radiated. Combinations of the pieces can be made up for different kinds of loads. An example is shown in Fig. 2 herewith, while others suitable for arc lamp circuits, searchlights, meter testing, controller rheostats, motor starters, and a further variety of similar applications readily suggest themselves.

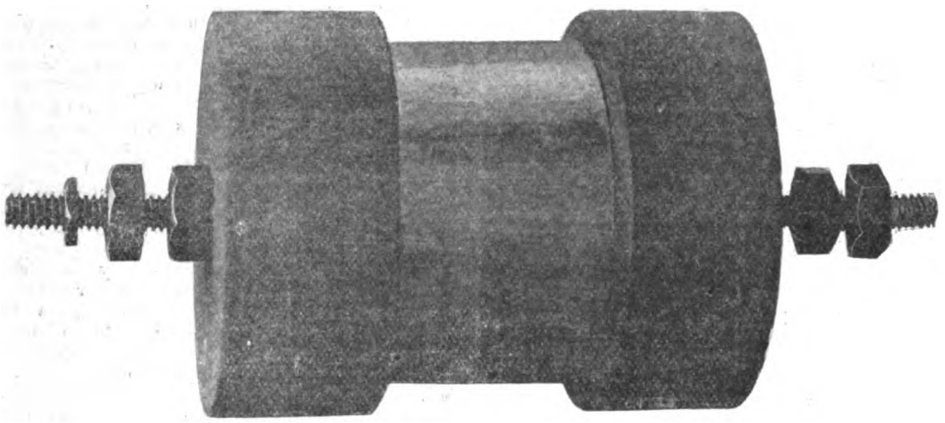

FIG. 1.—Kramos Resistance Piece.

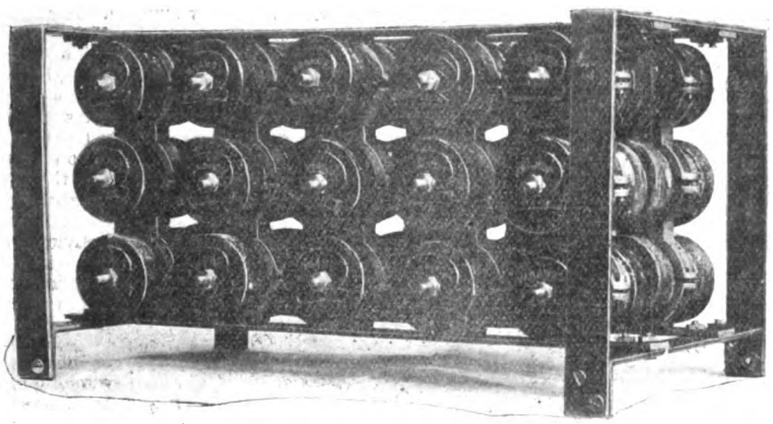

FIG. 2.—Combination of Kramos Resistance Pieces.

### Single-Phase Motors.

In our issue for Jan. 27 last we gave some particulars of a single-phase alternating-current motor which is now being manufactured by the Rhodes Electrical Manufacturing Company at their Bradford works. Through the courtesy of the above firm, we are now able to illustrate this motor. The machine, we are told, embodies all the latest improvements, and, it may be repeated, is a combination of a repulsion and induction motor, being designed in such a way that the operation is, to all intents and purposes, as good as that of a direct-current series motor. It runs at constant speed with the induction side cut in, and is reversible through the medium of an ordinary chopper-type switch. In our previous notice of this new departure we mentioned a 5-b.h.p. six-pole motor of the type in question, wound to operate on a 50-cycle circuit. On test this motor showed an efficiency of 82 per cent., and a power factor of 81 per cent. The same machine, we are told, will start 2½ times its full load running torque comfortably with a starting current not exceeding about double full load value, and will attain its rated speed in a smooth and gradual manner.

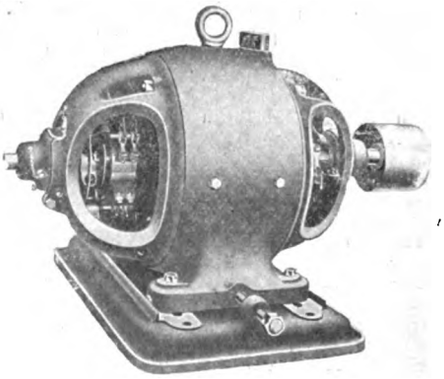

FIG. 1.—A Rhodes Single-Phase Motor.

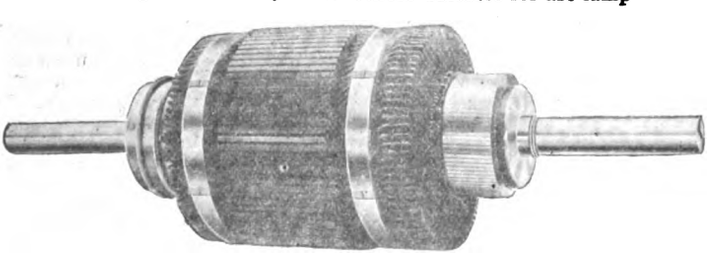

FIG. 2.—Rotor of Single-Phase Motor.

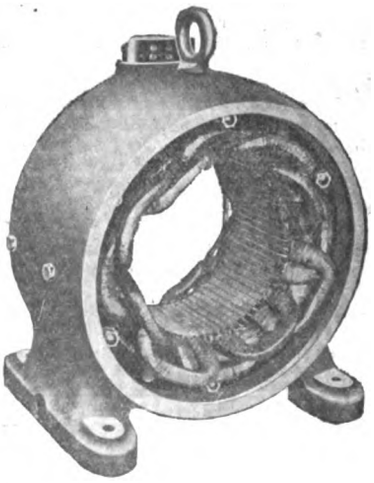

FIG. 3.—Stator of Rhodes Single-Phase Motor.

Referring to the accompanying illustration (Fig. 1), it will be seen that the external appearance of the machine is similar to that of the firm's continuous-current R. E. type motor. Figs. 2 and 3 show the rotor and the stator parts respectively. We have great pleasure in recording the advent of an English-built single-phase motor of such an obviously useful type as the above.

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## THE DEADRECKONER.

Through the courtesy of Messrs. Siemens Bros. and Co., York-mansions, York-street, Westminster, S.W., we are able to illustrate herewith an instrument introduced by them for ascertaining a ship's position at sea by account. The "Dead-reckoner," as it is called, was invented by the Hon. Reginald

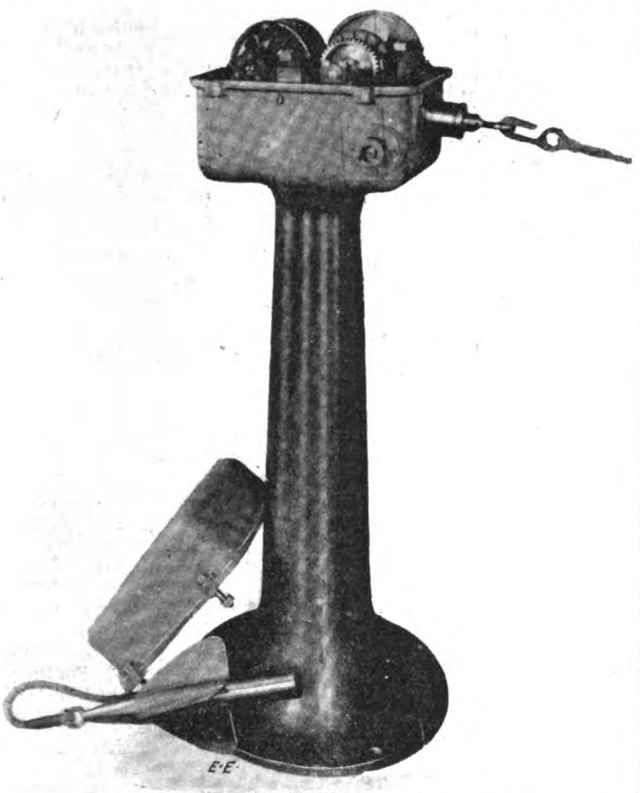

FIG. 1.—The Deadreckoner (Transmitter portion).

Brougham, and consists of two parts—the transmitter (Fig. 1), which is fixed on the poop, and the recorder (Fig. 2), placed in the chart-room. An electric cable forms the connecting link between them. Referring to Fig. 1, it will be seen that a shaft terminating in an eye projects from the after-end of the

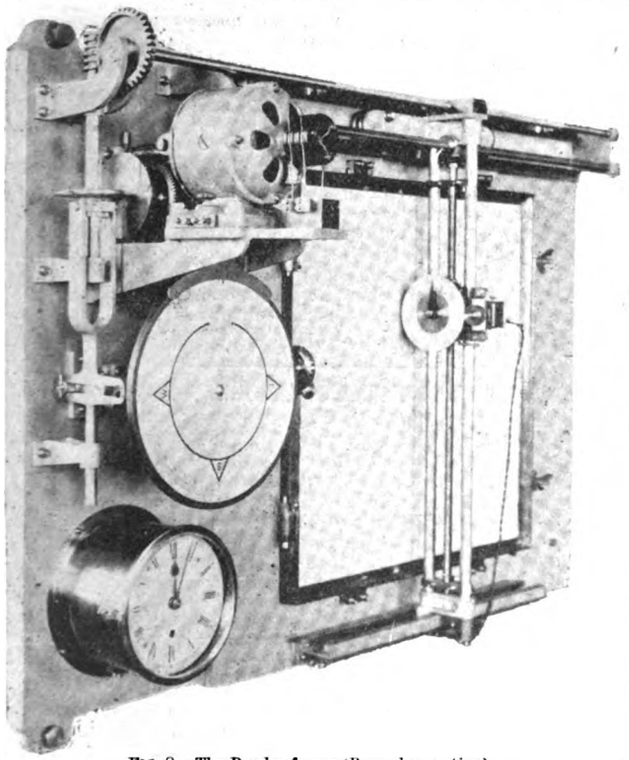

FIG. 2.—The Deadreckoner (Recorder portion).

transmitter box, and to this eye the rotator is connected by the usual log line. This shaft carries a worm which gears into a worm-wheel driving one half of a hunting switch, the other portion of the latter being driven through suitable gearing by a small three-phase synchronous motor. The action is as follows: As the portion of the hunting switch driven by the rotator is revolved, it makes a series of contacts with the portion driven by the motor. Directly the first contact is made the motor starts, and by revolving the other portion of the hunting switch breaks this contact and so comes to rest. If, however, the rotator continues to revolve, the motor will continue to run at a speed directly proportional to that of the rotator.

The recorder is mounted on a frame about 40in. by 30in., which carries two screw spindles at right angles to each other, one being termed the north spindle, and the other the east spindle. A time printing wheel is fixed on a nut carried by the former. Further, the spindles are connected by suitable worm gearing to two steel discs, which are free to slide upon the shafts on which they work. These discs are placed at right angles to two other discs connected together, which are revolved through suitable gearing by a synchronous motor similar to the one in the transmitting gear. The north and east discs, although free to move across the face of the other two discs, are connected together in a manner similar to the pistons of a two-cylindered steam-engine with cranks at 90deg. A "pelorus," divided into single degrees, is so geared to these discs that when an index points to the north point of the pelorus, the north disc is on the extreme edge of one of the discs driven the motor, and the east disc is exactly in the centre of the other disc. Similarly, when the index points to the east point of the pelorus, the east disc is on the extreme edge of one of the discs driven by the motor, and the north disc is in the centre of the other disc. Thus, at any position of the pelorus, the north and east discs will take up a position on their driving discs corresponding to the proportion of northerly or easterly direction as indicated by the pelorus. And so for all other points of the compass. The motor driving these two discs is connected in parallel with the motor on the transmitter, and being absolutely synchronous with it imparts a motion to the discs directly proportional to the speed of the rotator. Therefore the travel of the timewheel mentioned above will be directly proportional to the distance traversed by the ship, quite independently of the direction in which the timewheel travels. Now it has been shown that the direction of travel of the timewheel is controlled by the position of the pelorus relative to the index, consequently the line traced by the timewheel is, in length, directly proportional to the speed of the ship, and its course is that indicated by the pelorus. It may be mentioned that the timewheel referred to is normally held away from the paper by a spring, but every 15 minutes an electric current is sent by a clock, which forms part of the apparatus, to an electromagnet, which thereupon presses the wheel against the paper, printing on it the time as shown by the clock. The course is indicated by a series of dots, also printed by this timewheel. Further particulars of the "Deadreckoner," together with full directions for using it, are contained in a pamphlet just issued by Messrs. Siemens Bros. and Co., Limited.

## PERSONAL.

The Electric Light Committee of the Coventry Corporation have reconsidered the application of Mr. J. A. Jeckell, the manager of the electricity department, for an increase of salary, and have decided to adjourn the same until after the issue of the balance-sheet for the past year's trading.

Mr. William Augustus Kemm has been appointed chief electrical engineer to the Battersea Borough Council out of 63 applications. Mr. Kemm graduated at Haysman's University College, Hampstead; St. Joseph's College, Grammont, Belgium; and City and Guilds Technical College, Finsbury. He was engineer-in-charge and mechanical and electrical assistant, St. Pancras Vestry, from 1892 to 1898; chief assistant electrical engineer, Canterbury Corporation from 1898 to 1901; and has been chief assistant electrical engineer, Battersea Borough Council, since May, 1901.

On Friday evening last Mr. F. Gill, senior cash clerk (who is severing his connection with the Huddersfield Corporation tramways after 21 years' service), was presented with a gold curb albert and engraved medal attached. Mr R. H. Wilkinson, general manager, presided over the gathering and was supported by Mr. T. Hartley, traffic superintendent, and other heads of departments. Mr. I. Pogson, motorman, one of the oldest employés, made the presentation.

Sir Charles Todd, K.C.M.G., Deputy Postmaster-General for South Australia and well known in connection with the overland telegraph line, has retired from public service.

The Highways Committee of the London County Council are considering a number of increases of salary in the permanent staff, which includes officials in the tramway department.

A private meeting of the Exeter City Council was held last week under the presidency of his Worship the Mayor (Mr. E. C. Perry) to, according to the agenda, "enquire into the question as to the competency of the electrical engineer to discharge the several duties devolving upon him, and to make such report to the Council as may be determined upon." No specific charges were brought against the electrical engineer. Mr. Munro (the chairman of the Finance Committee) severely criticised the electric light undertaking from a financial point, and the discussion was chiefly directed to this side

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of the subject. It was eventually resolved that the general management of the undertaking and also the question of the competency of the electrical engineer, should be referred to a special committee to report, to which no member of the Electric Light Committee, with the exception of the chairman, is to be elected. Finally, Mr. Reed, the chairman of the Electric Light Committee, having intimated that he might not be able to devote sufficient time to the matter, it was agreed that his place should be taken by the vice-chairman, Mr. W. Wreford.

## WALSALL ELECTRICITY ACCOUNTS.

The accounts of the Walsall electricity department for the year ended Dec. 31, 1904, show a total expenditure on capital account to that date of £86,405. Abstracts of the revenue account, balance-sheet, and statement of electricity generated, sold, etc., are appended.

| Dr. REVENUE ACCOUNT. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 3 789 | 0 | 2 |
| Repairs, etc., of buildings and plant | 1,248 | 13 | 10 |
| Distribution of electricity | 201 | 0 | 10 |
| Attending and repairs to public lamps | 77 | 0 | 3 |
| Rents, rates, and taxes | 631 | 11 | 8 |
| Management expenses, salaries, etc. | 801 | 9 | 0 |
| Special charges—insurance | 43 | 8 | 10 |
| Total expenditure | 6,792 | 4 | 7 |
| Balance carried to net revenue account | 5,317 | 0 | 9 |
| | £12,109 | 5 | 4 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current for lighting, power, and traction | 11,417 | 10 | 4 |
| Public lighting | 503 | 0 | 0 |
| Rental of meters | 188 | 15 | 0 |
| | £12,109 | 5 | 4 |

| Dr. GENERAL BALANCE-SHEET. | £ | s. | d. |
|---|---|---|---|
| Sundry creditors on open accounts | 3,734 | 10 | 10 |
| Deposits returnable | 123 | 13 | 6 |
| Amount due to borough treasurer | 473 | 15 | 6 |
| Sinking funds, less loans paid off | 5,922 | 10 | 5 |
| Reserve for discount on current | 146 | 2 | 0 |
| Balance at credit of reserve fund | 175 | 19 | 5 |
| Balance at credit of net revenue account | 1,060 | 11 | 7 |
| | £11,637 | 3 | 3 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Stock on hand | 165 | 0 | 5 |
| Sundry debtors for current supplied, etc. | 3,914 | 16 | 5 |
| Amount in hands of engineer | 5 | 0 | 0 |
| Amount due from borough treasurer | 4,810 | 10 | 3 |
| Balance at debit of capital account | 2,741 | 16 | 2 |
| | £11,637 | 3 | 3 |

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

| | | | |
|---|---|---|---|
| Quantity generated in B.T.U. | | | 1,628,728 |
| Quantity sold | By public lamps | 34,392 | 1,165,238 |
| | Traction | 707,654 | |
| | Private consumers by meter | 423,192 | |
| Quantity used on works | | | 52,330 |
| Total quantity accounted for | | | 1,217,568 |
| Quantity not accounted for (chiefly transformation losses). | | | 411,160 |
| Number of public lamps | | | 19 |
| Total maximum supply demanded (kilowatts) | | | 754 |

# LEGAL INTELLIGENCE.

## INJURY TO WORKMEN.

### Kay v. the British Westinghouse Electric and Manufacturing Company, Limited.

The defendants applied to the Court of Appeal on Friday last for a new trial or judgment in an action tried before Mr. Justice Jelf and a special jury at Manchester Assizes. The action was brought to recover damages for personal injuries. The plaintiff was an ironturner in the employment of the defendants. The plaintiff alleged that on Feb. 22, 1904, while he was so employed, the defendants, in breach of their statutory duty in that behalf imposed by Section 10 (*c*) and (*d*) of the Factory and Workshop Act, 1901 neglected and omitted securely to fence all the dangerous parts of the machinery in their factory; and that by reason of the premisses the plaintiff, while engaged in his employment and while proceeding along a certain passage to a clock-off, came into contact with a switchboard, and his face was drawn on to the blades of the switchboard and held there by the electric current and set on fire, and the plaintiff sustained thereby terrible injuries which permanently incapacitated him from following his employment. The defendants by their defence denied that the switchboard or the blades thereof constituted dangerous machinery, or that the same constituted machinery at all within the meaning of the Factory and Workshop Act, 1901. In the alternative, they pleaded that, if the switchboard or the blades thereof were in an unsafe or dangerous or improper condition, such condition existed without any default or neglect on the part of the defendants. The jury returned a verdict for the plaintiff for £850. The defendants now moved for a new trial on the ground that the learned judge had misdirected the jury, or, in the alternative, for judgment.

In dismissing the application without calling upon counsel for the plaintiff, the **Master of the Rolls** said that the direction of the learned judge in the court below was substantially correct, and that there was abundant evidence that this system of lighting, if unprotected, was defective. The directors substituted a competent manager for themselves. But if that manager was negligent, and knowledge of his negligence was brought home to them, could they rely on the fact that they had substituted him for themselves? In his opinion they could not, because the antecedent underlying obligation to supply adequate materials and resources remained, and there was an obligation on them to rectify the mistake. The evidence showed that the mischief which caused the plaintiff's injuries had already attracted the notice of a Board of Trade inspector, who sent the company a formal notice with regard to it. One of the directors was asked about that, and he said he had no doubt that the specification for dealing with the matter was laid before the Board. The fact that the switchboard was unprotected must, therefore, have been known to the Board. The conclusion to which he came was that there was sufficient to saddle the directors with the duty of dealing with a crying danger. He thought there was abundant evidence of negligence on the part of the manager inadequately repressed by the directors. In his opinion, therefore, the appeal failed. It was not necessary to give any opinion on the question as to machinery.

**Mathew and Cozens-Hardy, L.J.**, concurred.

## TRAMLINES AND MOTOR OMNIBUSES.

Judgment was given on Saturday in the case of T. Tilling, Limited, *v.* Dick, Kerr, and Co., Limited, reported in our last week's issue.

**Mr. Justice Warrington** said the defendants pleaded that the obstructions were placed in the road under statutory authority, and that they were protected by Act of Parliament. The plaintiffs said that in any case the defendants were guilty of negligence, and were therefore liable. He, however, held that negligence was not proved. The London County Council had purchased the South London tramways, and had converted them from horse traction to electric traction. The defendants were contractors for the work, and were responsible for all damage caused by the interference with traffic. For the purpose of maintaining the trams on a double line of rails, and with a desire to interfere as little as might be with the ordinary traffic, the defendants laid between the kerb on one side of the road and the permanent tramway a temporary line of rails, at the same time closing altogether the other half of the road. The temporary line projected above the surface of the road about 2in., and he found that the raised rails were an obstruction to the highway, and caused damage to plaintiffs' omnibuses. There was evidence that it would have caused great public inconvenience to interrupt the service of cars, and that less interference to ordinary traffic was caused by the construction of a turn-out than by carrying on the tram service on a single line with cross-overs at intervals. He could not adopt the defendants' construction that they were authorised by statute. In his opinion the works they had constructed were not necessary for adapting the tramways to be worked by electricity, but were necessary, if at all, for maintaining the tramcar service uninterrupted. Works for this purpose were not covered by the Act, and the defendants were accordingly not protected by it. There arose the question whether as to the cause of the action arising more than six months before the date of the writ the action was barred by the 56 and 57 Vic., cap. 11, the Public Authorities Protection Act, 1893. In the absence of authority, he should have been prepared to hold that contractors undertaking work for their own profit were not within the protection of this Act, and this view was supported by a decision of the Court of Appeal. In his opinion the plaintiffs were entitled to the relief they asked. The damages were to be ascertained by some form of reference. The defendants must pay the costs up to and including judgment.

It was agreed to refer the question of damages to the Official Referee and to stay the reference until after the appeal had been heard.

## BRIGHTON CORPORATION'S APPEAL.

The Corporation's appeal in the action brought against them by Macartney, McElroy and Co., reported in our last week's issue, again came before the Master of the Rolls and Lords Justices Cozens-Hardy and Mathew last week, when, evidence having been taken on the Wednesday, Mr. Fletcher Moulton, K.C., intimated on behalf of the Corporation that he would not trouble their lordships further.

As the result of a consultation between counsel for the respective parties, judgment will be entered for an agreed amount.

The Master of the Rolls intimated that the parties had arrived at a very judicious arrangement.

## APPOINTMENTS VACANT.

**Electrical Engineer**, Great Western Railway. Salary £600 per annum. Applications by Feb. 27. See advertisement in previous issue.

**Inspector of Telephones**, Brighton Corporation. Applications by March 4.

**Mains Superintendent**, Carlisle. Salary £120 per annum. Applications to Corporation's Electricity Works by Feb. 28.

**Permanent-Way Superintendent**, Blackburn Corporation. Wages, £2. 10s. per week. Applications by March 3. See advertisement.

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# COMPANIES' MEETINGS AND REPORTS

## NORTHAMPTON ELECTRIC LIGHT AND POWER.

The annual meeting of this Company was held at the Northampton Town Hall on Saturday, Mr. F. H. Thornton, J.P. (the chairman), presiding. Particulars of the report appeared in our last week's issue.

In moving the adoption of the report, the **Chairman** said the accounts were even better than they appeared, for they were allowing £600 more for depreciation and carrying forward £316 against £209. They had a most efficient staff, and had greatly improved their machinery. With regard to the new shares, the 5 per cent. preference had all been taken up, and the ordinary shares had been well applied for. They proposed in the near future to pay off the 6 per cent. preference shares, which would cost £800; and then, when they had a little more money, to write off the founders' shares, which would cost another £1,000. The chairman then quoted a report of the Phœnix Fire Office to show that electric light was the safest illuminant when it was properly installed, and said that in Northampton steps were taken to ensure that proper installations were made.

The report was unanimously adopted.

The chairman and Mr. W. Tomes, J.P., were re-elected as directors, and Mr. B. Hesleden as auditor. A sum of £200 was unanimously voted to the directors as remuneration.

## MARCONI WIRELESS TELEGRAPH.

The annual meeting of this Company was held on the 16th inst., Sir Charles Euan Smith presiding. Particulars of the report appeared in our issue of the 10th inst.

The **Chairman** observed that they had made a profit of £12,681, and that without any adventitious aid or subsidy, as was the case in 1902 and 1903. It was not claimed that the system was in full working order. What the directors did say, however, was that they had laid the basis for their future operations, and that the contracts they had entered into had placed them in a position for reaping whatever future benefits there might accrue from wireless telegraphy such as no other system could attain. They were on the brink of completing the machinery for a regular Transatlantic service, and the estimated earnings per annum of a single pair of stations was £56,000. The capital cost of a pair of stations was but £250,000, as against £800,000 for a single Transatlantic cable. Ships carrying their apparatus were steadily increasing in number, and were thus establishing a large Marconi exchange. The agreement with the Postmaster-General had already borne fruit in the shape of the notice issued in January stating that messages would be collected at all post offices throughout the country for transmission through the Company's shore stations to ships at sea. They had further cemented their connection with the Post Office by consenting, at its request, to conduct a wireless service with the Scilly Islands during the recent breakdown of the ordinary means of communication.

The report was adopted.

## CHELSEA ELECTRICITY SUPPLY.

The report of the Chelsea Electricity Supply Company, Limited, for the year ended Dec. 31, 1904, submitted at the meeting on the 22nd inst., states that the profit for the year amounts to £35,053, which, with £1,200 brought forward, makes a total of £36,263. The directors recommend placing to credit of renewals and depreciation fund £10,344 and after paying a final dividend on the ordinary shares at the rate of 7½ per cent. per annum (making 6 per cent. for the year), there remains to be carried forward £1,170. Further expenditure, amounting to £3,875, has been incurred during the year in connection with changing the system of supply from 100 volts pressure to 200 volts. This amount has been added to the suspense account, from which £3,362 has been written off, leaving that account at £4,725. The number of lamps connected on Dec. 31, 1904, was 210,659, an addition of 15,424 during the year. The improvement in the units sold per lamp continues. The total number of units sold in 1904 was 3,212,412, being 473,060 more than the previous year. During the year an issue of £25,000 debenture stock was made at the price of £107. 10s., and the net premiums, amounting to £1,664, have been carried to debenture stock premium redemption fund. Reference is made to the lamented death of Major-General C. E. Webber, one of the first directors. It is not proposed to fill the vacancy.

## YORKSHIRE ELECTRIC POWER.

The report for the half-year ending Dec. 31, to be submitted to the shareholders on the 28th inst., states that since the meeting held in August, 1904, the buildings connected with the Thornhill power station have been completed, and with the exception of the turbo-generators, all the plant has been delivered and installed. The first two of the turbo-generators are completed and are now being tested at the makers' works at Rugby, and it is anticipated that they will be erected in the station during the month of February. The directors are glad to report that in accordance with their promise to the shareholders, a supply of electricity was available at the works before the end of December, and the first consumer was connected on Jan. 21, 1905. In addition to the agreement with the Urban District Council of Mirfield, agreements have been entered into with the Corporation of Pudsey and the Urban District Council of Liversedge for a supply in bulk, the agreement with the latter, as with the Mirfield Council, enabling the Company to supply large power users direct. Negotiations are proceeding with other local authorities, and agreements have been made with several large users of energy for power purposes in the districts in which mains have been already laid.

## LONDON ELECTRIC SUPPLY.

The report for the year ending Dec. 31, 1904, states that the profit on the working for the year is £65,333. 6s. 4d., to which has to be added interest on deposit and the amount brought forward, £2,137. 0s. 9d., making a total of £67,470. 7s. 1d. Out of this the interest to Dec. 31—viz., £15,478. 5s. 11d.—has been paid, leaving a balance of £51,992. 1s. 2d. The Board propose to pay a dividend of 6 per cent. on the preference shares for the year ended Dec. 31, 1904 (of which an interim dividend of 3 per cent. was paid on Sept. 1), to pay a dividend of 3 per cent. on the ordinary shares, to place to reserve account, to provide for contingencies, and to carry forward £2,009. 10s. 8d. The number of units sold during the year amounted to 10,531,785, as compared with 4,102,099 during 1903. The capital expenditure for the year was £49,377. 15s. 8d., necessitated by the expansion of the Company's business.

## CAMBRIDGE ELECTRIC SUPPLY.

The report for the year ending Dec. 31 states that during the year 1904 there has been added to the Company's mains the equivalent of 3,074 8-c.p. lamps, making a total to date of 47,112. The number of units supplied has been 523,298, an increase of over 51,000 units. After paying all charges, and placing £1,000 to depreciation fund account, the accounts of the Company show a balance of £6,691. 17s. 9d., which, added to £1,342. 9s. 6d. brought forward from last year, makes £8,034. 7s. 3d. An interim dividend of 2½ per cent. (£1,903. 4s. 3d.) has already been paid, and after deducting debenture and other interest (£455. 2s. 2d.) there remains a net balance of £5,676. 0s. 10d. Out of this the directors recommend the payment of a dividend of 4½ per cent.—making 7 per cent for the year. This will absorb £3,959. 5s., leaving a balance to carry forward (subject to fractional adjustment of income tax) of £1,716. 15s. 10d.

## SOUTH METROPOLITAN ELECTRIC LIGHT AND POWER.

The report of directors for the year ended Dec. 31, 1904, states that the revenue account shows a credit balance of £16,574. 16s. 3d., which, with £5,219. 19s. 1d., the balance brought forward from the previous year, makes a total of £21,794. 15s. 4d. After deducting £6,323. 18s. 6d. for interest on debenture stock paid and accrued, and for other interest, and £1,750 for interim dividend paid on 7 per cent. cumulative preference shares, there remains a balance of £13,720. 16s. 10d., which the directors propose to deal with as follows: To payment of final dividend to Dec. 31, 1904, upon the amounts paid up on the 7 per cent. cumulative preference shares, £2,439. 6s. 8d.; to credit of depreciation account, £2,250; to write off change over system in Greenwich account, £824. 19s. 11d.; in reduction of preliminary expenses account, £1,500; and to carry forward to the next account, £6,706. 10s. 3d. The business of the Company continues to show a large advance over preceding years. The Company took over the undertaking of the Crystal Palace District Electric Supply Company on June 16 last. The number of lamps added by the inclusion of this area was 29,572, and the accounts submitted include the returns of this business from that date. The change of system from direct to alternating current in the new area is being carried out as rapidly as possible, and should be completed before the end of the present year, when the Company will benefit by more economical working. The Urban District Council of Beckenham have served notice on the Company, exercising their statutory right to purchase a small portion of the new area, and the purchase price is now being adjusted.

## TELEGRAPH CONSTRUCTION AND MAINTENANCE.

The report for the year ended Dec. 31, to be submitted at the forty-first ordinary meeting on the 28th inst., states that there is a net profit of £48,825. 15s. 11d. after charging the interest on the debentures. To this sum must be added £120,483. 17s. 3d. brought forward from last year, making a total of £169,309. 13s. 2d. From this amount is deducted the interim dividend of 5 per cent., paid July 12, 1904, amounting to £22,410, leaving £146,899 13s. 2d. to be dealt with. Of this sum the directors propose to distribute a dividend of £1. 4s. per share, absorbing £44,820, being at the rate of 10 per cent., and making, with the amount already paid, a total dividend for the year of £1. 16s. per share, or 15 per cent., free of income tax, leaving £102 079. 13s. 2d. to be carried forward to the next account. Various lengths of cable have been manufactured, and sundry cable-repairing operations have been carried out, but the work generally has not been on so extensive a scale as during the past few years. The Company's factories at Greenwich and Wharf-road have been well and properly maintained. Advantage has been taken of the slackness of work to rebuild a portion of the factory at Greenwich, and to introduce improvements there which will add to the efficiency of the works. The Company's steamships are in good and thorough repair. The directors have every reason to believe that the "Camoria," launched on Nov. 22, will prove a valuable addition to the Company's cable fleet.

## IMPERIAL TRAMWAYS.

The report for the year ended Dec. 31, to be submitted at the ordinary general meeting to-morrow, states that the gross receipts from the Middlesbrough, Stockton, and Thornaby electric tramways amounted to £51,097. 4s. 4d., and the number of passengers carried was 9,818,349, compared with totals of £49,963. 7s. 7d. and 9,576,125

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in the preceding year. The net profit for the year is £16,564. 14s. 9d. The directors are pleased to be able to report that the Bill promoted by the Company last session received the Royal assent on Aug. 15 last. Under it the Company is empowered to construct a line of tramways, 4 miles 4·70 chains in length, commencing at the termination of the Company's existing system in Middlesbrough and running through the populous manufacturing districts of North Ormesby, South Bank, Grangetown, and Eston. The Company's interest in the London United Tramways (1901), Limited, has been slightly increased during the past year, and is now represented by 44,446 fully-paid 5 per cent. cumulative preference £10 shares. There is a corresponding increase in the dividends on these shares, which amount for the year to £21,135. 0s. 1d. net as shown in the revenue account. It will be seen that the Company's net revenue account for the year shows an available balance of £41,655. 15s. 3d., and after payment of interest on the debenture stock for the whole year, and interim dividends on the preference and ordinary shares in respect of the half-year to June 30 last, amounting together to £26,168. 4s. 7d., it is proposed to appropriate the balance as follows: dividend at 6 per cent. per annum on the preference capital (paid on Jan. 2 last), £5,700; final dividend at 10 per cent. per annum (making 9 per cent. for the year) on the ordinary capital (less income tax), £9,500; and to carry forward to the next account £287. 10s. 8d. The reserve funds now amount to £121,871. 14s. 7d.

## NATIONAL TELEPHONE.

The report for the half-year ended Dec. 31 last states that the income accrued in respect of the business of the half-year amounts to £1,033 705, as compared with £941 259 for the corresponding period of 1903, being an increase of £92,446. The working expenses for the half-year amount to £591 635, as compared with £527,284 for the corresponding period of 1903 being an increase of £64 351. The net result for the half-year (after deducting the Post Office royalties, amounting to £295 193) is a profit balance of £346,874, as compared with £327,739 for the corresponding period of 1903, being an increase of £19,135. The rentals carried forward for unexpired terms of running contracts amount to £889 577, as compared with £827,163 at the corresponding period of 1903, being an increase of £62,413. Out of the available balance of £274,057 shown by the net revenue account, the Board will recommend the payment for the half-year of a dividend at the rate of 6 per cent. per annum on the first and second preference shares, 5 per cent. per annum on the third preference shares, 6 per cent. per annum on the preferred stock, and 5 per cent. per annum on the deferred stock, less income tax in all cases. The Board also propose to transfer £115,000 to the reserve fund and to carry forward the balance of £10,141. The sum of £402,101 has been expended on capital account during the half-year in the erection of 18,625 additional exchange and private stations and in the construction of underground works. Allusion is made to the agreement just arrived at with the Postmaster-General.

## LONDON UNITED TRAMWAYS.

The report for the year ended Dec. 31 last states that the operation of the Company's undertaking during that period resulted in gross receipts amounting to £296.235, and the working and general expenses and renewals to £176,188, leaving, with the balance brought forward from last account, a net revenue of £120,834. After payment of debenture interest and dividend on the 5 per cent. preference shares for the year, there remains £42,087 (including £3,750 net premiums on new preference shares). It is proposed to pay a dividend of 6 per cent. on the ordinary shares, an interim payment in respect of which was made last August; to place £5,000 to the credit of a reserve fund, and to carry the balance of £563 forward. The gross receipts show an increase of £15 993, whilst the operating expenses have decreased by £203, notwithstanding the larger mileage open as compared with the previous year. The total number of passenger carried was 48,126,727, an increase of 2 833,254. The extension from Southall to Uxbridge, *via* Hayes and Hillingdon, and also the connecting line from Hammersmith Broadway *via* Askew-road, were opened for public traffic in June last, and the results have fully realised anticipations. The Bill promoted by the Company in the last session of Parliament to authorise an extension from Hounslow to Staines received the Royal assent on Aug. 15. Preparations are in progress for the construction of the authorised tramways in Kingston, Surbiton, the Maldens, and Wimbledon, and between Brentford and Hanwell. These Surrey lines will link up important centres of population, and will connect with the London County Council electric tramways system at Tooting, and over Kingston Bridge with the Company's tramways in Middlesex and London.

## NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY.

The report for the year ending Dec. 31 states that the total units sold during the year amounted to 17,132,153, which, compared with the previous year's figures of 9,033,625 units, shows an increase of 8,098 528. Of the units sold in the past year, 14 000,000 have been sold for power purposes, the remainder being for lighting only. The profits for the year, including the balance of £1,099. 0s. 8d. brought forward from 1903, amount to £52 539. 8s. 7d., out of which there have been paid: interest on debentures and loans, £14,256. 19s. 10d.; interim dividends, paid in July last, of 2½ per cent. on the amount called up on the whole of the preference and ordinary shares, £14 278. 7s. 6d.; and the balance of extra cost in connection with the electrical undertaking purchased from the Walker and Wallsend Union Gas Company, £1,500—leaving an available balance of £32,504. 1s. 3d., which the directors recommend should be appropriated as follows; in the payment of a further dividend of 2½ per cent. on the amount called up on the whole of the preference shares, and of 5½ per cent. on the amount called up on the ordinary shares, making total dividends of 5 per cent. and 8 per cent. respectively for the year, which will absorb £24,405. 0s. 10d.; in the payment of a dividend of 3½ per cent. on the ordinary shares allotted in connection with the purchase of the Walker and Wallsend Union Gas Company's electricity undertaking, making 6 per cent. on these shares, £1,226. 11s. 6d.; in writing off to depreciation account the sum of £6,000; and leaving to be carried forward to next year, £872. 8s. 11d. During the latter half of the year the North-Eastern Railway Company has been regularly supplied with electrical energy for traction, as well as for power and lighting purposes. The total expenditure on capital account during the year has been £124,242, representing outlay in completing the new power station at Carville, as well as other developments in the Company's area. The Carville station, the construction of which began in 1903, was put into commercial operation during the latter half of the year. An agreement has been entered into with the Northern Counties Electricity Supply Company, Limited, by which the working and developing of the districts of Whitley, Monkseaton, Earsdon, and Seghill, covered by provisional orders granted to that company, have now been transferred to this Company. The supply of electricity in Whitley and Monkseaton has been available for some time, and it is expected that this area will be a profitable acquisition to the Company's business. The payment of £13,684. 19s. 7d. made to the Northern Counties Company is for the provisional orders, plant, cables, etc., in the above-mentioned districts. The shareholders will be asked to confirm a provisional agreement which has been entered into for the purchase of the whole of the shares issued by the County of Durham Electrical Power Distribution Company, Limited. This scheme, if sanctioned, will largely increase the Company's output, and, being a matter of special importance, forms the subject of a separate report, which will be in the hands of the shareholders before the meeting.

An extraordinary meeting will follow the general meeting on March 2 for the purpose of effecting alterations to the articles of association.

## HART ACCUMULATOR.

The report for the year ended Dec. 31 states that the profit amounts to £5,813. 0s. 4d., and the balance brought forward from last year £5,737. 10s. 8d. After deducting the dividend on preference shares, £137. 17s. 8d., the balance standing to the credit of profit and loss account is £11 412. 13s. 4d. The directors recommend the payment of a dividend of 12½ per cent. per annum on the ordinary share capital, which will absorb £5,000, leaving £6,412. 13s. 4d. to be carried forward. The Company's buildings, plants, tools, etc., have been augmented by £4,261. 17s. 1d., which has been charged to capital, and due depreciation on same has been made. The maintenance of the works, plant, etc., has been well kept up at a cost of £799. 13s. 11d., which has been paid for out of revenue. The retiring directors are Messrs. L. W. Spratt and S. W. Hart, who, being eligible, offer themselves for re-election.

## NEW COMPANIES REGISTERED.

**Electric Flash Lights, Limited.**—Capital, £25,000. Objects: to acquire from B. Sherman, of 16 and 17, Devonshire-square, London, the benefit of certain existing inventions relating to electric flash-light advertising; to adopt an agreement with the said vendor, and to carry on the business of advertising agents and contractors, electrical engineers, manufacturers of and dealers in all kinds of electrical machinery, fittings and appliances, etc.

**Zea Arc Lamp Company, Limited.**—Capital, £1,000. Object: to carry on the business of lamp manufacturers, suppliers of electric light, electricians, engineers, etc., and, in particular, to take over from E. G. Abrahams, of 2, Staple-inn, London, the benefit of certain inventions relating to arc lamps. Registered office: 2, Staple-inn, Holborn.

### Lien Registered.

**Anglo-Argentine Tramways Company, Limited, London, E C.** Lien registered Jan. 23, for securing an annual sum of £71,060 during a period of 80 years, from Jan. 1, 1905, reducible in certain events to £70,860 and £70,060, and interest on instalments in arrear (if any); holder: City of Buenos Ayres Tramways Company (1904), Limited; secured by a floating charge on the net receipts of the entire undertaking, after payment of 6 per cent. interest on an issue of debenture stock not exceeding £266,600, and current working expenses.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Salamanca.**—The Municipality requires tenders for public electric lighting. Tenders by March 14.

**Bucharest.**—The Telegraph Department require 3,000 kilos of sulphate of copper. Tenders by March 7.

**Salford.**—Tenders are required by the Corporation for the alteration of storage batteries. Tenders by March 4.

**Oporto.**—The Municipal Authorities require tenders for lease of their electric tramways. Tenders by March 15.

**Leeds.**—The Corporation require tenders for the complete equipment of two sub-stations. Tenders by March 14.

**Croydon.**—Tenders for the annual supply of coal at the electricity works for the year ending March 31, 1906, will close on Feb. 28 at 11 a.m.

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**Barcelona.**—The Municipality require tenders for arc lighting of La barriada de San Gervasio de Cassolas. Tenders by March 15.

**Bucharest.**—The Post and Telegraph Department require tenders for 13,000 kilos 3mm. bronze wire and 120 kilos soft 1·5mm. copper wire.

**Bucharest.**—The Post and Telegraph Department require tenders for 14,000 large, 8,000 medium, and 3,000 small insulators. Tenders by March 16.

**Fulham.**—The Borough Council invite tenders for the supply of electrical stores for year ending March 31, 1906. Tenders by 4 p.m. on March 15.

**Plymouth.**—The Corporation invite tenders for the supply of electricity meters, transformers, and cables (paper insulated). Tenders by March 18. See advertisement.

**Bucharest.**—The Roumanian Government Railways require tenders for telegraph poles as follows: 2,000 7m. long, 2,000 8m. ditto, and 500 9m. ditto. Tenders by March 10.

**King's Lynn.**—The Corporation invite tenders for one 200-kw. steam dynamo, condenser, steam and other pipes. Tenders by 28th inst. See advertisement in previous issue.

**Hull.**—The Electric Lighting Committee invite tenders for the supply, etc., of mains and cables for 12 months. Tenders by 12 noon on March 1. See advertisement in previous issue.

**Ilford.**—The Council require tenders for the annual contracts for the year ending March 31, 1906, for the electricity department. Tenders by Feb. 27. See advertisement in last issue.

**Stoke Newington.**—The Council invite tenders for the supply, delivery, and erection of sub-station plant and mains. Tenders by 4 p.m. on March 8. See advertisement in previous issue.

**Liria.**—The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

**Battersea.**—The Council require tenders for the supply for one year from March 31 next of electricity meters, joint-boxes, carbons, coal, and oil stoves. Tenders by Feb. 27.

**Shoreditch.**—The Council invite tenders for their yearly contracts in the electricity works and other departments. Tenders by March 14. Full particulars in our advertisement columns.

**Laventhem (Belgium).**—The Municipality require tenders for erection of central station, laying of mains, etc. Particulars (3s. 4d.) may be obtained from the Secretary of the Mayor of that place.

**Madrid.**—The Post and Telegraph Department, Calle de Carretas 10, require tenders for telephone and telegraph apparatus, estimated at 35,337·50 pesetas. Tenders by March 10. This includes 50 Morse receivers.

**Lowestoft.**—The Corporation invite tenders for one water-tube boiler with superheater, brickwork settings, and accessories, together with the necessary pipework. Tenders by March 9. See advertisement in previous issue.

**Newport (Mon.).**—Tenders are invited for the installation of electric light, electric bells, and heating and hot-water apparatus in the new police station, Alexandra-road. Tenders to the Borough Engineer by 10 a.m. on March 2.

**Manchester.**—The Tramways Committee of the Corporation invite tenders for the supply of cement, chippings and broken stone, veterinary services, and general stores. Tenders by March 6. For full particulars see advertisement.

**Dax (France).**—Tenders are required for a concession to erect and work electric lighting of the town for 35 years. Particulars may be obtained from the Secretary to the Municipality of Dax, Province of Landes, France. Tenders by March 6.

**Great Western Railway.**—The directors invite tenders for the supply, delivery, and erection of plant in connection with their electricity generating station at Park Royal and proposed sub-stations and distributing centres at various places. Tenders by March 13.

**Wimbledon.**—The Urban District Council invite tenders for the supply of (3) engine-room stores, (4) cables, (5) joint-boxes and jointing materials, (6) transformers, (7) meters, (8) oils, (9) incandescent electric lamps, carbons, and accessories, (10) iron castings. Tenders by March 4.

**Madrid.**—Der Compania Electrica Madrilena de Traccion propose to extend their electric tramways from the Barquillo-street to Olivide-place. The concession for the works will be dealt with by the Public Works Department, Madrid, April 2. Tenderers for same must deposit a guarantee of £96.

**Switzerland.**—M. R. Vontobel, of Winterthour, and M. Charles Probst, of Lucerne, have obtained a concession for the construction of a narrow-gauge electric railway from Meiringen to Gletsch. The total cost of the enterprise is estimated at £241,600; £19,600 is to be expended on rolling-stock.

**Newport (Mon.).**—The Electricity and Tramways Committee invite tenders for 300-kw. continuous-current high-speed tramway generator (engines of enclosed type), 200-kw. continuous-current high-speed steam balancer (engines of enclosed type), boiler, switchboard, stores, etc. Tenders by March 6. See advertisement.

**Edinburgh.**—The Corporation invite tenders for the annual supply of arc lamp carbons, cast-iron pavement and road boxes, electricity meters, house service fuse-boxes, earthenware trunking for laying electricity cables on the solid system, bitumen, and arc lamp globes. Tenders by March 13. See advertisement.

**Glasgow.**—The Corporation invite tenders for supplying and erecting electric light installation, etc., required in the new central police office. Specifications and forms of tender may be had on application at the Office of Public Works, City Chambers, 64, Cochrane-street. Tenders to the Town Clerk (Police Department) by 27th inst.

**Gloucester.**—The Electricity Supply Committee invite tenders for three Lancashire boilers and accessories, one 600-kw. generating set and accessories, electrically-driven surface-condensing plant to deal with 30,000lb. of steam per hour, steam, exhaust, feed, drain, condensing water, and sundry pipes, valves, etc., and an electrically-driven boiler feed pump, the whole bound up in one specification. Tenders by March 16. See advertisement.

**Shanghai.**—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Pook and Co., 63, Leadenhall-street, E.C. Tenders by March 31, 1905.

**South Shields.**—The Electricity Supply Department invite tenders for the supply, delivery, and erection of the following plant: (Contract No. 67) one multitubular marine-type boiler, with chimney and mountings; (68) two medium-speed open-type vertical engines for two 550-kw. direct-current traction generators; (69) two 550-kw. direct-current traction generators; (70) traction switchboard; tramways department—(Contract No. 4) electric tramcars, complete with "Brill" trucks, for the Corporation. Copies of specifications, conditions, form of tender, also form of contract, can now be obtained from Mr. J. H. Cawthra, M.I.E.E., borough electrical engineer, South Shields, on payment of £2. 2s. for each contract, which sum will be returned on receipt of a bona fide tender for each contract. Tenders to Mr. J. Moore Hayton, town clerk, Court-buildings, South Shields, by noon on March 13.

**Johannesburg.**—The Municipal Council are prepared to receive tenders for 100 electric tramcars, two electric water-cars, one five-ton travelling crane, one electric car traverser, and various workshop tools, including erection at Johannesburg, to Specification No. 10 of their consulting engineers, Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W. Copies of the specification may be seen on and after Jan. 7 at the Council Offices, Johannesburg, and at the Consulting Engineers' Offices in London, and may be obtained on payment of five guineas, which will be returned on receipt of a bona fide tender. Duplicate copies of the specification may be bought for 10s. each (not returnable). Tenders must be addressed to Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W., and must be received by them not later than March 6. The Council will not be responsible for any expenses incurred in tendering.

## RESULTS OF TENDERS.

**Hammersmith.**—The Borough Council have accepted the tender of the Western Electric Company, London, at £1,057. 3s., for cables.

**Islington.**—The Borough Council have accepted the tender of Messrs. Graham-Morton and Co. for the supply of an ash elevator, at £112.

**Sheerness.**—Messrs. Johnson and Phillips have secured the contract from the Admiralty for two direct-current dynamos for the Sheerness Dockyard.

**Carlisle.**—The Town Council have accepted the terms of the Tudor Accumulator Company for the supply of a battery of 256 cells, type No. L.D. 13, at £725.

**Yarmouth.**—The following tenders have been recommended for acceptance: Brush Electrical Engineering Company, tramcars £5,646, electrical overhead equipment £2,357; F. Dennis and Co., railbonds, £480. 9s.

**Rochdale.**—The Corporation have accepted the tender of the British Thomson-Houston Company, Rugby, for high-tension three-phase switchgear and extensions to the low-tension continuous-current switchboards.

**India.**—The contract for supplying 10 passenger locomotives and tenders for service on the Indian State Railways has been placed with Messrs. Robt. Stephenson and Co., Limited, of the Springfield Locomotive Works, Darlington.

**Bournemouth.**—The contract for the extension of the Bournemouth and Christchurch tramways has been let to J. G. White and Co., Limited, London. There are six miles of track and three of route, and the amount of the contract is £39,000.

**Bradford.**—The Corporation have accepted the tender of Messrs. Bolckow, Vaughan, and Co., Limited, Middlesbrough, for supply and delivery at Bradford of 400 tons of steel girder tramrails and 20 tons fishplates, for electrical equipment of tramways.

**Neath.**—The Corporation have accepted the tender of Messrs. Evershed and Vignoles for an Evershed's "Megger" testing set, arranged for 250 volts and reading up to 20 megohms, at £17. 5s.; and that of the British Westinghouse Electric etc., Company, Manchester, for wattmeters of 5, 10, 20, 40, 80, 120, 200, 400, and 800 amperes, at £3. 5s., £3. 15s., £4. 10s., £5. 5s., £6. 6s., £7. 5s., £8. 8s., £10. 10s., and £15. 15s. respectively.

**Battersea.**—The Lighting Committee have accepted the tenders of Messrs. J. Oswald and Son to purchase and remove the damaged gas lamp columns, old iron, etc., at the central electric generating station, at 39s. per ton; Messrs. Babcock and Wilcox, Limited, to supply and fix three water tube boilers at the central electric generating station similar to those already erected there and fitted with chain grate stokers, at £3,600; and the National Boiler and the General Insurance Company, Limited, to inspect and test during construction, the three boilers referred to, for the sum of £8. 8s. each boiler.

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**Aberdeen.**—The Corporation have decided to take proceedings against the Suburban Tramways Company to recover £700 spent in the alteration of street levels, unless the matter is settled amicably.

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# BUSINESS NOTES.

## TRACTION.

**Perth.**—The work of reconstruction is now proceeding apace.

**Cardiff.**—The Corporation have decided against advertisements on the cars.

**Wellingborough.**—The Northants County Council have decided to lodge a petition against this Tramway Bill, the company not having agreed to the amendments suggested by the Council.

**Belfast.**—The arbitration proceedings have been concluded. The differences between the contractors and the workmen have been settled, and the work of reconstruction has been resumed.

**Derby.**—In addition to the Kedleston-road route, the Tramways Committee have decided to recommend the Council to proceed with an extension connecting the Pear Tree and Upper Dale-road routes.

**Leeds.**—The Tramways Committee on Tuesday decided to adopt a uniform 1d. stage of two miles, to make an experiment with ½d. fares on two more routes, and to grant further concessions to workmen and children.

**Pontypridd.**—Colonel Druitt inspected the Treforest line last week on behalf of the Board of Trade. The trial trip is reported to have been very satisfactory, and it is expected that the line will be opened on March 6.

**Portsmouth.**—The extension of the electric tramway on the Gosport side of Portsmouth Harbour is nearing completion. The intention is to ultimately connect this railway with Fareham, and afterwards with the light railway at Cosham.

**Stirling.**—The whole question of acquiring the Stirling and Bridge of Allan Tramway Company's system was discussed at the meeting of the Town Council, who ultimately decided not to purchase at present, but to give every encouragement to private enterprise in providing an improved service to Bannockburn.

**Hastings.**—The Corporation of Bexhill, the Bexhill Gas and Water Company, and owners, lessees, and occupiers of property and ratepayers in Hastings have given notice to the authorities at the Private Bill Office of the House of Lords that they intend to oppose the company's Bill through its committee stage in the Upper House.

**Lowestoft.**—A letter has been received by the Tramways Committee from Messrs. Hawtayne and Zeden as to the construction of the East Anglian light railways from Lowestoft to Kessingland (the right of which the Corporation has purchased), and the town clerk has been directed to write to that firm and ask the cost of advertising the concession.

**Dundee.**—It is reported that the experiments with top-covers have not turned out a success. The tramway men are agitating for shorter hours. A sum of £1,000 is stated to have been lodged with the Corporation by the promoter of the Broughty Ferry tramway as security for the construction of the line, which is expected to be commenced in three months.

**Manchester.**—It is reported that the motor omnibuses to be used on Manchester suburban routes will be purchased in a few days. Members of the Tramways Committee visited the Olympia show, and it is understood that they saw a suitable type. It is anticipated that these omnibuses will be useful for running in suburban districts, with the object of feeding the tramway system.

**Edinburgh.**—Representatives of the National Electric Construction Company have had an interview with the Linlithgowshire County Council and the Queensferry Town Council in reference to the projected electric tramway from Edinburgh. The company intimated their willingness to also undertake an electric light installation for Queensferry if the authorities consented to the tramway.

**London United Tramways Co.**—Another storm in a teapot occurred at the quarterly meeting of the Ealing Town Council, which has already distinguished itself by a somewhat frivolous attitude towards "those noisy trams." A letter of complaint was received from an inhabitant who offered to contribute towards the cost of proceedings, which were decided upon against the rational advice tendered by Councillor Johnson.

**Erdington.**—It is stated that the Urban District Council, under the power they have acquired, propose to lay a tramway from the bottom of Gravelly-hill to a point just beyond Chester-road, on the main line to Sutton Coldfield. The work will be commenced shortly, and when completed the lines will be leased to the City of Birmingham Tramways Company. The system will be linked up at the bottom of Gravelly-hill to the Aston tramways.

**Yarmouth.**—The arbitration to decide the amount of consideration to be paid by the Yarmouth Corporation to the Yarmouth and Gorleston Tramway Company for the compulsory acquisition of their undertaking was resumed and concluded on Saturday before Mr. Graham Harris. Counsel stated at the opening of the Court that the amount of the valuation of the buildings and land had been agreed at £2,500. Evidence on other matters was then tendered, and the arbitrator will deliver his award "in due course."

**Bath.**—The Light Railway Commissioners held an enquiry last week into an application of the company for sanction to extensions to Newton St. Lo and along Westgate-street. After hearing evidence, the Commissioners decided to disallow the second route, but they will recommend the Board of Trade to grant an order authorising the Newton St. Lo extension, subject to the settlement of clauses for the protection of the County Council. The Commissioners intimated that if the Bath Corporation, who have so far observed a neutral attitude, decide in the future to favour the Westgate-street route, the Commissioners might reconsider their decision. In regard to this route a question of the width of the street was involved.

**London County Council.**—At the meeting of the Stoke Newington Borough Council on Tuesday, the Highways Committee reported the receipt of a lettter from the Shoreditch Borough Council, enclosing a copy of the following resolutions passed by that Council—viz., "(*a*) That the London County Council, the borough councils north of the Thames, and the North Metropolitan Tramway Company be requested to consider the possibility of adopting a system of automobile tramcars driven by petrol or other engines, with a view to avoiding the heavy expense and immense public inconvenience and loss which will be caused by the construction of a conduit or overhead electrical system; (*b*) that the London County Council be requested to arrange with the North Metropolitan Tramway Company for the trial of an experimental petrol or other motor tramcar concurrently with the horse trams"—and asking this Council to similarly approach the London County Council on the matter. The committee recommended the Council to accede to the request. The Hampstead Borough Council have also approved of this suggestion.

**North London Railway.**—Presiding at the half-yearly meeting of this company last week, Lord Rathmore said that there were several features in connection with the working of their line which made comparison in the matter of electrification with other lines impossible. In the first instance, the North London was free from the atmospheric conditions which had conduced to the electrification of other railways; then their railway had a considerable amount of mineral and goods traffic, whilst the other lines with which comparison had been made had to deal with passenger traffic only. Many of the trains on the North London ran over lines of other railways, and until those companies adopted some uniform system of electrification it would be useless for the North London to electrify its line. Science had not spoken its last word on the subject of the most economical manner of applying electricity to traction purposes, and from time to time great advances were being made. The electrification of their line would entail an enormous expenditure of money, irrespective of the abandonment of the present rolling-stock, the loss from which had been estimated at half a million sterling.

**Glasgow.**—On Tuesday Lord Balfour of Burleigh heard arguments in regard to the exercise by the Corporation of running powers over a mile of track belonging to the Paisley Company. A short time ago his Lordship issued an award, but the parties were not agreed upon the interpretation of it, in so far as concerned the question of the cost of the electrical energy for the running of the cars. Tuesday's proceedings, which were held in private, were for the purpose of ascertaining his Lordship's determination as to whether the Corporation, in addition to their other working expenses, were to be allowed a sum to cover the cost of the electrical energy. Lord Balfour intimated that while he could not make any addition to the award in fixing the working expenses, which he previously allowed to the Corporation, he had intended that to those expenses should be added a sum to cover electrical energy. The committee in charge of the tramways provisional order have issued a circular letter letter to the 23 objecting petitioners intimating the abandonment of Clause 82 of the order, which asked that the tramways should be assessed on only one-fourth of their value. This step has been taken in view of the proposal of the Government, intimated in the King's Speech, to amend the law of procedure in making valuations.

**Sunderland.**—The estimated income of the tramways for the year ending March 31, 1905, is £65,003, and the gross expenditure £40,481. 12s. 5d., leaving a gross profit of £24 521. 0s. 7d. It is proposed to dispose of this as follows: reserve fund for accidents, etc., £500; alterations to overhead equipment, £58. 11s. 2d.; new machine tools, £62; interest, £9,357; depreciation and renewals fund (including sinking fund), £14,542 9s 5d. Compared with last year there is an increased revenue of £1,934. The cost of energy is put at £13,300, being an increase of £1,000, due to the East-end route. There is an increase of £700 for interest, and wages also represent an enlarged disbursement. The increase of £1,000 in the depreciation and renewal funds is due to a great extent to the East-end route. Out of the renewal fund the committee are paying for the new offices at the rate of £1.000 a year. The net loss on the East-end route was £950. At Tuesday's meeting of the committee this statement was unanimously adopted. It was pointed out that the working expenses for the year would be about 6·399d. The estimate for the year ending March, 1906. which was also submitted, showed an estimated net profit of £2,090, the receipts being put at £65,500, and expenditure £63 410. The amount put down for power is £12,031, the working expenses being estimated at £38,910 altogether, which is £1,571 less than this year, and £2,592 more than last, while for the compensation reserve fund £400 is set aside; for interest, £9,500; and for depreciation and renewals fund (including sinking fund), £14,600. This estimate was also agreed to.

**Birmingham.**—At a meeting of the Tramways Committee on Wednesday, the scheme for the city, which has been approved by the Council, was further considered in the light of suggestions and petitions presented for slight modification of it. In deference to a petition received from the Homœopathic Hospital it was decided to withdraw the Easy-row line, and the committee also consented to reduce the line in Monument-road between Icknield Port-road and Great Tindal-street from a double to a single track. Mr. Baker, the manager, is to make representations to the Board of Trade on the new regulations prohibiting top-covers on lines with a 3ft. 6in. or less gauge. The Small Heath route, leased to the City of Birmingham Tramways Company, was inspected by Colonel Druitt last week on behalf of the Board of Trade, the work of electrification having been completed. The inspector expressed himself as perfectly satisfied with the arrangements, and not only gave verbal consent for the electric service to run, but allowed a speed of 12 miles an hour between the corner of Moat-row and Small Heath and Yardley. The company approached the Tramway Committee some time ago, and it was ultimately agreed that the Corporation should relay the tramways and bond the rails, the

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company paying interest on the cost at the rate of 15 per cent. per annum until the expiration of their lease. The company on their part undertook to provide the electrical equipment and the cars. Various clauses were inserted in the agreement with regard to the purchase of the overhead apparatus and feeders at the conclusion of the lease, and also with regard to inter-running from the city to Yardley, and *vice versa*. It was one of the conditions of the agreement that the work of reconstructing the permanent way should be proceeded with as quickly as possible. The agreement was approved by the City Council at a special meeting on May 31 last year, and the reconstruction of the permanent way was commenced in June by Messrs. Dick, Kerr, and Co., contractors, who undertook to complete the contract in 13 weeks. Notwithstanding the fact that considerable difficulties had to be faced, such as the lowering of the road under Bordesley Bridge, the levelling of the road, and the repaving of it in part with granite setts, in part with wood blocks, the work was actually completed in 12 weeks, but owing to various difficulties there was some delay with the overhead equipment and cars. The major part of the overhead system has been installed on the span-wire system. It is expected that the line will be ready for service in a day or two, when there will be through cars from Station-street to Yardley.

**Australia.**—The *New South Wales Railway Budget* for Jan. 2 contains sundry announcements in connection with the railways and tramways of the Commonwealth. It is stated that arrangements are being made by the Victoria Railway Department to start the construction of the Brighton and St. Kilda electric tramway without delay. The Chief Commissioner has undertaken to start work on the project at once. The legal documents embodying the guarantee of the two local councils interested are being drawn up, but the guarantee is regarded as a mere matter of form, as the enhanced value which will be given to the Crown lands *en route* is expected to more than recoup the capital cost of the tramway. The Finance Committee of the Brighton Town Council recommended that the Council give the necessary guarantee of 4½ per cent., in conjunction with the St. Kilda guarantee, on the cost of the construction of the proposed electric tramway from St. Kilda to Brighton. The Mayor, in proposing that the guarantee be given, explained that the Council was not likely to be called upon to pay anything. If the sale of land at Elwood realised £60,000, as expected, £27,000 of that amount would go to the Board of Land and Works, and £33,000 to the construction of the line. This would cover the guarantee, and extend the line to Brighton Beach. The motion was carried. The traffic returns of the Melbourne Tramway and Omnibus Company for the month of November have been issued. They show that the number of passengers carried was 4,412,385, being 135,564 more than in November, 1903. The receipts were £39,761, being £837 more than in November, 1903. The mileage run was 779,221, being 6,529 less than in November, 1903. From Jan. 1 to Nov. 30 there were 45,963,734 passengers carried, the earnings were £414,328, and the train mileage run 8,482,846. For the five months ended Nov. 30, 1903, the revenue totalled £1,253,039; for the five months ended Nov. 30. 1904, the total was £1,410,167. The expired portion of the current financial year thus shows an increase of no less than £157,128 over the corresponding term of the previous financial year. Figures taken out last year covered the period from July 1 to Dec. 2, for which the revenue amounted to £1,258,881, a decrease of £54,668 over the corresponding portion of 1902. Notwithstanding this deficiency, the last financial year, owing to the heavy harvest, ended the best on record with a total revenue of £3,438,140. As the harvest traffic of the present financial year will start with a handsome credit balance, the year promises to prove as prosperous as 1903-1904, even when considerable allowance is made for the prospective falling off in the grain yield. On the New South Wales loan estimates, which have been passed by Parliament, are the following items in connection with railways and tramways: For railways, £250,000; being £110,000 for rolling-stock, to meet additional traffic requirements; £80,000 for additions to railway lines, buildings, and for other purposes; £50,000 to further improvements of grades; and £10,000 towards the duplication of Penrith Viaduct—further sum. For tramways, £85,000; being £65,000 for additions to lines, workshops, and buildings, and for other purposes, to meet the requirements of traffic; and £30,000 for rolling-stock to meet traffic congestion in certain directions. The following amounts were also voted for the railway and tramway construction: Railways, £282,883; being £18,000 for Narrabri to Walgett, with branch to Collarendabri—further sum; £2,300 for Cobar Mines Railway (Land)—further sum; and £202,583 to recoup City Railway extension and Sydney Central Station votes, on account of the following services charge thereto—viz.: £22,583 for new cemetery, La Perouse—laying-out, re-erection of headstones, and other works; £15,000 for Prince of Wales's Hotel—erection; and £165,000 for surplus lands, Central Station approaches. A sum not exceeding £14,248 for tramway construction—tramways generally—to recoup City Railway extension and Sydney Central Station votes—tramways into Central Station. The South Australian Government, it is reported, intend to lose no time in seeking to put into operation the Tramways Act passed during last session. Preliminary arrangements are being made to secure the option over all existing tramway companies as provided by the new law, and at the earliest possible date the Government will invite tenders for taking over the lines and converting them to electric traction in terms of the Act. Ministers are sanguine that satisfactory tenders will be forthcoming, and in this view they are supported by the Adelaide representatives of more than one company interested in such undertakings. Enquiries have been made by several electric traction firms, and copies of the Act forwarded to the head offices in order to facilitate the preparation of tenders. The tramways companies of this State are in receipt of a letter from the Government which is the outcome of conferences that have taken place between the Premier and the solicitor for the companies. The Government invite the companies to confer and agree upon a price they are prepared to accept for their properties. If the amount should be what the Government consider reasonable, the expense and delay that would be caused by arbitration may be avoided. It is understood that the directors of the various companies will meet at an early date and agree to act together in the negotiations with the Government. As soon as the option of purchase has been secured at a price agreed upon, the Government intend to call for tenders.

## LIGHTING AND GENERAL.

**Bath.**—The City Council will apply for a loan of £10,000 for electric supply extensions.

**Dundee.**—No arrangement has yet been made with regard to the site for the new electric power station.

**Bishop's Stortford.**—The Urban District Council are still discussing the transfer of their electric lighting order.

**Grantham.**—An electrical exhibition, promoted by the Urban Electric Supply Company, is being held in the Wharf-road hall.

**Leith.**—The estimates for plant in connection with the extension of the electric lighting station have been remitted to the engineer for report.

**Southmolton.**—The District Council have sanctioned the overhead telegraph extension to Rackenford, subject to the approval of their surveyor.

**Edinburgh.**—The number of lamps applied for from Jan. 20 to Feb. 9 was as follows: lighting, 1,758; power, 1,425; and heating, 408—in all, 3,591 of 8 c.p.

**Bradford.**—An expert is to be appointed to report in connection with the proposed extensions estimated to cost from £35,000 to £40,000, and on the plant generally.

**Plymouth.**—The Corporation have reduced the charge for power from 3½d. to 2d., and have made other concessions to the users of current for power purposes.

**Galashiels.**—The Town Council have resolved that an agreement be entered into with a company to carry out the installation and supplying of electric light to the town.

**Southend.**—The gross profits on the Corporation electric light undertaking last year were £3,806. After meeting interest and instalment charges, £358 was devoted to the relief of the rates.

**Calcutta Electric Supply Co.**—The number of units delivered to consumers during the four weeks ending Jan. 27, 1905, was 199,288, compared with 124,324 in the corresponding four weeks of the preceding year.

**Western Telegraph Co.**—The directors have declared an interim dividend, payable on March 25, of 3s. per share, or at the rate of 6 per cent. per annum (free of income tax) for the quarter ended Dec. 31, 1904.

**Sir John Cass Technical Institute.**—The Science Students' Association paid a visit on Saturday to the works of the Metropolitan Electric Supply Company at Willesden. Messrs. Hayes and Bedbrooke conducted the party.

**Swinton.**—The Swinton and Pendlebury District Council intend to apply for sanction to a loan of £6,900 for purposes of electricity supply to the district, as to which an agreement was recently concluded with the Lancashire Electric Power Company.

**Parliament.**—Among the Bills read a second time on Tuesday were the Administrative County of London and District Electric Power Company Bill, Alexander Park and Palace Bill, and the East London and Lower Thames Electric Power Bill.

**W. T. Henley's Telegraph Works Co.**—The directors have decided to recommend a dividend for the year ending Dec. 31, 1904, on the ordinary shares of 15 per cent., less income tax, including the interim dividend of 5 per cent. paid Sept. 1 last.

**Stoke Newington.**—Arrangements have been made with the Islington Borough Council for the supply of electrical energy in bulk to enable the Stoke Newington Council to supply current to the premises at the corner of Blackstock and Seven Sisters roads.

**Wainwright Bros.**—We understand that this firm, which have branches at Pritchard-street, Saville-street, and Oxford-street, Manchester, have opened an electrical department in charge of S. B. Wainwright, who has had many years' experience in that direction.

**Sligo.**—We understand that the Corporation have granted the application of Messrs. P. A. M'Hugh, M.P., E. Foley, and J. P. Higgins to erect poles and lay mains in or on the streets and roads in connection with electric lighting and the distribution of electric power in the borough.

**Horsham.**—It has been decided to apply for sanction to borrow £4,500 for electric lighting purposes, to cover £3,100 (cost of new feeders and steam balancer), £400 for free wiring purposes, and £1,000 for the cost of various extensions already carried out, but not included in the previous schemes.

**Portsmouth.**—The Telephone Committee are unable to comply with most of the new applications that are coming in so steadily, and on Wednesday the consulting engineer's (Mr. Bennett) plans and estimates were approved for extensions in town and country, and will be sent to the Local Government Board for sanction.

**Paddington.**—An electrical exhibition which is being organised by the Metropolitan Electric Supply Company at the Queen's-road Baths, Bayswater, we are informed, has met with a most gratifying response from the electrical trade, and that practically the whole of the space has already been allotted. Attractiveness as well as instruction is the motto.

**Dalkeith.**—The Electric Supply Corporation, Limited, have asked the Council to substitute a definite schedule of hours for lighting and putting out the lamps, and to calculate the amount of electricity consumed from

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that schedule, instead of by meter. The Council declined to accede to the request, and arrangements are being made to fit meters for the street lamps.

**Bournemouth.**—The following members of the Council have been appointed a committee to consider and report upon all matters which were referred to the Telephone Committee, dissolved by the Council on Dec. 6 last: Aldermen Abbott, Burden, Lawson, Parsons; Councillors Banks, Elcock, Evans, Hawkes, W. E. Hutchins, Minty, Jolliffe Wilson, and Youngman.

**Wimborne.**—The Bournemouth and Poole Electricity Supply Company have informed the Council that they do not intend to place any overhead wires in connection with the proposed supply of electricity in Wimborne and district. The Council had previously decided to withhold their consent because they were under the impression that the company intended to do so.

**Barnstaple.**—The mayor's financial statement in regard to working the municipal electrical undertaking for the year ending Jan. 28. 1905, shows a total expenditure of £1,958. The income, including £128 shares in hand, was £3 540. This gives a surplus of £1,582, from which must be deducted £1,290 interest on mortgage debt and repayment of principal, leaving a net surplus of £291.

**East London and Lower Thames Electric Power Bill.**—This Bill has passed Mr. Campion, senior examiner of Standing Orders. It provides for the incorporation of a company with a capital of £2,200,000 to supply electrical energy throughout Hackney, Bethnal Green, Stepney, Poplar, Deptford, Woolwich, Greenwich, and Bermondsey, the county borough of West Ham, and a large part of the county of Essex.

**Lowestoft.**—There are now connected to the mains 578 consumers representing 29,903 8-c.p. lamps. During January five new consumers were connected representing 708 8-c.p. lamps. The agreement with the railway company with reference to the new cables under the harbour (which is almost similar to the existing agreement) has been approved by the Town Council, subject to the approval of the engineer.

**Hammersmith.**—The last report of the Electricity and Lighting Committee shows that the premises of 16 additional consumers, representing a maximum of 865 8-c.p. lamps, have been connected to the mains; that 12 consumers have been disconnected; and that the present number of consumers taking current from the mains is 1 541. Advertisements are to be issued inviting tenders for the erection of the boiler-house extension, so soon as the quantities are ready.

**Keighley.**—New plant is required at the electricity works at a cost of £4,480, as the present plant is not sufficient reserve in case of a breakdown. The output of the works during the current year will, it is estimated, amount to 350,000 units, and the proposed new plant would give an increased generating power of 200 kw., and would increase the revenue-earning capacity of the works by 45 per cent., while the capital charges would be increased by only about 22 per cent.

**Walsall.**—The Electricity Committee's annual statement of accounts shows a net profit, after payment of interest and sinking fund, of £1,060, as compared with £313 in the previous year. This sum is to be carried to the reserve fund. This is a very satisfactory result, seeing that the price of current had been reduced from 6d. to 4d. per unit to the public and from 2d. to 1½d. to the tramway undertaking. Electric mains are to be extended at a total estimated cost of £1,855.

**Stock Exchange.**—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Baker-street and Waterloo Railway Company's scrip certificates to bearer (fully and partly paid) for £500,000 4 per cent. perpetual debenture stock. The committee has also been asked to allow Metropolitan District Railway Company's further issue of £200 000 4 per cent. perpetual debenture stock, 1903, to be quoted in the official list.

**Devonport.**—The Electric Power Committee have decided to instal electricity in the free public library at a cost of £84, and also to allow a sub-committee to deal with the question of extending the main to Argaum Villas, Stoke, and with the application from the Admiralty for an estimate of the cost of lighting the eastern part of the Royal Albert Hospital. The Local Government Board have declined to allow repayment of the loan recently sanctioned for extending the electricity works to cover a longer period than 21 years.

**St. Marylebone.**—The Chairman of the Finance Committee was asked from what fund the interest on the electric light loan would be paid, or whether it was suggested that they should have a suspense account; also why there was no statement of the amount of money which would have to be provided by the Council when it took up the Bill. Councillor Leaf, in reply, said the question of the interest on the Bills would come up under the Finance Committee's estimate next fortnight. The auditor would decided the legality of the payment.

**Dartmouth.**—Elaborate arrangements are being made for the electrical exhibition to which we referred in a previous issue. We note that electricity is well supported considering the size of the town, which has only 6 579 inhabitants. In the first three months 2 400 8-c.p. lamps were connected with the mains, and since then they increased to Dec. 31 last to 10,305. The power used aggregates to 35 h.p., being used for drawing railway trucks to coal ships, and driving wood-working, forge-blowing, organ-blowing, pumping, and engineering machinery.

**Mansfield.**—Extra staff will be needed at the works when the tramways supply commences. The charges from March 31 will be as follows: For lighting—7d. per unit for any quantity of electrical energy used during each quarter not exceeding the equivalent of 100 hours of supply at the maximum demand, and 1d. per unit for any quantity used during each quarter in excess of the above. For power—4d. per unit for any quantity of electrical energy used during each quarter not exceeding the equivalent of 100 hours of supply at the maximum demand, 1d. per unit for any quantity used during each quarter in excess of the above.

**Ealing.**—The account for the nine months ending December shows a profit despite the reduction of 1d. per unit in price charged. The Hanwell District Council have asked whether the Ealing Town Council would be willing to supply Hanwell with current, and, if so, on what terms? Further consideration of the letter has been deferred. The Council have decided to join the Shoreditch and Hampstead combinations for the purpose of jointly opposing the Administrative County of London and the Metropolitan Electric Supply Company's (Various Powers) Bills respectively.

**Cleckheaton.**—From the last accounts of the electric lighting and refuse destructor works, it appears that £22 653 has been borrowed and £24.600 expended on the former account, but that on the latter account (for which £7.560 had been authorised) there remains an unexpended balance of £1,936. A sum of £1,600 has been transferred from the destructor to the electricity loan account. The electricity revenue account shows expenditure £4,331, income £3 531, loss £800. The chairman of the committee and the electrical engineer have been requested to present a report to the next meeting on a revision of charges for current.

**Walton-on-Thames.**—The Walton Ward Committee have elected Mr. Miskin as chairman. The ward committees, at the last Urban District Council meeting, recommended, after correspondence with the Edmundson's Electricity Corporation, that one arc lamp be erected in each ward, and that the remainder of the free power for the current year be taken in Nernst lamps. It was left to the Walton and Hersham Ward Committees to decide as to the position and power of their share of the lamps, according to rateable value. After discussion the substitution of Nernst for the proposed arc lamps was agreed to, and the report, thus amended, was approved.

**Aberdeen.**—Mr. J. B. Hegarty, postmaster, presided on Saturday evening at the annual presentation of prizes under the auspices of the Aberdeen branch of the Telegraph Messengers' Institute, at which there was a large attendance of the lads and their parents and friends. Bailie Eeslemont, in presenting the awards to the boys, said there were about 100 messengers employed in the telegraph department at Aberdeen. Last year the number of ordinary telegrams delivered amounted to 554,194; and, in addition to that, there were 125 758 Press messages, making a grand total of 679,772. A competition in drill took place in the course of the evening, and the judge, Lieutenant Robertson, V.C., awarded the prize to E team.—*The Scotsman.*

**Chester.**—The Chester electrical engineer has presented a report to his committee on the subject of public lighting in the city. The following epitome has appeared in the *Chester Chronicle*: "The increased cost of public lighting by electricity as compared with gas is due to the improved lighting of the thoroughfares. In practically every case where gas has given place to electric lighting, either arc lamps are erected in place of two or three gas lamps, or more incandescent electric lamps have been erected in place of the gas lamp abolished. Since March, 1903, 57 arc and 115 incandescent electric lamps have been erected at an annual cost of £800, as compared with 110 gas lamps disconnected, at an annual cost of £330, being an increased expenditure (in about two years) of £470. When it is realised that the aggregate candle-power of these electric lamps is about 38,340, and costs about 4·94d. per candle-power per annum as compared with the gas lamps giving about 2,920 c.p. at about 28·08d. per candle power per annum, it hardly appears possible that there can be two opinions as to whether the citizens get value for the cost of the additional lighting. The charges for public electric lamps are based on each lamp burning 3,644 hours per annum—viz., each open type arc burning all night £19, each open type burning half-night £10, each enclosed arc burning all night £13. 10s., each enclosed arc burning half-night £8, each 16 c.p. incandescent £2. 17s. 9d., and for public 4ft. gas burner on the same basis per annum £2 14s. 6d. The charges per candle-power per annum for the different kinds of lamps are—(1) electric: 1,000-c.p. arc lamps 4·56d., 600 c.p. arc lamps 5·4d., 70-c.p. Nernst lamps 19 8d., 16-c.p. incandescent 43·3d.; (2) Gas: 13-c.p. (4ft.) burner 50·3d. It may interest the committee to know that recently the Manchester Corporation went very deeply into the question of public lighting by the most modern and improved systems of gas and electricity, and in each instance electricity came out cheapest. Another valuable and interesting report is that of the city surveyor of Westminster. There are 1,105 electric lamps and 2,076 gas lamps on the thoroughfares of Westminster, and the lighting by electricity is considerably cheaper than by gas. The average income per unit supplied to public lamps for the year ending March, 1904, is 1·753d., as compared with private consumers 3·9d., and tramways 1·75d. Comparing the public lighting accounts (gas and electric together) for the last nine months with the corresponding period of last year, there is an increased expenditure of £208 18s. There are a number of circuits which do not contain the full number of lamps, and in consequence of resistances which have to be used there is a waste of energy; these circuits might be completed with advantage to the public lighting and the electricity department, at no very considerable cost, as there are a few lamp columns and accessories on hand which are quite suitable for the purpose."

**Bexhill.**—An electrical exhibition is now being held at the Kursaal by the Borough Council, and will remain open until Saturday. A very special feature is being made of electric heating and cooking. An electric kitchen is fitted up, and lunches and dinners are being prepared and served daily at popular prices. The Council is arranging to hire out the various cooking utensils, and, we are informed that, judging by the interest taken by the public in the electric kitchen, this move promises to substantially increase the day load. A number of engineers from neighbouring towns visited the exhibition yesterday,

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and were entertained by the Mayor Earl de la Warr) at an electrically-cooked luncheon. During the time of the exhibition the Kursaal is being lighted at intervals and alternately by incandescent lamps, arc lamps, and Nernst lamps, thus illustrating the different systems of electric lighting. Demonstrations of the power of electric searchlights across the channel take place every night and attract large numbers.

**Richmond.**—It appears that at the interview of the deputation with the Postmaster-General, Councillor Chancellor pointed out that, although the amenities of the borough had been preserved from being spoiled by the erection of telegraph and telephone poles, it had only been done at an expense of £120, and that it was hoped that, having regard to the large expense incurred in preserving the view from Richmond Hill, and the particular amenities of the borough, the Postmaster-General would avoid sanctioning the erection of poles in this unique suburban district, and that all necessary wires would be placed underground without expense to the borough. The Postmaster-General assured the deputation that he would do his best to facilitate the preservation of places of natural beauty where this could be done by taking a longer route for the wires, but it was impossible to place long trunk telephone wires underground, as their efficiency would thereby be destroyed. He also promised to carefully consider any representations made to him.

**London Gazette.**—The partnership between Howard Marryat and Harry Alexander Place, carrying on business as electrical engineers at 28, Hatton-garden, London, E.C., has been dissolved by mutual consent. The partnership between George Edward Vint and Maurice Edgar Moss Vint, carrying on business as electrical engineers at 92, Rusholme-road, Manchester, has been dissolved. The partnership between John Boutch and Colin Bell Heaviside, electrical and mechanical engineers, Neville-street, Newcastle-on-Tyne, has been dissolved by mutal consent. A first and final dividend of 4½d. in the £ has been declared in the estate of Thomas Williams, electrical engineer, 54, Bridge-street, Llandaff, Glamorgan. Arthur Francis Whinney (with a committee of inspection), 32, Old Jewry, London, E.C., has been appointed liquidator in the estate of the Sir Hiram Maxim Electrical and Engineering Company, Limited, 44, Gillingham-street, Westminster. The partnership between George Brearley, Joseph Horrox, and James Bertram Horrox, carrying on business as mechanical and electrical engineers at 90, Back George-street, Manchester, has been dissolved by mutual consent.

**Kingston.**—Councillor Francis, in moving the approval of the Lighting Committee's minutes at the last Town Council meeting, referred to the working of the change in the method of charging for the light, which took effect just about a year ago. He said it was estimated that the alteration would cost them the first year some £700, and, as a matter of fact, they had received £650 less from their old customers, which was a very close estimate, upon which the engineer was to be congratulated. The undertaking had shown a very good expansion, and the money so lost had been made good by the increased number of units sold. But it had to be borne in mind that there were larger capital charges to face this year, and he did not wish to convey the idea that the whole of that additional receipt was in the nature of increased profit. Councillor Sprunt said most of the £650 they had lost had gone to benefit their good customers, and what the committee hoped for was actually happening—they were greatly increasing their use of the light. Private houses in the town were now getting their light at 4½d. per unit instead of 6d. as formerly.

**Surbiton.**—The following details of the position of affairs in regard to the electric lighting undertaking were laid before the last District Council meeting: "On Oct. 31 last it was found necessary for the first time to run both the 100-kw. engines which comprise the first plant, and after that date they were run together each night, excepting on Sundays and Wednesdays. The new 220-kw. plant was installed early in December, and put into permanent work on the 20th of that month, and it had taken the load every night since then. The highest load recorded was 138 kw. The full capacity of the station, allowing for the possibility of the failure of any one of the engines, was 220 kw., and it might, therefore, be considered that there was at present a margin in hand of 80 kw. The total number of lamps now fixed was 13,000 of 8 c.p., and it was estimated that by the end of the year the total would increase to 17,800 lamps, and that the maximum load would then be 180 kw. This margin of 40 kw. would serve for a second winter, but it was certain that an extension of the works would be required by the autumn of 1907. This extension would cost about £7,500. It was evident that if a supply was given to the Dittons the enlargement of the plant would, in all probability, become necessary 12 months sooner."

**West Ham.**—The expenditure of the electricity department during the year ended March, 1904, amounted to £83,342, chiefly upon the completion of the new generating station buildings and equipment at Canning Town. This made the total capital expenditure £268,511. The tramways took 23,740 units. The net result of the year's working is a deficiency of £3,788, partly owing to the disorganisation of the supply while the transfer to the new station was made. The expenses of generation, distribution, public lamps, rents, management, etc., were £20,647, and the income was £30 364, made up as follows: Energy sold for public lighting, £3,096; private lighting, 1,602,829 units at rates ranging from 7d. to 2d. (over a million at the latter figure), £25,001; power supply, 121 309 units at from 5d. to 1d., £1,514; traction supply, £210; special lighting for artisans' dwellings, £246; received in respect of hire purchase and hire of motors and installations, £183; and sundry other amounts from meter rents and wiring and fittings. The gross profit thus figures at £9,817, and there is a further receipt of £44 in respect of arc lamp columns, making £9,861. On the other side of the net revenue account, however, repayment of loans receives £3,168, interest on loans receives £2,609, and interest (£2,020) is paid on the bank overdraft; also redemption and extinction of stock requires £1,808, and interest on Corporation stock another £4,045, thus making a net deficiency of £3,788, which is carried to the appropriation account. As this fund already had £1,689 to its credit, the deficiency at March 1904, thus became reduced to £2,099. There is a reserve fund from previous years of £1,740.

**Metropolitan Power Bills.**—Reporting on the Electric Power Bills now before Parliament, the Parliamentary Committee of the London County Council stated on Tuesday that in their opinion the proposals in respect of which powers were sought were such as to constitute a serious menace to existing and future municipal electrical supply undertakings, and they were fully persuaded that the magnitude of the proposals, the overlapping powers sought, and the general reversal of the conditions now applying to London, left the Council no alternative but to oppose the Bills. Whilst the object aimed at by the promoters of the two new companies might not be to establish a monopoly, it must inevitably result in this, and the existing companies had introduced Bills, mainly, it would appear, in self-defence. It was obvious that a supply of electricity for power purposes and also for the lighting of premises supplied with power could leave in the hands of the existing authorities the residue of the custom only. They proposed reporting further on the matter at a later date, and in the meantime petitions on behalf of the Council were being presented against the Bills. The committee, after reviewing the circumstances existing at present in London under the Electric Lighting Acts and the Council's action in connection with the matter, state that they desire to direct special attention to the general principle to which the Bills seek to give effect—viz that in the opinion of the promoters, electrical energy can be more economically produced and transmitted by means of a large undertaking supplying over a much wider area than was perhaps thought necessary when the Electric Lighting Acts of 1882 and 1888 were passed, and on the faith of which enormous capital has been expended. This view has already been adopted by the Westminster and St. James's Companies and also by the Kensington and Notting Hill Companies, which take a large portion of their supplies from two stations established to supply in each case two companies. Out of many suggestions which they have considered, they say that the three most practicable seem to be—(*a*) that such companies as supply in bulk should be placed on a sliding scale of price and dividend, and that powers of purchase be given to the Council with regard to these on lines similar to those laid down by the Electric Lighting Acts, (*b*) that the Council itself should be the authority for generating electricity in bulk in London; or (*c*) that some arrangement should be arrived at between the existing companies, satisfactory to the Council and the borough councils, with the object of securing a supply of electricity to London consumers upon the most economical basis. They recommended that the action taken by the Parliamentary Committee, as explained in the above report, in connection with the Supply and Power Bills introduced into Parliament in the session of 1905, be approved. The Council postponed discussion of the report, and the same will be brought up for discussion again on Feb. 28. Practically each of the eight London Bills is opposing all the others. There are over 100 petitions against the Administrative County of London and District Electric Power Company's measure, among the petitioners being the Metropolitan Water Board and the City Corporation. A further six petitions have been lodged against the Bill of the Central Electric Supply Company, among the petitioners being the City Corporation and the London County Council. The County of London Electric Supply Bill will be opposed by the Metropolitan Water Board, the City Corporation, the London County Council, and others. Thirteen further petitions have now been lodged against the East London and Lower Thames Electric Power Bill. The Metropolitan Electric Supply Company's (Various Powers) Bill is to be opposed by the County of London Electric Supply Company, the London County Council, St. James's and Pall Mall Electric Supply Company, and others. Against the North Metropolitan Electric Power Supply Bill a further batch of 12 petitions has been received.

## PROVISIONAL PATENTS, 1905.

FEB. 13.

**2888. An improvement in electrical trolley heads with wire-finding apparatus attached.** John Thomas Cherry and Edward Henry Clive, 2, Bedford-park, Plymouth.

**2890. Improvements in apparatus for electrically operating gas-valves.** Herbert Scott, Marchfield, Wilmer-drive, Bradford.

**2894. An improved electric lampholder with locking device to prevent the withdrawal of a lamp therefrom.** Hugo Hirst and Henry Bevis, 71, Queen Victoria-street, London.

**2908. Improvements in and relating to telephone switch-board connections.** Robert McLean, Telephone House, Brock-road, St. Sampson's, Guernsey.

**2918. Improvements in and relating to dynamos and the like.** Charles Anthony Vandervell and William Henry Wardon Proctor, 1, Queen Victoria-street, London.

**2919. Improvements in and relating to devices for controlling electric currents.** Claude William Atkinson, 1, Queen Victoria-street, London.

**2920. Improvements in electric switches and resistances.** Edmund Garside, 1, Queen Victoria-street, London.

**2934. Improvements in temperature compensating device for therme-electric measuring instruments.** William Henry Bristol, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

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**2939. Improvements in electric incandescence lamp fittings.** Frank West Suter, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**2940. Improvements in electric switches.** David Garbutt Pinkney and Howard Melville Rootham, 82, Mark-lane, London.

**2944. Improvements in and relating to transformers.** Oswaldo de Faria, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Feb. 20, 1904, being date of application in France.) (Complete specification.)

**2980. An electric light maximum demand alarm relay.** George Octavius Wills, 502, Romford-road, Forest Gate, London. (Complete specification.)

**2982. Improvements in line selectors for telephones and like systems.** Paul Hardegen, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

FEB 14.

**2998. Improved ironing machine with electrically-controlled pressure.** Albert Ernest Hacking and John Pycroft, 11, Burlington-chambers, New-street, Birmingham.

**3009. Improvements in electrical tramway conduit systems.** Aubrey Llewellyn Coventry Fell and John Hall Rider, 303, Camberwell New-road, London.

**3029. An improved electrical insulating material.** Joseph Devonport Finney Andrews, 2, Park-avenue, East Sheen, London.

**3047. Automatic electric early morning waiter.** George James Gray, 151, Capstone-road, Bournemouth.

**3049. Combined electric coupling and two-way plug.** Harold Stokes, 25, Ringmer-avenue, Fulham, London.

**3076. Improvements in electric signalling apparatus.** Evershed and Vignoles, Limited, and Sydney Evershed, 1, Queen Victoria-street, London.

**3078. Improvements in lightning arresters.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**3081. Improvements in protective devices for electric circuits.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**3088. Improvements in combined switches and fuses.** Arthur John Fuller, 13, Chipstead-street, Fulham, London.

FEB. 15.

**3125. Improvements in or relating to electric motor starters.** Frederick John Jones, 104, Colmore-row, Birmingham.

**3129. An improved lifeguard for electric tramway cars and similar vehicles.** Samuel Robert Cameron, 22, Withington-street, Cheetham Hill, Manchester.

**3155. Improvements in dynamo-electric machines and motors.** Wilfrid Robert Vernet Marshall, Torrieburn, Barnes, Surrey.

**3157. Improvements in the construction of dynamo-electric machines and electric motors.** Edmund Scott Gustave Rees, Prince's-chambers, Wolverhampton.

**3166. An improved X-ray tube for use with alternate or unidirectional currents.** Alfred Charles Cossor, 54, Farringdon-road, London.

**3171. Improvements in and relating to electric motors and dynamo-electric machines.** Vickers, Sons, and Maxim, Limited, and Alfred David Williamson, 7, Southampton-buildings, Chancery-lane, London.

**3177. Improvements in or relating to the control of electric motors.** William Geipel and Frederick Montague Townsend Lange, 46, Lincoln's-inn-fields, London. (Complete specification.)

**3183. Automatic regulating apparatus for electrical installations with variable current consumption, worked by dynamos and accumulator batteries.** Emil Dick, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**3184. Improvements in installations for controlling electrically-propelled trains.** Siemens Bros. and Co., Limited, and Charles Frewen Jenkin, Birkbeck Bank-chambers, Southampton buildings, Chancery-lane, London. (Complete specification.)

**3189. Improvements in and relating to dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83 Cannon-street, London. (The General Electric Company, United States.)

**3195. Improvements in or relating to apparatus for controlling electric motors.** John Martin Barr, the Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act 1901, March 7, 1904 being date of application in United States.) (Complete specification.)

**3196. Improvements in controllers for electric motors.** Thomas Steel-Perkins, the Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, March 7, 1904, being date of application in United States.) (Complete specification.)

**3201. Improvements in central-station telephone systems working with a common battery.** Isidore Bernard Birnbaum and Francis George Bell, 322, High Holborn, London.

FEB. 16.

**700A. Improvements in apparatus for use in wireless telegraphy.** Hermann Heinicke, 3, Upper Vernon-street, London. (Date applied for under Patents Rule 9, Jan. 13, 1905.) (Complete specification.)

**3250. Improvements in and relating to electric arc lamps.** Hugo Bruckmann, 81 High Holborn, London.

**3265. Improvements in electrical switches.** Edward Tyer, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**3280. Devices for exerting an electromagnetic influence upon the arcs of electric arc lamps.** Tito Livio Carbone, 322, High Holborn, London. (Complete specification.)

**3283. Improvements in electrical sound-producing apparatus.** Albert Charles Marie Legendre, 70, Chancery-lane, London. (Date applied for under Patents Act, 1901, Sept. 24, 1904, being date of application in France. (Complete specification.)

**3289. Improvements in electric heaters.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**3291. Improvements in electric control apparatus.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

FEB. 17.

**3293. Improvements in electric traction on a shallow-conduit system.** Samuel Green Bennett, Clyde House, Heath Town, Wolverhampton.

**3312. Electric self-acting apparatus for tightening ropes and the like.** Heinrich Otto Adam, 57, Barton-arcade, Manchester. (Date applied for under Patents Act, 1901, Feb. 18, 1904, being date of application in Germany.) (Complete specification.)

**3313. Improvements in or relating to wireless telegraphy receivers.** Francis Patrick Reid, 37, West Nile-street, Glasgow.

**3327. Improvements in electrolytic meters.** George Hookham and Sydney Holmwood Holden, 18, Southampton-buildings, Chancery-lane, London.

**3346. Method of, and apparatus for, electrically oxidising atmospheric nitrogen.** Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (Demetrio Helbig, Italy.)

**3347. Improvements in switch apparatus for coin-freed electricity meters.** John Meany Tourtel, 146A, Queen Victoria-street, London.

**3356. Improvements in automatic electrical cut-outs.** Charles Anthony Vandervell and William Hodgson, 1, Queen Victoria-street, London.

**3357. Improvements in and relating to means for driving dynamos and the like.** Charles Anthony Vandervell and William Hodgson, 1 Queen Victoria-street, London.

**3360. Improvements relating to sight magnetic compasses.** Arthur Fred Collins Bentley, 8, Quality-court, Chancery-lane, London.

**3371. Improvements in mechanism for actuating electrical clocks.** Gustav Schonberg, 1, Great James-street, Bedford-row, London. (Complete specification.)

**3372. Improvements relating to casings for electric switches and fuses.** Frederick Hagger Headley, 322, High Holborn, London.

FEB. 18.

**3392. Improvements connected with trolley wires of overhead electric tramways systems.** George John Conaty and Harry Hartley, 128, Colmore-row, Birmingham.

**3394. Improvements relating to electric ignition apparatus for internal-combustion motors and for like purposes.** Timothy Morris, 18, Southampton-buildings, Chancery-lane, London.

**3401 Improvements in and relating to resistances for electric current.** Robert Hopfelt, 10, Friedrichstrasse, Berlin, Germany. (Complete specification.)

**3409. Improvements in the arrangement of multiple switch-boards for telephone exchanges.** Siemens Bros. and Co., Limited, Queen Anne's-chambers, Broadway, Westminster, London. (Siemens und Halske, Akt.-Ges., Germany.) (Complete specification.)

**3424. Improvements in belt tension regulators.** The British Thomson-Houston Company, Limited, 83. Cannon-street, London. (The General Electric Company, United States.)

**3431. Improvements in and relating to electrolytic meters.** Claude William Atkinson, 1, Queen Victoria street, London.

**3432. Improvements in electric machineries.** The Company "Sachsenwerk Lichtund Kraft-Akt.-Ges.," 1, Queen Victoria-street, London. (Date applied for under Patents Act, 1901, Feb. 20, 1904, being date of application in Germany.) (Complete specification.)

**3433 Improvements in devices for exerting an electromagnetic influence on the arcs of electric arc lamps.** Tito Livio Carbone, 322, High Holborn, London. (Complete specification.)

**3442. Improvements in and relating to gloves for electric insulation purposes.** Karl Weilbier, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

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## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published March 9.*

1904.

**3637. Dynamos.** Lapeyrade. (Date applied for under International Convention, Feb. 10, 1903.)

**3356. Electric and other lifts and hoists.** Chaudoir.

**3523. Hand telephones.** Friedlaender.

**3826. Manufacture of insulating or non-conducting materials for electrical purposes.** Pontite, Limited, and de Pont.

**3885. Electrical switching systems.** Wright and Nicholls. (Date applied for under International Convention, Feb. 16, 1903.)

**4110. Electrical connectors.** Martin and Lowson.

**4943. Electric controllers for use with cranes, winches, transporters, and similar or other machinery.** Cleveland Bridge and Engineering Company, Limited, and Hill.

**5926. Electric motors.** Mavor and Coulson, Limited, and Mavor.

**6040. Electric arc lamps.** Levis. (General Electric Company).

**6041. Electric arc lamps.** Levis. (General Electric Company.)

**6042. Electric arc lamps.** Levis. (General Electric Company.)

**6617. Controlling devices for electric motors.** Marples.

**7062. Electric arc lamps.** Carolan. (General Electric Company.)

**7985. Attachments for electric incandescent lamps.** D'Olier, junior.

**8096. Means or device for catching and supporting overhead electric cables or wires when fractured.** Denton-Ingham and Jones.

**8399. Alternating electric current motors.** British Thomson-Houston Company, Limited. (General Electric Company.)

**8402. Alternating electric current motors.** British Thomson-Houston Company, Limited. (General Electric Company.)

**8590. Brush-holders for dynamo-electric machines.** British Thomson-Houston Company, Limited. (General Electric Company.)

**8699. Windings for dynamo-electric machines, and methods of and apparatus for forming the same.** British Thomson-Houston Company, Limited. (General Electric Company.)

**8777. Attachment of globes or shades to electric lamp fittings.** Williams-Thomas and Northwood.

**9427. Automatic electromagnetic sanding gear for use on electric railways and tramways operated instantaneously with the electric brake from the controller handle.** Crosbie and Ward.

**10356. Construction of mounting of trolley arms for collecting electric energy from overhead cables for electric traction.** Phillips and Parkin.

**13928. Automatic electric cut-out mechanism.** Jones. (Long Arm System Company.)

**19126. Dynamo-electric machines.** Foot. (Date applied for under International Convention, Sept. 16, 1903.)

**20953. Electric igniter for simultaneously igniting and simultaneously or successively extinguishing gas burners.** Candi and Candi.

**21601. Trolley sheaves for engaging electric power wires, applicable also to sheaves and guide pulleys used with wire ropes, cables, and the like.** Williams.

**26499. Electric motor-controlling systems.** Eastwood.

**27185. Electric couplings.** Sorg.

**27538. Means for transforming direct electric current into multiphase alternating current.** Steinmetz. (Date applied for under International Convention, Dec. 17, 1903.)

**27860. Forming tank for accumulator elements.** Gardiner.

**28155. Dynamo-electric machines.** Phœnix Dynamo Manufacturing Company, Limited, Pohl, and Pohl.

**28156. Construction and ventilation of field coils of dynamo-electric machinery.** Phœnix Dynamo Manufacturing Company, Limited, and Pohl.

**28369. Electric switches.** Harrison. (Guett.)

**28852. Conduit for containing electric cables and wires and other wires, tubes, pipes, and the like.** Hepworth-Collins.

**28875. Electric coupling for use in lamp fittings.** Simmonds.

**29061. Electric railway conduit systems.** Van Aerschot.

**29118. Electric insulators and supports therefor.** Fairbanks.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ¾-¾ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 7/16-17/32 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | – | 5¾-6¼ |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | – | 5¼-5⅝ |
| —— 4½ per cent. Mortgage Debentures | 100 | – | 101-104 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 101-103 |
| British Westinghouse Elec. and Manuf., 5 per cent. Pref., 275,001-375,000 | 5 | – | 2½-2⅝ |
| —— 4 per cent. Mortgage Debenture Stock | 100 | – | 87-89 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,751 | 2 | – | ½-⅝ |
| —— Non. Cum., 5 per cent. Pref. | 2 | – | 1½-1⅝ |
| —— 4½ per cent. 1st Debenture Stock | 100 | – | 94-97 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | – | 79-82 |
| Callender's Cable, Debentures | 100 | – | 105 107 |
| —— Ordinary | 5 | – | 10¼ 10⅝ |
| —— 5 per cent. Pref. | 5 | – | ⅝ 5⅝ |
| Crompton and Co. | 5 | – | 2½ 2⅝ |
| —— 5 per cent. Debentures | 100 | – | 96 98 |
| Edison and Swan United, "A" Shares, 1-98,261 | 3 | – | ⅜ ½ |
| —— "A" Shares, 01-017,139 | 5 | – | 1-1¼ |
| —— 5 per cent. Debentures | 100 | – | 79-84 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 77 82 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | – | 1½ 1¾ |
| —— 7 per cent. Cumulative Pref. | 2 | – | 2¼ 2½ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | – | 97 99 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-96 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | – | 9-10 |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | – | 91-96 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | – | 12 12½ |
| —— 4½ per cent. Preference | 5 | – | ⅞ ⅞ |
| —— 4½ per cent. Debentures | 100 | – | 111 113 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | – | 15½ 16½ |
| —— 4 per cent. Debentures | 100 | – | 100 103 |
| Parker, Thos., Limited, Ordinary | 10 | – | 10 10½ |
| Telegraph Construction and Maintenance | 12 | – | 34-36 |
| —— 5 per cent. Bonds | 100 | – | 101½-103½ |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary | 10 | – | 12½-12⅝ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | – | 9½-10 xd |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | – | 11-12 xd |
| —— 4½ per cent. Debenture Stock. Red. | 100 | – | 104-106 |
| Bromley (Kent) Electric Light and Power Co. | 5 | .. | 5¼-5⅝ |
| —— 4½ per cent. 1st Debenture Stock, Red. | 100 | – | 101-104 |
| Brompton and Kensington, Ordinary | 5 | – | 10½-11 |
| —— 7 per cent. Preference | 5 | – | 10½-10⅝ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 | 5 | – | 9 9¼ |
| —— Nos. 60,001-80,000 | 5 | – | 6-7 |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | – | 12½-13½ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 105-108 |
| Charing Cross and Strand, Nos. 1-70,000 | 5 | – | 8-8½ |
| —— 70,001-80,000 | 5 | .. | 7⅜-8½ |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5⅛-5⅜ xd |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | .. | 4 15/16 5 1/16 |
| —— 40,001-80,000 | 5 | .. | 4 15 16-5 1/16 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | – | 102 104 |
| Chelsea Electricity Supply | 5 | – | 6⅜-7½ |
| —— 4½ per cent. Debentures | 100 | – | 108-110 |
| City of London, Ordinary | 10 | – | 12-12½ |
| —— 6 per cent. Cumulative Pref. | 10 | – | 13½-14 |
| —— 5 per cent. Debenture Stock | 100 | – | 125-127 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | – | 103-105 |
| County of London Electric Supply, Ordinary | 10 | – | 9 9¼ |
| —— 6 per cent. Cum. Pref. | 10 | – | 12-12½ |
| —— 4½ per cent. Debentures Prov Certs. All pd. Rd. | 100 | – | 102 104 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. | 100 | .. | 108-111 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | – | 6¼ 6½ |
| —— 6 per cent. Cum. Pref. | 5 | – | 5-6¼ |
| —— 4½ per cent. First Mort. Deb. | 100 | – | 106-108 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 1¼-2¼ |
| —— 5 per cent. Debenture Stock, Red. | 100 | – | 86-91 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | – | 5¼-6 |
| —— 4½ per cent. First Deb Stock, Red. | 100 | – | 101-104 |
| Havana Electricity, Limited, 1-15,000 | 10 | – | 9¼-10½ |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | – | 7½ 8 |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 100-102 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 | 1 | – | 9/16-11/16 |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | | 13-13½ |
| Kensington and Knightsbridge and Notting Hill, 4 per cent Debenture Stock Red | 100 | – | 102-104 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅝-10¼ |
| London Electric, Ordinary | 5 | – | 2½-2⅝ |
| —— 6 per cent. Pref. | 5 | – | 5⅜ 6¼ |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | – | 96 98 |
| Metropolitan Ordinary | 10 | – | 18¼-19 |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | – | 110 115 |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5⅜ 5¾ |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | – | 96 98 |
| Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb. | 100 | – | 97-100 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | – | 98-101 |
| —— Preference | 4 | – | 100-102 |
| Notting Hill Electric Lighting | 10 | – | 14½-15½ |
| —— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.) | 100 | | 102-104 |
| Oxford Electric, Ordinary, 1-90 and 1,-14,510 | 5 | – | 6¼ 6⅜ |
| —— 4 per cent. Debenture Stock | 100 | – | 98 100 |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures | 100 | – | 100-102 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 | – | 3⅜-3¾ |
| —— 4 per cent. Debenture Stock | 100 | – | 79-83 xd |
| South London, Ordinary | | – | 4¼ 4⅜ |
| South Metropolitan Electric Light and Power Co., Ord. | 1 | .. | ½-1 |
| —— 7 per cent. Cum. Pref. | 1 | .. | 1 13/32-1 15/32 |
| —— 4½ per cent. 1st Mort. Deb. | 100 | .. | 107-110 |
| —— Ditto, June, 1904 | | .. | |
| St. James's and Pall Mall, Ordinary, 101-80,080 | 5 | – | 13½-14½ |
| —— 7 per cent. Pref. | 5 | – | 8¼-9 |
| —— 5½ per cent. Deb. | 100 | – | 96-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | – | 5-5¼ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5⅛ 5⅜ |
| Westminster, Ordinary | 5 | – | 13½ 13¾ |
| —— 5 per cent. Cum. Pref., 110,101-138,951 | 5 | – | 6¼-6⅜ |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 | 5 | – | 5⅛-5⅜ |
| —— Ord. | 5 | .. | 8¼-8½ |
| —— Permanent 6 per cent. Debenture Stock. 1888 | 100 | – | 140 143 |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 104-105 |
| Barcelona Tramways, Limited, Ord., 1-20,000 | 10 | .. | 11⅜-12¼ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 | 10 | .. | 9-10 |
| —— 5 per cent. Deb., Red., 1-600 | 100 | .. | 99 102 |
| —— 4½ per cent. Red. Deb. Stock | 100 | .. | 96-100 |
| Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606 | 1 | .. | 11/16-15/16 |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 | 1 | .. | 15/16-1 1/16 |
| Belfast Street Tramways, Ord., 1-26,600 | 10 | .. | 10-11¼ |
| Blackpool and Fleetwood Tramroad | 10 | – | 13⅜-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | – | 1¼-1⅜ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | – | 3⅜-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 91 93 |
| British Columbia Electric Railway Co., Ord. Def. | 100 | – | 102-105 |
| —— Ord Pref. | 100 | – | 100-103 |
| —— Non. Cum. 5 per cent. Pref. | 10 | – | 10-10¼ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each | 40 | – | 103 105 p c |
| —— 4½ per cent. Vancouver Power Deb. | 100 | – | 93-102 |
| British Electric Traction Ord. 1-500,000 & 60,001-80,000 | 10 | – | 9¼-9⅜ |
| —— 6 per cent. Cm. Pf., 50,001-60,000 | 10 | – | 11-11¼ xd |
| —— 5 per cent. Perpetual Debenture Stock | 100 | .. | 120-122 |
| —— 4½ per cent. 2nd Deb. Stock | 100 | | 97-99 |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Buenos Ayres and Belgrano Tram. Ord., 1-100,000 | 5 | 3¾-4 |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | 5⅞-5¾ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | 5½-5⅝ |
| —— 5 per cent. Deb. Stock, Red. | 100 | 107-109 |
| —— Prov. Cert., all paid | 100 | 103-105 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | 94-97 |
| Calcutta Tramways, Limited, 1-102,268 | 5 | 8¾-9 |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | 106-108 |
| Cape Electric Tramways Nos. 1-480,000 | 1 | 1⅜ 1⅜ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | 4⅞-5⅛ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | 101-104 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1s Mortgage Debenture Stock, Red. | 100 | 102-104 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | 9¼-10 |
| —— 5 per cent. Cum. Pref. | 10 | 11-12 |
| —— 4 per cent. Debentures | 100 | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | 13-14 |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 | 15¼-16¼ |
| —— 3½ per cent. Mort. Debs., 1-3,000, Red. | 100 | 94-97 |
| Imperial Tramways Ordinary | all | 18-19 |
| —— 6 per cent. Cum. Pref. | all | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000 | 5 | 3¼-3⅜ |
| —— 4 per cent. Debenture Stock | 100 | 90-93 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | 8-8¼ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | 10⅜ 10⅝ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | 103-105 |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016. | 1 | 13/32 15/32 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | 15/16-1 xd |
| —— 4½ per cent. Deb. Stock, Red. | 100 | 104-106 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1925, 1-5,500 and 7,001-8 000 | $1,000 | 105-110 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 | 102-105 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 | 103-106 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000 | 5 | ¼-1¼ |

| Name. | Amount paid. | Last price |
|---|---|---|
| | £ | £ |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | ·12¼ |
| —— 5 per cent Cum. Pref. | 10 | 9¾-9¾ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk. | 100 | 102-105 |
| Potteries Electric Traction, Ordinary 20,001-40,00 | 10 | 8¼-9 |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | 8¼-8¼ xd |
| —— 4½ per cent. Debenture Stock | 100 | 100-10 |
| South Lancashire Electric Traction and Power Company | | |
| —— £250,000 Ordinary | 1 | 1 |
| —— £101,152 5 per cent. Preference | 1 | 1 |
| —— £597,170 4½ per cent. Debenture Stock | 100 p.c. | 100 p.c. |
| **Electric Railways.—** | | |
| Central London, Ordinary | 100 | 92-94 xd |
| —— 4 per cent. Pref. | 100 | 101-103 xd |
| —— ,, ,, deferred | 100 | 86-87 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | 101-112 |
| City and South London, Consolidated Ordinary | 100 | 44¼-45½ xd |
| —— 4 per cent. Debenture Stock | 100 | 107-109 |
| —— 5 per cent. Pref. Stock '91 | 100 | 120-123 xd |
| —— ,, ,, ,, '96 | 100 | 118-121 xd |
| —— ,, ,, ,, '01 | 100 | 115-118 xd |
| Liverpool Overhead, 5 per cent. Pref. | 10 | 10-10¼ |
| —— Ordinary, 1-50,000 | 10 | 3¾-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — | 98-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | — | 98-99 |
| Waterloo and City, Ordinary | 100 | 92-94 xd |
| **Telephones.—** | | |
| National Telephone, Preferred | 100 | 109¼-110½ |
| —— Deferred Stock | 100 | 104-106 |
| —— 6 per cent. Cum. First Pref. | 10 | 13-14 |
| —— 6 per cent. Cum. Second Pref. | 10 | 12-13 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | 5¼-5⅜ |
| —— 5¼ per cent. Deb. Stock, Red. | 100 | 98-100 |
| —— 4 per cent. Deb. Stock, Red. | 100 | 103-105 |
| —— 4 per cent. Prov. Cert. | — | 103-105 |
| Oriental Telephone and Electric Company | 1 | 1 1/16-1 3/16 |
| —— 6 per cent. Cum. Pref. | 1 | 1 3/16-1 5/16 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905. | 1904. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Feb. 11 | 1,052 | 1,034 | + 41 | + 5,755*h* | 19¼ | 19¼ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·14 |
| Ayr Corporation | ,, 18 | 175 | 159 | + 16 | + 553 | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 336,049 | 1·03 | 10·11 | 1,770 | 5 0 |
| Barking Corporation | ,, 18 | 52 | 40 | + 12 | + 216 | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 19 | 970 | 949 | + 21 | — 777 | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,319,701 | 1·158 | 9·98 | 2,383*b* | 6·1 |
| Birmingham Corporation | ,, 18 | 368 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | Jan. 20 | 4,585 | 5,083 | — 498 | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | — | — | — | — | — | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10·94 | — | 4·59 |
| Blackpool Corporation | Feb. 16 | 303 | 275 | + 28 | + 6,110 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 18 | 185 | 179 | + 7 | — 93 | 16½ | 16½ | Dec. 31 | 32,021 | 2,258,984 | 600,757 | 3·34 | 12·75 | 2,001 | 7·05 |
| Bolton Corporation | ,, 19 | 1,630 | 1,622 | + 8 | + 461 | 38 | 38 | March 31 | 94,161 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·89 |
| Bournemouth Corporation | ,, 15 | 895 | 858 | + 37 | + 2,185 | 10·15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 18 | 3,841 | 3,517 | + 324 | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 19 | 760 | 711 | + 49 | + 3,623*h* | 9 | 7½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 17 | 4,431 | 4,242 | + 189 | — | 51½ | 51½ | Dec. 31*g* | 253,150 | 44,391,439 | 6,033,528 | — | — | — | — |
| Burnley Corporation | ,, 18 | 964 | 867 | + 97 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 19 | 292 | 290 | + 2 | — | 8¼ | — | March 31*j* | 11,574 | 2,556,134 | 282,378 | 1·08 | 9·84 | 1,570 | 7·57 |
| Cardiff Corporation | ,, 18 | 1,848 | 1,804 | + 44 | + 2,018 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 18 | 144 | 163 | — 19 | — 166 | — | — | Dec. 31*g* | 9,987 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 18 | 7,142 | 7,036 | + 96 | + 1,003*h* | 6 | 6 | ,, 31 | 362,471 | 44,933,938 | 1,292,674*a* | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 19 | 2,816 | 3,177 | — 361 | — 1,545*h* | 6½ | 6⅝ | ,, 31 | 165,003*a* | 19,069,319*a* | — | — | — | — | — |
| Colchester Corporation | ,, 15 | 156 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 16 | 449 | 381 | + 68 | — | — | — | ,, 31*g* | 25,657 | 6,353,323 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | ,, 17 | 205 | 200 | + 6 | — 91 | 7·23 | 7·23 | March 31*g* | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 18 | 169 | 162 | + 7 | — | 4½ | 4½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0·94 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | ,, 17 | 91 | 94 | — 3 | — *h* | 7 | 6½ | Dec. 31*g* | 6,234 | 388,905 | 107,164 | 3·88 | 14·09 | 952 | 7·39 |
| Dublin U. T., electric cars | ,, 17 | 3,594 | 3,555 | + 39 | } — | 47 | 46 | ,, 31*g* | 134,643 | — | 3,429,356 | — | — | — | — *h* |
| Dublin S. District, Electric | ,, 17 | 759 | 660 | + 99 | | | | | | | | | | | |
| Dundee City Tramways | ,, 15 | 776 | 773 | + 3 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 18 | 651 | 600 | + 51 | + 1,783 | 10·77 | 10·75 | March 31 | 34,312 | 12,950,269 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 18 | 13,391 | 12,917 | +1,074 | +26,550*h* | 143 | 123 | May 31*g* | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489*b* | 7·40*d* |
| Gloucester Corporation | ,, 15 | 216 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 8 | 2,411 | 2,195 | + 216 | + 4,789 | 33 | 30½ | March 31 | 68,289 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,069 | 8·77 |
| Huddersfield Corporation | ,, 18 | 1,193 | 1,118 | + 75 | + 3,950 | 35 | 35 | ,, 31 | 65,545 | 11,893,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | ,, 18 | 2,050 | 1,987 | + 73 | +10,978 | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | ,, 11 | 368 | 338 | + 30 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | ,, 15 | 101 | 118 | — 17 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 15 | 197 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 18 | 5,391 | 4,956 | + 435 | +15,237 | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | ,, 18 | 1,782 | — | — | — | 7¼ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | ,, 11 | 10,030 | 9,471 | + 559 | + 1,634 | 103 | 103 | Dec. 31*g* | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | ,, 19 | 1,440 | 1,472 | — 32 | — 444*h* | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185*a* | 1·82 | 19·30*a* | 5,110 | — *e* |
| London County Council | ,, 11 | 12,372 | 9,661 | +2,711 | +11,652 | 46¼ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 20 | 132 | 118 | + 14 | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | ,, 16 | 95 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 18 | 11,670 | 10,572 | +1,098 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Metropolitan Elec. Tramways | — | — | — | — | — *h* | 10 | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 13 | 107 | 94 | + 13 | + 1,364 | 2¾ | — | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newcastle-on-Tyne Corptn. | ,, 18 | 3,513 | 3,433 | + 80 | — | 45 | 38½ | ,, 25 | 185,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111*b* | — |
| Newport (Mon.) Corporation | ,, 11 | 485 | 460 | + 25 | + 1,393 | 15 | — | — | — | — | — | — | — | — | — |
| Oldham Corporation | ,, 19 | 1,764 | 1,068 | + 296 | + 4,400 | 34½ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 18 | 1,342 | 1,312 | + 20 | + 6,467 | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·16 | 12·39 | — | — |
| Rochdale Corporation | ,, 18 | 404 | 94 | + 310 | + 5,933 | 4½ | 4½ | ,, 31*g* | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | — |
| Rotherham Corporation | ,, 16 | 391 | 387 | + 4 | — | — | — | ,, 31 | 20,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 7·66 |
| Salford Corporation | ,, 20 | 3,846 | 3,668 | + 178 | — | — | — | — | — | — | — | — | — | — | 6·68 |
| Scarborough Tramways Co. | ,, 18 | 63 | — | — | — | 7¾ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 19 | 4,387 | 4,282 | + 105 | + 5,797 | 34¼ | — | ,, 25*g* | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 15 | 794 | 880 | — 86 | — 2,579 | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 15 | 223 | 216 | + 7 | + 1,590 | 6¼ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 17 | 429 | 365 | + 64 | + 8,435 | 11¼ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 19 | 1,079 | 1,061 | + 18 | + 1·472 | 19·54 | 18·48 | ,, 31 | 62,506 | 14,848,958 | 1,433,463 | 1·01 | 10·46 | — | 6·08 |
| Swindon Corporation | ,, 15 | 163 | — | — | — | 3¾ | — | — | — | — | — | — | — | — | — |
| Wallasey U.D.C. | ,, 18 | 631 | 568 | + 63 | + 2,332 | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·60 |
| West Ham Corporation | ,, 16 | 1,079 | — | — | — | 8·62 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 16 | 659 | 338 | + 271 | — | 7½ | — | ,, 31*g* | 20,878 | 4,263,066 | 417,335 | — | 12·006 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures. Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**Wireless Telegraphy.**—The Marconi Wireless Telegraph Company, Limited, have decided to prepare their own telegraphic code. The company will from time to time issue a register containing the names and telegraphic and business addresses of all people who use the code, for which, together with a copy of the register, a charge of one guinea will be made.

**Radium.**—According to a communication just made to the Academy of Sciences, radium has been found to be a complete antidote to all snake bites. Its emanations totally destroy the venom, and, at the same time, kill all germs contained in it. It is stated, however, to have no effect upon the poison of a reptile described as the "land salamander," or on that of the toad.

**The Telephone Purchase.**—The Select Committee to consider the agreement between the Postmaster-General and the National Telephone Company, and to report whether it is desirable in the public interest that the agreement shall become binding, will consist of Mr. Beckett, Sir Horatio Davies, Mr. Helme, Sir William Holland, Mr. J. Nolan, Sir Charles Renshaw, and Mr. Stuart Wortley.

**Olympia Motor Show.**—The Society of Motor Manufacturers and Traders have decided to hold their next exhibition at Olympia in the late autumn, probably November. All classes of vehicles and motor-boats may be represented, and the society point out that the most prominent builders of motor-boats are also carmakers, and that, as the purchasers are of the same class, both should be shown at the same time.

**The Institution.**—The provisional arrangements for the remainder of the session were announced last week. Beside the extra meeting called for last night to discuss Mr. Murray's paper, an additional meeting has been arranged for April 13. The dates are as follows: March 9, to read Dr. Glazebrook's report on "Temperature Experiments in Field Coils," and Mr. Goldschmidt's paper on "Temperature Curves"; March 23, to discuss same; April 6, to read congress report and Mr. Creedy's paper; April 13, to discuss same; April 27, to read and discuss Mr. H. Laws Webb's and Mr. A R. Bennett's papers.

**Permanent Way.**—Mr. Justice Warrington's dictum in the case of Tilling *v.* Dick, Kerr, and Co, reported in our last week's issue, that the London County Council's Act of 1900 does not confer power to execute works "in, over, or under the streets" for the purpose of providing a temporary service while reconstruction is proceeding, has led to prompt action on the part of the Council. At Tuesday's meeting the Highways Committee submitted a recommendation that a clause be added to the Council's pending Tramway Bill authorising the use of temporary raised tracks so as to avoid a cessation of the service. We expressed our views on this subject last week in a leading article.

**Niagara.** — The American public have apparently awakened to the fact that the Niagara Falls constitute a national property, and consequently a Bill is shortly to be introduced into the State Legislature to exact payment from all persons using the Falls to create power, as is done with regard to the other side of the Falls by the Dominion Government. The tax proposed is 6s. per annum per horse-power up to 20,000, and 4s. per horse-power from 20,000 to 30,000, and so on, the charge above 40,000 horse-power being 2s. Many enormous franchises were given away to the first American users of the Falls, and presumably these will continue to have the free use of this vast source of power unless some bold statesman introduces retrospective legislation.

**Motorcars and Electric Timing Devices.**—An electric chronometer recently devised by Lord Kelvin was responsible for the appearance of a batch of motorists before the Hayward's Heath justices on Monday, when some tolerably heavy fines were inflicted, besides three licenses being endorsed, for furious driving. An interesting episode occurred when Mr. Staplee Firth, the champion of oppressed motorists, questioned the reliability of the instrument. "But it was made by Lord Kelvin," protested the guardian of the law who effected the arrest. "Oh, I know that Lord Kelvin is very good at deep-sea sounding, but I never heard of him coming out with electricity before!" replied the defending counsel. Really, we scarcely know whether to regard the remark as ingenuous or disingenuous. If the former, Mr. Firth's scientific knowledge must be a long way behind his legal attainments; while if it were one of those little *ruses* practised by counsel for discounting the value of the other side's evidence, the effort scarcely seems a happy one, considering his lordship's world-wide reputation in electrical matters. Anyway, it was futile, and the motorist monster, or martyr, is threatened with another thorn in his side as the result of Lord Kelvin's contribution to delicate time-registering devices.

**Municipal Tramways Association.**—The managers' section of the Municipal Tramways Association held a conference in the Council House, Birmingham, last week. Mr. Alfred Baker presided, and there was a large attendance of members from the principal towns of the United Kingdom. Alderman Beale, the chairman of the Birmingham Tramways Committee, in extending the party a cordial welcome to the city, humorously described the Birmingham tramways as a collection of "old masters," which ere long will be superseded by a modern type. Mr. J. B. Hamilton (Leeds), the vice-president of the association, expressed the thanks of the members to Alderman Beale for his words of welcome. He remarked that if Birmingham was the last of the large towns to municipalise its tramways, it was the first to take the courageous step of providing through communication with the outside districts. The following subjects were subsequently discussed: "Overhead Equipment," introduced by Mr. J. M. McElroy, and "Tramway Telephones," introduced by Mr. Baker; "Local Taxation of Tramways" (Mr. E. Coutts), "Collection and Delivery of Parcels in Connection with Tramway Systems" (Mr. C. J. Spencer), and "Universal Indicators for Tramway Stopping Stations" (Mr. A. R. Fearnley).

**Electric Driving in Cotton Mills.**—A large cotton-spinning mill, to be operated entirely by electricity, is under construction for the Acme Spinning Company, Limited, Pendlebury. The energy will be obtained from the Lancashire Electric Power Company, who will transmit to the mill from their generating station at Outwood three-phase alternating current at 10,000 volts, which will be transformed down to 400 volts for driving purposes and 230 volts for lighting. Fine and coarse counts of cotton will be produced at the mill. As turbines are used for driving the dynamos at the power station a very perfect drive should be obtained on the spindles, which is, of course, a matter of great importance in the spinning industry, as thereby increased production can be obtained, and not only this, but the product itself is improved in quality. Exactly how much improvement there will be in these respects is one of the most important questions of the whole subject, the steam-engine makers insisting that with their most modern plant no cyclic irregularity occurs. As, however, this new mill is being built side by side with a steam-driven mill of the same proportions and under the

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same management a very useful comparison will be instituted. If the electric driving succeeds as well as is hoped, it will be an incentive to other mill-owners to follow the lead.

**American Electrical Exports.** — The electrical exports from the United States during 1904 totalled some £2,250,000, this constituting a record. About 60 per cent. of this was represented by "electrical machinery," and the remainder by "electrical appliances." The totals for 1902 and 1903 were £200,000 and £1,971,220 respectively. Hitherto the United Kingdom had been the largest buyer, but for 1904 the figure dropped from £345,400 to £240,000, and Canada, with £320,000, was the largest customer during last year. The exports to France and Germany were both more than doubled, the figures being £25,500 and £38,000 respectively. In the course of the year the exports to Mexico were increased by nearly 20 per cent over the previous twelvemonth, £130,000 being the figure for 1904. The trade with South America was substantially increased. To the British East Indies goods to the amount of £40,000 were exported—more than to Germany or France. The exports to British Australasia rose from £45,000 to £80,000, and to British Africa from £14,000 to £27,000. The most notable feature of the year, however, was the expansion of exports to Japan, who, notwithstanding the war, took goods to the extent of £238,000 from the States—nearly four times the figure for any preceding year.

**Engineering Standards Committee.**—This committee is about to issue a report on "The Temperature Rise in Field Coils of Electrical Machinery," which will be of great service to electrical manufacturers. The report, which will be brought before the Institution of Electrical Engineers on Thursday next, deals with a vast amount of experimental work carried out at the National Physical Laboratory under the supervision of Dr. Glazebrook. We understand that the actual experimental work was performed by Mr. Rayner. The report deals with the question from two points of view, the first being the effect of heat on the electrical and mechanical properties of dielectrics, and the second the temperature distribution in the interior of the coils. The co-operation between the Engineering Standards Committee and the National Physical Laboratory in carrying out this work is exceedingly gratifying, and shows that the financial aid received from the Government in the establishment and maintenance of the laboratory is of practical service to the industry at large. The report will give ample evidence of the value of the researches to designers of electrical machinery, and will, we hope, tend to standardisation in the temperature limits allowable in such coils. We understand that the preface to the report has been written by Sir William Preece, the chairman of the Electric Plant Committee.

**Italian Railways.**—Bills relating to the working of the railways by the State have been introduced into the Chamber of Deputies. These provide for the Government undertaking the working of the State systems, which have been leased to two companies, whose concessions expire in July, and for the expropriation of the Southern Railways Company. It is reported that after the transfer has been completed the State will expend £20,000,000 in putting the railways on a good working basis, but no mention is made of electrification. The lessee companies conducted some trials a few months back with this end in view, the results being favourable to electric traction, for which the country possesses natural advantages. It was recognised, however, that the Government could not very well undertake the large expenditure involved without the co-operation of the companies, and the public incline towards the State working of the railways. This may account for the apparent shelving of the question for the present. Provision is made for considerable improvement in the position of the railway staffs, whose novel manœuvres have been described in the daily Press during the last two or three days. At first sight it seems an ingenious device to substitute such tactics for the intimidation sometimes practised by strikers, but by disregarding the convenience of travellers the employés made the fatal mistake of alienating the sympathy of the public, with the result that the movement has virtually collapsed.

**Electrical Investments.**—A glance at the share list of the electric lighting companies illustrates what a good investment the debentures and preferred stock of the representative concerns afford to the man who wants a return of 4 to 5 per cent. for his money coupled with good security. Taking a score of the leading metropolitan and provincial companies during the past year, their securities of the classes mentioned maintained a remarkably uniform level, notwithstanding that in some cases the shares were at a considerable premium. The stability of the securities is emphasised by the fact that this occurred in a year when consols fluctuated between 91⅜ and 85. The City of London Company's debentures and preferred stock were in especial favour, the former being, on the average, at a premium of nearly 25 per cent., while the preferred stock was never at a lower premium than 30 per cent. The debentures and preferred stock of the various companies carry dividends varying between 7 per cent. and 4 per cent. on the price of issue, but the return on the present prices averages about 4½ per cent., none of the securities varying much from this figure. Considering the comparatively short term of existence which these undertakings, unlike the metropolitan gas companies, have to provide against, and which may be expected to detract from their value in the eyes of the investor, the support accorded to their securities testifies to the confidence with which the public view the operations of electric lighting companies.

**Rating Government Telephone Wires.** — In December last we noted the fact that the St. Pancras Borough Council had passed the following resolution: "That the Postmaster-General be requested to consider as to making contributions in lieu of rates in respect of all Government telephone wires." The resolution was forwarded to Lord Stanley, M.P., and the Borough Council have now received from the Postmaster-General a copy of a letter which has been addressed to him on the subject by the Lords Commissioners of his Majesty's Treasury to the effect that the proposal involves an innovation upon existing practice which cannot be taken by itself. Before any changes can be introduced it will be necessary to examine other questions connected with the Government contributions in lieu of rates, and more particularly contributions in respect of properties subject to limited rating under special Acts, museums, and the like, and the cost of the fire brigade, and that the Government, if desired, would be prepared to move for or support the appointment of a Select Committee to enquire and report upon the whole system. The Borough Council have now decided to inform the Postmaster-General that they favour the appointment by the Government of a Select Committee. Surely, in this matter of telephone wires, any contribution in lieu of rates is equivalent to taxing local subscribers to lighten local rates. There can be no real gain from such a procedure, but it may require the report of a Select Committee to convince some people of this.

**The Ministry of Commerce.**—At a meeting of the Birmingham Chamber of Commerce the other day, it was reported that an unfavourable reply had been received from

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Mr. Chamberlain anent the proposed Ministry of Commerce, which, after a period of peaceful repose since the committee of enquiry submitted its conclusions, was revived by the King's Speech. The right hon. gentleman stated that he could not see the advantage of calling the Board of Trade by another name, though amendments might be made in the organisation of the Department. It appears to us that the gist of the matter is embraced in the latter clause. Business men are not likely to feel greatly concerned about the designation of the Department, provided that it performs its duties efficiently. The new title would perhaps be the more appropriate, as disposing of the mythical "Board"; but this is a detail. If the alterations are not to go much beyond changing the title of the Department's presiding genius and increasing the emoluments of the office by 150 per cent., the outlook for increased efficiency is not brilliant. The scheme of reorganisation outlined by the Government, however, promises some useful reforms, not the least of them being the transfer of certain functions from the Home Office, which will avoid overlapping, and the removal of consular control from the Foreign Office. It is reported that if a Ministry of Commerce is decided upon, the first occupant of the office will be the Parliamentary Secretary to the Board of Trade (Mr. Bonar Law), who has fulfilled the latter position with considerable success. The minister will have the status of a first-class servant of the Crown, commerce being thus assigned a leading position in the Cabinet. A commencement might be made with the reforms by seeing that the Department's reports are compiled with a greater regard for accuracy, instead of being followed by a formidable list of errata, as has frequently happened of late.

**Electric Trams versus Motorcars.**—The astute gentlemen who preside over the destinies of the London United Tramways Company are evidently not among the believers in the supersession of the electric tram by the motorcar. In an interview last week, Mr. Clifton Robinson stated that within a few days contracts to the amount of £700,000 will be placed for the extension of the system. One result of this will be to bring the picturesque Surrey districts of Ewell and Esher within the range of a tram ride, the lines on the southern side of the river being linked with those on the Middlesex side by taking the rails over Kingston Bridge, for which the Board of Trade have given their consent. Another line will run from Kingston through Malden to Wimbledon and Tooting, where it will join the London County Council system. When these extensions are completed an important portion of the scheme for linking up the Metropolis and its environs by tramways will have been accomplished. Mr. Robinson summarises the rivalry between the two forms of traction in this succinct manner: "In my opinion the motor-omnibus cannot hope to compete with the electric tramcar. The working expenses of the tramcars average 6d. per mile against 1s. for the motor-omnibus. The electric car carries 70 passengers, and will run for 14 years, while the motor-omnibus carries only 32 passengers, and lasts only two years." Even if the life which Mr. Robinson allows the motorcar is rather too short, the electric tram has little to fear from that vehicle where anything like a frequent service is demanded, unless a radical change can be effected in its operating and maintenance costs, which, in the present position of mechanical science, does not appear likely. The motorcar may, however, have a useful sphere of utility before it, and if it brings the passengers along to the tram terminus from the less frequented localities, the trams will have cause to view it as an ally rather than an enemy.

**Fulham's Charges.**—The Fulham Borough Council considered on Wednesday a report from the borough engineer, Mr. A. J. Fuller, as to a proposed alteration in the charge for current for private lighting. Under the present system the charge is 5d. per unit for an average consumption of 12 units per 8-c.p. lamp per annum. If the consumption exceeds this, the price falls to 4d. up to 24 units, and beyond that the charge is 2d. per unit. We gather from the report that the objection to this scale is that the consumer has to pay at the 5d. rate for the first two or three quarters in the year, the reduction only coming into play at the last quarter. It will be seen that the system in use is a compromise between a flat rate and the maximum demand system. Mr. Fuller does not consider the latter system practicable, as he has found it lead to general discontent and cause great trouble. He also finds that the system now in force restricts the number of lamps which a consumer will put in a private house, in order that the consumption per lamp fixed may be high. He, therefore, recommended a reversion to a flat rate, and advocates a charge of 3½d. per unit. An alternative course left to the consideration of the Council was to charge 3d. per unit. This, Mr. Fuller calculates, would mean a loss for the first year, which would afterwards be recouped by the large number of new consumers obtained. It will be interesting to see in future years how the records of the load factor on the Fulham mains will compare with those of metropolitan boroughs where preferential rates are given to the long-hour consumer. We quite agree, however, with Mr. Fuller's contention that the price for electric light should be reduced to the lowest possible limit consistent with clearing, working expenses, interest, and redemption charges. The terms finally decided upon by the Council are as follows: a flat rate of 3½d. per unit, with a discount of 2½ per cent. on all bills over £2 per quarter, and 5 per cent. on all bills over £5 per quarter, if paid within 14 days. In this way the larger consumers will receive more favourable terms.

**City and Guilds of London Institute.**—The prizes and certificates awarded to students of the colleges and schools under the management of the City and Guilds of London Institute were distributed on Saturday at the Mansion House by the Lady Mayoress. The chair was taken by the Lord Mayor, and amongst those present were Sir John Watney (hon. secretary), Mr. Alexander Siemens, Prof. W. E. Ayrton, Prof. Silvanus P. Thompson, Dr. William Garnett, Mr. S. Stewart Gladstone (treasurer), and Prof. Unwin. Sir John Watney explained that the greater number of the students who received their awards that afternoon were evening students, who had attended one or more classes in the institute's colleges during last session. There were no evening classes at the Central Technical College, the work of that college being confined to providing systematic courses of day instruction, of a university character, in engineering and chemistry. At the close of last session 61 students from the Central Technical College, who had matriculated with distinction, were awarded the diploma of associate of the City and Guilds of London Institute, and with a few exceptions all these students had gone out into the world to commence their professional career as engineers. With regard to the extension to the Technical College, Finsbury, he stated that the work was making progress, and would, it was hoped, be completed before the end of next session. Mr. Siemens, who delivered the customary address to the students, said that when he first came to England, in 1867, there was hardly any technical college in the United Kingdom. Since then the subject of technical education had received an ever-increasing amount of attention, and nowadays everybody was alive to its value. The habits of observation, reasoning, and judgment should be inculcated

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at every step during the whole course of studies. Such training, he observed, had the additional advantage that it prepared the mind for the constant stream of new discoveries that were crowding upon one another since the achievements of the last century had totally altered the conditions of living.

**British Association.**—The association have issued a notice in reference to the South African meeting, stating that members who propose to attend the gathering should send their names to the chief clerk not later than May 31. On receipt of their subscription they will receive a voucher entitling them to a reduction of 25 per cent. on passages booked at the offices of the Union Castle Steamship Line, and a certificate entitling them to a reduction of 50 per cent. on railway fares in South Africa. The council will assign to members in priority of application and seniority the limited number of free passes granted by the railway administrations. To participate in this advantage associates of former years must apply for full membership before May 31. Hotel expenses are estimated at 25s. per diem first class and 18s. second class. The acceptance of papers and the days on which these are to be read will be determined, so far as possible, by the organising committee of each section before the beginning of the meeting. It is therefore necessary, in order to enable the committees to do justice to such communications, that each author shall prepare an abstract of his paper, of a length suitable for insertion in the annual report of the association, which abstract, with the original paper, should be posted on or before June 15, addressed thus: "General Secretaries, British Association, Burlington House, London, W. For Section —." Authors who comply with this request, and whose papers are accepted, will be furnished before the meeting with printed copies of their abstracts. If it be inconvenient to the author for his paper to be read on particular days, he will be required to send information thereof to the recorder of the section in a separate note. Abstracts received after June 15 will appear in the annual report, but cannot be printed before or during the meeting. No report or abstract can be inserted in the annual report of the association unless it be in the hands of the assistant secretary before the conclusion of the meeting. The following are the titles of the sections and the names of the presidents who have been appointed by the council: Section A—Mathematical and Physical Science—Prof. A. R. Forsyth, F.R.S.; Section B—Chemistry—G. T. Beilby; Section C—Geology—Prof. H. A. Miers, F.R.S; Section D—Zoology—G. A. Boulenger, F.R.S.; Section E—Geography—Admiral Sir W. Wharton, K.C.B.; Section F—Economic Science and Statistics—Rev. W. Cunningham, D.D.; Section G—Engineering—Colonel Sir C. Scott Moncrieff; Section H—Anthropology—Dr. A. C. Haddon, F.R.S.; Section I—Physiology—Colonel D. Bruce, F.R.S.; Section K—Botany—Harold Wager, F.R.S.; Section L—Educational Science—Sir R. C. Jebb, M.P.

**The Judicial System and Technology.**—If our legislators are desirous of introducing a useful reform, they might well direct their attention to the constitution of tribunals for adjudicating upon cases involving technical questions. A letter on this subject recently appeared in a contemporary, and the writer made some cogent observations. Not long since Mr. Justice Ridley refused point-blank to try an engineering case, frankly confessing his ineligibility for that function. This state of affairs has, of course, long been recognised in the Admiralty Division, where nautical assessors come to the rescue of the learned judge. An arrangement of this kind is obviously the rational solution of a somewhat complex situation, for a judge, however capable a lawyer he may be, cannot be expected to be conversant with marine engineering—a remark which applies with equal force to other branches of technology. The Bar certainly includes in its ranks men who have devoted a large amount of attention to technical matters, notably Mr. Fletcher Moulton, who is not only an ornament of the legal profession, but is a member of the Institution of Civil Engineers. The advantage to litigants when one of these "specialists" ascends the Bench is, however, very limited, since there is no arrangement for assigning actions to certain judges because of particular qualifications. Patent Office officials are very rightly required to possess some technical qualifications, if not of a very advanced character, and there is an obvious need for similar knowledge being at the disposal of a high functionary who has often to decide complicated questions of infringement and other important technical matters. A few years ago a section of the King's Bench Division was constituted into a "Commercial Court." If the Bench always included a capable scientist among its members, it might be practicable to establish a "Technical Court," but this is rather too much too expect, as there is no particular affinity between law and science. The best method would therefore appear to be to follow the precedent of the Admiralty Court, and have experts in attendance to guide the judge upon technical points, as recommended by the correspondent referred to above. It is true that litigation is already expensive enough, but suitors would not be likely to object to any reasonable extra cost resulting from this innovation. That our judicial system has, with the exception mentioned, dispensed with such an arrangement hitherto, is certainly no reason for continuing the practice, as experience has shown that in many cases it is unsatisfactory to judge and litigant alike. The various institutions might do worse than adopt the hint of the above-mentioned writer, and consider the matter with a view to making representations to the authorities.

**Load Factor and Cost of Power.**—We have received an advance proof of an interesting paper to be read before the Canadian Society of Civil Engineers. The author is Mr. E. M. Archibald, B.Sc., and his method of treatment shows that he has carefully investigated the question. He points out, in the first place, the desirability of obtaining customers who have a steady load for a large number of hours per day, and that these should be offered lower rates than those who only require energy for a short time. He then proceeds to show by means of curves how much the cost of power is decreased with an increasing load factor, and consequently how much the charge for energy can be reduced to customers who require supply with a good load factor. The subject is investigated by means of curves, assuming a definite capacity of plant and peak load. Curves are then given to show how the total operating expenses vary with the load factor and with the cost of coal, which becomes the all-important item at high power factors. For the smaller station investigated, 900 kw. of plant is assumed, working first with condensers and then non-condensing. The author then proceeds to deal with a power station of twice this size, working condensing. In the smaller station he assumes that coal-handling apparatus, automatic stoking, etc., will not be warranted unless a load with a good power factor can be obtained. With the larger station labour-saving devices are included, and it is shown that the extra investment for providing these will reduce the cost of labour and fuel to a greater extent than the fixed charges are increased. In all the examples treated in the early part of the paper steam plant is assumed, but the last curves given are for a station working with gas-engines supplied

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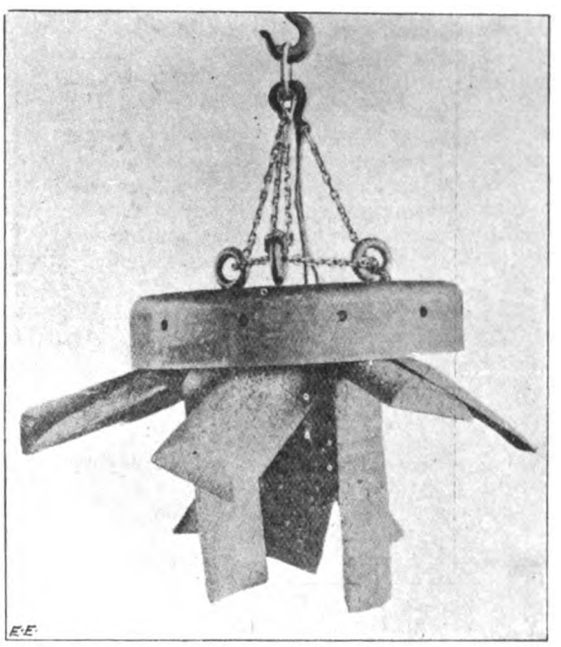
by means of producers. A comparison of the author's curves shows that, with the conditions he assumes, the gas plant is the more economical at high load factors, but less economical than steam at low power factors, due to the influence of the heavy fixed charges. It also follows, naturally, that the higher the cost of coal the greater the advantage of the gas-producer station over one using steam boilers and steam-engines. The figures assumed by the author are for Canadian conditions, but it is interesting to note that in his fixed charges he allows 5 per cent. interest on the capital outlay, 10 per cent. for depreciation of machinery, 3 per cent. for depreciation of buildings, and 2 per cent. for taxes and insurance. The depreciation is somewhat higher than is allowed as a rule in this country. The obvious conclusion from the author's curves, that a maximum demand system of charging is the correct one to adopt in all power supply, is not pressed home by the author; but in one set of curves he shows what the average charge for electrical power should be to consumers with different load factors.

**The Present Shrinkage of the Earth's Magnetism.**—A paper on this subject was read by Mr. L. A. Bauer before the American Physical Society, the February number of whose *Journal* contains an abstract of same. The author observes that the values of the earth's magnetic moment as derived by various analysts for the period 1843 to 1885 show a diminution for the interval of 40 years of about 1·6 per cent. Computations of the earth's total magnetic energy made by the author for the same period proved that the shrinkage in the portion equivalent to a uniform magnetisation was not compensated by a corresponding increase in the remaining portion of the earth's magnetism. As all of these results, however, were obtained on the basis of the distribution of the earth's magnetism as portrayed by the existing magnetic charts, which owing to paucity of data especially in the oceanic areas, are more or less inaccurate, the deductions regarding a possible shrinkage of the earth's magnetism could not be accepted as absolutely conclusive. In the present paper the results derived depend on actual observations between 1890 and 1900 at a series of land stations fairly uniformly distributed over the earth and lying between the parallels 60deg. N. and 60deg. S, the same number of stations having been selected in each magnetic hemisphere. From the mathematical analysis of the secular variation of the earth's magnetism between 1890 and 1900, it is found that the observed secular variation in the uniform portion of the earth's magnetism is to be ascribed to systems of magnetic or electric forces, two of which are as follows: (1) A system situated below the earth's surface, having a potential and acting in opposition to the earth's momentary field, hence demagnetising it. The magnetic axes of this system of forces besides being reversed with reference to that of the earth's momentary field is also displaced towards the west, so that its effect is to cause the north magnetic pole to move westward and southward and to diminish the earth's magnetic moment at the rate of about one twenty-two-hundredth part annually. (2) A system situated above the earth's surface, also having a potential, having its magnetic axis directed nearly transverse to the earth's axis of rotation. This system plays a most important part in the secular variation of the magnetic declination. The annual rate of shrinkage of the earth's magnetic moment for the period 1890 to 1900 is practically the same as that deduced on the basis of the magnetic charts for 1843 to 1885, adopting the mean of the two ratios we find that the earth's magnetic moment has been shrinking since 1840 at the rate of about one twenty-four-hundredth part of its prevailing value annually. At this rate the earth's magnetic moment will have dwindled to one-half its present value in 1,600 years. However, we have not yet sufficient grounds for such predictions. All we know is that a shrinking is occurring now, and the indications are that this shrinkage will be found to have been prevailing as far back as our available data extend. It is thus found that the secular variation of the earth's magnetism results not only from a change in the direction of the axis of magnetisation, but also from a change in the intensity of magnetisation.

**Electro-Lifting Magnets.**—The economies effected by electro-lifting magnets are the subject of an article in the San Francisco *Journal of Electricity, Power, and Gas.* The experience in steel mills and similar works where steel or iron in quantities is handled by means of cranes, shows that the saving in time and labour resulting from the introduction of electro-lifting magnets is sufficient to pay for the apparatus in from one to six months. A flexible twin conductor conveys the current to the magnet, which is suspended from the hook of the crane. A small switch operated by the crane-man is usually the only additional apparatus necessary. The amount of current used is small, being from one to 12 amperes, according to the service for which the magnet is designed.



As will be seen from the accompanying illustration of the magnet hoisting iron slabs and billets, the operation is very simple, the magnet being lowered upon the material and the switch closed, thus causing the magnet to attract the material. Having transported this to the desired spot, it is released by opening the switch. The magnets have been found of great value in moving small articles such as pig iron, scrap, rivets and bolts, and are extensively employed by the Illinois Steel Company, who have found the economy in time and labour so substantial that they have decided to introduce them in their works wherever possible. In general, the attachment of the load to the magnet and the detachment from same may be performed by the crane operator, no other hand labour being required, and the rapidity with which the articles are moved increases the service capacity of the crane. A single design of magnet is not adapted to handling all classes of goods, and the form of the articles should be carefully considered in constructing the magnets. The magnets are invariably tested to hold several times the specified load, and accidents are practically unknown.

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## BRIDLINGTON ELECTRICITY WORKS.

The reputation of Bridlington is such that an apology is almost necessary for the reminder that it is a popular

THE MAYOR OF BRIDLINGTON, MR. C. E. FIELD.

MR. J. V. MAINPRIZE, CHAIRMAN OF THE ELECTRICITY COMMITTEE.

and delightful resort situated on the shores of a magnificent bay some four miles south of Flamborough Head, 47 miles from York, and 30 miles from Hull. The borough has a population of about 14,500 inhabitants, and consists of the old town and the quay. The former, with its fine Priory Church and picturesque surroundings, is closely associated with the past. The latter is of more modern construction, and is the business centre of the town. The persistent increase which has taken place during recent years promises to destroy the distinction between the two parts of the town, and unite them in a prosperous and enterprising whole. Bridlington is an ancient market town under a charter granted by King John in 1200, but the history of the town can be traced back to an even earlier period.

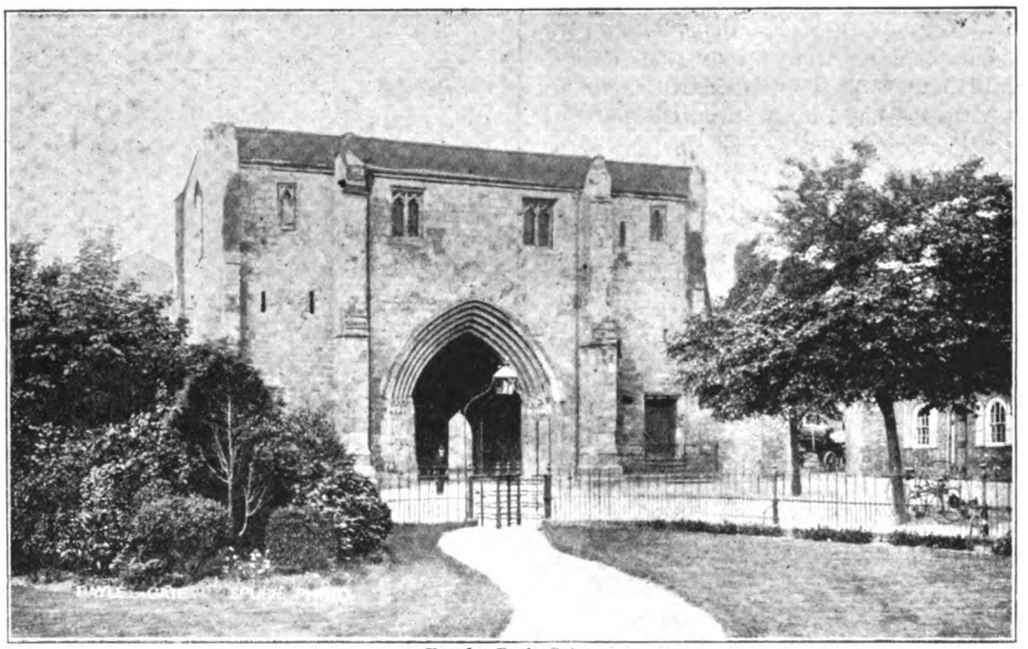

FIG. 1.—Bayle Gate.

MR. A. E. MATTHEWMAN, TOWN CLERK.

MR. F. H. MEDHURST, CONSULTING ENGINEER.

Many circumstances combine to prove the existence of a Roman station at or near the place. Bridlington was certainly a place of importance at the time of the Conquest, and increased throughout the twelfth and three succeed-

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ing centuries, during which time the monastery, founded in 1136, attained a considerable degree of magnificence and power. The monastery was dissolved in the reign of Henry VIII., when the revenues were seized and the buildings demolished, with the exception of one portion,

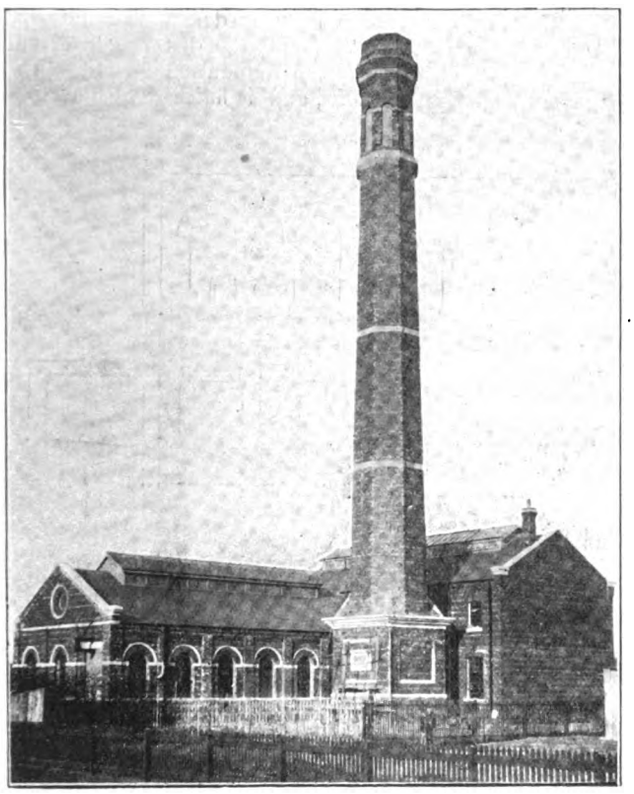

FIG. 2.—Exterior View of Buildings.

which served as a parish church, and the building now known as Bayle Gate (Fig. 1). This formed part of the outer walls of the monastery. The manor of Bridlington at one time belonged to the Priors. It was purchased in 1630 from Sir George Ramsey by the freeholders, who periodically elect from amongst their number 25 persons known as feoffees, of whom 13 are called lords and 12 assistant lords. Up to 1863 the lords feoffees had the general control of public matters, but in that year a local board was formed to carry on the government of the town. In 1895 the Local Board was superseded by the Urban District Council, and this in its turn gave place, on Nov. 9, 1899, to the Corporation, Bridlington being made a borough by Royal charter on that day. Amongst the memorable events of the past was a bombardment of the town during the Civil Wars in 1653, and in 1779 a sea fight in the bay between Government vessels and those of Paul Jones, the pirate.

Bridlington possesses a harbour, partly enclosed by stone piers. On the north side of the harbour the Royal Prince's Parade, opened in 1867, is now being extended, while to the south are the Spa Gardens, with fine promenades and a concert hall. The town and district offer many attractions to visitors—good boating, fishing, and bathing, miles of firm clean sands beloved of children, first-class bands, and a fine parade with gardens laid out on ground reclaimed by the construction of the sea-wall. The climate is bracing and equable, and the water supply excellent. The history of electric lighting at Bridlington does not lend itself to any extended treatment, though it is of interest to note that the lighting of the Royal Prince's Parade has for many years past been carried out by a gas-driven arc lighting set. So long, indeed, has this plant been in operation that the dynamo is one of the earliest type of arc-lighting machines.

The inception of the works to be described dates back to the summer of 1899, when communications were received by the then Urban District Council from several companies who were desirous of obtaining an electric lighting order for the district. Instead of approving any of these schemes, the Council decided to apply for a provisional order themselves, a course of action strongly advocated by Mr. W. C. Townsend, the chairman of the Electric Lighting Committee. The Council then invited Mr. F. H. Medhurst (of the firm of Messrs. F. H. Medhurst, Page, and Lloyd, of London and Manchester) to report on the whole subject, the result of his investigations strengthened their previous convictions, and the Bridlington electric lighting order was duly confirmed in the course of the following year.

In 1902 the question of establishing electricity works was again brought forward, and it was resolved to proceed at once with the construction of the works. Mr. Medhurst was appointed consulting engineer, and requested to prepare plans and specifications for a scheme of both public and private lighting on the three-wire, low-pressure

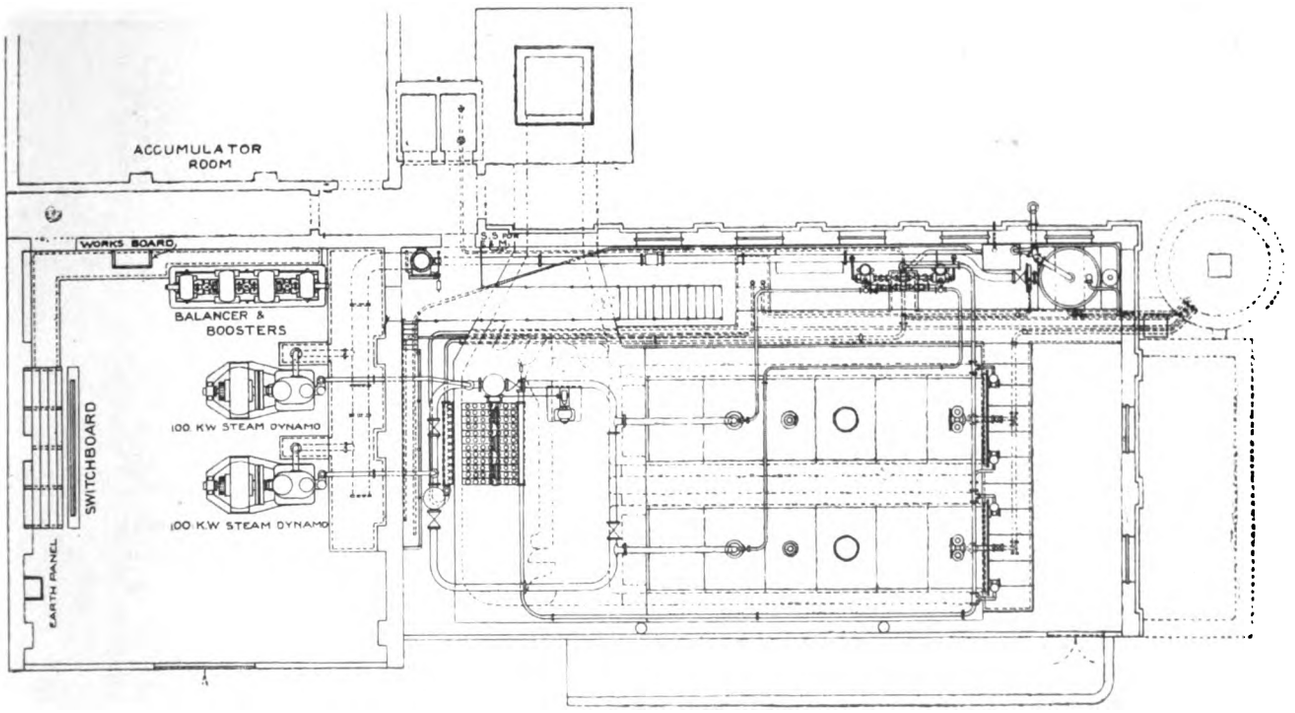


FIG. 3.—Plan, showing Arrangement of Plant.

system, with a pressure of 220 volts at consumers' terminals. Tenders were invited in March, 1903, and provisionally accepted. A pause of seven or eight months then ensued before the Local Government Board enquiry was held. The sanction of that Department to the borrowing of £26,481 was received early in 1904, and

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it may be remarked that the estimates of expenditure have proved practically correct. The outlay is, in fact, almost identical with the estimates in Mr. Medhurst's report of 1900.

Work was commenced on the various contracts in January, 1904, and a glance at the names of the contractors given below will show everyone connected with the electrical industry that the Corporation have been well served, an impression which will be confirmed by an inspection of the works: Buildings and chimney shaft, G. Storr and Son, Bridlington, £5,238; boilers, Clayton, Son, and Co., Limited, £1,413; steam-pipes, etc., John Spencer, Limited, £1,429; steam dynamos, balancer booster, switchboard, Johnson and Phillips, £3,317; storage battery, Electrical Power Storage Company, Limited, £1,067; mains, Anchor Cable Company, Limited, £9,251; lamp posts and fittings, British Prism Globe Electrical Company, Limited, £2,597.

The buildings (Fig. 2) designed by Mr. Ernest R. Matthews, the borough engineer, are situate in a central position close to the Elms estate, recently acquired by the Corporation. Their general appearance is a credit to all concerned. Red Armitage bricks have been used in the ventilators in the roofs. The boiler-house and engine-room have temporary ends of galvanised iron, so that the buildings can be readily extended, an ample space for this purpose being available on the site.

The chimney shaft, 130ft. in height above the ground level, is a massive octagonal structure with a square base. The shaft is built on a block of concrete 23ft. square and 8ft. thick, reinforced with steel girders. The internal diameter of the shaft is 7ft., and the distance from the surface to the bottom of the foundation is 24ft. The base rises to a height of 20ft., and is finished with a stone cornice. The chimney stack is relieved by bands of stone at intervals of 30ft., and the top is treated in an ornamental style with white brick panels and a stone cornice, the whole being surmounted by a cap of the same material. Access to the engineer's office, meter-room, and lavatory on the first floor is obtained on the north side of the buildings. These rooms are over the battery-room, which is separated from the engine-room by the entrance lobby. The engine room is on the west side of the office block, and runs parallel with the boiler-house (see Figs 3 and 4). The latter section of the works is 33ft. 6in. in length, 63ft. wide, and 25ft. high. The floor is paved with concrete and has been sunk some 8ft. below that of the engine-room to facilitate the delivery of coal into the bunkers. The bunkers have a capacity of 25 tons of coal, and are roofed with concrete carried by steel joists. An inclined footway of blue Staffordshire brick leads to the ground

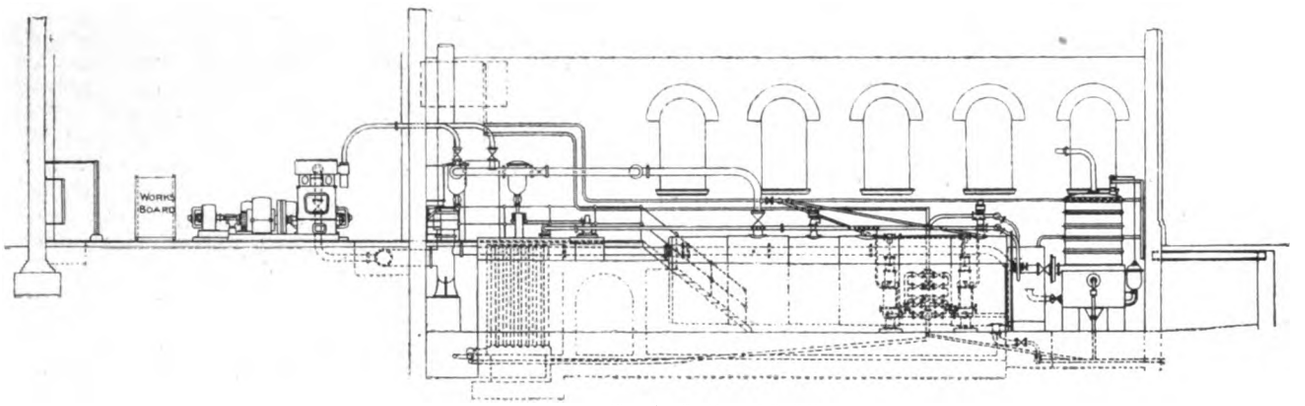


FIG. 4.—Section of Buildings.

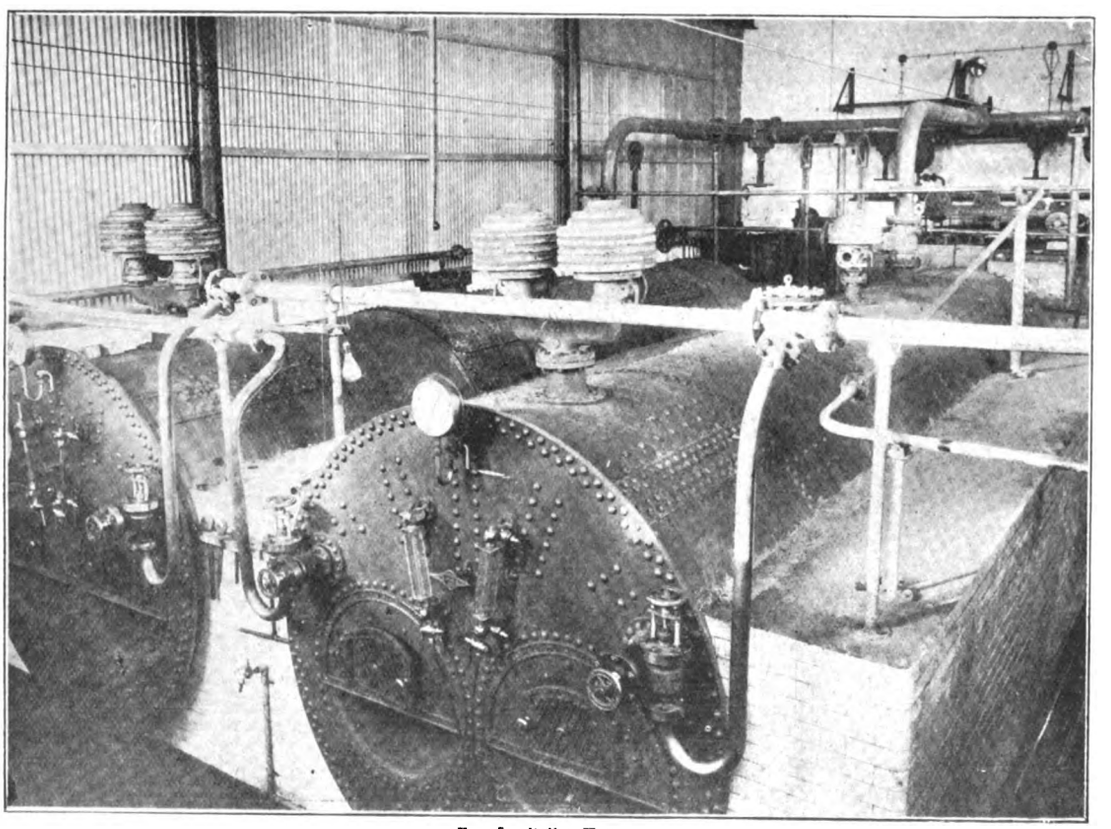

FIG. 5.—Boiler House.

construction of the work, and the exterior is ornamented with stringcourses and window mouldings of Robin Hood stone. Considerable attention has been given to lighting and ventilation. Large windows with semicircular heads and hopper ventilators are fitted throughout in addition to

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level, and is used for the removal of ashes and clinker. Ventilation is obtained by louvre ventilators in the roof and by seven large windows with hopper ventilators.

The steam-raising plant (Fig. 5) comprises two Lancashire boilers. Each boiler is 7ft. 6in. in diameter and 30ft. in length, and is capable of supplying steam for both the steam dynamos. The working pressure is 135lb. per square inch, but the boilers have been designed to carry 150lb. per square inch, so that there may be an ample margin of strength to allow of some deterioration when the boilers get old without the necessity of reducing the working pressure. The boilers are seated on Poulton blocks, the brickwork is faced with white glazed bricks, and the boiler fittings are of Dewrance's and Turnbull's manufacture. A 96-tube Green's economiser is placed in the main flue, and its scrapers are driven by a 1½-b.h.p. motor. The feed water is pumped through this apparatus on its way to the boilers, and absorbs the heat from the flue gases, which pass between the sets of tubes to the chimney shaft. The temperature of the water can be increased by this arrangement from 212deg. Fah., at which it issues from the water softener, to 300deg. Fah. or more.

The boiler feed pumps are vertical compound Hall pumps, each designed to deliver 2,000 gallons of water per hour against a pressure of 150lb. per square inch. The exhaust steam from these pumps is taken to the feed-water heater. The pipe system has been arranged so that steam can be supplied to either or both the steam

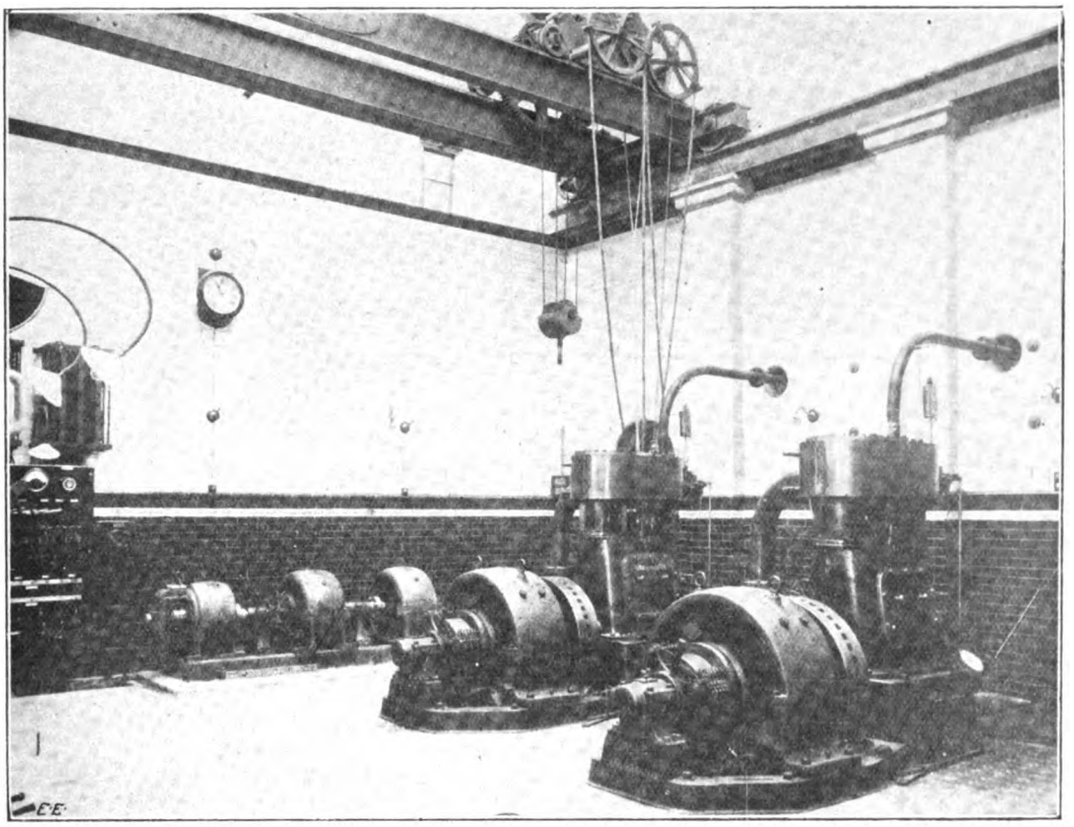

FIG. 6.—Engine Room.

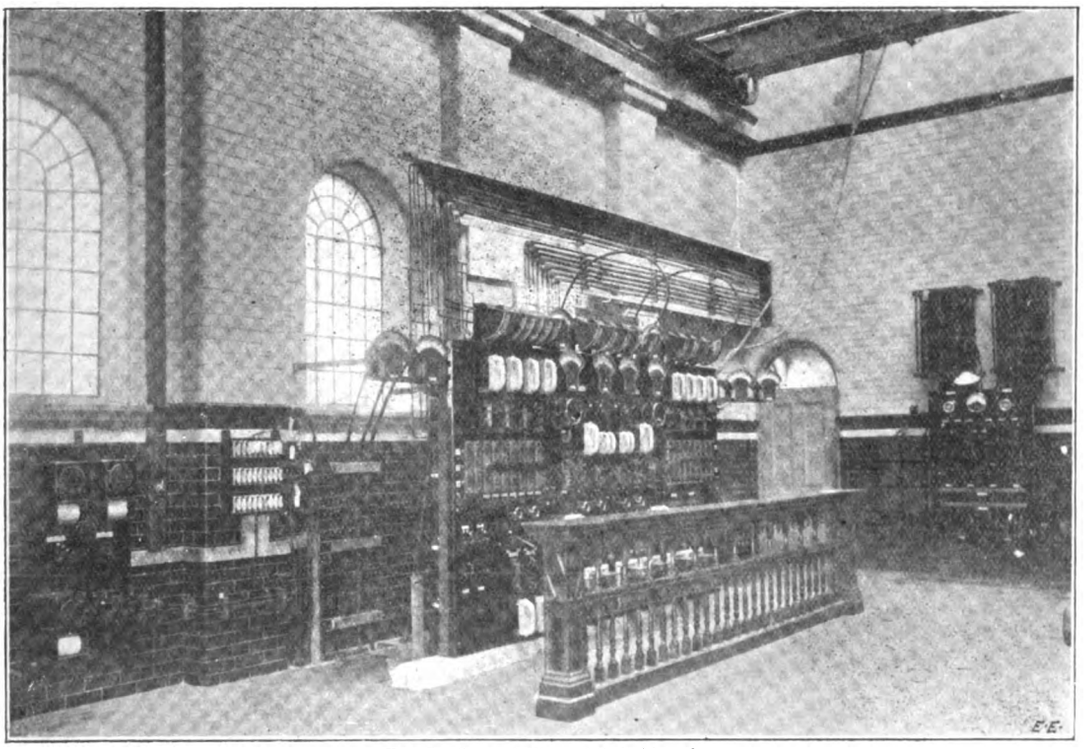

FIG. 7.—General View of Switchboard.

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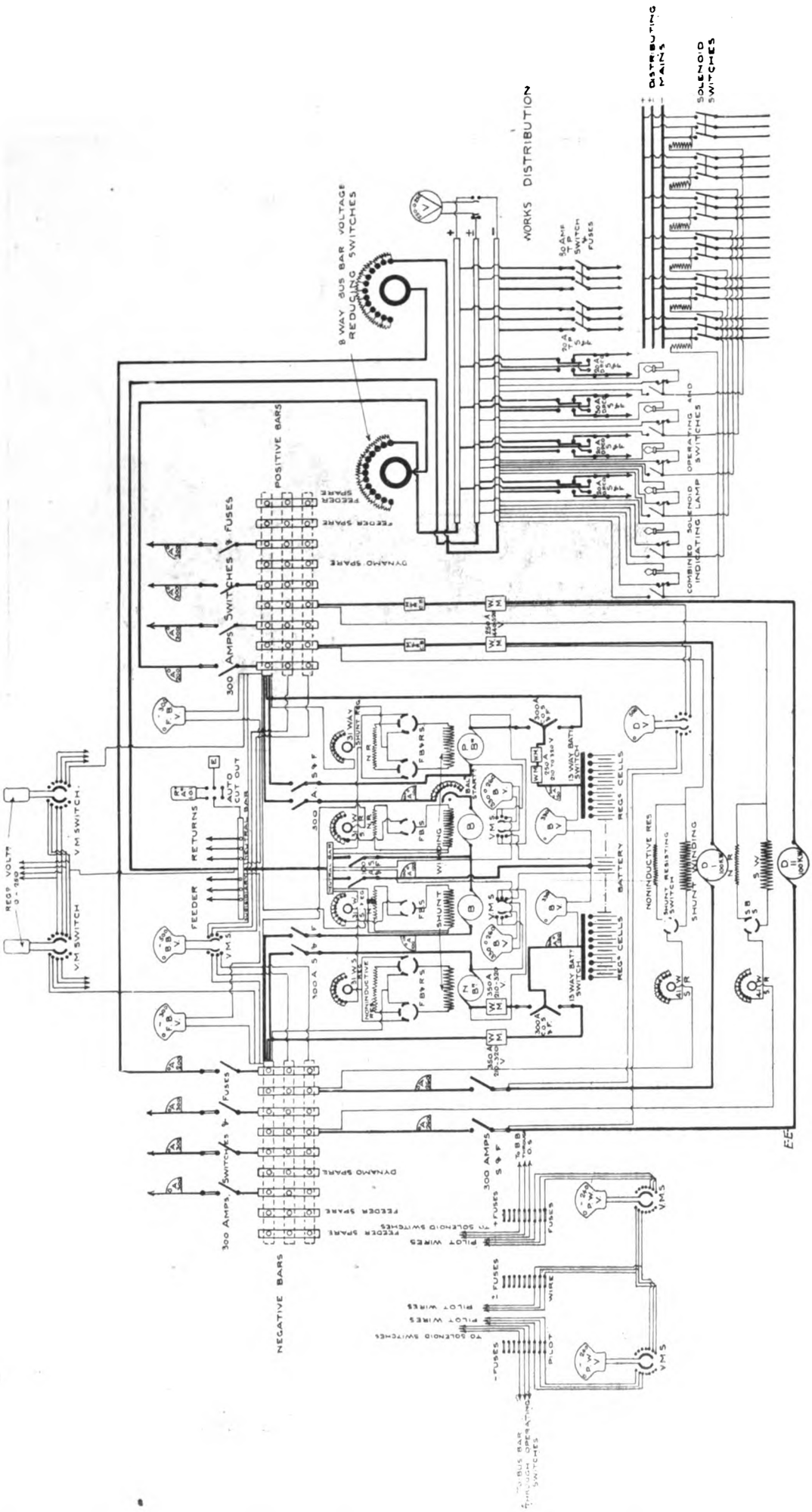


Fig. 8.—Diagram of Switchboard Connections.

dynamos from either boiler; the steam-pipes are of mild steel with welded flanges. These pipes are drained through contraction traps to the feed tank, and a duplicate feed-water service is provided for each boiler. The drains

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from the boilers, economiser, and water softener are taken to a sump outside the boiler-house. The valves on the steam and feed pipe systems are made by Templer and Rance and J. Blakeborough and Sons. The pipework, including valve bodies and flanges, is lagged with removable mica coverings, canvas wrapped, and painted.

The water supply is taken either from the Corporation mains or from a tank placed above the men's lavatory. This tank is supplied by water pumped from a well by the feed pumps, as it has been found that there is an ample supply of good water available on the site for all purposes. From the tank it gravitates to the Boby-Chevalet feed-water heater and softener, or detartariser. This machine has been installed to reduce the hardness of 1,500 gallons of water per hour from 20 or more degrees to 4deg. of

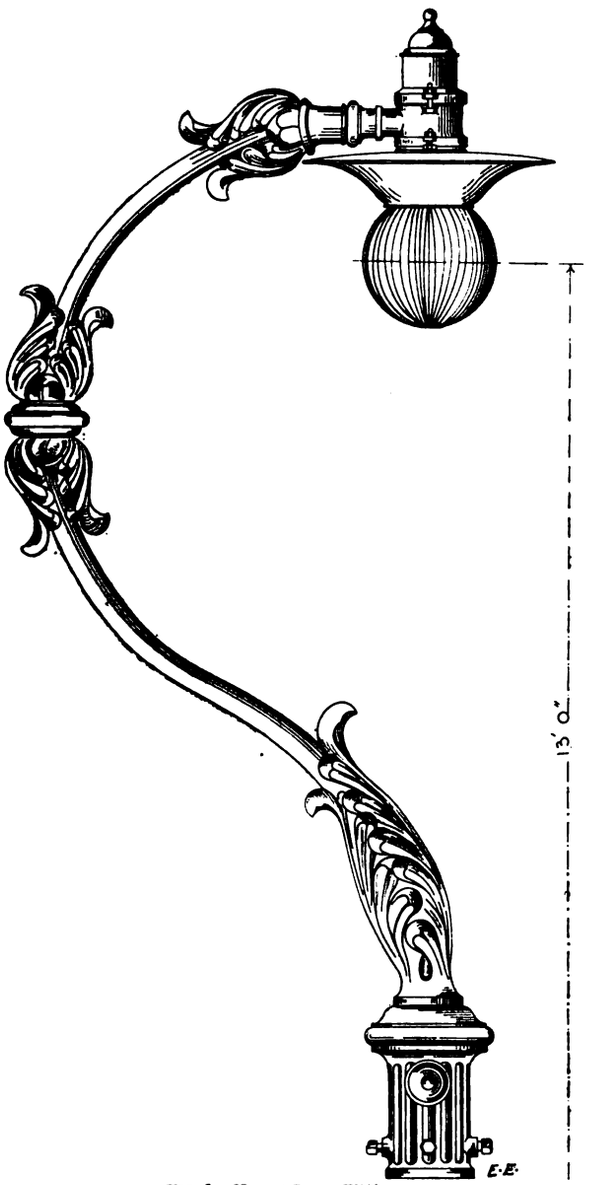


FIG. 9.—Nernst Lamp Fitting.

total hardness, and to raise its temperature at the same time to boiling point. The apparatus is worked by the exhaust steam from the dynamo engines, and consists of a series of trays in which the deposit from the feed water is thrown down by the heat from the steam. The machine is readily dismantled, and the trays when full are lifted by a travelling pulley block, passed through the door behind the heater, and emptied outside the boiler-house. This procedure saves time, and prevents an accumulation of litter and dirt in the gangway. An iron staircase from the north end of the boiler-house leads to a platform over the flues. Here are two doors, one communicating with the exterior of the building, the other with the engine-room.

The engine-room is 36ft. in length, 32ft. in width, and 25ft. to the springing of the roof, and presents a fine appearance. The walls are faced with glazed bricks to a height of 18ft.; the dado is of chocolate-coloured bricks, and is 6ft. in height. The walls above the glazed work are rendered with Parian cement and colourwashed. Mellowes glazing has been used in the roof, and the sashes in the lantern lights are controlled from the floor level. The floor is paved with Staffordshire encaustic tiles. A 10-ton overhead travelling crane, supplied by Marshall, Fleming, and Jack, spans the room, and the electrical equipment consists of two 100-kw. Allen-Johnson and Phillips steam dynamos (Fig. 6), with the usual accessories. The engines, each of 160 h.p., are of the double-acting vertical compound enclosed type, with forced lubrication, and their speed is 475 revolutions per minute. The dynamos are each capable of supplying some 4,000 lamps of 8 c.p. No condensing plant is installed at present. The matter, however, received due consideration in the first instance, and arrangements have been made in the lay-out of the works for the provision of this plant and a cooling tower as soon as the load warrants its adoption.

The balancing set stands on the east side of the engine-room. These four machines have a speed of 1,000

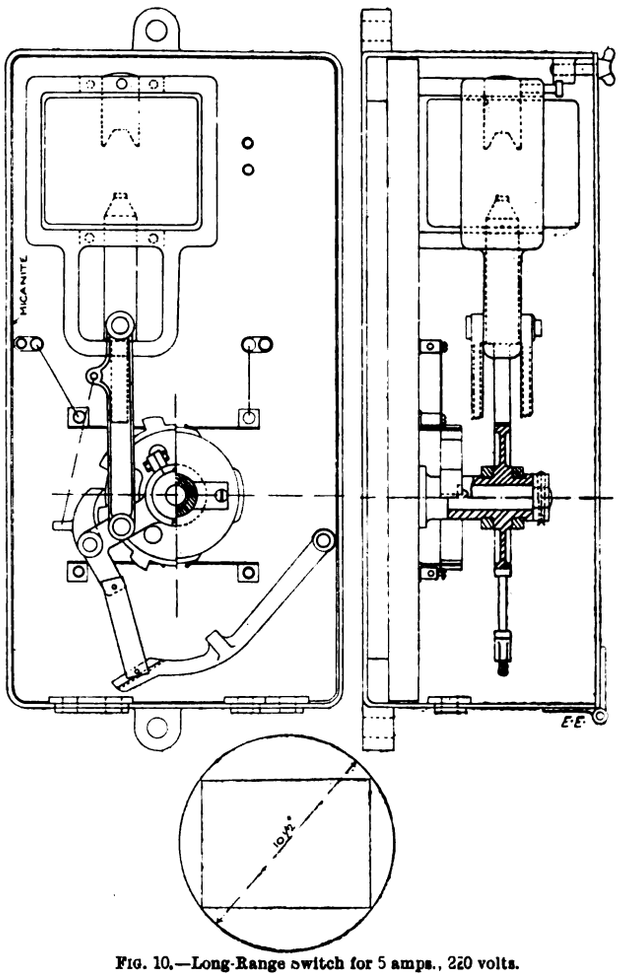


FIG. 10.—Long-Range Switch for 5 amps., 220 volts.

revolutions per minute. Their duty is to regulate the electrical pressure on each side of the system of mains and to assist in charging the storage battery.

The switchboard (Fig. 7) is erected some 4ft. from the north wall of the building. The board is built up of polished slate panels fixed to a metal frame, and is of neat and substantial design. It is equipped with the usual regulating and measuring instruments, and is of fire-proof construction. Bare copper connections run from the board to the storage battery. The main cables to the town and to the dynamos are brought to alternate copper bars on this board, so that any cable can be connected to either dynamo. The connections to the main switchboard are shown in Fig. 8. A smaller switchboard for controlling the street lamps and the lighting of the works is placed near the balancing set.

A very complete system of mains has been laid in the borough. Three feeder cables radiate from the works to different centres, or feeding points, and are there connected in suitable pillars to the distributing mains. The total length of mains for all purposes is 30 miles. Each

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main is made up of three cables of stranded copper wire well insulated from each other. A lead sheathing is placed over the insulation, followed by a serving of jute yarn; two thicknesses of steel tape are then wound on spirally, and a further covering of jute yarn completes the cable. The mains are laid direct in the ground.

The street-lighting consists of 410 incandescent lamps of varying candle-power, and 32 arc lamps. Sixteen of the latter are 12-ampere open-type lamps of 1,000 c.p. each, and the remainder 500-c.p. 3-ampere enclosed lamps These lamps are of Messrs. Johnson and Phillips and the Reason Manufacturing Company's make, and will burn for 30 and 90 hours respectively without recarboning. The incandescent lamps are hung from graceful brackets fitted with special light-diffusing globes Some of these lamps are of the Nernst type (Fig. 9). The street-lighting is divided into four groups, and is switched on and off from the works. There are 26 "all night" lamps, 16 of which are arc lamps. These are switched on and off in the same way. Some 4,160 8-c.p. lamps are being supplied at the present time, or will shortly be connected, so that the undertaking starts with excellent prospects.

Although in the main the whole installation is laid down on lines which are well known to all engineers, there are one or two points in which the ordinary practice has been departed from, which are worthy of special attention. The water supply is one of the special points referred to. It was found when excavations for the foundations were in progress that at a depth of about 8ft. from the ground level a large supply of water was met with, and, in fact, this water interfered to some extent with the progress of the works. It was arranged to collect all this water by means of special drains into a large sump, and as the water was found to be of good quality it was decided to use it for feeding the boilers instead of pumping it away, as would otherwise have been necessary. This arrangement obviated the necessity of a well for which provision had been made. Another unusual feature is the method of controlling the street-lighting, the whole of which is switched on from the station. This is effected by six small switches on the works board, which in their turn operate long-range switches (Fig. 10) fixed in various parts of the town.

The borough has been fortunate in its Electricity Committee, who have throughout laboured hard for the success of the scheme under the guidance of their energetic chairman, Councillor J. V. Mainprize. The Mayor and Corporation have consistently backed up the efforts of the committee. The policy of the committee has been a happy mean between that excessive caution which in some well-known instances has greatly hampered the success of similar municipal schemes and the extravagance which has characterised others. Every step has been considered carefully, and nothing has been left undone which could attract consumers or help to make the scheme a success. In the spring an elaborate pamphlet was issued by the Corporation to all householders setting forth the advantages of electricity for various purposes. The whole of the street-lighting has been taken over from the gas company, a step of the greatest importance in the interests of the electricity scheme. The town clerk (Mr. A. E. Matthewman, B.A., LL.B.) and the borough engineer (Mr. E. R. Matthews, A.M.I.C.E.) have thrown themselves willingly into the project, while the consulting engineers (Messrs. F. H. Medhurst, Page, and Lloyd) have spared no pains to produce successful works by the adoption of the best modern practice in all departments. Mr. Arthur J. Beckett was selected in the spring of 1904 as clerk of works, from a very large number of applicants, to supervise the erection of the works under Mr. Medhurst, and on the completion of the works he was appointed by the Corporation as the first holder of the position of borough electrical engineer. His past experience in similar works has stood him in good stead, and the undertaking may safely be expected to flourish under his guidance.

In short, the installation of the works has been marked by a smoothness and absence of special difficulties which has been a source of satisfaction to the consulting engineers, and has led those responsible for the installation to form great hopes for its future.

We are indebted to the consulting engineers, Messrs. F. H. Medhurst, Page, and Lloyd, for the above description and loan of the photographs and drawings from which our illustrations have been prepared.

## ARMATURE WINDINGS OF THE CLOSED-CIRCUIT TYPE.

BY WM. CRAMP.

*(Continued from page 230.)*

### Quadruple Winding Doubly Re-entrant.

Now in Fig. 12 we might (if there were room in the diagram) insert another winding exactly like that already drawn, with the spirals of the new winding occurring alternately with those of the old, just as we did in the cases of Figs. 1 and 10. This would give us 62 spirals upon the armature (in place of 31), a distance-pitch of $\frac{4}{62}$ (instead of $\frac{2}{31}$); and on the armature there would be two windings, each double, and each independent of the other. This additional winding would again double the number of commutator sections, and if the brush were wide enough would simply be placed in parallel with the original winding. We should describe this arrangement as a *quadruple multiple-circuit ring winding doubly re-entrant*, and we should denote it by $\omega\ \omega$. These symbols are in accordance with those used on page 187, and appear to explain themselves, since they denote two independent windings, each of which is in itself double. It will be noticed in the distance-pitch $\frac{4}{62}$ that the winding is quadruple, as shown by the numerator, and the number of spirals is 62, as shown by the denominator, and that these two numbers have a G.C.F. = 2, showing that the winding is only *doubly re-entrant*. Had there been 64 spirals with a distance-pitch of $\frac{4}{64}$, the winding would have been a quadruple winding four times re-entrant, and the armature would have been like Fig. 10, with two extra independent windings added.

### Drum Windings, Multiplex, Various Re-entrancy.

All this applies to ring armatures, and we will proceed to develop the corresponding drums. Using the same construction as before, we shall have 62 inductors as the equivalent of the 31 spirals, and just as in Fig. 12 we start from the spiral numbered 1 and pass to the next spiral but one, so in Fig. 13 (which shows the drum winding) we shall start from inductor No. 1, pass to one under a pole of opposite sign, and then return, not to No. 3, as in the case of a single winding, but to No. 5. In this diagram, where the inductors are numbered separately, the same arguments in favour of the number-pitches being odd apply as in the case of Fig. 8.

Following this scheme through, we find that arriving at inductor No. 61 we begin to pass into the second part of the winding, as shown by the connections 16 to 3, 3 to 20, and 20 to 7.

### Rules for these Drum Windings.

In the particular case illustrated the number-pitches are forward 17 and backward 13, and it will be remembered that in the case of a single winding $y_1 - y_2 = 2$. It is thus clear that one difference between a single and a double drum winding is that, instead of having $y_2 = y_1 - 2$, it becomes equal to $y_1 - 4$.

This rule will be seen to be exactly the same as that numbered 2A above—*i.e.*, $m$ has become in the general case not necessarily the number of *independent* wind-

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ings, but merely the number of windings, where the word "winding" has the definition just given.

Of course, since the drum winding corresponds exactly to the ring, the re-entrancy will be governed by the same rule. It will, in fact, be the G.C.F. of $m$ and of the total number of spirals on the armature. Each spiral may be considered as consisting of two inductors with their connections, from which we get the rule as usually stated for multiplex multiple-circuit drums: *the re-entrancy is the G.C.F. of the number of windings and of half the number of inductors.*

In all other respects these multiple-wound multiple-circuit armatures, whether ring or drum, follow precisely the same laws as already laid down for the multiple-circuit single-wound armature. Thus the ring-wound armature of Fig. 10, if placed in a four-pole field, needs four rows of brushes, and in every respect fulfils the rules numbered 1, 2, 3, 4 on p. 114. Similarly, the arguments as to length of end connections, etc., used on p. 114 apply equally to multiple-wound multiple-circuit drums.

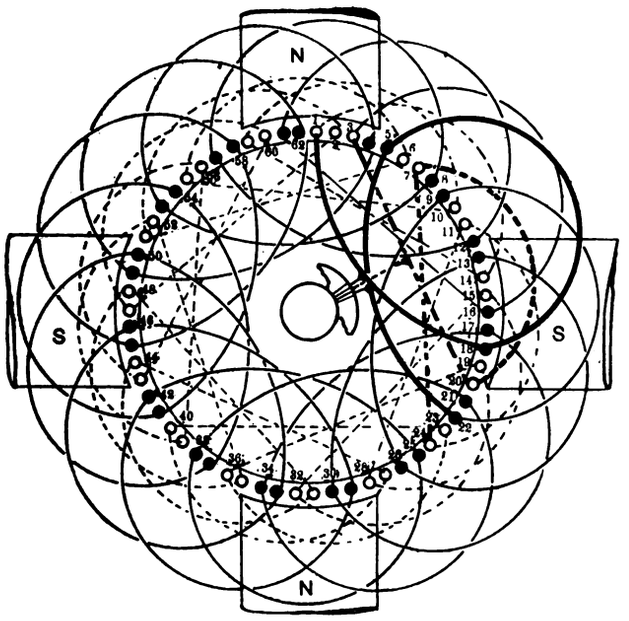


FIG. 13.

Now, as has been said, many writers on drum armatures draw a distinction between *lap* winding and *wave* winding. All the foregoing are lap windings, because having started from a certain inductor and crossed the armature, we *return* (or *lap* back) with a slightly smaller pitch toward the conductor from which we started. This "lapping back" is more clearly seen either by taking a small armature and actually winding a turn or two in place, or by drawing a development of a winding as is frequently done in other text-books. But we think that the system of constantly referring to the corresponding ring winding in the case of all multiple-circuit armatures, leads to a far better understanding of any particular problem than any system of projection or development.

We now append a *résumé* of the laws of multiple-circuit armatures, derived from all those rules previously developed.

**Laws of Multiple-Circuit Windings, Ring or Drum.**

Multiple-circuit armatures are of two classes, ring and drum.

*Ring Armatures.*—A ring winding consisting of $n$ spirals, or sets of spirals, placed evenly about the armature will be a single winding if the distance-pitch from one spiral to the next immediately in series with it is $\frac{1}{n}$ of the total circumference, whether the number of spirals is even or not.

If the *number of spirals is even* and the distance-pitch from one to the next immediately in series is $\frac{2}{n}$ of the total circumference, the armature will be double wound, having *two independent single windings*. It is, therefore, doubly re-entrant and expressed by the symbol o o. Or generally, if it have $n$ spirals having a distance-pitch = $\frac{g}{n}$ of the circumference, and $n$ is divisible by $g$, the winding will be a $g$-fold winding $g$ times re-entrant.

If, on the other hand, with a distance-pitch still equal to $\frac{g}{n}$, the number of spirals be not divisible by $g$, or only by some factor of $g$, say $h$, then we have a $g$-fold winding $h$ times re-entrant. All these windings will have as many sets of brushes as there are poles, and each pair of sets (positive and negative) adds $g$ parallel circuits to the winding.

In reckoning the distance-pitch, it must be remembered that the spirals are assumed to be uniformly distributed around the armature, this being a theoretical assumption. In many ring armatures the actual spirals are grouped in slots, but this need cause no confusion if, in arranging the winding, the smooth uniform armature is first assumed and the grouping arranged after.

Thus, if we have a four-pole machine with a ring armature consisting of 213 spirals, or sets of spirals, and the distance-pitch from one set of spirals to the next immediately in series is $\frac{6}{213}$ of the circumference of the armature, then:

There are two sets of positive brushes and two sets of negative brushes.

The winding is a sextuple winding triply re-entrant, expressed by the symbol $\omega\ \omega\ \omega$, because $\frac{6}{213} = \frac{3}{3} \times \frac{2}{71}$. Each brush must cover nearly six sections of the commutator, and the average number of circuits in parallel at any instant will be 24.

Of *multiple-circuit drum windings* we may say they are necessarily *lap windings*, and follow the same general rules as the ring windings above, being simplex, duplex, triplex, etc., according to the number of parallel paths per pole in the armature.

A duplex or multiplex winding may be singly or multi re-entrant, but this re-entrancy depends entirely upon the number of inductors.

There must be *in all cases* an even number of inductors, which must be a multiple of the number of commutator sections, and in the case of slotted armatures a multiple of the number of slots.

The number-pitches for any singly re-entrant winding must be odd, and consequently for each independent winding, or set of windings, the number-pitches *considered without reference to other windings upon the same armature* must be odd. From this it follows that, for instance, for a double-wound doubly re-entrant armature the number-pitches *may* be both even numbers; but generally odd numbers are taken.

The number-pitches for any number of inductors must differ by a number = 2 $m$, where $m$ is the number of windings.

The re-entrancy is = G.C.F. of $\frac{w}{2}$ and $m$, where $w$ is the number of inductors.

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The forward number-pitch will usually be approximately equal to $\frac{w}{p}$, where $p$ is the number of poles.

The number of sets of brushes is equal to the number of poles, and each brush must cover a number of segments on the commutator greater than $m-1$.

No other formula whatever is necessary for these windings.

Taking as example an armature similar to the ring that we have just considered, we have a drum with 213 spirals or 426 inductors, the number-pitch (which is always more convenient in the case of drum armatures) is $y_1 = \frac{426}{4} = 107$ approximately, $y_2$ will be $= 107 - 2m = 107 - 12 = 95$. Thus it is a sextuple winding, and since the G.C.F. of $m$ $(=6)$ and $\frac{w}{2}$ $(=213)$ is 3, it is triply re-entrant, *exactly as the ring with 213 spirals.* If we wish to know whether an armature with this number of inductors might (with different end connections) be used for a six-pole field, we set about it as follows:

The forward number-pitch will be $\frac{426}{6} = 71$. If we arrange it as a single winding, the backward number-pitch will be 69; if as a double winding, it will be 67; if as a triple winding, 65. As a double winding the armature will be singly re-entrant, since there is no common factor of 2 and 213. As a triple winding it will be triply re-entrant, as 3 divides exactly into 213.

We have said that the forward number-pitch is an odd number approximately equal to $\frac{w}{p}$.

In the above instance we took it exactly $\frac{w}{p}$, but as a rule a better electrical result will be obtained if the mean number-pitch—*i.e.*, the arithmetic mean of the forward and backward number-pitches—is equal to $\frac{w}{p}$. This results in the forward number-pitch being a little greater than $\frac{w}{p}$, especially in the case of multiplex windings.

Thus, in the above example, the forward number-pitch would be better if taken 73 (instead of 71) with a backward number-pitch of 69 (instead of 67). This gives the mean number-pitch $= \frac{69+73}{2} = \frac{142}{2} = 71 = \frac{w}{p}$.

With the double winding $y_1 = 71$ and $y_2 = 67$ the mean number-pitch is only 68, but the other arrangement is better. The reason for this is as follows:

In a fairly uniform field with the ratio pole-arc ÷ pole-pitch large, if the mean number-pitch be less or greater than $\frac{w}{p}$ a certain differential action takes place, resulting in some inductors included between any pair of brushes generating an electromotive force opposite in direction to the current in that section of the armature. This may easily be seen by drawing out a drum armature with an extremely short mean number-pitch.

The greatest number of usefully active inductors is obtained always with a mean number-pitch $= \frac{w}{p}$. In some cases, however, the advantage gained by shortening the end connections more than counterbalances the disadvantages of the smaller mean number-pitch, particularly when the pole-arc is less than 80 per cent. of the pole-pitch.

An actual example, showing how the above laws may be applied in practice, may here be of interest.

A certain four-pole machine was required to give an output of 2 kw.—viz., 9 volts 220 amperes. On referring to the standard 2-kw. machine, it was found that there was room to fit a commutator large enough to carry the above current, and it was also known that the most favourable position on the magnetisation curve was where the number of magnetic lines passing through the armature per pole was $10^6$. The speed of the machine was 1,200 r.p.m., and the number of slots in the standard armature was 60. It was assumed that the electromotive force (allowing for fall of potential due to armature resistance, armature reaction, and possible belt slip) which must be developed by the armature was equal to 11·5 volts.

From the formula:

$$\text{No. of armature inductors} = \frac{\text{electromotive force} \times 10^8}{(\text{revolutions per second} \times \text{armature lines})}$$

we find that the number of armature inductors necessary will be 58, and the nearest number to this which is possible with the number of slots at our disposal is 60. Now, with a reasonable current density, the minimum size of solid wire which could be used would be No. 7 S.W.G., and the armature if wound with this gauge will have 60 inductors, a forward number-pitch of 15, with a backward number-pitch of 13, and a maximum number of commutator sections 30. But this small number of commutator sections will most certainly lead to serious sparking. We decide, therefore, upon a double winding giving double the number of sections. The winding becomes

| | |
|---|---|
| Inductors | 120 |
| Forward number-pitch | 31 |
| Backward number-pitch | 27 |
| Number of commutator sections | 60 |
| Gauge of wire (if solid) | No. 11 S.W.G |
| Re-entrancy double | symbol o o |

It will be noticed that besides the commutation advantages secured by this double winding, we have also a much easier gauge of wire to wind, and consequently a better distribution in the slots.

A double winding which is doubly re-entrant has always this advantage over a double winding singly re-entrant, that in case of an accident to one winding the other still continues to do its work.

This example only emphasises the value of a knowledge of these various winding schemes. When one becomes accustomed to dealing with all sorts of simplex and multiplex arrangements, it is astonishing to find how flexible a given machine may be in respect to the division of its output into volts and amperes The dimensions of the commutator, as a rule, are the limit, and the powers of any given design in this respect are much increased if the number of standard slots and sections is wisely chosen, thus enabling the same armature to be used for either a multiple or two circuit winding. This will become more clear after the study of the next chapter.

If after following the rules and explanations here given unforeseen difficulties occur in dealing with multiple-circuit drum armatures, we think such difficulties will immediately disappear if the course already recommended of setting out the corresponding ring winding be followed.

We shall, therefore, now leave these windings for what are termed *two-circuit or "wave" windings.*

*(To be continued.)*

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## APPLICATION OF ELECTRICITY TO MINES.*

BY A. C. ANDERSON, STUDENT.

### PREAMBLE.

There is no longer any need to discuss the advisability of using electric energy for light and power in mining work. One can hardly pick up a technical paper nowadays without coming across a note to the effect that electricity is to be installed in some mine or that such an installation has established its superiority over other systems of driving. Steam is impossible owing to the prodigious condensation losses in lines of piping. Compressed air, electricity's only formidable rival for power, is still finding favour in some places for coal-cutting machinery, but even then the compressors are electrically driven, the compressed-air gear being purely subsidiary to, and a part of, the electric installation. Extensions are very easy on this system, as the compressors may be readily moved forward. At the Wharncliffe Silkstone Colliery, which has upwards of 800 h.p. in compressed-air plant installed, a change is being made in favour of electrical driving, as the efficiency of the present system is only about 30 per cent. In the case of the St. John's Colliery, Normanton, Yorks, also, electricity has proved more economical and convenient than compressed air. It has been argued that the exhaust from pneumatic motors has a beneficial cooling effect, but the proportion of the exhaust air to the main current flowing is so small as to hardly affect the temperature. The South Staffordshire Mines Drainage Commission, which commenced nearly two years ago to drive its surface pumps electrically, has found the results very satisfactory. It has reported that there has been less time spent in pumping, and that a further decrease is expected as steam is replaced more fully by electricity. Mr. Henry Hall (H M. Inspector of Mines for the Liverpool and North Wales district), in a report on mines and quarries issued by the Home Office, states that no accidents during 1903 were attributed to electricity, while rapid progress was made in its application to pumping, coal-cutting, and hauling. It would be a very excellent thing if the use of horses below ground could be entirely eliminated; they are most undesirable from the hygienic standpoint. Much has been done; both in the conversion of existing plant to electric driving and in the laying down of new installations. Satisfaction has been practically universal, and there can be no doubt that a great field has been opened for the enterprise of makers of electrical machinery for use in mines. In special circumstances, such as these, it must always be borne in mind that electricity is a "risk," like any other form of energy, and must be treated with due care. "Good work" should be the motto of an electric mining installation. The man who sacrifices efficiency and reliability to cheapness is courting disappointment and possible disaster. But given a sound, efficient system, carefully installed and properly handled, there cannot fail to be an appreciation of the advantages appertaining to electric transmission. Accidents occur, of course, but are almost invariably due either to bad workmanship in the construction of the plant or to carelessness on the part of those in charge of it, and are simply parallels of those which crop up in the use of any other system. Frequent reference is made below to the rules formulated by the Committee of Enquiry on the Use of Electricity in Mines, and throughout they are mentioned shortly as the "new rules."

### CHOICE OF A SYSTEM.

The mine owner or manager who wishes to instal electrical plant is immediately confronted with the question as to system. He wants the utmost efficiency and reliability, and these with a low capital expenditure and small maintenance costs. He will probably have received a large amount of contradictory advice as to the respective merits of direct current and three-phase alternating, and it is to be feared that the progress of electricity in mines is somewhat hampered by the inability of the non-electrical man to decide for himself on the best system for his special conditions. Opinion on this point is very divergent. Three-phase, though costly to produce, owing to the relatively poor power factor, is the cheapest to instal, given material and workmanship of equal quality.

From the results of experience it seems to have the greatest freedom from breakdown, with consequently reduced maintenance costs; moreover, it is very efficient in the generation, distribution, and transformation of energy in the main, but it is much hampered by line losses at low load and fall of pressure due to starting of motors. It is urged that by the use of induction motors sparking is entirely obviated, a point of paramount importance in fiery mines. Certainly the possible sparking at the commutator of the direct-current motor is got rid of, but there always remains the chance of a break in the mains or failure of the windings.

Moreover, the direct-current machine may be made gastight, and though sparking in such motors when driving coal-cutters may not be absolutely eliminated because of the excessive vibration, it is thereby rendered harmless. For haulage plants, motor-generators or converters are necessary with an alternating system, and batteries in the mains are out of the question. The small air-gaps in polyphase motors necessary for a good power factor necessitate the closest and most frequent inspection to prevent trouble. They are hardly suited for the drastic conditions of coal-cutting. Coal-cutters are also very disadvantageous to three-phase motors owing to the constantly varying load and consequent fluctuation in line pressure. This is sometimes so serious as to make it necessary to have separate plants for power and lighting. Such complication as this entails is very prejudicial to the employment of alternating currents. The excessive starting current taken by induction motors can only be made light of when the generating plant, etc., is relatively very large. With a well-designed squirrel-cage rotor a fair torque is obtained at starting, but the rush of the current is far greater than for a direct-current motor giving the same starting effort. A heavy line drop is thus inevitable unless a special expenditure is made in cables. Resistances cannot be done away with in connection with induction motors, but in place of a separate box they may be arranged in the rotor itself, or some pole-changing device may be adopted. This, however, will probably mean additional slip-rings and contacts. It would appear that fuses rarely blow on overloading of three-phase motors, as the windings exert a choking-coil effect, which keeps the current within certain limits. Variable speed with alternating motors is a most difficult problem, and proscribes their use to a large extent. It is an absolute necessity with fans, as the air supply must be capable of nice regulation. Moreover, one is rather restricted in the choice of speeds with three-phase motors. Alternating motors are very good when they can be run on constant load at constant speed, conditions met with in certain classes of pumping work, etc. By-passes can easily be arranged on the pumps to allow of gradual starting. A single-phase system, if it could be made practicable, would be most suitable for mining work. Three-phase alternating is quite unsuitable for locomotive traction in mines where trolley wires would be permitted, and no other form of alternating current is at present admissible for general use. It would be reasonable in some cases to transform from alternating to direct current by means of rotaries or motor-generators, more especially if the frequency of supply was 50, or thereabouts. For a large scheme, such as where several pits are fed from one central station above ground, an alternating system would unquestionably be adopted, at any rate for transmission. Continuous current is eminently suitable for large machines, such as winding and haulage gears, and large pumps, owing to great comparative ease of starting and regulating.

Speed variation is practically essential in most of the departments of mining work, and can now be accomplished very economically with direct-current machinery. In addition, a continuous-current system gives far better results on varying load (also an essential of mining work) than an alternating one. It seems to me that rather too much stress has been laid on commutator sparking. Arcing in switches is unavoidable in any case. It has been said—by Mr. Hall, I think—that the direct-current motor cannot be entirely enclosed, a fact cited as showing a distinct

* Paper read before the Birmingham Local Section of the Institution of Electrical Engineers.

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advantage of the induction motor. There is no reason whatever why a continuous-current motor should not be completely enclosed if it is properly rated. For coal-cutting there is no motor giving a more efficient starting torque than the direct-current series type. When fuses blow with overloads on continuous-current motors driving coal-cutters, the men in charge, disliking the frequent stoppages, apparently have a knack of substituting larger and larger fuses, resulting finally in a burn-out of the armature, causing a serious waste of time. Unfortunately, this sort of thing is very difficult to put down. In the evidence given before the Departmental Committee on the Use of Electricity in Mines, it was stated on behalf of a company insuring electric plant at collieries, that 85·7 per cent. of accidents to dynamos and motors occurred in armatures or commutators, these mishaps being chiefly due to overloading. Mr. H. M. Hobart says that a continuous-current motor for coal-cutting would for a given output and speed have a smaller diameter, a much deeper air-gap, a higher efficiency, and a lower temperature rise than a polyphase motor for the same work. Further, the regulation would be much more suitable for lighting circuits.

The E.M.F. of an alternating system is much more flexible than that of a direct-current one; it is so easy to step up or down with static transformers, but it must be remembered that the frequency suitable for power is not suitable for lighting, a very important consideration, and one which by the introduction of further complication is likely to neutralise largely the copper economy incidental to the use of alternating currents. A direct-current plant for 500 volts, in the case of comparatively small plants, on the concentric system with earthed return is very good and elastic for all classes of work, but the choice of a system must really rest on the special circumstances of the particular case.

### Voltage, etc.

In the evidence rendered before the Mining Commission the majority of witnesses were agreed on limiting the pressure to from 500 to 600 volts at the actual workings. This seems really too cautious when compared with Continental practice. To quote one instance among many, at the Gneisenau Colliery an asynchronous motor receiving current at 2,200 volts is driving a pump situated 1,476ft. below the surface. The advantages of high-tension transmission in connection with mining are doubtful unless there is a large area to be supplied from one central station, necessitating considerable lengths of line on the surface. The new rules merely allow 650 volts as a maximum for motors or transformers up to 75 h.p. capacity. Consequently, when considering the question of single collieries with closely situated shafts, a 2,000-volt system, say, with its inevitable complication and increased first cost, owing to necessity for special insulation and transforming devices, is distinctly inadvisible, as not only will the economy in copper be swamped by the disadvantages named, but also a small proportion of the whole system will be worked at the high pressure. With a large and widely-distributed scheme, however, a three-phase high-tension system of transmission is admirable and absolutely necessary for the best commercial results; the considerable gain in copper much more than compensates for the extra apparatus necessary. With regard to the danger objections, it has been argued that the knowledge of the use of a high pressure tends to make men more careful. This would seem to be a somewhat neutral advantage. In alternating practice a low frequency of about 25 should be adopted for power circuits, and for lighting certainly not less than 45 to 50.

### Generating Plant.

In the ordinary way special consideration of this portion of the installation is hardly necessary, as it is nearly always placed on the surface, and is of the same nature as that in any other power station. But large size generators for mining work will most generally be required of the low-speed type, as colliery engineers much prefer to use horizontal engines for driving, as being machinery with which they are more familiar. High-speed engines of the type now almost universal in our central stations are, of course, perfectly suitable for mines, but it is somewhat difficult to persuade mining engineers to use them owing to the necessity of having a special staff of mechanics to look after them properly. Dynamos of over 250 kw. capacity would probably be coupled direct to the prime movers, machines of a less output being rope-driven. Without question all generators should be liberally rated. Machines intended for use below ground, including rotary transformers or motor-generators, have specially to be designed for ease of transport. They should be as absolutely reliable as possible, both electrically and mechanically, and should be subjected constantly to the most thorough supervision. The new rules have specially provided for the proper installation and care of the generating plant. It is to be isolated, an ample sufficiency of room is stipulated for each set, and all machines at a pressure higher than 250 volts are to have their frames efficiently connected with earth. It is to be hoped that there will no longer be any of that cramped huddling together of machinery which, unfortunately, so often characterises mining installations.

### Distribution.

The distribution system, comprising wiring and switch-gear, is from every point of view by far the most important factor in an electrical mining installation. The few isolated cases in which mining managers have actually condemned electricity as unsuitable have been almost entirely created by shoddy workmanship and thoughtless design in the wiring scheme. It is absolutely essential for the successful adaptation of electricity to mining that the system of wiring, with its controlling gear, should be as "solidly" installed as possible with the greatest care and the best material, due regard being paid in the design to any special circumstances. For continuous-current work concentric cables with the outer conductor earthed have proved very satisfactory, but the new rules prohibit earth circuits in the main, and the neutral point of a polyphase system may not be earthed until the district inspector of mines has been formally notified. All metallic sheathings and armourings should unquestionably be properly connected with earth. In an alternating system care must be exercised in the use of metallic armourings or the laying of cables in iron pipes, to minimise, as far as possible, inductive effects. Three-core cables should be used, not triple-concentric, and the algebraic sum of the currents must equal zero, as otherwise the inductive effects of the three cores will be unequal, and there will be a loss in efficiency. Moreover, in special cases, where for some reason direct-current and alternating mains have been laid in the same pit, great care must be taken to avoid the mutual effects of self-induction. The most favourable means of laying cables varies largely with circumstances. Bitumen-filled troughs are very good, but can very rarely be used in mining work without an additional armouring of the cables. Insulation consisting of paper or jute sheathed with vulcanised fibre or vulcanised bitumen with a double armouring of galvanised steel wires, is very good for difficult situations. Opinions, however, vary widely as to the protective covering to be adopted. Trailing cables for use with coal-cutters and portable drills present a very difficult problem. It is a hard matter to combine proper flexibility with sufficiently strong and reliable armouring. Some engineers use oak or teak casing in taking the mains down the shaft, others clamp with massive wooden cleats, and in the case of a brick-lined shaft, lewis bolts may be used to sustain the clamps. On the other hand, loose suspensions are often preferred, as giving the cable a better chance of withstanding mechanical shock. Joints in the cable are best made in connection boxes, which may, of course, at the same time contain switches or fuses. It is a moot point as to whether roof suspension is better than an arrangement on the sides or in the floor. It really depends on the relative strength and general suitability of these three alternatives. Certain it is that unless proper means are taken to prevent it, a fall of roof will probably break the cable suspended therefrom—a very dangerous possibility in a "gassy" mine. With a roof suspension some arrangement should be made such as that adopted at the Hulton Collieries, Bolton, where the cables are loosely suspended from the roof by

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means of spun yarn, so that in the event of a fall no undue tension is put on another part. The floor would seem at first sight to be the best place for the mains, but it is frequently very uneven. It should not be possible for any circuit to be opened in the presence of an inflammable gas—that is to say, all boxes enclosing switches and fuses to be used in the dangerous sections of a mine should be gastight. Further, the switches are better immersed in oil. With regard to the general control of the scheme, it is best to arrange a disconnection box to ground cables at the top of the shaft and a distribution board with switches and fuses immediately at the bottom. Switchboards of the skeleton type, where there is really no "board" at all, are excellent for straightforward work, as every detail can be so readily inspected. Mr. Roslyn Holiday, of the Ackton Hall Colliery, makes his own switch-boxes for attaching to coal-cutter motors They are fitted with an accurately-machined cover and a cement joint. The switch handle works into a box through a gland. The voltage is 320, and there has been no sparking trouble. The more complex forms of gear, especially motor-starting rheostats, should be designed for the utmost reliability and ease of working. The movement of the switch arm over the contacts should be restrained in order to reduce the risk of an armature burn-out, an accident which should be rendered still more improbable by the use of proper protective devices in circuit with the machine. All metallic boxes, etc., should be earthed.

*(To be continued.)*

## SOME ELECTRIC LIGHTING TROUBLES WHICH MIGHT BE AVOIDED.

BY ALFRED H. MAYES.

Those who have had considerable experience of electric lighting installations can scarcely fail to have observed that the causes of breakdown or other trouble are comparatively few in number, and, consequently, the same class of fault presents itself again and again. Short-circuiting in lamp-holders is a prolific source of destruction to lamps, and frequently of far more serious damage. The cause is generally a stray strand from the end of the duplex conductor, which finds itself free from the remaining strands and manages to make contact with the opposite pole. The remedy for this trouble is simply to exercise more care in fixing the bunches of fine strands in their respective terminals. By far the most satisfactory plan is to burn off the insulation, which can be done without injuring the wires in the slightest degree, and then to tightly twist the strands into the semblance of a solid conductor, using the finger and thumb only for the operation. Should the pliers be brought into requisition for this purpose, the fine wires will certainly be bruised or broken, and the difficulty we are seeking to guard against will result.

The difficulty of obtaining a sufficiently high insulation resistance between the poles of the whole installation is not an unusual trouble, and is sometimes due to a little-suspected cause—that is to say, the employment of a cheap class of poorly-insulated duplex cord in some of the fittings. When one realises that the positive and negative poles of the system are closely twisted together, the necessity of high-class flexible cord is at once apparent, especially so in damp or exposed positions.

Serious loss and annoyance to users of the electric light is frequently caused by the "blowing" of sub- or main fuses. Whilst fully recognising the importance of not providing too much carrying capacity in fuses, it must also be borne in mind that if the capacity is cut too fine, that the premises may be plunged into darkness owing to a momentary and trifling increase in the supply voltage, and this frequently happens, causing much difficulty to the unfortunate consumer, who frequently has trouble in obtaining the services of an electrician to put matters right, especially should it occur late at night.

As anything tending to bring electric lighting into disrepute is strongly to the disadvantage of wiring contractors, attention to the foregoing hints will be amply repaid by increased satisfaction to users.

## INSTITUTION OF ELECTRICAL ENGINEERS.

The following candidates were elected at the ordinary general meeting on the 23rd ult. :

*Member.*—C. L. Edgar, Edison Electric Illuminating Company, Boston, Mass., U.S.A.

*Associate Members.*—J. Askew, 17, Moore-street, Preston, Lancs.; W. Briggs, 90, Camperdown-road, Scotstoun, Glasgow; J. W. Hadfield, Electricity Works, Castle-street, Barnstaple; D. Huntley, 70, Loveday-road, West Ealing; J. S. Morton, Corporation Electricity Works, Ashton-under-Lyne; G. R. J. Parkinson, 24, Wellington-road, Bilston; J. S. Peck, British Westinghouse E. and M. Company, Trafford Park, Manchester.

*Students.*—H. R. Ainsley, Faraday House, Charing Cross-road, W.C; E. Barraclough, 36, Hermitage-road, Crumpsall, Manchester; K. D. Bullpitt, The Mount, South Norwood-hill, S.E.; J. A. Cook, 12, Willowbridge-road, Canonbury, N.; H. Corney, 107, Jesmond-road, Newcastle-on-Tyne; T. C. Dunne, 5, Desmond-street, S. C.-road, Dublin; A. V. Ferguson, 6, Suez street, Warrington; H. O. M. Gammon, 25, Hawke road, Upper Norwood, S.E.; C. E. Garratt, The Uplands, Hagley, Worcestershire; E. W. Heathcote, Sunnyside, Erdington, Birmingham; L. B. Hewitt, Faraday House, Charing Cross-road, W.C.; C. Hobson, Kinrara, 93, Union-road, Clapham, S.W.; R. H. F. Houston, 1A, Ovington-square, S.W.; H. T. Jager, North View, Snakes-lane, Woodford Green, Essex; R. D. Jenner, 5, Bedford-street, Chorlton-on-Medlock, Manchester; D. Knowles, 8, Marshall-place, Cheetham, Manchester; T. S. Lacy, Saumarez, Sunninghill, Ascot; A. W. Lambourne, Bloxham House, Harborne, Birmingham; W. T. Massey, 4, Lee-grove, Salford, Manchester: M. Mercer, Bank Villas, Preston New-road, Blackburn; E. R. Myers, 6, Moreton-avenue, Stretford, Manchester; H. Pearce, Normanhurst, The Butts, Brentford; T. S. Pipe, South View, St. Saviour's road, Saltley, Birmingham; W. A. Pitts, 124, Cecil-street, Whitworth Park, Manchester; W. Rodger, 139, Morrin-street, Springburn; J. E. Roberts, 42, Albert-street, Rugby; H. M. W. Royce, 208, Plymouth-grove, Manchester; F. C. Russell, 303, Burton-road, Derby; C. E. Savage, Electric Power Station, Springsmire, Dudley; R. Savarimathen, Central Technical College, Exhibition-road, S.W.; R. Shaw, 7, Summerside-place, Bonnington, Edinburgh; T. M Taylor, Rosendale, Newcastle, Staffordshire; T. L. B. Westerdale, 13, Rectory-place, Woolwich, S.E.

## FORTHCOMING EVENTS.

FRIDAY, MARCH 3.

**North-East Coast Institution of Engineers and Shipbuilders (Newcastle).**—At 7.30 p.m., special meeting to consider the present Board of Trade Regulations for Certificated Marine Engineers, and to suggest certain modifications.

**Royal Institution.**—At 9 p.m., "Recent Advances in Wireless Telegraphy," by the Chevalier G. Marconi.

**Institution of Electrical Engineers (Leeds Section).**—Annual dinner.

**Junior Institution of Engineers.**—At 8 p.m., "Possible Improvements in Locomotive Practice," by Mr. W. Longland.

MONDAY, MARCH 6.

**Faraday Society.**—At 8 p.m., "Recent Developments in Electric Smelting in Connection with Iron and Steel," by Mr. F. W. Harbord.

**Society of Arts.**—At 8 p.m., "Internal-Combustion Engines" (Lecture IV.) by Mr. Dugald Clerk.

TUESDAY, MARCH 7.

**Institution of Civil Engineers.**—At 8 p.m., resumed discussion on Mr. R. W. Allen's paper, "Surface-Condensing Plants, and the Value of the Vacuum produced."

THURSDAY, MARCH 9.

**Institution of Electrical Engineers.**—At 8 p.m., report on experiments carried out at the National Physical Laboratory: "On the Effect of Heat on the Electrical and Mechanical Properties of Dielectrics," and "On the Temperature Distribution in the Interior of Field Coils," presented by Dr. R. T. Glazebrook, F.R.S.; "On Temperature Curves and the Rating of Electrical Machinery," by Mr. R. Goldschmidt.

FRIDAY, MARCH 10.

**Institution of Electrical Engineers (Manchester Section).**—At 7 p.m., annual dinner.

**Royal Institution.**—At 9 p.m., "The Structure of the Atom," by Prof. J. J. Thomson.

SATURDAY, MARCH 11.

**Junior Institution of Engineers.**—At 3 p.m., visit to the New Ritz Hotel, Piccadilly, to inspect the "cage skeleton system" of constructional engineering.

**Birmingham Electric Club.**—At 7 p.m., "Electric Lifting Machinery," by Mr. E. C. R. Marks.

**Royal Institution.**—At 3 p.m., "Electrical Properties of Radio-active Substances," by Prof. J. J. Thomson.

**Institution of Civil Engineers.**—On March 22, at 7 p.m., annual dinner at Merchant Taylors' Hall. Sir Guilford Molesworth, president, in the chair.

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THE
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### TO CORRESPONDENTS.

*All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

*All communications intended for the Editor should be addressed* C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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## EVOLUTION IN ELECTRICAL DISTRIBUTION.

In the *London Gazette* of Nov. 25 last appeared the customary advertisement relating to application to Parliament for "power to establish stations and works for the generation and supply of electricity, etc., in the counties of Middlesex, Surrey, Essex, and Kent, and the administrative county of London . . ." This has been termed a mammoth power scheme, and it is. Its promoters have carried out a large scheme on the Tyneside, and we presume the experience thus gained leads them to the desire to tackle the Metropolis. The scheme may be good, bad, or indifferent; neither of these phases are we now going to discuss, much less to decide. The time, however, is ripe for the consideration of the subject generally, leaving special cases for the future. Assume for a moment that mammoth distribution schemes are in the natural order of things, and are better than aught that has gone before—that is, are more economical or efficient, for the product remains the same whether obtained from a large or a small installation. How is this advanced step in the evolution of the electrical industry going to affect what exists? Some of us, perhaps, are just old enough to recollect the inception of electric lighting, in the attempt and failure to light a street of Paris by battery power. For years after this lighting lapsed, except in a few instances for lighthouse purposes. Wilde, Siemens, and others worked to replace the battery by the dynamo, but electric lighting did not progress till Gramme on the one hand and Jablochkoff on the other provided, the one the machine, the other the candle. Then came a race of Titans. Who would be first, and who would succeed? The exhibition of 1881 at Paris opened the eyes of the world to the possibilities of the new system of lighting. There the arc was accompanied by the incandescent form of lamp, and experts had learned how simply and effectively the work could be done. We do not say the machines or the lamps were then perfect, but those who had studied the question knew the thing was possible, and that the experience gained in use would improve and hurry details towards perfection. The cry was, we can do it; let us do it; and the storm of opposition was roused. Gassites opposed the use of public money and laughed to scorn the possibility of electricity ever successfully contending with gas. The supporters of electricity were emphatic, but money to really test the matter was not easily forthcoming. We do not suggest that those who preached the perfections of gas were not in earnest, for history tells us that when in the early part of last century the attempt was made to introduce gas lighting, the opposition was just as violent and just as uncompromising. It may not be out of place to quote lines written nearly half a century ago about the opposition to gas lighting:

> "Only half a century since,
> Fifty years or so,
> Safely through our London streets
> At night, you could not go;
> Oil lamps, and Charlies,
> Strove with thieves and night;
> The public got the worst of it,
> And called for better light;
> When straight a cry was heard,
> 'No popery—no mass—
> Our glorious Constitution—
> No gas—no gas!'"

Time passed, money for small and for private installations was forthcoming—these invariably showed that the faith of electrical engineers was well grounded. At last, after herculean efforts, municipalities began to realise that companies or themselves would have to undertake the work of generation and distribution, for the demand for this kind of light was growing, and the multiplication of small plants was inefficient and uneconomical. We thus

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come to schemes initiated and carried out for lighting whole districts. At the present time such installations run well into hundreds. The new departure practically argues even these schemes are too small, and that they should be replaced by larger schemes. Supply in bulk is the watchword. What of it? It must be remembered here that a step in progress is accentuated by the demand for power, and that this demand is rapidly overshadowing the demand for electrical energy for merely lighting purposes. The subject is a large one, and cannot be dealt with wholly in a short article. Take two points. Assume half a dozen towns, say within a circle of a dozen miles radius, each having its own electricity works, each having embarked £100,000 in those works. A promoter comes along and suggests a mammoth scheme to supersede the half-dozen. His contention is that he can supply in bulk to these centres cheaper than they can generate for themselves. Is it a necessity of progress that these half-dozen works go the way of the many little private installations, and be more or less consigned to the scrap heap, and the cost written off as a bad debt? Of course, the answer depends on simple arithmetical calculations which as yet have not been clearly proved. The other point we can refer to is whether really a mammoth scheme is more economical than a smaller one, though of considerable size. The answer to this is also an arithmetical calculation, which must be solved for each particular case, but we can at once say that in many cases the mammoth scheme would have no economical advantage over the smaller schemes. If the aid of Parliament is to be invoked, the greatest precautions should be taken to safeguard capital already involved unless it can be unmistakeably proved that the new step is sufficiently economical to counterbalance the loss involved.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### TELEPHONE PURCHASE.

SIR,—On Feb. 24 you were good enough to grant me space for a letter on this important subject, in which I demonstrated that (1) the proposed agreement meant the continuance of high rates till 1911 at least, without any indication as to what would happen thereafter, and (2) that it would make ducks and drakes of the existing municipal exchanges. I now propose to show that it is calculated to do the same with the Post Office itself. The maximum and minimum schedules of rates between which the company may oscillate at will constitute the ingenious device for compassing this end. The maximum schedule enables the company to maintain its high rates in non-competing centres; the minimum enables it to undercut the corporations and victimise the Post Office. One would imagine that the object of a minimum schedule would be to prevent the company undertaking unremunerative business to the injury of its successors, if not of its competitors. If this is not its object, what possible excuse can be advanced for such a schedule? Well, under the proposed minimum schedule the company is empowered to make contracts for two-party lines, and party lines serving three, four, or more subscribers for a first and last charge of ½d. for each outward call (inward calls being free), provided the receipts per subscriber do not fall below 20s. per annum. Thus a two-party line may produce £2 per annum, a three-party £3 per annum, and so on. No limit is placed on the length of such a line, which may extend to five or ten miles. Sir William Preece, in giving evidence for the Post Office before the Select Committee of 1898, said (Question 5,376) that on a five-party line it would be necessary to receive £4 per annum from each subscriber, or £20 in all, in order to make a profit of 12s. per subscriber per annum. That is to say, the working expenses would amount to £3. 8s. per subscriber per annum. He says that a yearly rental of £2, with 1d. calls amounting to another £2, are required to make such a line pay. Under the minimum schedule in the agreement the total receipts from such a line may be only £5, equivalent to a loss of £15 on Sir William Preece's figures. For a two-party line costing at least £40 to construct, according to Post Office figures, and costing at least £5. 5s. to work and maintain, the proposed income is £2! The Post Office charge for a two-party line is £3 per annum for each party, and 1d. per call (with a minimum of 30s. per annum), which gives them a certain revenue of 10s. in excess of Sir William Preece's estimate. The cheapest telephone system working is probably that of the States of Guernsey. The accounts of the Guernsey undertaking for 1904 show that the average working cost per telephone in the island was £3 1s. 11d. Supposing Guernsey let their telephones at 20s. per annum each, the handsome profit they would make would become a deplorable loss. So the company is to be free to build up a business of an absolutely ruinous character, and in 1911 to say to the Post Office, "These lines have cost us £40 each; please pay us back that amount." And the Post Office will be obliged to do so, less depreciation. Their first act will then no doubt be to give notice to such unremunerative subscribers to terminate contracts, but the taxpayer will have paid for plant which will lie derelict and useless. The prime intention of the minimum schedule is no doubt to enable the company to undercut the corporations, as I have already pointed out, but it also permits it to torpedo the Post Office itself. In 1869, when the telegraphs were purchased, the amount to be given depended on the mileage of wire existing at the date of transfer. There are officials in the Post Office to-day who were then employés of the various telegraph companies, and who still boast of the great deeds they performed in erecting hundreds of miles of useless wire between the date of agreement and the date of transfer for the Post Office to buy at three or four times its value. Similarly, when 1911 looms near the possibilities afforded by the minimum schedule for erecting plant will be sure to present themselves. Cheap telephones will have a tremendous spurt, and there will be a large if not choice assortment of 20s. subscribers, at £40 or £50 per line, for the Post Office to buy! But this is not all. Under Clause 9 (3A) *any* charges which the company may have in force at the date of the agreement are legalised, in spite of the schedules. In non-competing centres charges in excess of the maximum schedule exist; in competing centres charges below even the amazing minimum schedule are rife, all of which may be continued till 1911 and then handed over to the Post Office.

Other objections may and will be taken to this loose and ill-digested agreement, but consideration for your space deters me from touching upon more than one—I do hope that the clause referring to the company's staff will be reconsidered. Salaries have ruled very low, work has been hard, responsibility has been great. Hundreds have spent their best years—many count a quarter of a century—in the service. It is said—I know not how truthfully—that their own superannuation fund will not be available. But certainly, under Clause 8, the Post Office proposes to cast them adrift, or at least to give compensation, if at all, as a mere favour and not as an obligation. Surely this is not just and not what the British public would desire.—

Yours, etc, A. R. BENNETT.

## DIESELHORST-MARTIN TELEGRAPH AND TELEPHONE CABLES.

Following is a description of the Dieselhorst-Martin system of making dry-core telegraph and telephone cables. We understand that these cables are being used in very large quantities by the British Post Office, as it is recognised that only with cables made on this system is it possible to superimpose circuits with entire freedom from cross-talk.

The cores are made up of more than one pair by successive twinning operations, thus: (A) one insulated con-

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ductor twisted with another insulated conductor to form a pair; (B) two pairs, made as in A, twisted together, to form a core of four wires; (C) two four-wire cores, made as in B, twisted together to form a core of eight wires; (D) two eight-wire cores, made as in C, twisted together to form a core of 16 wires; and so on. The length of lay is varied throughout, and a number of 4, 8, 16, etc., wire cores may be stranded into a cable, all being alike, or some of one and some of another size, while pairs or larger cores may be wormed between the main cores of the cable.

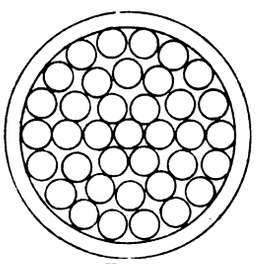

FIG. 1.

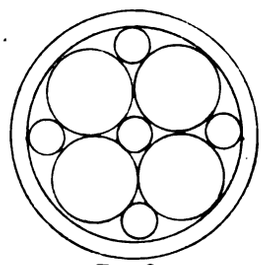

FIG. 2.

A 74-wire cable made up in the ordinary way is shown in section in Fig. 1. It is made up as follows: centre, 1 pair; first layer, 6 pairs; second layer, 12 pairs; third layer, 18 pairs—total, 37 pairs. Compare the above with the 74-wire cable made up on the Dieselhorst-Martin system (Fig. 2). This cable is made up as follows: centre, 1 pair; first layer, 4 16 wire cores; worming first layer, 4 pairs—total, 37 pairs. One of the 16-wire cores is shown in diagrammatic form in Fig. 3, which shows how the conductors are twisted together.

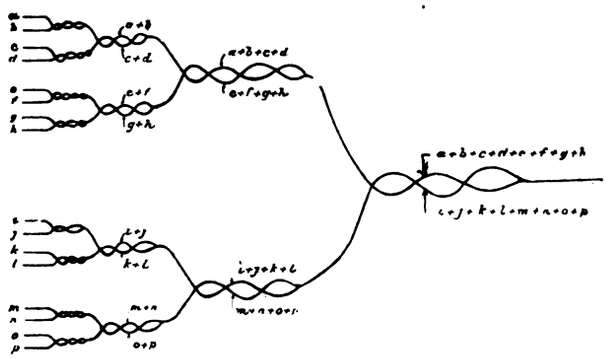

FIG 3.

If each conductor weighs 100lb. per mile, we may obtain from any one core of 16 wires the undermentioned loops: eight loops with conductors of 100lb. per mile, four loops with conductors of 200lb. per mile, two loops with conductors of 400lb. per mile, one loop with conductors of 800lb. per mile. It is important to notice that the loops of any one group will not interfere with the loops of the same or any other group, since they are twisted independently with different lengths of lay. The four 16-wire cores shown in Fig 2 might also be used as two loops of 1,600lb per mile each, or as one loop of 3,200lb per mile. It is found that, in any operation of bunching or grouping as described above, the increase in the electrostatic capacity is small compared with the decrease in the electrical resistance, the increase in capacity measured between wire and wire being only about 30 per cent.

The following table, showing the decrease in K.R. as the grouping proceeds, is compiled from the results of actual tests.

L = one conductor of the loop. $L^1$ = the other conductor of the loop.

| L. | $L^1$. | Resistance of loops in ohms per mile. | Electrostatic capacity per mile between conductors. | K.R. per mile of loop. |
|---|---|---|---|---|
| $a$ | $b$ | 11 | ·056 | 616 |
| $a+b$ | $c+d$ | 5·5 | ·073 | ·402 |
| $a+b+c+d$ | $e+f+g+h$ | 2·75 | ·098 | ·270 |
| $\left\{\begin{matrix}a+b+c+d+\\e+f+g+h\end{matrix}\right\}$ | $\left\{\begin{matrix}i+j+k+l+\\m+n+o+p\end{matrix}\right\}$ | 1·375 | ·135 | ·186 |

By the successive twinning system of constructing cable core, therefore, circuits of lower K.R. than one pair may readily be obtained, and because of the differential twinning of the components, the circuits so obtained will be free from overhearing. In addition to the advantage of being able to obtain loops of low K.R., the cores made by successive twinning may be used for superimposed circuit working without overhearing between the various parts. Fig. 4 indicates how 15 circuits may be obtained from a 16-wire core, and it will be seen that the 74-wire cable shown in Fig. 2 would provide for 65 circuits at least, as compared with 37 circuits if made up in the ordinary way (Fig. 1). The superimposing may take place over the whole length of cable as shown in Fig. 4, or over one part only.

The number of combinations obtainable is too great to be fully discussed here, but all of them consist of modifications or extensions of those shown. One other point may, however, be mentioned. In all telephone systems inconvenience is felt for want of circuits between one exchange

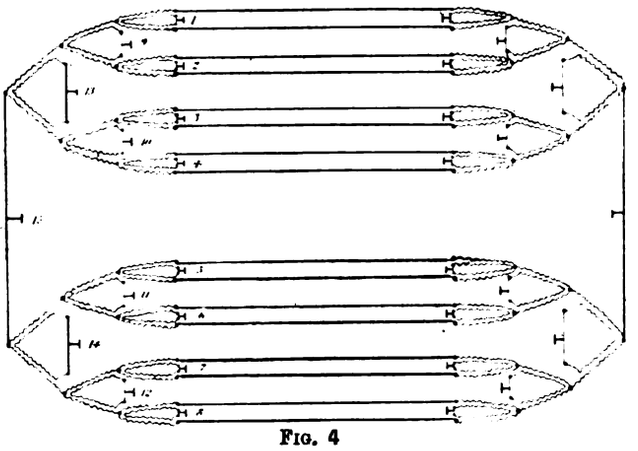

FIG. 4

and another for switching through purposes (called junction circuits). At present the number of these circuits cannot be increased without laying additional cables, but if a cable made up as described were employed between one exchange and another, additional circuits could be obtained by superimposing after each pair in the cable had been made use of.

Thus it is evident that, whereas in an ordinary dry-core cable the circuits to be obtained are the equivalents of the number of pairs of wires, the number of circuits in cables made on the Dieselhorst-Martin system is much greater than the number of pairs of conductors, and great economy may therefore be effected by the employment of such cables.

It remains to add that Messrs. Siemens Bros. and Co., Limited, 12, Queen Anne's-gate, London, S.W., to whom we are indebted for the particulars given herewith, are the manufacturers of these cables; also the sole licensees for the same.

## SOME NOTES ON THE RUNNING OF A PRIVATE LIGHTING AND POWER PLANT.*

BY P. T. BLISSET, ASSOC.MEMB.

(*Concluded from page 269.*)

The cost of maintenance for turbo sets should be very little, the biggest item, perhaps, being new brushes and the renewal of the commutator, say, every four years. It may be safely said that the cost of repairs and oil together for them is not one-sixth of that for the Willans engines.

Any comments on the running of Mather and Platt generators are not necessary, as no complaint is ever heard concerning them. The middle-wire current is dealt with by two balancer sets, which were made up of old 210-volt generators.

The power wiring has been done chiefly by the staff on the works, and some time ago was carried out with lead-covered and armoured cables fixed by means of teak cleats. Although this style of wiring gave comparative safety, it was impossible to pull the cables quite straight, and it was difficult to bend them neatly round sharp corners. Much of the armoured cable was afterwards put into wood troughs and covered with a teak capping, the smaller cables being put into specially heavy pitch-pine casings. For the heavier cables, say $^{37}/_{16}$, the wood troughing with cleats every 2ft. makes a very good job, and if the troughing is well coated with shellac inside to keep

* Paper read before the Dublin Local Section of the Institution of Electrical Engineers, Feb. 9.

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moisture from coming through, the arrangement has been found to stand well under very trying conditions, braided cables only being used. Braided cables have been drawn into galvanised iron screwed tubes, but the drawing-in part is very difficult with cables of over $^{7}/_{16}$. There is a great temptation to thread the pipe fittings over the cables and then screw them up, resulting in the cables being twisted and badly damaged.

coming in and going out near the axis of the hinges need have no slack in them. A diagram (C) of a pair of fuses and meter are shown which illustrates this idea. When anything went wrong in a circuit, it was very difficult for anyone not knowing the geography of it to find where all the various fuses were.

As distributing boxes, with their many more or less weak connections, is where trouble is often found, the importance of

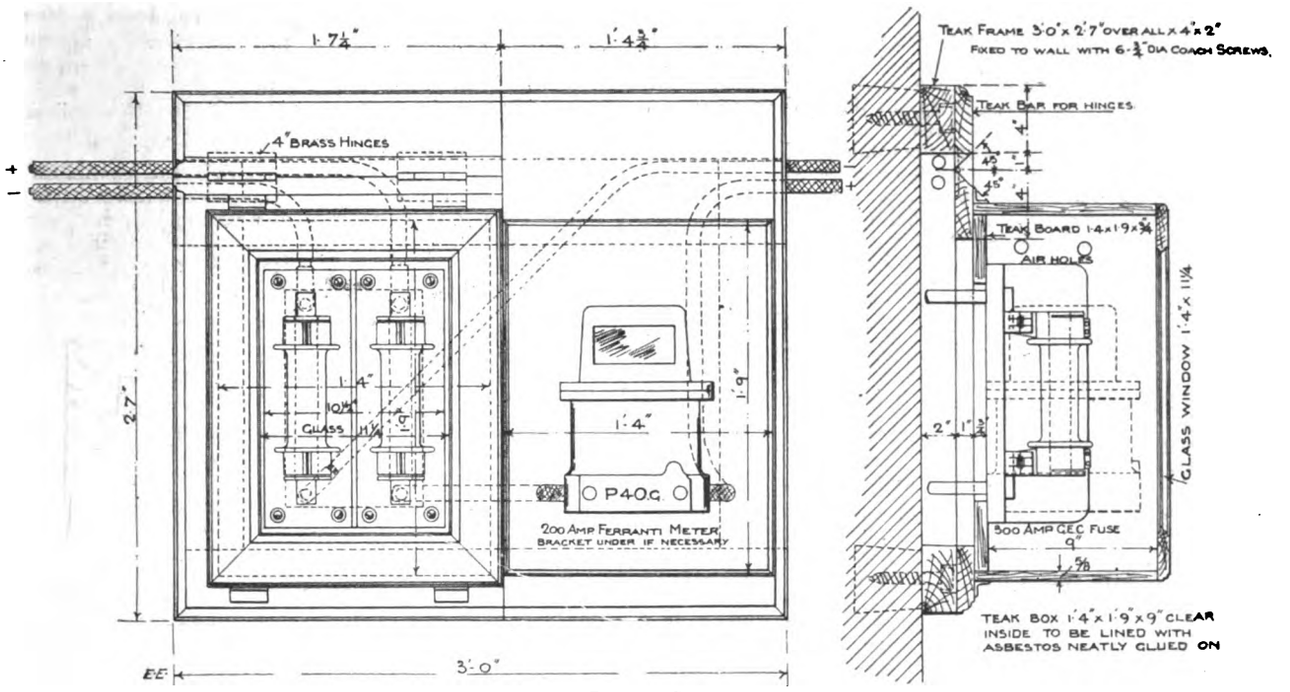


DIAGRAM C.

The draw-in system, perhaps, exists more in theory than anywhere else, and though a large variety of junction and draw-in boxes are supplied, it has not been possible to arrange the circuits so that the cables could be drawn in unless it was an easy run. Long straight runs for cables have been fixed to porcelain cleats—an old arrangement which is very satisfactory.

The cable fixings inside and out of factories are generally the worst-looking job about the place, and as their safety is of

very ready access to both front and back should be recognised. Cables sweated into cable eyes (sometimes badly) have been known to fall out from the melting or softening of the solder. No weight of cable should, therefore, be allowed to hang on a cable eye into which it is only sweated. In a running plant, where so much depends on the distributing system, these small details are of more importance than is thought by those who design small electrical gear.

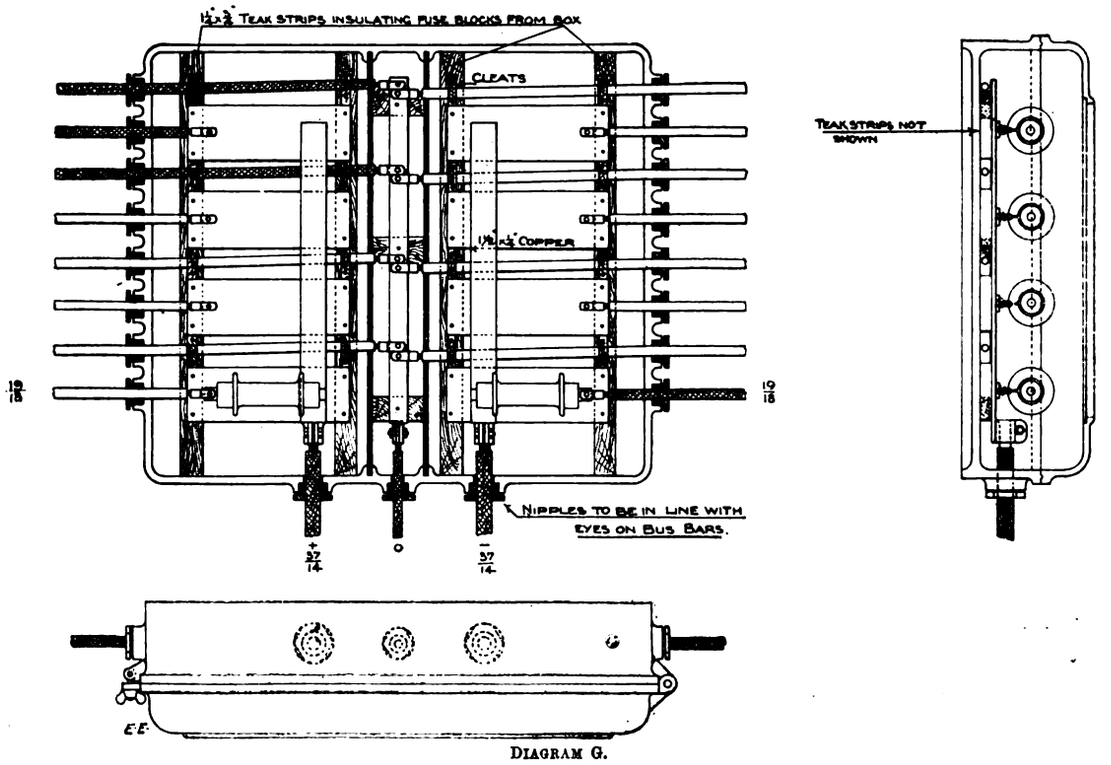


DIAGRAM G.

the greatest importance, carrying, as they do, the energy of the whole concern, it is surprising that more attention has not been bestowed upon them. When cables come to a distribution or fuse box, they should preferably be brought into it direct on to front-connected switches or fuses, or, if back connected, should be brought in at the side of a frame on which is mounted a door, hinged horizontally, and carrying the fuse or switch gear, so that the back connections are accessible, and the cables

Small gear as supplied in the ordinary way by manufacturers is usually too light for the usage it has to put up with. Screws, etc., are generally put where they cannot be tightened up without taking off much covering. Highly-polished hexagon nuts, etc., are fixed where a spanner cannot be got on them, and results in the pliers being used. Brassfinishers' nuts, being of various sizes, do not usually fit ordinary Whitworth spanners. Little troubles like the above result in many connections becom-

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ing loose, and there is no reason why electrical apparatus could not be as standardised as far as these details go as ordinary engine work.

Of the various types of fuses tried, the switch type with the porcelain handle appears to be the best. The hollow handles should, however, be lined with plaster or asbestos; porcelain handles with no lining being extremely dangerous to anyone putting in a fuse with "a short" on the line, which is likely to burst the handle, the arc inside the handle causing it to expand suddenly. The damper type of fuse cannot be seen when blown, and in the larger sizes the holders are burst. Copper wire appears to be the best to use for fuses except for very small currents. In the majority of switch fuses the spring contacts are easily bent, and no provision is made to prevent the fuseholder from falling out when the contact springs are bent.

The number of first-class motors for continuous current on the market at present, makes the selection of suitable motors easier than a few years ago. In the matter of efficiency there is not much to choose between any of the good makers. The importance of the mechanical design of most of them has been well considered, some, however, being rather badly arranged for changing the armature. It is not much good to arrange the top half of the motor to lift off in a few seconds and find that it takes 10 minutes to disconnect the shunt. There is no reason why the shunt connections should not be made automatically when the top is lifted on, as is done in some of the motors.

There is a great difference in the winding of armatures, some being very much more difficult to get a coil out of than others. Certainly the best kind is the "former" wound type for repairing, the individual coils being bound together very hard. Some makers of armatures use very soft coils, and not only does the insulation get rubbed off the wires, but the coils are very difficult to get into the slots. A great many breakdowns of armatures are due to the wires flying out at the commutator end, where they are sweated into the bars. They should always be bound down with piano wire binding, or some better connection provided. Some breakdowns are due to careless handling in putting the armatures into the carcases, but this can only be expected when it is such a difficult job in some cases. The unfortunate part of this kind of fault is that it takes time to develop. As sometimes the spindles of motors get bent or damaged, it is a great advantage to have the coil mounted on a sleeve which can be drawn off the spindle. A weak point in the insulation of armatures is at the outer end of the commutators, as there is generally a thickness of mica only between the end of the commutator and the spindle.

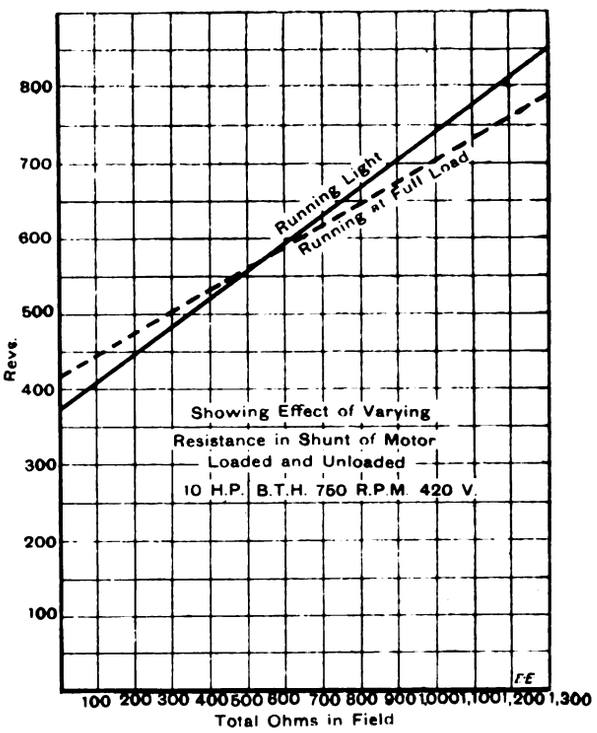
TABLE E.—Efficiency of Shunt-Wound Motors.

| Motor makers. | Horse-power. | Revs. per min. | Commercial efficiency per cent. at Full. | ¾ load. | ½ load. | ¼ load. |
|---|---|---|---|---|---|---|
| B.T.H. | 7½ | 1 250 | 87 3 | 84·0 | 78·5 | 73·8 |
| ,, | 10 | 1,050 | 85·7 | 83 9 | 78·2 | 64·8 |
| ,, | 10 | 750 | 89·5 | 87·1 | 83·1 | 72 0 |
| ,, | 15 | 1,050 | 90 4 | 88·1 | 84·0 | 73·5 |
| Bergmann | 1 | 155 | 68 5 | — | 59 8 | 46·6 |
| ,, | 4·5 | 375 | 81·7 | 82·3 | 79 5 | 69 9 |
| ,, | 15 | 275 | 88·2 | 88·2 | 84·7 | 68·0 |
| Parker | 3 | 300 | 67·0 | 62 9 | 54·0 | 42·8 |
| Scott and Mountain | 10 | 2,400 | 81·5 | 77 0 | 65·9 | 64 6 |
| Mavor and Coulson | 1 | 460 | 63·0 | 60·2 | 53·7 | 44·2 |
| Lundell | ¼ | 1,500 | 67 0 | 62 8 | 55·5 | — |
| ,, | ½ | 1,330 | 77·8 | 72·5 | 63 7 | 46 8 |
| ,, | 1 | 1,350 | 73 6 | 68·7 | 60 7 | 41·5 |
| Mather and Platt | 10 | 750 | 86·75 | 83·9 | 79·1 | 67·4 |
| E.C.C. (series) | 8 | 600 | 88·0 | — | 80·0 | 70 0 |
| Siemens | 15 | 1,050 | 84·63 | 80·2 | 74·82 | 60 9 |

Practically all the motors used are of the enclosed type and coupled direct on to the machinery they drive. Of course the slow-speed motor is an expensive one for its power, but there is no doubt that it is a more satisfactory arrangement. As there are 204 motors in use, varying from ¼ h.p. to 15 h.p., with a total horse-power of 1,363, it speaks well for electrical driving, under the worst conditions when it can be said that there are rarely more than two or three armatures under repair. Spare armatures are kept for all motors, and a breakdown causes little delay. The majority of the motors being well above their work, breakdowns from overloading rarely occur. There is no serious loss in efficiency when working under full load, and with small motors particularly it pays to put in a much larger motor than actually required, as this is about the only way of preventing breakdowns on small motors. A table (E) is given which shows the results of the tests made on some of the motors used, from which it will be seen that the efficiencies do not decrease much at the smaller loads. It will be noticed also that the efficiency of the high-speed motors is not quite as good as the moderate-speed. The temperature rise inside the motors varies from 32deg. F. in the slow and moderate speed motors to 88deg. F. in the highest speed. Great temperature rises in motors affect the speed by heating the shunts, weakening the fields, and raising the speed. This difficulty, however, is got over by taking a few series windings round the fields to increase their strength.

As speed regulation by means of altering the field strength is becoming common, a curve showing an experiment on a 10-h.p. motor will perhaps be interesting (see Curve F). It will be noticed that the alteration in the speed is much greater when running light than with a full load. The upper part only of the curve was found by experiment, about one-third of the lower part being produced from the upper. Twenty-five-horse-power motors are being installed with a variation in speed of 275 revolutions per minute to 600, one half being done by shunt regulation on the 420-volt circuit and the other half on the 210-volt circuit.

The best form of brush gear is found to be the parallel frame arrangement with a spring across the diagonal, which is certainly better than the gear provided with a rectangular slot hole in which the carbon slides. Unless considerable pressure is put on the brushes, they are liable to stick, and too much pressure causes great wear of the commutator.




CURVE F.

Motor-starting gear is, perhaps, one of the most troublesome arrangements—far more than are the motors. The makers of this kind of gear have not brought their branch up to the same standard as the motor builders. Resistances are seldom properly divided. Insulation from the frames is often not good, and generally the resistance coils are not heavy enough to stand the starting current long enough. The starters adopted are made to stand the starting current for about a minute without injury, so that if the circuit breaker or fuse goes whilst starting, the motor can be started again without waiting for the resistance to cool down. The ordinary man does not think of waiting for cooling, and often results in the burning out of small capacity resistances. The asbestos tubes used for winding the coils on are liable to get moist, and when wet there are leakages to the frame, from which bad shocks are to be had. Many of the handles for switches and starting levers are ridiculously small, and, as they have fairly rough work to do, should be made much heavier. The card-wound type of resistances used were very unfortunate in breakdowns, and have nearly all had to be replaced by other types. The insulating material being porous absorbed moisture, which caused much of the trouble. Some of the resistances supplied were insulated with a kind of paper tarred over, and which set fire when the resistance warmed up.

Circuit breakers were used on the distributing mains and many of the motor panels, but it was found that a very small short would pull out a large circuit breaker: they were therefore replaced by fuses. Circuit breakers on motor panels were not satisfactory, as they did not always come out at the right time, and sometimes got stuck if they were not used for some time.

All motor panels are provided with double-pole switches, fuses, and an ammeter with a full-load mark on it. The ammeter should be of the dead-beat type, and is a great advantage at starting, showing if anything is wrong with the motor or the gear driven. It is important that all connections to starting gear should be accessible from the front,

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and that the starters can be changed quickly. The complete panels should be enclosed in a case to keep all contacts clean, especially the starting contacts, which, when dirty, sometimes cut the greater part of the resistance out at one jump. Coal dust on the slates has sometimes caused an arc between two terminals. As starting gear for motors is responsible for the greater number of failures, their importance should be appreciated, and though much has been done recently in making starting gears more substantial, there is room for great improvement in the designs.

Although the wiring question has been discussed for years a satisfactory system has not been found. Much thought has been put into the perfecting of the various tube systems, and no doubt these are very good where there is no moisture, which is the greatest enemy to wiring systems. Unfortunately, the tubing systems have been a failure when there is much moisture or variation of temperature. Brazed steel conduit was used, and it was found that moisture collected in pockets, due to condensation, which soon destroyed the insulation of the wires. The enamelling of the tube was not good enough to resist corrosion for long, and rusted through in some cases in less than two years. The "draw-in" system for light wiring may be possible in dwelling-houses, but where the runs are round joists and girders or other difficult runs, it is practically impossible to draw the wires in, and consequently the tubes have to be slipped over the wires. Tubing unless fastened on to girder work very carefully is likely to get loose and the ends of the tubes cut through the insulation. Galvanised screwed tubing has been used with fairly good results, but is expensive and has the condensation trouble. The steel tubing used in offices and dwelling-houses was in some cases installed by local contractors, whose men made sure that the wires could never be drawn out of them, perhaps with the object of covering up some very bad work which has begun to show itself. A large quantity of concentric wiring was installed, and, according to the claims made for it, the system would have been a perfect one for wet situations. Unfortunately, this, too, had to be replaced by entirely new wiring. The concentric wires were lead sheathed, but could not have been perfectly watertight, as faults are continually occurring, as many as six or eight in a length of a foot. A fault soon burns itself out, blowing the fuse which is replaced, and goes on for another day or two, where another fault occurs, perhaps quite close to the first, as when burnt out the insulation test is fairly good, but has left a large hole in the wire somewhere. As this sort of thing going on continually is very dangerous from a fireman's point of view, it was decided to abandon this system. The watertight distribution boxes used sometimes got filled with water, which was soon boiled and fuses blown. A peculiar thing with these fuses was that if one blew several more would do so at same time, probably due to induction in the line supplying the box.

For moderately dry situations a specially heavy pitch-pine casing (fixed by carpenters) has been very successful. The capping was screwed on to the casing at the outside instead of the middle as usual. In this way a fairly tight joint can be made if thick paint is used to make a joint. Casing can be finished off very neatly, and wiring carried out on this system has given little or no trouble. Switch and fuse distributing boxes used with casing should have all the switches in one row, and the complete box hinged at its upper horizontal edge, so that the wires coming down from the casings come straight on to the terminals at the back without any slack or crossing wires, the hinges being provided to allow of easy access to the back of the board and prevent the usual entanglement of slack wire.

The cleat system of wiring for light has been tried with success, and although this form of wiring is not looked upon favourably by insurance companies, it has proved itself up to now to be as safe as the other systems, and has certainly many advantages. It can be done very neatly, and in much less time. Unfortunately, porcelain fittings for this kind of work have not been obtained, and various makeshifts have been used in consequence. Junction and cross-over boxes could be made, but the prices are prohibitive for small quantities. There appears to be a good opening for manufacturers to take this matter up, and an extensive use of wiring on porcelain cleats would be likely to be made, especially for factories. The accompanying diagram (G) of a fuse box for cleat wiring gives an idea of how such a system as this could be made very reliable for wet situations.

The result of experience with lighting of large areas broken up with columns, joists, etc., has led to the conclusion that groups of incandescent lamps are more economical to run and require less attention than enclosed arc lamp lighting, arc lamps being always a source of more or less trouble, especially in steamy places. Perhaps arc lamps of the open type may be successful for street-lighting, but for interior lighting on 210-volt circuits the losses in the lamp are so great that probably a new three-watt incandescent lamp can show as good an efficiency as a small arc lamp. If the cost of trimming and maintenance are considered, the cost of arc lamp lighting may come out more than incandescent.

In conclusion, I have to thank the firm, who do not wish their name made known, for allowing me to bring these notes before you, and trust that much of it will not be too commonplace for your discussion.

## TRADE NOTICES AND NOVELTIES.

### Battery Telephones.

The accompanying illustrations (Figs. 1 and 2) show respectively a battery telephone table set suitable for offices, hotels, etc., and an intercommunication table set. Particulars of both these sets are included in a handy little catalogue of battery

FIG. 1.—G.E.C. Battery Telephone Table Set.

ringing telephones and accessories just issued by the General Electric Company, 71, Queen Victoria-street, E.C. They are quite new, and will doubtless be appreciated. We need not enumerate here the further contents of the catalogue in detail. Suffice it to say all the instruments listed have been specially designed to meet the demand for cheap indoor and short-distance apparatus. Only such accessories are included as are most suitable for use in conjunction with the instruments illustrated, so as to prevent the possibility of wrong selection.

FIG. 2.—G.E.C. Intercommunication Battery Table Set.

A comprehensive set of diagrams showing how to connect up the instruments is added at the end of the catalogue.

### Electric Cranes

Messrs. Royce, Limited, Manchester, have recently issued a revised and enlarged edition of their catalogue of electric cranes and auxiliary apparatus. This is a very excellent production of its kind. Fig. 1 herewith is a reproduction of one of the numerous illustrations which the catalogue contains. It shows a "Royce" electrically-driven transporter, adapted for dealing with loads of from 10cwt. to five tons. Two motors are provided, one for each of the motions of hoisting and travelling.

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This particular transporter is designed for running on curved tracks, and is fitted with swivelling bogies for that purpose. The hoisting motion is fitted with an automatic electrical brake, which can be released by hand from the driver's cage, and loads lowered without current when necessary. An overwinding safeguard is also provided, and the gearing throughout is machine-cut. For the rapid handling of material and conveyance of

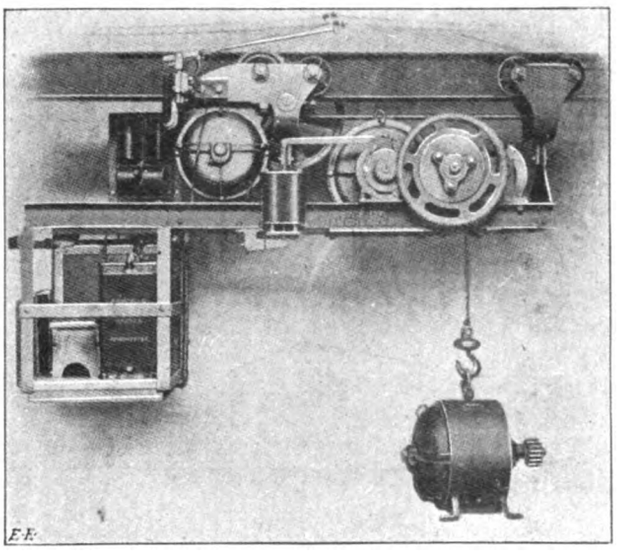

FIG. 1.—Royce 5-ton Electrically-Driven Transporter.

the same from one point to another, transporters of the above type are extremely useful.

## ELECTRICAL EXHIBITION.

A meeting of station engineers, under the presidency of Mr. W. H. Patchell, was held on Monday at the instance of the National Electrical Manufacturers' Association, when the proposed electrical exhibition, to which we referred in our issue of the 17th ult., was considered. After Mr. Patchell had explained the position, the following gentlemen were elected to represent supply stations on the executive: Mr. W. H. Patchell (Charing Cross and Strand Company), Mr. Cunliffe Owen (Metropolitan Electric Supply Company), Mr. Sydney Dobson (St. James's and Pall Mall Company), and Mr. Sydney Baynes (St. Pancras Borough Council).

The Municipal Electrical Association has been asked to nominate a representative, so that the supply station interests will be served by three company and two municipal men. The promoters suggest that the supply stations shall contribute £3 000. Already some 70 firms have promised to exhibit, and excursion trains will be run from the provinces.

## PERSONAL.

The King has been pleased to appoint the Hon. Alfred Erskine Gathorne-Hardy to be a commissioner under the Railway and Canal Traffic Act, 1888, in the room of Viscount Cobham, resigned. Mr. Alfred Gathorne-Hardy takes the position of chairman of the Light Railway Commission (unpaid) in the place of the Earl of Jersey, resigned.

The Southend Town Council have appointed Mr. J. Milton, A.M.I.E.E., mains superintendent and general assistant, as temporary assistant electrical engineer for six months, at a salary of £150 per annum.

The Newcastle City Council have appointed Mr. Ernest Hatton, manager of the Salford Corporation tramways, as manager of the Newcastle tramways, in place of Mr. A. E. Le Rossignol, resigned, at a salary of £700 a year.

Mr. W. H. Brown, of 7, Lothbury, London, E.C., has been elected a director of the London United Tramways, Limited.

The Grimsby Public Lighting Committee have increased the salary of Mr. Channon, chief assistant, from £150 to £175, and that of Mr. Horton, chief clerk, from £120 to £150.

The Ayr Tramways Committee have appointed Mr. William Grant, tramway manager, Rotherham, manager of the Ayr Corporation tramways in succession to Mr. Frederick Coutts, at a salary of £200 per annum.

## APPOINTMENTS VACANT.

**Depot Foreman,** Exeter Corporation Tramways. Salary, £2 a week. Applications by March 10. See advertisement.

**First Assistant Electrical Engineer,** City of Wakefield. Salary, £150 per annum. Applications by March 14. See advertisement.

## POST OFFICE ENGINEERING DEPARTMENT, LONDON.

The second annual dinner of the above department was held on Friday, Feb. 24, 1905, in the Victoria Hall, Hotel Cecil, Strand, Mr. J. Gavey, C.B., M.I.C.E., engineer-in-chief of the Post Office, again presiding. The guests of the evening included Mr. H. Babington-Smith, C.S.I. (secretary); Mr. J. C. Lamb, C.B., C.M.G.; Mr. J. Ardron; Mr. A. F. King; Sir Robert Hunter; Mr. S. C. Hooley, I.S.O.; Mr. J. C. Badcock, C.B.; Captain R. H. H. Boys, R.E., D.S.O.; Dr. Walmsley; Mr. A. M. J. Ogilvie; Mr. J. W. Willmot; Mr. W. Bosomworth; Mr. G. Morgan; Mr. A. W. Heaviside, I.S.O.; and Mr. W. J. Etheridge; the company numbering about 200. Lord Stanley, the Postmaster-General, who was attending his Majesty's second Court of the season, was prevented from being present.

After the loyal toasts had been duly honoured, **Mr. Lamb,** in the absence of Lord Stanley, in proposing the "Engineering Department," said: As your chairman has told you, gentlemen, it is the unavoidable absence of the Postmaster-General that procures me the honour of addressing you to-night and proposing the toast of the evening; but while it procures me this honour it leaves me in some embarrassment, because Lord Stanley has not handed me his notes or given me any indication of what he was going to say; and, therefore, I am afraid I shall be but a sorry substitute. But I am sure that I am speaking for him truly when I say that he cordially wishes you every prosperity, and that he regrets his absence quite as much as you do. If envy were a permissible thing, I think I might envy you engineers your association with those brilliant men, past and present, who have done so much to improve and facilitate and quicken communication in the world; who have invented instruments of the most marvellous kind for simplex, duplex, quadruplex, and multiplex telegraphy; for high-speed telegraphy; for telegraphy which will produce your writing at the other end; and for telegraphy which will turn Wheatstone signals into Roman characters. But I think my envy might go further, because I see opening before you another field that you did not dream of years ago—a field in which you are to be associated with the men, both past and present, who have worked wonders for the transmission of power and energy in the world and for rapid transport. In the past you have been associated with men like Morse and Hughes and Cooke and Wheatstone and Graham Bell and Marconi; and now you find yourselves associated also with men like Watt and Stephenson, and with those who are now applying electricity to the things to which those men applied steam. Well, I think we might all envy you engineers when we see this wonderful development of your field of industry. It is a development not merely in the outside world, but it is in the Department itself; your sphere within the Post Office is being extended and enlarged; you are ceasing to be telegraph engineers; you are becoming more and more general engineers. But I think I appeal to your hearts more when I say that you are all proud to be telegraph men, not telegraph engineers, but telegraph men; and here I detect no envy in my mind, because I am one of yourselves. I am a telegraph man. I began in the Post Office in 1864, I became a telegraph man in 1868, and have been one ever since, and I have given my whole heart and soul to telegraphs, and am proud of it. Well, gentlemen, speaking to you as one of yourselves, I say that we telegraph men have a sphere which is larger than that of any other body of men in the world. It is larger than that of the soldier; it is much larger than that of the ordinary Civil servant. We are not limited to our own Empire. We go out in friendship and harmony to every corner of the world, and we find people ready to receive us as brothers. It has always been to me a pride and consolation that no matter where I go I find men who understand me. Even when I speak in broken language they apprehend what I mean and are ready to welcome me, and this is the case with telegraph men all over the world. Now, gentlemen, when I was young and unwilling to go to bed, my father used to say to me

"Oft' fitted the halter, oft' traversed the cart,
And often took leave, but seemed loth to depart."

That was a little thing which was said about gentlemen who were sent to Tyburn. I am rather in the position now of the gentlemen who were carted off to Tyburn. They generally made a last dying speech and confession, and that is what I am doing. It is an accident—the accident of the absence of the Postmaster-General—that procures me the honour of making this speech; and in that respect I differ from the men who went to Tyburn, because it was generally not an accident which procured them the honour—the accident in their case generally happened afterwards. But, accident or no accident, I am very much in the position of those gentlemen, for I don't suppose I shall have the pleasure of being present at one of these dinners again, and therefore I take the opportunity of wishing you from the bottom of my heart an affectionate farewell. I now ask you to drink—you gentlemen here who do not belong to the engineering department—I ask you to join me in heartily drinking the health of the engineering department.

**Mr. Gavey,** in responding, said: Gentlemen,—In the first place I know that I am only voicing your feeling of regret when I say how sorry we are that the Postmaster-General is unable to be here to-night. Lord Stanley, by his soldierly frankness, has endeared himself to all with whom he has come into contact, and I am sure we feel that there is something missing in the evening's programme. On the other hand, I may say on your behalf that we are very proud to see the permanent chiefs of great departments and the heads of so many branches around our table to-night. I think that for the benefit of the service as a whole the heads of the great administrative departments of the Post Office, and the hands and brains that they direct in the shape of executive officers, should come into contact whenever it is possible. In a great service like the Post Office it is only on special occasions like

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this that such community is possible, and I hope it is a pleasure to the administrative heads to meet you to-night; and I am sure it is a pleasure to the executive officers to see those gentlemen enthroned on high, of whom they can only form a definite opinion on occasions like this. At a meeting of this kind they see that these great officers are, after all, men with passions like themselves, and I hope when some of you gentlemen, disappointed that suggestions of yours or appeals of yours are not acceded to, that you will not come to the conclusion that they are rejected by beings who are stocks and stones, but by sympathetic officers who look carefully and considerately into everything you put before them. Now, gentlemen, the thread of my thoughts has been diverted into a painful channel, by what I can only assume to be our friend Mr. Lamb's species of valedictory address. I may say that I listened to the latter part of his speech with considerable pain and with very great regret. Those who, like myself, have been associated with the telegraph service for very many years, can hardly look back to the period of State control without the recollection of seeing the magical letters "J. C. L." at the bottom of papers. As time has gone by my appreciation of Mr. Lamb's talents, of his extraordinary knowledge of the telegraphs, not only of this country, but of the whole world, has grown day by day. In fact, I think that he is absolutely the supreme authority on telegraphs throughout the whole of the world. If the time has arrived, or is about to arrive, when he bids farewell to the service, I hope, and most sincerely hope, that he will not bid farewell to this company or to its successors. I trust that for many years to come we, or our successors, may be favoured with his presence at meetings of this kind, when we can look back to the past with pleasure and look forward to the future with appreciation. Now, gentlemen, we have adopted the practice, or, rather, we started the practice last year, of briefly reviewing what we had done during the year, and I think it may not be considered inappropriate if I continue that practice. I am glad to say that our progress, both telegraphically and telephonically, appears to be very satisfactory. From the telegraphic point of view, I think I may say that the Post Office telegraphs is certainly in the forefront, or if that may be considered too ambitious, I may say that it is not behind any other telegraphic service of the whole world. I have had the pleasure from time to time of meeting the higher officials of the telegraph administrations both in Europe and America, and they have all said to me that we had nothing to learn from them. Now, if you accept that statement with a grain of salt, and if you discount it to allow for the natural courtesy of the host to the guest I think we may say, or rather we may assume, that we are certainly not in the background, but in the front. The telegraph administration of this great department has always done everything to foster and encourage progress. In the course of the last year or two a number of experimental trials of the most advanced type of telegraph apparatus have been carried out. We have, in addition, forwarded that great work of the underground telegraphs of the North, and at the present times our lines may be said to be complete to Carlisle, and to be on the verge of completion to Glasgow. In other words, during the last few years we have laid something like 30,000 miles of underground wire to steady and to make absolutely free from all climatic disturbances the great trunk-line service of the country. This work is to be continued so long as our paymaster, the Treasury, finds the funds. I am glad to say that those funds are provided for next year, so that for one year at least this progress is absolutely sure. In the matter of the extension of the London telephone service, which perhaps more closely affects many of the gentlemen who are here present, I am glad to say that we have made very solid and very steady progress. You will all remember that it was in February, 1902, that the first London exchange was opened with 250 subscribers. I find that on Feb. 22 of this year we had joined up 25,138 stations, and in the present year of that number 8 803 stations were provided. In the case of the trunk-line service, the adjunct to the local service, or perhaps I should say the local service is the adjunct to the trunk-line service, if we speak of the importance of the relative services and not of their numbers, we have to record continued growth. In 1897, shortly after the Post Office had acquired the trunk lines erected by the Telephone Company, and had commenced the extension of the service throughout the country, there were 47,855 miles of trunk line in use. At the end of last financial year there were 102,752 miles erected, and the Post Office is steadily erecting from seven to eight thousand miles of trunk wires every year. Now, gentlemen, I come to another point which no doubt has exercised your minds more or less, and in which you have, no doubt, felt a considerable amount of interest. The agreement between the Post Office and the National Telephone Company has now been laid before Parliament, and you are, no doubt, generally acquainted with its contents. You will have observed, of course, that the final acquisition of the company will take place in 1911. As an old warhorse, who sniffs the battle from afar, I may say that, personally, I might have wished to have had my little share in that great transfer, but the fates and the wisdom of our chiefs have decided otherwise. So far, however, as you are concerned, and more especially the younger men that I see around me, I should like to offer a word of suggestion and a word of advice. I have a settled conviction that we are only on the threshold of this very great enterprise. The magnitude of the work that you gentlemen will have to carry out in future years is perhaps only appreciated by a few. To give you an illustration of what I mean, I should like to refer to the abnormal growth of telephones that has taken place in the United States within the last few years. For instance, I was in America in 1898, and in New York at that time there were 26,031 telephone exchange stations, the term station, of course, being well understood by all. I have recently received a letter from the general manager of the New York telephones, who tells me that at the end of the year 1904 that 26,000 had increased to 140,000 stations in New York, and you will bear in mind that New York proper is not the greater New York, including Brooklyn and New Jersey. It is a little bit of an island 10 miles long by about three miles broad, with a population of about two millions. Again, taking the report of the American Bell Telephone Company, I find that in 1899 throughout the United States they had 465,000 subscribers' stations. In 1904, after an interval of five years, they had 1,525 000 stations. Now, in this country the rapid growth of the telephone is of comparatively recent date, and the problems which you gentlemen will have to solve in the future will increase in magnitude as the square of the number of subscribers, and not as the numbers themselves. Think, gentlemen, what you will have to consider in the year 1911. It will not be a question of intercommunication between 100,000 subscribers—it will be a question of intercommunication between a quarter of a million, with probably the possibility of having to provide intercommunication between half a million 10 years later. It means that you will have to apply the highest technical and scientific knowledge that it is possible for men to obtain in order to do this work in a satisfactory and an economical manner, and what I want to suggest to you gentlemen, if you will not consider it an impertinence, and if you will not think that I am acting too much as the schoolmaster, is that before the transfer takes place you should fit yourselves, by keeping abreast with all the technical knowledge of the age, to take the position which you ought to occupy when that great transfer takes place. We have now in preparation at headquarters a species of technical summary of the theoretical principles on which telephony is based, and the lines on which the work ought to be done in the future. With the consent of our chiefs, I propose to have this printed and issued shortly, and I invite your careful attention to it, not by any means as a complete work, but rather as an index, a sort of direction post, pointing out the various paths in which you should carry out your investigations. Gentlemen, I am afraid I have rather transgressed the etiquette of an after-dinner speech. I ought to have been light and airy—I have been heavy and ponderous, but I hope the occasion justifies the character of the address.

**Mr. J. W. Woods**, the superintending engineer of the metropolitan central district, in proposing the toast of "The Visitors," said: Mr. Chairman, Gentlemen,—The members of the Post Office engineering department are always pleased to gather together in this quiet and homely way, and, like hospitable Britons, we like to have our visitors with us to taste our frugal fare. I confess that we are sorry that one visitor, Lord Stanley, has been unable to be with us to-night; we should have liked to tell Lord Stanley how much we appreciate him as Postmaster-General. As engineers, we realise that everything human, as well as everything material and physical, has its limitations—the higher the altitude the more the stress of the storm is felt, and consequently the more the structure needs to be stayed. The Postmaster-General's position is exalted, but is well supported. We have already heard, and heard with regret, that Mr. Lamb will soon be leaving the service. I realise, and I am sure you realise, that the service will lose a very true friend when Mr. Lamb goes. As I have said, the Postmaster-General's position is buttressed and supported by secretaries, and we are very thankful, indeed, that Mr. Babington-Smith, the secretary, has again come and graced our meeting. We realise the arduousness of his position, and how difficult it must be to meet every necessity of such a position, but, again, Mr. Babington-Smith is well supported by his secretaries (Mr. Lamb, Mr. Ardron, and Mr. King), whom I see before me, who are all supporting, very definitely and loyally, a chief who is worthy of their support. I am almost afraid, gentlemen, to mention another name, but there is an illustrious gentleman opposite me—Sir Robert Hunter. Naturally you would expect that I should be very diffident, indeed, in saying anything about so legal a gentleman, but we do sincerely thank Sir Robert Hunter for being present, and we realise that in Sir Robert Hunter the Postmaster-General is well supported on the legal side. Before me I see also Mr. Hooley, the controller of stores. Now, gentlemen, I think you will agree with me that there are many present who have looked upon the controller of stores as almost supernatural — an abstract being who has been prayed to and prayed for many a time, and about whom many things, wise and otherwise, have been said. It is a great boon for the younger members of the engineering branch to have seen the genial personage, Mr. Hooley, and to realise that he is a gentleman such as they scarcely expected. We honour Mr. Hooley because he has brought a department, on which every other department has to lean to a certain extent, to a state of great perfection. We are delighted to see Mr. Hooley at our table, and we thank him for the hard work that he has done since he has been the head of the stores department. I am delighted also to see Mr. Badcock, representing the postal side. What should we do without the postal side of our department? We should scarcely be able to live, and we are thankful to see Mr. Badcock here. I see also my good friend, Mr. Preston, on the other side. We have to rub shoulders very often with Mr. Preston. Do not imagine for one moment that there is friction. We rub shoulders in the sense that we each put our shoulder to a wheel, and thus make the whole thing go. If you will allow me, I should like also to refer to two grey-headed veterans, Mr. Heaviside and Mr. Fleetwood. We greet them most heartily, and we trust that when our time comes to "sit down" we shall look as hale and hearty as our two friends. I think you will agree with me, gentlemen, that I have demonstrated my inability to adequately express your views and your thanks to the visitors. What I have lacked in eloquence I have no doubt you will make up in heartiness in drinking the toast of "Our Visitors."

**Mr. Babington-Smith** said: Mr. Chairman, Gentlemen,—I have to thank you very warmly both for the way in which the toast of "The Visitors" has been proposed by Mr. Woods and received by you, and also for your genial hospitality to us to-night. I thank you on my own behalf, and I thank you on behalf of my colleagues who are here as your visitors to-night, and on behalf of those distinguished strangers who are also your guests. I may mention specially Dr. Walmsley, to whose instruction the engineering service of the Post Office is much indebted. I may mention Mr. Murray. I am not sure whether I ought to call him a visitor, for I am glad to say that now

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he has at least one foot in the engineering service of the Post Office; and I speak also on behalf of the representatives of the distinguished firm of Siemens, to whose co-operation in telegraphic matters the Post Office is also so much indebted. Gentlemen, it is a very great pleasure to all of us to be here as your guests to-night, and to take part in what Mr. Woods has described as this family occasion. Your service, gentlemen, is sometimes maligned. I have heard it said sometimes that you obstruct the streets. That is a calumny to which I have never paid any attention—except this evening, when for the first time I was somewhat inclined to echo it. On my way here to join your gathering my cab was stopped—I don't know for how many minutes—by a block in the traffic, and when at last I was able to move on I recognised certain familiar brown structures which I have heard described as "wigwams," and I recognised that your work, or perhaps I should say our work—for I am afraid I cannot divest myself of a share in the responsibility—had caused obstruction in the traffic. But these, gentlemen, are passing incidents to which we pay no attention. You belong to the party, not of obstruction, but of progress. Your chairman has spoken of progress in the past. The engineering service of the Post Office is, if I may so describe it, a fine growing boy; and with growing boys the only difficulty is that they outgrow their clothes so fast. Mr. Woods mentioned Mr. Hooley with respect, tempered, shall I say, with awe; and I should like to say incidentally that the only complaint I have to make of Mr. Hooley is that he outgrows his clothes so fast. We bought recently a large site in the centre of the City—the Christ's Hospital site—consisting of more than three acres of land. When we had bought this land, Mr. Hooley came to us with a mild request to be allowed to put down a few stores in a corner of the site. I passed there a fortnight afterwards on my way to the Post Office, and I found the whole three acres covered with enormous drums of cable. How long they are going to remain there I don't know; but I think that when we want to build on that site we shall have some trouble with Mr. Hooley. Gentlemen, the history of your service in the past has been a history of progress. That progress has been watched over from its infancy, I may say, by my colleague, Mr. Lamb. He assisted at the birth of the telegraph service of the State; he has watched over its growth, and though to our very great regret we are soon to be deprived of his great talents and his long experience, he may rest assured that his name will always remain associated with the great service of which he has for so long been a distinguished member. The record of the service, gentlemen, has been a record of progress in the past, and it will be a record of still greater progress in the future; of progress upon the present lines, of progress in the development of new inventions. Your chairman has mentioned an agreement recently concluded, which, if it is confirmed by Parliament, as I hope it will be, will mean that the telephonic service of the Post Office will see a very great development some years hence. Not all of us, but I hope a great many of us, will assist at that development, and I should like to take this opportunity of saying that if that agreement has been made upon sound lines, if in settling the many technical points which arose in the negotiation of that agreement any satisfactory solution has been reached, it is in a very great measure due to the keen scientific and large-minded insight with which your chairman advised the authorities of the Post Office on those technical problems. Gentlemen, I have only once more to thank you very heartily in the name of your visitors for your kind welcome to-night, and to wish all prosperity in the future to the engineering department of the Post Office.

The musical programme, under the direction of Mr. H. J. Hoggarth, was of an exceptionally high order.

# LEGAL INTELLIGENCE.

## ACTION FOR DAMAGES DISMISSED.

In the King's Bench Division Mr. Justice Ridley and a special jury tried an action to recover £1,000 damages from the East Ham Council for injuries alleged to have been received by the breaking of an electric wire while the plaintiff, Henry Neal, a cycle maker, of 19, Meanley-road, Manor Park, was travelling on an electric car.

Mr. McCall, K.C., and Mr. Blaiklock appeared for the plaintiff. Mr. Montagu Lush, K.C., and Mr. Higgins represented the defendant Council.

**Mr. McCall, K.C.**, in opening the plaintiff's case, said it was a difficult and complicated one. On Sunday morning, Sept. 13, 1903, plaintiff left his house with his nephew to go to Woolwich. They got on a car which was not covered, and sat on the extreme seat on the left-hand side on the top. While they were travelling towards Beckton one of the overhead wires snapped. The broken wire struck plaintiff on his head and shoulder, burnt a hole in his cap and coat, and gave him a shock. The iron trolley pole also struck him. The immediate effect was to make him dizzy, and for a time he was unable to realise what had happened. He returned home and was laid up. Later in the day he took some tea, was then seized with a violent sickness, and a doctor was sent for. In his youth plaintiff had a slight accident to his left eye, but the effect was not serious. Since the accident on the tramcar his right eye was almost useless, and his eyesight had gone from bad to worse. He had been quite unable to carry on his business, and he had had an attack of locomotor ataxy, which prevented him from earning his living. There was no hope of plaintiff ever being able to follow any trade in which good eyesight was essential, and there was little hope that in the future he would be able to use his limbs without great effort and without great pain.

The Plaintiff bore out his counsel's statements, and corroborative evidence was given.

**Mr. Lush, K.C.**, in opening the case for the defence, said it was a painful thing to have to say, but the whole of plaintiff's case was a preposterous tissue of exaggerated mis-statements. The plaintiff at the time of the accident was sitting on the back seat of a car crowded with passengers, when a wire broke and fell upon the shoulders of the travellers. The only man who complained of being hurt was the plaintiff. Another passenger called admitted no shock or injury, only a coat burnt, for which she was compensated. The whole of plaintiff's case rested entirely upon his own evidence. If he had not been telling the truth in that court, it was perfectly consistent that he had not been injured at all. Plaintiff said he was hurt by a pole, but his doctor said his injuries would be caused by a wire. The plaintiff and his wife said that his system was so shattered that he could not walk, and only limped. A witness would be called to prove that he had seen plaintiff since the accident walk to his business. It was childish nonsense for the plaintiff to say he could not walk. Counsel then adverted to the fact that plaintiff had not produced any books in support of his assertion that his business yielded a profit of some £400 per annum.

Several witnesses having been called on behalf of the defence to prove the facts, and technical and medical testimony having been tendered, the jury returned a verdict for the Council, with costs, the judge expressing his complete concurrence.

We are glad to see that the Council succeeded in resisting this claim, which excited serious criticism at the hands of the expert witnesses for the defence.

## ARC LAMP PATENT.

After a protracted hearing, judgment has been delivered in the case of the Jandus Arc Lamps and Electric Company *v.* Arc Lamps, Limited.

The dispute centred around a patent granted in 1893 to Mr. L. E. Howard for an invention to prevent the carbons from being rapidly consumed, which the defendants were alleged to have infringed. The grantee enclosed the two carbon points in a very small glass cylinder, which was as nearly as possible hermetically sealed, so as to materially increase the life of the carbon. The patentee found that the nearer he could get the glass to the carbon the longer the life of the carbon. This idea was further developed in an amended complete specification.

The main defence was lack of novelty.

**Mr. Justice Kekewich**, in summing up, said that the essentials of the patent were a glass envelope, small but not too small, and joints, tight but not too tight. The specification indicated 3in. diameter or less, while in practice the plaintiffs had found 4in. better. The defendants had worked this divergence for all it was worth, but his Lordship held that the smallness was sufficiently indicated. Howard, unlike Beardsley, had recognised the value not only of tight joints, but of small globes, and his patent was, therefore, valid.

Judgment for plaintiffs, with costs.

## NORWICH CORPORATION v. NORWICH TRAMWAYS COMPANY.

The company's appeal from the decision of Mr. Justice Phillimore, who awarded the Corporation £53. 13s. 10d., as reported in this journal at the time, for street repairs, came before the Court of Appeal last week, when counsel argued points of law.

# COMPANIES' MEETINGS AND REPORTS

## KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING.

The eighteenth ordinary general meeting was held last week, Colonel Crompton presiding. Particulars of the report appeared in our issue of the 17th ult.

The **Chairman** said that the Company's high position as regarded economical management was maintained, but they were still groaning under the heavy load of municipal rates. The outlook for the future was satisfactory. The price which the Company charged their consumers depended entirely upon the number of hours during which the plant could be utilised. So long as electricity was only adopted for lighting purposes, the use of the plant was limited to about 12 per cent. of the total hours of the year. In other countries, notably in America, the electric lighting companies were able to utilise their plant during the daylight hours to a very considerable extent by supplying electricity for motors and for uses other than lighting. The Board and the staff had been fully aware of the great advantages which would follow, both to the public and to the shareholders, from the increased use of electricity during the daytime; and no effort had been spared to get a day load. There were signs that the domestic uses of electric power were on the increase.

The report was adopted.

## LONDON UNITED TRAMWAYS.

The third ordinary general meeting of this Company was held on Tuesday at the offices of the Company, Mr. Charles T. Yerkes (chairman) presiding.

The **Chairman**, in moving the adoption of the report (which we published last week), first reviewed the financial aspect of the undertaking, and then dealt with the affairs of the Company generally. The Company are doing all they can to provide double lines wherever possible, and have already derived benefit from the conversion of some of the single lines. The company's working has now been standardised so as to secure the maximum of economy consistent with efficiency. Since the last meeting the line from Southall *via* Hayes and Hillingdon to Uxbridge, and also the connecting line from Hammersmith-broadway *via* Askew-road, have been successfully put into operation, and the

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result of the working of these lines since June last has fully realised anticipations. The directors believe that a very large development of traffic will now rapidly take place along the fine stretch of country between Southall and Uxbridge. The directors are concluding contracts for the building and equipment of the authorised extension of the system in Kingston, Surbiton, the Maldens, and Wimbledon, and between Brentford and Hanwell. The work of construction will be proceeded with forthwith, and the lines, it is expected, will be completed and put into operation during the course of the year. These lines will link up important centres of population, putting them in through communication with the rest of the Company's system, and with the London County Council's electric tramway system at Tooting. Mr. Yerkes concluded by moving the following resolution: "That the directors' report and statement of accounts be received and adopted; that the payment of the dividend on the preference shares having been made, and, being hereby confirmed, a final dividend of 6 per cent. per annum be paid on the ordinary shares for the half-year ended Dec. 31 last, making 6 per cent. for the year, and that such dividend be payable on and after the 4th prox."

**Mr. Clifton Robinson** seconded.

A **Shareholder** expressed the view that the reserve fund was inadequate.

The **Chairman** replied that the amount was only the nucleus of a reserve fund.

The report was unanimously adopted.

Mr. W. H. Brown (of Messrs. Speyer and Co.) was elected a director in the place of Mr. Samuel White.

**Mr. Yerkes** intimated his intention of resigning the chairmanship, owing to other engagements, but he will continue on the board of directors.

A resolution was carried authorising a maximum of seven instead of five directors.

An extraordinary general meeting was then held, and the following resolution passed: "That the following Bills be, and the same are hereby, approved, subject to such additions, alterations, and variations as may be made in the Bills by Parliament, and approved of by the directors: (1) 'A Bill to extend the time limited by "The London United Tramways Act, 1901," and "The London United Tramways Act, 1902," for the construction of tramways and the acquisition of lands.' (2) 'A Bill to empower the Great Northern, Piccadilly, and Brompton Railway Company to construct new railways in extension of their authorised railways and for other purposes.'"

## NERNST ELECTRIC LIGHT.

The adjourned general meeting of shareholders of this Company was held on the 26th ult. at the Westminster Palace Hotel, under the presidency of Mr. Bernard M. Drake, chairman of the Company.

The **Chairman** stated that the business before the meeting that day consisted of the appointment of a director and the election of auditors. As shareholders were aware, the two names before them for the directorship were Mr. Wallis-Jones (the director retiring in rotation) and Sir H. Seton-Karr, who was put forward by Mr. Oppenheimer. After a lengthy discussion, Mr. Oppenheimer's amendment was defeated, and Mr. Wallis-Jones re-elected.

The retiring auditors (Messrs. Deloitte, Dever, Griffiths, and Co.) were unanimously re-elected.

**Mr. Langham Reed** proposed a vote of thanks to the chairman for the way in which he had fulfilled the arduous task of presiding at that meeting.

**Mr. Zusman** seconded the motion, and the vote having been accorded, the proceedings terminated.

## NATIONAL TELEPHONE.

The half-yearly meeting of this Company was held in London on Tuesday, Sir Henry Fowler, M.P., presiding. Particulars of the report appeared in our last week's issue.

The **Chairman** reviewed the financial results, and then dealt with the arrangement just entered into with the Postmaster-General. As soon as the agreement had been ratified, he said, the directors intended to take the opinion of counsel as to what were the real legal rights of the various classes of debenture stock and shareholders. It was their intention to spend a great deal more capital, and to extend their business as far as possible. When the agreement became operative the directors would at once consider the wisest course for raising the capital and the mode of raising it. Shareholders might depend on it that the Board would see that they got 20s. in the £ for all their capital in 1911.

A **Shareholder** asked: Will the compensation we are to receive from the Government result in the return of the whole of the capital of the Company?

The **Chairman**: You ask me the most important detail of all, and as the matter is *sub judice* I cannot answer it. However, we have done the best we could.

The report was adopted.

## YORKSHIRE ELECTRIC POWER.

The fourth half-yearly meeting of the Yorkshire Electric Power Company was held on Monday at the Hotel Metropole, Leeds, Mr. A. G. Lupton presiding. Particulars of the report appeared in our last week's issue.

The **Chairman**, after reviewing the position, remarked that it was very dangerous to prophesy, but the Company had made a beginning in supplying their customers, and were entering into contracts at what, to any one accustomed to lighting prices, seemed exceedingly low prices, which, however, he believed were no smaller than other companies were asking. They had settled agreements with customers for supplying current to the extent of 900 h.p. They were about to supply three local authorities—Pudsey, Liversedge, and Mirfield—they had other negotiations in hand, and he had the greatest confidence that by the end of the year they would at all events have doubled the supply of 900 h.p. already agreed upon. The directors had under consideration a scheme for hiring-out motors.

**Mr. Robert Armitage** (Lord Mayor of Leeds) seconded the motion, which was agreed to without discussion.

Messrs. H. A. Earle, H. C. Embleton, and W. P. J. Fawcus were re-elected directors, and Mr. Ernest Crewdson was reappointed as one of the auditors for two years.

## CHELSEA ELECTRICITY SUPPLY.

The annual general meeting of this Company was held at Winchester House last week. Mr. J. Irving Courtenay presided. Particulars of the report appeared in our last week's issue.

The **Chairman** said that the equipment of the generating station at Alpha-place had been completed; but to provide for the further generating power required, the building of a section of a new generating station in Manor-street, adjoining the present Alpha-place station, would be carried out during the present year.

The report was adopted unanimously.

At an extraordinary meeting which followed the Company was authorised to introduce a Bill into Parliament for the extinction of the founders' shares.

Subsequently, Mr. W. Reginald Davies presided over a meeting of the holders of founders' shares, who agreed with the resolution passed at the extraordinary meeting.

## BAKER STREET AND WATERLOO RAILWAY.

At the half-yearly meeting of this Company, held under the presidency of Mr. T. J. Hare, the report, of which we gave particulars in our issue of the 17th ult., was adopted.

## CAMBRIDGE ELECTRIC SUPPLY.

The thirteenth annual meeting of this Company was held at the registered offices in Cambridge last week, Mr. D. Munsey, chairman of directors, presiding. The report, of which we published particulars last week, was adopted.

## W. T. HENLEY'S TELEGRAPH.

The report for 1904, to be presented at the meeting on the 6th inst., states that the net profit is £46,521. After payment of directors' and auditors' fees, debenture interest, and income tax, and making the usual allowance for depreciation of buildings, plant, machinery, etc., there remains £38,263, making, with £27,585 brought forward, a total of £65,848. The directors have transferred £1,000 to the debenture redemption sinking fund, and recommend a dividend on the ordinary shares at the rate of 15 per cent., including the interim dividend of 5 per cent. paid on Sept. 1 last. These payments will, together with the preference dividend, amount to £39,337, leaving £26,511 to be carried forward.

## NORTHWICH ELECTRIC SUPPLY.

The seventh annual report of this Company states that for the past year there were 388 consumers, and the number of lamps in use was equivalent to 18,123 8 c.p., as compared with 351 consumers and 16,678 8 c.p. in 1903. This table includes motors, which now aggregate 227·05 h.p. There is an increase in revenue for current supplied of £190, and from other sources £9, making a total increase of £199. The power load has considerably increased, 39,110 units more than the previous year having been supplied for this purpose, a result fully justifying the policy of charging a low price in order to improve the load factor. The total expenses, however, have been considerably swollen by the cost of opposing rival schemes

## TELEGRAPH CONSTRUCTION AND MAINTENANCE.

The annual meeting of this Company was held on Monday, Sir R. G. W. Herbert presiding. Particulars of the report appeared in our last week's issue.

The Chairman, having reviewed the year's work generally, moved the adoption of the report, which was unanimously agreed to.

In reply to a shareholder, the **Chairman** said he was allowed to tell the shareholders that the Company had made arrangements for the construction of the new Atlantic cable, and that the work would be put in hand before the end of the year.

## CITY OF LONDON ELECTRIC.

The report for 1904 states that the year's capital outlay was £55,827 The total revenue was £256,858. After charging all expenses, adding £21,882 brought forward, transferring £1,220 interest to the debenture stock premium debenture fund, £306 to the staff superannuation fund, £45,000 to reserve, and £500 to reserve for leasehold redemption, and paying the dividends already announced, for which warrants will be posted on 8th inst., there will remain £21,877 to be carried forward. The Company's Extension of Powers Bill and the East London and Lower Thames Electric Power Bill, which has been taken over by the Company's directors, have passed the Standing Orders, and will be introduced into the House of Lords.

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## CARLISLE TRAMWAYS COMPANY.

The annual meeting of this Company was held at Carlisle on Monday, Mr. T. D. Lingard presiding.

The **Chairman** said that the high prices paid to the Carlisle Corporation for electrical energy had handicapped the Company, and the continuation of a 10 minutes' service in winter instead of a quarter-hour service cost them an expenditure of over £600 to make £200 in extra fares. It was the desire of the Company to oblige the citizens, but it was absolutely impossible to continue the 10 minutes' service while the Corporation were so exacting in their prices. They could have paid a small dividend this year, but the directors thought it better to carry a sum forward.

The report was adopted.

## NOTTING HILL ELECTRIC LIGHTING.

The annual report of the directors made up to Dec. 31 states that the gross revenue for the year was £34,565, showing an increase of £5,120, and the total net profit was £19,890, an increase of £4,872. From the net profit have to be deducted depreciation, renewal, and reserve fund, £2,750; debenture interest, £2,450; and Kensington and Notting Hill joint debenture stock interest and sinking fund, £8,227. The directors recommend the usual dividend of 6 per cent. on both the preference and ordinary shares, and propose that the balance of £3,353 be divided in accordance with the articles of association, one-half, amounting to £1,676, being credited to the founders' shares and the other half to the ordinary and preference shares. This will enable a further 1 per cent. to be paid on both ordinary and preference, with a distribution of £3 per share on the founders' shares. An interim dividend of 3 per cent. was paid to the holders of the ordinary shares on July 1, and the balance of 4 per cent. will be paid forthwith, together with the distribution on the founders' shares. The preference shares having received their full 6 per cent., the 1 per cent. bonus will be added to the interim dividend on these shares, to be paid on July 1 next.

## FALKIRK ELECTRIC CONSTRUCTION.

The first statutory meeting of the shareholders was held at Edinburgh last week. The directors reported that 940 shares of £100 each had been allotted. The total cash received by the Company to date in respect of shares allotted amounted to £17,200. The payments were £15,808, including £4 520 in subscriptions for shares in the Falkirk and District Tramways Company held by the syndicate or its nominees. The preliminary expenses connected with the flotation of the Company were estimated to amount to £1,000, of which sum £800 had already been paid.

The report was adopted.

## BLACKPOOL AND FLEETWOOD TRAMWAYS.

The ordinary half-yearly meeting of this Company was held in Manchester last week, Mr. George Richardson presiding.

The report, of which we gave particulars in our issue of the 10th ult., was adopted.

## NEWCASTLE AND DISTRICT ELECTRIC LIGHTING.

At the annual meeting of this Company, **Mr. J. D. Milburn** stated that 3,259,389 units were supplied last year, as against 2,649 841 for the preceding year. The directors had cemented their connection with the Elswick works, which was proving valuable.

The report was adopted, and a dividend of 8 per cent. per annum for the half-year declared.

## IMPERIAL TRAMWAYS.

The annual general meeting of this Company was held on Saturday at Bristol, Sir George White presiding. The report, of which we gave particulars last week, was adopted.

## ABERDEEN SUBURBAN TRAMWAYS.

The report by the directors for the half-year ending Jan. 31, 1905, recommends that the balance of £1,357 4s., standing at the credit of profit and loss account, should be carried forward, and dealt with at the close of the next half-yearly account. The Company will by that time have had the experience of a full year's working of the line, and may determine, in the light of that experience, how the balance then at credit of profit and loss should be dealt with.

## BRITISH ELECTRIC TRANSFORMER.

The report for the year ending Dec. 31, 1904, to be presented at the meeting on the 6th inst., states that the result of the year's working has been satisfactory. The accounts show that after paying all manufacturing costs and the expenses of administration there remains a net profit of £12,030. 7s. 9d.; which, with the amount brought forward from last year—viz., £1,572. 13s. 4d.—makes a total available balance of £13,603. 1s. 1d., which the Board recommend shall be allocated as follows: depreciation reserve, £1,500; reserve fund, £2 000; preliminary expenses written off, £1,500; payment of preference dividend of 6 per cent. (£537. 12s. paid Aug. 1, 1904), £1,150. 11s. 8d.; payment of a dividend of 7½ per cent. on the ordinary shares, £4,957. 12s.; carry forward a balance of £2,494. 17s. 5d. The two new bays mentioned in last year's report have been completed and fitted with the necessary plant. This extension of the works has been of great value, and has enabled the Company to deal with the increased volume of business. In spite of the general depression in trade the works were fully occupied, and running overtime during the whole year.

## NEW COMPANIES REGISTERED.

**Light Electric Motor Company.**—Capital, £6,500. Object: to acquire and carry on the business of the Light Electric Motor Company, of 164, Howard-street, as manufacturers of electrical specialities and electric power and light contractors.

**Webster Electrical Engineering Company.**—Capital, £10,000. Object: to take over the business of an electrical engineer carried on by C. W. Webster at Laycock's Mill, Thornton-road, Bradford. Registered office: Laycock's Mill, Thornton-road, Bradford.

**Electrical and Hardware Company, Limited (83,661).**—Capital, £1,000. Object: to manufacture and deal in electrical and other lamps, bulbs, bells, batteries, etc.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Salamanca.**—The Municipality requires tenders for public electric lighting. Tenders by March 14.

**Hoylake.**—The Council invite tenders for 250-kw. steam alternator, with piping, etc. Tenders by March 21.

**Bucharest.**—The Telegraph Department require 3,000 kilos of sulphate of copper. Tenders by March 7.

**Salford.**—Tenders are required by the Corporation for the alteration of storage batteries. Tenders by March 4.

**Oporto.**—The Municipal Authorities require tenders for lease of their electric tramways. Tenders by March 15.

**Leeds.**—The Corporation require tenders for the complete equipment of two sub-stations. Tenders by March 14.

**Verin (Spain).**—The Municipal Authorities require tenders for installation of public electric lighting. Tenders by March 9.

**Barcelona.**—The Municipality require tenders for arc lighting of La barriada de San Gervasio de Cassolas. Tenders by March 15.

**Antwerp.**—Tenders will shortly be invited by the Belgian State Railways for the installation of electric light in their local railway station.

**Bucharest.**—The Post and Telegraph Department require tenders for 14 000 large, 8,000 medium, and 3,000 small insulators. Tenders by March 16.

**Fulham.**—The Borough Council invite tenders for the supply of electrical stores for year ending March 31, 1906. Tenders by 4 p.m. on March 15.

**Zurich.**—The Swiss Electricity Works (Schweizer Electricitätswerke) require tenders for 294,600 incandescent electric lamps. Tenders by March 15.

**Madrid.**—The Post and Telegraph Department, Carretas No. 10, require tenders for 32,000 zinc cylinders for Collaud batteries. Tenders by March 15.

**Plymouth.**—The Corporation invite tenders for the supply of electricity meters, transformers, and cables (paper insulated). Tenders by March 18. See advertisement.

**Bucharest.**—The Roumanian Government Railways require tenders for telegraph poles as follows: 2,000 7m. long, 2,000 8m. ditto, and 500 9m. ditto. Tenders by March 10.

**Johannesburg.**—The Corporation require tenders for 30 direct-current arc lamps with lanterns. Tenders by March 15 to Messrs. Mordey and Dawbarn, 82, Victoria-street, S.W.

**Stoke Newington.**—The Council invite tenders for the supply, delivery, and erection of sub-station plant and mains. Tenders by 4 p.m. on March 8. See advertisement in previous issue.

**Liria.**—The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

**Shoreditch.**—The Council invite tenders for their yearly contracts in the electricity works and other departments. Tenders by March 14. Full particulars in our advertisement columns.

**Laventhem (Belgium).**—The Municipality require tenders for erection of central station, laying of mains, etc. Particulars (3s. 4d.) may be obtained from the Secretary of the Mayor of that place.

**Madrid.**—The Post and Telegraph Department, Calle de Carretas 10, require tenders for telephone and telegraph apparatus, estimated at 35,337·50 pesetas. Tenders by March 10. This includes 50 Morse receivers.

**Lowestoft.**—The Corporation invite tenders for one water-tube boiler with superheater, brickwork settings, and accessories, together with the necessary pipework. Tenders by March 9. See advertisement in previous issue.

**Manchester.**—The Tramways Committee of the Corporation invite tenders for the supply of cement, chippings and broken stone, veterinary services, and general stores. Tenders by March 6. For full particulars see advertisement.

**Dax (France).**—Tenders are required for a concession to erect and work electric lighting of the town for 35 years. Particulars may be obtained from the Secretary to the Municipality of Dax, Province of Landes, France. Tenders by March 6.

**Swindon.**—The Corporation invite tenders for annual supply of incandescent and Nernst lamps; cables; fuse boxes, service boxes, and

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feeder pillars; lubricating oils and grease; and direct-current meters. Tenders by March 21. See advertisement.

**Great Western Railway.**—The directors invite tenders for the supply, delivery, and erection of plant in connection with their electricity generating station at Park Royal and proposed sub-stations and distributing centres at various places. Tenders by March 13.

**Wimbledon.**—The Urban District Council invite tenders for the supply of (3) engine-room stores, (4) cables, (5) joint-boxes and jointing materials, (6) transformers, (7) meters, (8) oils, (9) incandescent electric lamps, carbons, and accessories, (10) iron castings. Tenders by March 4.

**Madrid.**—Der Compania Electrica Madrilena de Traccion propose to extend their electric tramways from the Barquillo-street to Olivide-place. The concession for the works will be dealt with by the Public Works Department, Madrid, April 2. Tenderers for same must deposit a guarantee of £96.

**Switzerland.**—M. R. Vontobel, of Winterthour, and M. Charles Probst, of Lucerne, have obtained a concession for the construction of a narrow-gauge electric railway from Meiringen to Gletsch. The total cost of the enterprise is estimated at £241,600; £19,600 is to be expended on rolling-stock.

**Stockport.**—The Corporation invite tenders for the team and manual labour and the supply of sand, drain boxes, and drains (only) in laying the permanent way of about 3½ miles of double line of tramway, including laying of special work in junctions and crossovers. Tenders by noon on 13th inst.

**Newport (Mon.).**—The Electricity and Tramways Committee invite tenders for 300-kw. continuous-current high-speed tramway generator (engines of enclosed type), 200-kw. continuous-current high-speed steam balancer (engines of enclosed type), boiler, switchboard, stores, etc. Tenders by March 6. See advertisement.

**Edinburgh.**—The Corporation invite tenders for the annual supply of arc lamp carbons, cast-iron pavement and road boxes, electricity meters, house service fuse-boxes, earthenware troughing for laying electricity cables on the solid system, bitumen, and arc lamp globes. Tenders by March 13. See advertisement.

**Gloucester.**—The Electricity Supply Committee invite tenders for three Lancashire boilers and accessories, one 600-kw. generating set and accessories, electrically-driven surface-condensing plant to deal with 30,000lb. of steam per hour, steam, exhaust, feed, drain, condensing water, and sundry pipes, valves, etc., and an electrically-driven boiler feed pump, the whole bound up in one specification. Tenders by March 16. See advertisement.

**Shanghai.**—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Pook and Co., 63, Leadenhall-street, E.C. Tenders by March 31, 1905.

**South Shields.**—The Electricity Supply Department invite tenders for the supply, delivery, and erection of the following plant: (Contract No. 67) one multitubular marine-type boiler, with chimney and mountings; (68) two medium-speed open-type vertical engines for two 550-kw. direct-current traction generators; (69) two 550-kw. direct-current traction generators; (70) traction switchboard; tramways department—(Contract No. 4) electric tramcars, complete with "Brill" trucks, for the Corporation. Copies of specifications, conditions, form of tender, also form of contract, can now be obtained from Mr. J. H. Cawthra, M.I.E.E., borough electrical engineer, South Shields, on payment of £2. 2s. for each contract, which sum will be returned on receipt of a bona fide tender for each contract. Tenders to Mr. J. Moore Hayton, town clerk, Court-buildings, South Shields, by noon on March 13.

**Johannesburg.**—The Municipal Council are prepared to receive tenders for 100 electric tramcars, two electric water-cars, one five-ton travelling crane, one electric car traverser, and various workshop tools, including erection at Johannesburg, to Specification No. 10 of their consulting engineers, Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W. Copies of the specification may be seen on and after Jan. 7 at the Council Offices, Johannesburg, and at the Consulting Engineers' Offices in London, and may be obtained on payment of five guineas, which will be returned on receipt of a bona fide tender. Duplicate copies of the specification may be bought for 10s. each (not returnable). Tenders must be addressed to Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W., and must be received by them not later than March 6. The Council will not be responsible for any expenses incurred in tendering.

## RESULTS OF TENDERS.

**Stoke-upon-Trent.**—The Town Council have accepted the tender of Crompton and Co. for a 22-h.p. motor, at £74. 17s., subject to 2½ per cent. discount.

**Derby.**—The Electric Lighting Committee have accepted the tender of the Sunbeam Lamp Company for the supply of incandescent lamps during the ensuing year.

**Southend.**—The Town Council have accepted the tender of W. E. and H. B. Davey, at £1,558. 13s. 2d., for the extension of the boiler-house at the electricity works.

**Leith.**—The tender of Messrs. M. P. Galloway, Limited, has been accepted by the Tramways Reconstruction Sub-Committee for the supply of centre poles and accessories to be used in the electrical reconstruction of the tramway system, at £4,471.

**Brighton.**—The Lighting Committee of the Town Council recommend that the tender of Siemens Bros., at £2,350, be accepted for the supplying and laying of low-tension cables from Fishersgate-terrace, Southwick, to the point of supply to Aldrington.

**Salford.**—The Electricity Committee have received tenders for the supply of cables from the British Insulated and Helsby Cables, Callender Company, Dennis and Co., Electrical Company, W. T. Glover and Co., W. T. Garnett, and Henley's Telegraph Works Company.

**Grimsby.**—The Sub-Committee have recommended that a water-purifier be purchased from Messrs. Lessen and Hjort for the sum of £315, that motors be supplied by Crompton and Co., and that the tender of the Keighley Electrical Engineering Company for motor starters be accepted.

**Rochdale.**—The Corporation have accepted the tender of the British Thomson-Houston Company, Limited, Rugby and London, for the supply, delivery, and erection at the electricity works of high-tension three-phase switchgear and extensions to the low tension continuous-current switchboards.

**Erith (Kent).**—The Urban District Council have accepted the following tenders: (Contract 5) overhead line equipment, etc.—Brush Electrical Engineering Company, Loughborough, £4,217; (6) underground feeder cables, etc.—Callender's Cable, etc., Company, Belvedere, Kent, £2,590. 4s.; (7) rotary converters, etc.—British Westinghouse Electric, etc., Company, Norfolk-street, Strand, W.C., £1,545 5s.; (8) main high and low switchboards, etc., Kelvin and J. White, Limited, Glasgow, £1,047. 10s.

**Leith.**—The Electric Lighting Committee of the Town Council have considered tenders for a boiler, a dynamo, and a switchboard, required in connection with the extension that is being made at the electrical station to provide additional power for the working of the new tramway cars. The contract for the boiler was placed with Babcock and Wilcox, at £2,287. For the dynamo there were 83 tenders, and the committee made a selection, which, however, is subject to an arrangement. The 26 tenders for the supplying of a switchboard are before a sub-committee with powers.

# BUSINESS NOTES.

## TRACTION.

**Leeds.**—The Corporation have adopted the alteration in fares mentioned in our last issue.

**Geneva Tramways Co.**—The receipts for January amounted to £76,016, against £444 last year.

**Derby.**—The section from the corn market to the Market-place has been inspected by the Board of Trade.

**Llanelly.**—The Urban District Council are depositing a formal petition against the Electric Traction Bill.

**The Machynlleth Light Railway.**—The Board of Trade have confirmed this order subject to a few conditions.

**Manchester.**—A sub-committee has been appointed to visit the route between City-road and Moss Side, with a view to constructing a line.

**Linlithgow.**—It is reported that the District Committee have refused their consent to the proposed electric tramway between Edinburgh and Queensferry.

**Yardley.**—It is stated that the City of Birmingham Tramways Company have approached the District Council with a view to substituting a motor 'bus service for the prospective electric trams to Shirley.

**West Cumberland.**—The Bill to further extend the period for the completion of the tramway has been found to comply with the Standing Orders of Parliament, and has been sent for second reading in the House of Lords.

**Kirkcaldy.**—At the meeting of the Town Council Mr. Francis, burgh surveyor, recommended an extension of the service, including the doubling of certain lines. The Council have instructed Mr. Francis to report upon the cost.

**Glasgow.**—The extensions of the Glasgow system from Johnstone to Kilbarchan and of the Paisley Company's system to Barrhead are likely to proceed it appears, the Renfrew Council having now waived their stipulation as to double lines.

**Bradford Road.**—The British Electric Traction Company, who asked for an extension of their license to use steam on the Bradford Road lines for another 12 months, have been informed by the Board of Trade that only six months can be allowed.

**Gisburn Light Railway.**—The Light Railway Commissioners announce that the promoters of the Barnoldswick and Gisburn light railway order have abandoned their application, the reason being inability to make arrangements with either of the existing railway companies.

**South Lancs. Tramways Co.**—The company decline to issue season tickets on their system. The greater proportion of tramways revenue, it is pointed out, is derived from the working classes, and, as these cannot prepay their fares, the adoption of contracts would create a favoured class of passengers.

**Edinburgh.**—Matters of general policy in connection with the extension of the tramway system in and around the city were under discussion by a sub-committee, with the result that the town clerk has been instructed to prepare a full report on the situation, enlisting the services of Prof. Kennedy, if necessary.

**Yarmouth.**—The arbitrator, Mr. Graham Harris, has fixed the amount which the Corporation is to pay the Gorleston Tramway Company for their undertaking at £13,400, together with the cost of the fodder in stock at the depôt. The Corporation are to pay the costs. The Corporation were asked £19,000 for the undertaking.

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**Aston.**—An accident occurred on the newly-opened Small Heath route on Saturday night, when two cars were approaching each other from opposite directions. They were about six yards apart, when a horse and four-wheeled van went between, and became wedged. The van was driven by a man in the employ of the Corporation health department, who was arrested.

**Hastings.**—The company's Bill has been referred to the Standing Orders Committee in respect of non-compliance in regard to the Bexhill section. The suggestion for a conference between the company and the Hastings Corporation has been revived. Good progress is being made with the work of construction. A formal meeting of the company was held last week, when it was stated that everything was proceeding satisfactorily.

**Coventry.**—On the Standing Orders Committee of the House of Commons considering the report of the Examiners of Private Bills, it appeared that the Standing Order requiring the consent of the local road authority had not been complied with in the case of the Coventry Electric Tramways Bill. There was no appearance entered by the parliamentary agents, and it was intimated that the Bill will not be proceeded with.

**Greenock.**—The Greenock and Port Glasgow Tramways Company has appealed to the High Court, London, against the decision of the Board of Trade awarding the sum of £602. 19s. 9d. as the proportion of profits due to the Corporation, and also ruling that the company is to account for two sums of £75 set aside for maintenance and £1,500 placed to depreciation. The plea of the company is that the Board of Trade acted *ultra vires*.

**Italy.**—The *Gazzetta Ufficiale* publishes decrees authorising the Leghorn Tramways Company to construct and work an electric tramway in that city; authorising the Carthagena Tramways Company to substitute electric for animal traction on the lines between Carthagena and San Antonio Abad, Dolores, Barris, Peral, and Santa Lucia; and authorising the Roman Tramways and Omnibus Company to substitute electric for animal traction on the tramway between the Piazza del Popolo and Ponte Milvio.

**London County Council.**—The receipts for the week ended Feb. 18 amounted to £12,878, against £9 653 for the corresponding week of last year, and from April 1 to £588 357, against £456,442. The invitation from the Shoreditch Borough Council to support a request that the County Council should experiment with motorcars for its northern system has met with a lukewarm reception from the Stoke Newington Borough Council. The second reading of the County Council's Tramway Bill has been postponed until the 7th inst.

**North Metropolitan Tramway Co.**—At the meeting of this Company Mr. G. Richardson, who presided, stated that there was no doubt the time was coming when locomotion in the streets would be altered, perhaps in favour of motor 'buses as against horse 'buses. So far as the company was concerned, the point that would affect them was when they would be able to get a suitable motorcar which would run upon the rails. The directors were carefully watching developments, so that at the proper time they would run these motorcars instead of those propelled by electricity.

**Rochdale.**—At a meeting of the Tramways Committee it was decided to commence the reconstruction of the line along Bolton-road to the borough boundary at Heywood Cemetery on, or if possible before, March 13, and as soon as the work there is done the men will be transferred to the Littleborough section. A deputation of the Whitworth District Council waited on the committee, and asked them to take into favourable consideration the question of extending the lines and running into the Whitworth district. The committee decided to go fully into the subject at a future meeting.

**South Australian Tramways.**—In pursuance of the article on this subject in our last issue, we note that the private tramway companies have retained the services of Sir Josiah Symon as their legal adviser during the negotiations, and have appointed Mr. H. F. Rymill as arbitrator on their part. The Government have not yet announced their choice. When both arbitrators are appointed, application will be made to the Supreme Court for directions as to procedure. We are informed that a tracing of the lines in question may be inspected at the offices of the Agent-General for South Australia, 1, Crosby-square, E.C.

**West Bromwich.**—The following resolution is to be moved at the next meeting of the Council: "That the General Purposes Committee be empowered to take proceedings against the tramways company to enforce the terms of their agreements and leases with the Corporation." What the Corporation complain about is that the tramway company are running a 10 minutes' instead of a seven minutes' service of cars between Carter's Green and Great Bridge, and also Carter's Green and Wednesbury; and, further, that they have failed to carry out their agreement in not providing proper shelters for the convenience of passengers.

**Cardiff.**—At a meeting of the Tramways Committee last week the estimate for the year ending March 31, 1906, was submitted. From this it appeared that the estimated expenditure was £110,643. 3s., as compared with £112,385. 14s. 2d. for the year ending March, 1905, while the revenue was estimated to be £115,709, as compared with £118,366 for the year about to end. There was, therefore, a decrease both in the revenue and the expenditure, but the revenue showed an estimated balance over expenditure of £5 065. 17s. The figures for the year just ending were, however, only estimates. The estimate was adopted.

**Edinburgh.**—The Corporation have decided to apply for sanction to an electric tramway from Tolleross along Gilmore-place to the Edinburgh Hydropathic, thence back to the city by Slateford and Fountainbridge; a line from the top of Broughton-street to the burgh boundary at Pilrig-street, and from Canonmills to join the line at Bellevue. The Council declined to grant permission to a private syndicate to construct an electric tramway from Fountainbridge to Slateford. They approved of an application by the National Electric Construction Company for a new order amending the Portobello and Musselburgh Tramways Orders.

**Falkirk.**—There has been some little friction between the tramway company and the Corporation. The company propose to take energy in future from the Scottish Central Power Company, whose right to supply same is disputed by the Corporation, who now offer to provide power on the following terms: 2d. per unit for the first 100 000 units, and 1½d. thereafter, with a minimum consumption of 100,000 units per annum, the supply to be given by meter at the generating station, and to be direct current at from 500 to 550 volts; the maximum demand not to exceed 150 kw., and the hours during which supply is to be given to be within 5 a.m. and 11 p.m. on weekdays.

**The Underground.**—A successful experiment was made on the Metropolitan Railway on Monday night after the ordinary traffic had ceased. An electrically-propelled train was run from Neasden to Baker-street, where it crossed to the company's portion of the Inner Circle line. From Baker-street the train proceeded to Notting Hill-gate and thence to Aldgate, after which it returned to Baker-street. An extraordinary general meeting of the Underground Electric Railways Company of London, Limited, was convened for yesterday for the purpose of passing resolutions authorising the directors at their discretion to raise or borrow or secure the payment of any sum or sums of money for the purposes of the company, not exceeding £4,000,000, in addition to the amounts which they are at present authorised to borrow, etc.

**Aberdeen.**—At a meeting of the Tramways Committee a discussion ensued as to the issuing of celluloid tokens and season tickets. The consensus of opinion was to the effect that celluloid tokens should only be issued at their face value—namely, 12 for 1s.—as in all other corporations in the south it was found that this was the system on which they were given out, no reduction being given even for the purchase of a number of those tokens. It was also considered that season tickets on the various routes were in a number of cases issued at too low rates, but in view of the close of the financial year in May, before which any rearrangement of fares over the whole system must take place, it was resolved to call a special meeting next month to consider the three questions of the issuing of celluloid tokens, season tickets, and the extension of ½d. tickets, or, alternatively, a universal 1d. fare.

**Wellingborough.**—The Wellingborough and District Tramroads and Electricity Supply Bill came before Mr. Campion, examiner of Bills for Standing Orders, at Westminster, last week, for proof of compliance with the Standing Orders of Parliament. There was no opposition at this stage, but with regard to the withholding by Northamptonshire County Council of their consent to the new lines promoters contended, upon certain technical grounds which they advanced, that the consent of the County Council was unnecessary. The examiner, however, decided against the promoters, and intimated that he would report non-compliance with the Standing Orders of the Committee of the House of Commons. Councillor Joseph Wilson has given notice of a motion, "That the Tramways Committee be requested to consider and report upon the desirability of introducing self-propelled motorcars or omnibuses to work in conjunction with, or apart from, the present system of electric cars."

**Municipal Tramways.**—At a further conference held of representatives of municipal tramways, held at the Westminster Palace Hotel, the clauses in Railway Bills as to the running of omnibuses were considered, and it was decided to obtain a modification of those clauses as far as possible, so that the omnibuses should be limited to running to and from the stations of the companies. The question of the erection of guard wires over the trolley lines in places where telegraph and telephone wires crossed the trolley lines was also considered. As the law stands at present, if the tramway promoters were first in the field, and the Postmaster-General subsequently desired a telegraph wire to be erected over a trolley line, the tramway promoters were called upon by the Board of Trade to erect guard wires at their own expense. This the promoters considered to be an unfair and inequitable arrangement, and it was determined to request the Board of Trade to receive a deputation on the subject, and also upon the question of certain regulations recently issued by the Board of Trade on the subject of the construction of cars and other matters connected with tramway equipment.

**Leicester.**—At a special meeting of the Town Council on Tuesday, Councillor Flint, chairman of the Tramways Committee, presented the report for the year. The total receipts, including rents and bank interest, were £79 900, and the working expenses £47,993, leaving a gross profit of £31,907. They had paid in interest and sinking fund £18,849, leaving a net balance on the year of £13,088. By way of comparison, Councillor Flint stated that the gross receipts in 1903 were £47 599, signifying an increase of £31,126 for the past year. The working expenses in 1904 amounted to £47,993, and in 1903 to £38 850, an increase of £9,143. The passengers carried in 1904 numbered 18,394,183, against 10 813 430, an increase of 7,580,753. The car miles run were 1,850,479, against 960,934. It will be remembered that mixed traction has been in use this year, owing to reconstruction for electric working, and Councillor Flint gave some interesting figures in relation to the two systems. With horse traction the receipts averaged per car mile 10 41d., while for the electric cars the average was 9 70d., this being accounted for by the longer distance which the electric cars carried passengers, and by the lateness of the season when they commenced running. The working expenses were all in favour of the electric car. The horse traffic cost 8·85, while the electric traffic cost only 4 82, a difference in favour of the electric traffic of 4·03. The committee proposed to devote the balance of £13,000 to a reserve fund for maintenance and repairs instead of creating a depreciation fund. In conclusion, Councillor Flint alluded in appreciative terms to the efforts of

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the staff, particularly Messrs. Mawbey, Lucas, and Smith. An amendment in regard to the appropriation of the balance was submitted by Councillor Kemp, who thought it ought to be devoted to reducing the capital account. Eventually the report was adopted unanimously.

**South Shields.**—At a meeting of the Town Council on Wednesday a deputation was received from the South Shields Property Owners' and Ratepayers' Association on the question of motor omnibuses *v.* electric trams. The leader of the deputation said that it represented not only the Property Owners' and Ratepayers' Association, but also a representative body of ratepayers, and they asked the Council, before committing themselves to the laying of tramlines, to seriously consider the desirability of adopting some other system, such as motor 'buses, which would be more up-to-date, more appropriate, more adaptable, and cheaper than electric trams. The memorial had been signed by 730 ratepayers of the borough, but this did not adequately represent the feeling of the town on this question. The petitioners, therefore, asked that an exhaustive enquiry founded on expert and unbiassed evidence, should be held, so that South Shields might have the best and most up-to-date system of locomotion. Alderman Readhead, in supporting the memorial, remarked that three reasons were given for the adoption of motorcars—viz.: (1) Less cost in the purchase and working of motor 'buses; no cost of street widenings or laying of lines; and overhead gear not required. (2) Freedom of motion, there being no necessity for motor 'buses to keep to any particular route or routes; their ability to run outside the borough; less interference with traffic; and less danger to the public. (3) That other electric tram companies are now adopting motor 'buses in substitution for such trams, and that if the Council adopt electric trams some private company may compete against them with motor 'buses. He suggested that the Council should acquire three motor 'buses at an estimated cost of £3,000, which could be run over the Westoe-lane and Stanhope-road routes, and they would then be able to judge whether or not it would be advisable to adopt them generally instead of the trams. Councillor J. Grant, speaking on the Tramway Committee's report, referred to the discussion in committee on the question of motor omnibuses, remarking that the reason the committee rejected the motion in favour of an enquiry was that at that time they had no data to go upon, and all the statements then made were purely hypothetical. Everyone knew what an electric car could do, but no one could tell them the extent of life of these motor 'buses. He pointed out, in contradiction to statements which had gone abroad, that the total costs of the tramway system would not exceed £129 000. An animated discussion ensued, Alderman Rennoldson remarking that the Council had no power to run motorcars. Councillor Barlow supported a resolution for an exhaustive enquiry into the matter, on the ground that the motorcar was making great strides, and eventually this was agreed to, the report to be presented at a special meeting in two or three weeks' time.

**Dalkeith and Bonnyrigg.**—At a conference between representatives of the Dalkeith and Bonnyrigg Town Councils and representatives of the Edinburgh Suburban Electric Tramway Syndicate in regard to the proposed electric tramway from Edinburgh to Dalkeith and Bonnyrigg, Provost Chisholm submitted a memorandum of suggested conditions and provisions, which had been approved by the Dalkeith Town Council the previous day, and of which the following are the chief: The company to be bound within one year from the date of the passing of the provisional order to substantially commence the work of laying down the tramways, and within two years from said date to complete the tramways and open them for the public conveyance of passengers. The tramways within the burgh to be laid as a double line, except in such portions as may be adjusted with the Council, and the precise position of the lines also to be adjusted with the Council or their surveyor. The size, position, design, and construction of all posts, standards, wires, supports, and other apparatus must be first approved of by Town Council, but such approval not to be unreasonably withheld. The Council or their lighting contractors to be entitled to free use thereof for electric or gas lighting. The posts, standards, and supports to be painted and kept painted to the satisfaction of Council. All cars to be of most modern and approved design, which is to be approved of by Council. The cars to be lighted by electricity and to be provided with lightning arresters. Fares not to exceed 1d. per mile. Through fare Nether Liberton to Dalkeith not to exceed 4d., and Dalkeith to Bonnyrigg 1½d. Fares for workmen's cars not to exceed half these rates. The Council to have option on six months' notice to acquire undertaking in burgh (and rest of tramways, also subject to rights of local authorities outside burgh) on the following terms: (1) at expiry of 14 years from commencement of order at valuation to be fixed by arbitration upon the basis of cost of construction (less depreciation), and (immediately preceding) four years' net profits in name of goodwill; (2) after expiry of 21 years as above, with two (immediately preceding) years' net profits for goodwill; (3) after 28 years on same terms, with profits for one year (preceding) for goodwill; (4) at expiry of 42 years on same terms without goodwill. Before selling undertaking to other than the Council, six months' notice and offer to be made to this Council on same terms. Goods, minerals, and animals only to be carried by company with consent and on terms and conditions approved of by Town Council. Company to pay Council at rate of £50 per mile as rent for lines within burgh, so soon as company pays its shareholders 5 per cent., with £50 additional per mile for every 1 per cent. paid to shareholders over 5 per cent. Company to repair and make good all streets, roadways, and footpaths opened or broken by them at any time, and Council be at liberty, after notice, to do so in event of company's default and at their expense. These conditions were approved of generally, with the exception of the proposed terms of acquisition by the Council and the proposed rent to be paid by the company after it earns a dividend. The syndicate could not see their way to agree to these proposals, and the Council representatives agreed to consider as to the modification thereof. Provost Gilchrist stated than the Bonnyrig Committee concurred in the provisions suggested by Provost Chisholm on the understanding that the Bonnyrigg section of the undertaking should be proceeded with concurrently with Dalkeith.

## LIGHTING AND GENERAL.

**Partnership.**—Particulars of a partnership open appear in another column.

**Thirsk.**—On Wednesday telephonic communication was opened at Thirsk to all parts.

**Cairo.**—The electric lighting of the town is to be greatly extended. The French gas company has the monopoly.

**Lighthouses.**—During last year to March, £3,847 was spent on establishing electric communication with lighthouses and light-vessels.

**Cardiff.**—An enquiry has been held into an application of the Corporation for sanction to borrow £87,868 for purposes of electric lighting.

**Chester.**—The discussion on the public electric lighting has been adjourned until a further report has been received from the electrical engineer.

**Southend.**—The electrical engineer has submitted a report urging the need for the installation of the additional plant in time for the summer load.

**Bournemouth and Poole Electric Supply Co.**—The directors recommend a dividend on the ordinary shares of 7 per cent. per annum for the year 1904.

**Swindon.**—An enquiry has been held into an application of the Corporation for sanction to borrow £22,000 for the extension of the borough electricity works.

**South Shields.**—The following reductions in the charges for electric energy have been made: after the first hour's consumption from 2d. to 1½d. per unit, and the flat rate from 5d. to 4d.

**East Barnet.**—The Council have decided that negotiations with the North Metropolitan Electric Supply Company for the supply of electricity to East Barnet should not be proceeded with.

**Torquay.**—A post-card poll of the ratepayers concerning the scheme is about to be taken in regard to the Corporation's proposal to construct a new electric light and power station at a cost of £42,000.

**Penrith.**—The Local Government Board has refused to accede to the application of the Urban District Council for sanction to borrow £6,850 for the purpose of laying down an electric lighting plant.

**Colchester.**—In reference to the application for sanction to the borrowing of £16,500 for purposes of electric lighting, the Local Government Board have sanctioned £12,920 without, it appears, specifying the items excluded.

**Electric Supply in the Metropolis.**—The London County Council on Tuesday adopted the report of the Parliamentary Committee, fully dealt with in our last issue, and decided to leave open the date of the proposed conference.

**Metropolitan Electric Supply Co.**—The directors recommend the payment of a final dividend for 1904 of 11s. per share on the ordinary stock, making a total distribution for the year of £1 per share, or 10 per cent., carrying forward £9,000.

**Fulham.**—The charges for lighting decided upon by the Borough Council on Wednesday are as follows: a flat rate of 3½d. per unit, with a discount of 2½ per cent. on all bills over £2 per quarter and 5 per cent. on all bills over £5 per quarter if paid within 14 days.

**Paisley.**—The electric light installation at the refuse destructor works was formally inaugurated last week. Bailie Fisher, convener of the Electric Lighting Committee, started the engine, and Bailie Glover, convener of the cleansing department, switched on the current.

**Hackney.**—The borough engineer and surveyor, Mr. Norman Scorgie, in his report for the year ended March, 1904, says that during that year 40 seven-ampere "open" type arc lamps have been placed at a distance of about 100 yards apart in three roads in lieu of 91 existing gas lamps.

**Kent Electric Power Co.**—This company, which is incorporated by special Act of Parliament, and has for its operations the county of Kent, has completed the purchase of the undertaking of the Chatham, Rochester, and District Electric Lighting Company, Limited, as from Jan. 1 last.

**Removal.**—Messrs. Oetzmann and Co., of 62 to 79, Hampstead-road, W., announce that they have purchased the entire stock of Messrs. Norman and Stacey, Limited, of 252 to 256, Tottenham Court-road, and are now removing it to their own showrooms and galleries in Hampstead-road.

**Ormskirk.**—The Urban District Council have now adopted an electric lighting scheme, which includes the provision of a refuse destructor, and is estimated to cost £20,000. The Council have entered into a provisional agreement with the Electric Construction Company to carry out the works.

**Grimsby.**—A temporary draughtsman is to be engaged to assist in preparing a scheme for the enlargement of the electricity station and the extension of the plant. During the last year the increase of lamps was about 16,000, the average increase since the department was established having been 10,841 per annum.

**Arbroath.**—Matters with regard to the proposed electric lighting are apparently not getting any forwarder. The Council are corresponding with the Empire Electric Lighting Company with regard to a provisional agreement entered into in October last. In the meantime the Board of Trade have revoked the order.

**Bath.**—The Council have adopted a report in which Mr. Teague showed the necessity of extending the continuous-current generating

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plant required to prepare for next winter's load, and although this extension will cost £1,321 more than another generator, Mr. Teagne considers that there will be an annual saving in the cost of generating of £300 a year.

**Annual Dinner.**—The seventh annual dinner of the Central Technical College O'd Students' Association was held at the Trocadero Restaurant, Piccadilly, on Wednesday, Feb. 22. About 60 Old Centralians were present, the guests including Sir William Crookes, F.R.S., and Dr. Hartog, the academic registrar of London University. Prof. W. E. Ayrton occupied the chair.

**London Telephone Exchanges.**—Lord Stanley on Wednesday, in reply to a question of Sir T. Dewar, said 11 Post Office telephone exchanges were open in London on Dec. 31 last, and the number of subscribers in connection with them was 22,181. The amount of annual rental payable for the use of these instruments, together with messengers' fees, during 1904 was £156,485.

**Hull.**—We understand that the large contract with Messrs. Earle's Shipbuilding and Engineering Company for the supply of electricity to the company, which will expire in May, is to be renewed for a further 12 months. The town clerk's report in respect to the hiring of electric motors, and a suggestion that motors be purchased out of revenue, has been referred to a sub-committee for report.

**Swansea.**—The Corporation, under the terms of the license held from the Postmaster-General, considers itself entitled to demand from the National Telephone Company intercommunication between the subscribers to the two rival systems. Various reasons have been put forward by the company for resisting the demand, and we understand legal action is being taken by the Corporation to enforce it.

**Glasgow.**—The following information has reached us: The National Telephone Company has now 20,000 telephones on rental working in the Glasgow district. Their net increase for last week amounted to the enormous total of 215 telephones, which is a record. The company has during the past month opened four new exchanges in this district, thus bringing a number of outlying villages into touch with the city.

**Gloucester.**—The Council have agreed to borrow £24,673 for the purpose of carrying out electric lighting extensions. At the last meeting of the City Council Alderman Fielding expressed satisfaction that the report of Mr. R. A. Chattock on the proposed extensions of the electricity plant confirmed the report of their own engineer, Mr. Bache, both with regard to the extension and the probable profit on the undertaking.

**Agencies.**—Messrs. Hellesens Enke and V. Ludvigsen, Blaagaardsgade 14 and 17, Copenhagen N., Denmark, have appointed Messrs. Fuller, MacLeod, and Co., Limited, of Norfolk House, Laurence Pountney-hill, Cannon-street, their sole agents for Great Britain for the Hellesen dry cells. Messrs. Monté Calow and Co., 6, Ludgate-broadway, E.C., have resigned their agency for Messrs. Lionel Robinson and Co.'s specialities.

**Croydon.**—Tenders are to be invited for coal supplies for the ensuing year, and also for supply of cables. The following particulars are available: current sold this year—private lighting, 136,577 units (corresponding period last year, 105,343 units); public lighting, 54,243 (47,153); traction, 89 563 (81,161). The extension of mains to supply current to houses in Craignish-avenue is to be carried out as recommended by the borough electrical engineer.

**Elland.**—The Electricity Committee, in their statement of the first year's working of the combined refuse destructor and electricity works, say that the total receipts have amounted to £655, and the working expenses to £442, leaving a gross profit of £213. This is, however, more than absorbed by the interest and repayment of principal on the borrowed capital of £16,000 which amounts to £833, leaving a net deficiency on the year of £670.

**South Africa.**—The King William's Town Corporation have just taken over the local electric lighting undertaking, and will soon be giving out new orders; while Potchefstroom is greatly concerned about its electric lighting arrangements. They had agreed to purchase the local company's business for £6 000, but Mr. Stevens, the Government electrical engineer, reports that the plant is inadequate to the needs of the town.—*South African Traders' and Export Gazette.*

**Manchester.**—The chief engineer in a recent report dwelt on the need for further capital expenditure. This does not concern extensions at the chief generating stations; the money is required chiefly for extensions of mains and for generators, etc., at the sub stations. For instance, there is no room at Dickinson-street for more boilers, and it has been decided to introduce three generators of 500 kw. capacity each, and drive them from high-tension mains from Stuart-street.

**Wimbledon.**—The Council have agreed to charge a flat rate of 2½d. per unit for all units consumed for street-lighting as from April 1 next. On and after that date the incandescent street lamps will be kept lighted from dusk to dawn, and each alternate arc lamp switched off at midnight. The electrical engineer's plans and estimate for the additional plant and extensions required at the electricity works have been approved, and application will be made for sanction to borrow £13,218.

**Stoke-on-Trent.**—A committee of the Guardians have considered a proposal made by the electrical engineer at the workhouse that they should dispose of the storage battery and instal a dynamo to take the night load. A tender offering £75 for the battery and other apparatus, of which it was proposed to dispose, and offering to supply the dynamo which it was proposed to instal at £100, has been received. The opinion of an independent electrical engineer is to be obtained on the matter.

**Dartmouth.**—An electrical exhibition was opened at the Dartmouth Subscription Rooms on Wednesday last week by Mrs. Gouldsmith, who was introduced by Mr. H. Brent Grotrian, a director of the Urban Electric Supply Company. A vote of thanks to Mrs. Gouldsmith was moved by another of the directors of the company, Mr. J. C. Wigham, who explained some of the many uses to which electricity can be put. He particularly referred to the hospital ward. The vote was seconded by Lord Aylesford.

**Middlesbrough.**—The electrical engineer (Mr. Taylor) in his last report states that 116,000 units have been generated during February, against 70,000 for the corresponding month last year. The estimated revenue for the past month was £1,477, against £1,020, an increase of £457, although the selling price had been reduced by 10 per cent. The total cost had been £476, against £338. The estimated profit for the month was £1,001, exclusive of interest and redemption. The lamps connected to date numbered 71,400, and there were applications in hand for a further 4,764 lamps.

**Exports to the British Colonies.**—We are informed that, owing to the growth of their export business, the Union Electric Company, Limited, 151, Queen Victoria-street, E.C., are sending out one of their most experienced officials, Mr. C. O. Barwell, for a trip through the British Colonies—in fact, round the world. The main objects of this extensive trip are to ascertain the condition of the Colonial markets, appoint agents for the purpose of furthering the company's and general interests in the British Colonies by personal activity. We understand that Mr. Barwell is open to represent one or two other leading electrical firms whose interests do not conflict with the Union Company's.

**Eastbourne.**—The following figures are available for the year ended March 31, 1904: Number of 8 c.p. lamps connected at end of year (arcs, incandescents, and motors, equivalent in 8 c.p.), 64.898, previous year 56,227; units sold, private supply 733,322 (628,685), public lighting 163,871 (40,446)—total, 897,193 (669,132); units sold per 8-c.p. lamp (connections during the year averaged), 14·8 (13 0); maximum load on feeders in kilowatts, 743 (629); load factor, 13·75 per cent. (12·14 per cent.); capacity of dynamos at end of year, kilowatts, 1,200 (1,200); average price obtained, private supply 5·95d. (6·18d.), public lighting 3·02d. (4 08d.). Prices charged: private lighting 6½d. per unit; power and heat, 3d. per unit; hotel and theatre lighting, maximum demand system, with initial charge of 7½d. per unit for daily average of one hour and 4d. per unit after; public lighting, arc lamps, £25 per lamp per annum.

**Newcastle.**—A report as to the comparative statement of the annual cost of gas and electric lamps was issued to members of the City Lighting Committee of the Corporation on Wednesday by the lamp inspector (Mr. George Lamb). In this report the inspector, among other suggestions, says: "The thoroughfares of Walker are lighted by 235 16-c.p., 95 25-c.p., five 32-c.p., and three 50 c.p. incandescent electric lamps, there are also eight enclosed arc lamps. In this report it is proposed to deal only with the 25-c.p., 32-c.p., and 50-c.p. lamps, the annual cost of which is £328. 15s. 6d., and the aggregate candle-power is equal to 2,710 candles. If those lamps were replaced with Nernst lamps, and two lamps fixed on each pillar in accordance with the design submitted, there would be light equal to 80 candles at each pillar, and a total candle-power equal to 8,320 candles. The annual cost for each pair of lamps would be £3, and the total cost £312 per annum. The cost for the new head and the necessary alterations would be about £2. 12s. 6d. per lamp, and would amount to £274. 12s. for the 104 lamps under consideration."

**Fire.**—A large fire broke out soon after two o'clock on Tuesday morning on the premises of the National Telephone Company at Oxford-court. We understand that the fire started in the test-room at the top of the building, and the cables fastened to the derrick over the building were burnt. The result was that some 6,000 subscribers on the Bank exchange were disconnected. Arrangements were at once made to restore communication at the earliest possible moment. A large staff was employed on this work day and night. Subsequent reports show that the damage by fire did not involve all the switchboards, which were, however, injured by water. The cause of the fire is yet to be definitely ascertained, but it is rumoured that it was due to a leakage on to some telephone wires of current from the third rail on the Underground Railway. Some of the National Telephone Company's cables are carried through the tunnels of the District Railway, so that this is possible. If this rumour proves to be correct, it will be interesting to know why the devices usually installed in telephone exchanges to guard against the possibility of such inter-connections were not effective.

**Parliament.**—Lord Balfour of Burleigh, acting chairman of committees of the House of Lords, and Mr. J. W. Lowther, chairman of committees of the House of Commons, have conferred together and have determined the House of Parliament in which the private Bills deposited this session shall originate for consideration. The following London Electricity Bills will be first heard in the House of Lords: the Administrative County of London and District Electric Power Company, Central Electric Supply, *Charing Cross and Strand Electricity Supply Corporation, *City of London Electric Lighting Company, County of London Electric Supply Company, East London and Lower Thames Electric Power, Metropolitan District Railway, *Metropolitan Electric Supply Company (Acton District), *Metropolitan Electric Supply Company (Various Powers), Metropolitan Railway, North Metropolitan Electric Power Supply, West Cumberland Electric Tramways (Extension of Time). The metropolitan Bills which will originate in the House of Commons are Baker-street and Waterloo Railway, Central London Railway, Charing Cross, Euston, and Hampstead Railway, Chelsea Electricity Supply, Edgware and Hampstead Railway, Great Northern, Piccadilly, and Brompton Railway (Nos. 1 and 2), Hammersmith, City, and North-East London Railway, London County Council (Tramways), London Southern Tramways, London United Tramways (Extension of Time), Metropolitan Electric Tramways, *Whitechapel and Bow Railway, *Walton-on-Naze Electric Supply, *Aberdare Tramways. * These Bills have now been read a second time.

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**Stirling.**—The last report of the electrical engineer, Mr. A. C. Hanson, on the progress of the undertaking for the four weeks ending Jan. 21, shows that 32,715 units were generated, as against 28,061 for the same period last year. The total number of equivalent 8-c.p. lamps connected for all purposes was 16,348, as compared with 12,861 at the corresponding date last year. A sum of £1,700 is to be borrowed on electricity account. A number of electric lamps will be substituted for the gas lamps in various streets.

**New Firm.**—The Telephone and Electrical Installation Company, Mansion House-chambers, 11, Queen Victoria-street, E.C., have commenced business as telephone experts and contractors for practically all kinds of electrical installations under the management, we understand, of Mr. Horatio Bell, A.M.I.E.E., late metropolitan contract and sales manager National Telephone Company, Limited, and Mr. Stanley C. Russ, late chief of staff, metropolitan contract department, National Telephone Company, Limited.

**Electric Clocks.**—The Synchronome Company, of 32 and 34, Clerkenwell-road, whose system of electric clocks was, we are informed, the only one awarded a gold medal at the St. Louis Exposition, inform us that they have sold their Australian rights to the Synchronome Company of Australasia, Limited, of Brisbane. Mr. Alexander Knox, the managing director, who has already installed some large electrical time-circuits in Queensland with the assistance of Mr. A. G. Jackson, A.I.E.E., the technical manager, is at present on a visit to this country to perfect his arrangements with the manufacturers.

**Sunderland.**—The Electric Lighting Committee have decided to reduce the price of electricity to lighting consumers from 5d. with discount to 4½d. with discount. The present price for small motor consumers is 2½d. per unit with discount, and it was decided to give them the benefit of the maximum demand system, and charge 2½d. per unit for the first hour and 1½d. afterwards. They have also agreed to offer a reduction from 1½d. to 1¼d. per unit to the tramways, which will mean a reduction of nearly £1,000 a year. The estimate for the year ended March, 1905, shows a net profit of £4,090.

**West Hartlepool.**—An enquiry has been held into the Town Council's application for sanction to borrow £2,200 for the provision of additional plant at the electric lighting station, required in order to make provision for the increasing consumption. The borough electrical engineer (Mr. Friederichs) stated that the top load upon their plant last year was 565 kw. They had anticipated a 600-kw. load in January, but they had not been able to get the works connected which they had anticipated to supply. They now asked for sanction to borrow sufficient money to provide additional plant of 250 kw. power. The net cost of production per unit last year, exclusive of loan charges, was 1·59d., and the price for lighting 4d. per unit.

**City of London.**—The Streets Committee last night submitted a report on the proposal of the Charing Cross and Strand Electricity Supply Corporation to change the pressure from 100 to 200 volts in those portions of the western area of the City where a supply of 100 volts is now being given, the object being to make the supply in the City of uniform voltage throughout. The committee recommended that the undertakers should make at their own expense the necessary alterations to consumers' lamps, etc., and allow a deduction of 10 per cent. in the price of electric energy to consumers whose supply is changed from the lower to the higher pressure. It was also suggested that, concurrently with the alteration of the standard pressure, the undertakers should establish proper means, under the direction of the Board of Trade, of testing the public and private supply of energy.

**Football.**—On Saturday the half-yearly match between the Robertson lamp makers and the head office staff of the General Electric Company was played on the ground of the Robertson lamp makers. Owing to the fact that the lamp makers had won every year since the match was first instituted, the headquarter staff turned up in full force with a firm intention of vanquishing the lamp makers on this important occasion. The lamp makers were victorious by three goals to two, the winning goal being scored through a penalty in the last half minute of the game, much to the disgust of the headquarter staff. The football match was followed by the annual concert in the dining hall at Brook Green Works. The concert was attended by considerably over 500 people, and was, we are informed, a great success. About 30 items, including instrumental performances and songs, comic and otherwise, were gone through.

**Erith.**—The Council have agreed to supply Messrs. Callender's with further current required at the flat rate of 1½d. per unit, upon condition that the energy consumed by them for lighting purposes shall not in any year exceed 20 per cent. of the total amount of energy supplied to them by the Council. The Electric Lighting and Tramways Committee have reported that they cannot recommend the lowering of the cost of electric light to small consumers. The committee have further considered the question of the charge to be made for the lighting and maintenance of the arc lamps, which was referred back to the committee, and have reported that they see no reason to alter their previous recommendation, which they again make to the Council—viz., that as from March 31, 1904, the sum of £25 per lamp per annum be charged for the lighting and maintenance of the arc lamps in lieu of £20, previously charged. The committee are strongly of opinion that the arc lamps should be retained. Both reports were agreed to at the last meeting.

**Continental Telephones.**—During the present month every town in England where there is a first-class telephone centre will be able to telephone direct to any similar town in France. Between the two No. 1 zones the charge will be 8s. 4d., between the two No. 2 zones 12s. 6d., and between either No. 1 and either No. 2 zones 10s. 3d. per conversation. Communication will be established between the following English and French towns: Besancon, Lons-l-Saulnier, Le Mans—London (inner), Bristol, Cambridge, Leicester, Lowestoft, Norwich, Southampton, and Great Yarmouth; Fecamp—London (inner), Brighton, Cambridge, Ipswich, Lowestoft, and Norwich; Le Treport—London (inner). "Inner" London embraces the whole of the telephone exchanges within the administrative county of London, while "outer" London includes the remainder of the Post Office exchanges in the London telephone area. Communication is now practicable from London (inner as well as outer) and 20 provincial centres to 44 towns in France, in addition to many of the suburbs in Paris. From the same places in England there are telephone lines to 13 Belgian towns.

**Newport.**—The electric light installation at the parish church consists of 87 incandescent lamps, mostly of 16 c.p. The lights are fitted in the nave and chancel in groups of five on handsome wrought-iron electroliers suspended from the arches between the stone columns, and three light wrought-iron electroliers are fitted under the organ galleries and in the main porch, single lights being arranged for the galleries, vestries, and north and south porches. Special adjustable lamps are fitted to the pulpit, reading desk, and organ. The belfry and steps leading thereto are provided with small wrought-iron brackets. A distributing switchboard is fixed near the choir vestry, and this has been so arranged that the lighting can easily be graduated from two-fifths of the total light upwards, and can also be divided so that particular portions of the church may be separately lighted when so required. It is estimated that mainly owing to this arrangement the cost of lighting the church will not exceed £10 per annum. The work has been carried out to the specification under the supervision of Mr. B. H. Jenkinson, consulting engineer, of 9, Gray's-inn-square, London, by the Isle of Wight Electric Light and Power Company, whose managing engineer at Newport is Mr. E. H. Crowe.

**Islington.**—At to-night's meeting of the Council the Works Committee will report on a letter from the London County Council again calling attention to the delay in the improvement of the telephonic communication between Kentish Town fire station and the Highgate street station, and in the provision of certain fire alarms in the borough of Islington, which it is alleged are caused by difficulties between the Islington Borough Council and the Post Office as regards wayleaves, and asking that having regard to the extreme importance of the telephonic communication referred to being rendered satisfactory without any further delay, the Borough Council will make every effort to effect a speedy settlement of their differences with the Post Office. The committee will recommend that the London County Council be informed that the Islington Borough Council are not aware of any difficulties existing with the Post Office authorities with respect to wayleaves, and that any delay that has occurred in the improvement or provision of telephonic communication in the borough has not resulted from the action of the Borough Council or their officers. The electrical engineer has reported with regard to the failure on the 25th ult. of the electric light in a portion of Highbury New-park and to the danger created by the thoroughfare being left in darkness for some considerable time, that the breakdown was due to atmospheric conditions, but that steps will be taken with a view to prevent a recurrence of the failure.

**Holborn and Finsbury Electrical Exhibition.**—Holborn and the immediately surrounding boroughs are centres of considerable commercial importance, and the headquarters of many notable industries. The County of London Electric Supply Company supplies current to these districts, and there is naturally a great demand for it as a motive power to drive machinery. The exhibition, which will be held from March 20 to April 5, has been arranged with a view of familiarising users and intending users of current for power purposes; but there will also be many interesting exhibits of every form of electric lighting. We are also informed that the company are arranging for a number of exhibits, the nature of which is kept a dead secret. Altogether there are over 60 exhibitors, and we are informed that the applications for space received have largely exceeded the space available, and that the list has been closed. Among other exhibitors will be found the following firms: Babcock and Wilcox, Limited, Oriel House, Farringdon-street, E.C.; Brockie-Pell Arc Lamp Company, 60, Worship street, E.C.; Callender's Cable and Construction Company, Hamilton House, Victoria-embankment, E.C.; Crompton and Co., Salisbury House, London-wall, E.C.; Electrical Company, 122-4, Charing Cross-road; General Electric Company, 67-71, Queen Victoria-street; Johnson and Phillips, Old Charlton, Kent; Reason Manufacturing Company, Lewes-road, Brighton; Simplex Conduit Company, Westinghouse-buildings, Norfolk-street, Strand; Western Electric Company, 171, Queen Victoria-street, E.C.

**Carnarvon.**—The current at the Carnarvon electricity works was switched on last Thursday week by the Mayoress (Mrs. D. T. Lake), assisted by Mrs. W. G. Thomas, who started the engines. The plant, which provides for 10,000 8-c.p. lamps, consists of two Davey-Paxman "Economic" boilers of 7,000lb. per hour evaporative capacity; two Peache high-speed engines direct coupled to two Lancashire 100-kw. generating sets with balancer and booster; a Hart battery of 400 ampere-hours capacity, and a 96-tube Green economiser. Cables have been laid along all the main thoroughfares with extensions into the principal streets, and the supply is arranged on the three-wire continuous-current system at 230 volts. Applications have already been received for upwards of 3,000 8-c.p. lights, and 50 services have already been connected. The prices to be charged are 5d. per unit for lighting, and for power a maximum of 2½d. per unit with a sliding scale. The whole of the contract has been carried out for the Corporation by the National Electric Construction Company, Limited, who have undertaken to run the station when completed. Mr. Price F. White is the consulting engineer for the Corporation, and Mr. A. C. Goodman the resident engineer, acting under the direct supervision of Mr. E. A. Mitchell, M.I.E.E., the company's chief engineer, and Mr. D. O. Evans, A.M.I.E.E., of Bangor, the company's manager for North Wales. The building, consisting of a boiler-house, engine-room, battery-room, offices, etc., has been erected by Messrs. Heenan and

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Froude, of Manchester and Worcester, under the supervision of Mr. S. Wilkinson, A.M.S.A.

**Liverpool.**—According to the annual report of the consulting electrical engineer (Mr. A. B. Holmes) on the work of the electric supply department of the Liverpool Corporation, 8,299,811 units were supplied for lighting at an average price of 3·544d.; for power purposes 2,054,679 units were supplied at an average price of 1·803d. per unit; and for tramways 18,979,133 units at 1·159d. per unit—the total supply being 29,333,623 units at an average price of 1·879d. per unit. It appears that the special efforts which have been made to reduce the working costs in the generating stations have met with satisfactory results. Mr. Holmes says that in the general expenses there were constantly increasing charges for rates and taxes, the amount last year being £14,441, as against £10,845 in 1893. The surplus of receipts over expenditure amounted to £27,575, and out of this £16,934 had been contributed in aid of the rates. Owing to various funds having to be provided for, and a material rise in the price of fuel, the engineer does not think any general reduction in charges could be prudently made, but he recommends that in order to encourage a more extensive use of electrical energy for power purposes, the 1½d. now charged after the first 3,000 units per quarter should be reduced to 1d. per unit, and that in special cases where arc lamps are used in the daytime for medical or other purposes, and not for lighting, the charge, subject to a guaranteed minimum consumption, should be made on the power scale. The engineer is of opinion that to conform to the basis of charge authorised by the Council, the price for electrical energy for the tramways for the current year should be reduced to 1·070d. per unit, with an addition at the rate of 4 per cent. for each shilling per ton paid for fuel in excess of 6s. per ton.

## PROVISIONAL PATENTS, 1905.

FEB. 20.

**3510. Improvements in and connected with devices for preventing the overcharging of electric cables.** Land und Seekabelwerke Akt.-Ges., 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1901, April 1, 1904, being date of application in Germany.) (Complete specification.)

**3511. Improvements in devices for preventing the overcharging of electric cables.** Land und Seekabelwerke Akt.-Ges., 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1901, April 1, 1904, being date of application in Germany.) (Complete specification.)

**3525. Improvements in apparatus for producing electric reactions in gases by aid of electric arcs.** Kristian Birkeland, 46, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Feb. 20, 1904, being date of application in Norway.) (Complete specification.)

FEB. 21.

**3538. Sectional system for third or electrified rail on electric railways.** John Reed, 134, Rodsley-avenue, Gateshead-on-Tyne.

**3553. Improvements in fuse heads for electric blasting.** Frederick Render, 6, Bank-street, Manchester. (Complete specification.)

**3554. Improvements in detonator fuses for electric blasting.** Frederick Render, 6, Bank-street, Manchester. (Complete specification.)

**3560. Secondary battery.** William Morrison and Charles Caldwell Bulkley, 65, Chancery-lane, London. (Complete specification.)

**3562. Improvement in electric arc lamps.** August Eckstein and Arthur Ernest Angold, Peel Works, Adelphi, Salford.

**3567. Improvements in fog and ordinary signalling for steam and electric railways and the like.** John James Munro and Thomas Common, 11, Royal-arcade, Newcastle-on-Tyne.

**3568. Trolley change guide for electric tramway cars.** James Stewart, 20, Seedhill-road, Paisley, N.B.

**3573. Improvements in electrical means for starting prime movers for electric generators and controlling the current.** Arthur William Sclater, 182, Oxford-street, London.

**3594. Improvements in and relating to the transmission of electrical energy through space for the purpose of wireless telegraphy and the like.** Alessandro Artom, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**3604. Improvements in and relating to prepayment attachments for electricity meters.** Robert John Jocelyn Swan, 1, Queen Victoria-street, London.

**3614. Improvements in trolley heads employed in electrical traction.** Charles Edwin France, 15, St. James's-row, Sheffield.

**3616. Improvements in fuses for electric current circuits.** Ernest Francis Moy and Percy Henry Bastier, 4, Greenland-place, Camden Town, London.

FEB. 22.

**3688. Improvements in or relating to electric warp-stop motions for looms for weaving warping machines and the like.** Cecil Henry Whittington, Queen Anne's-chambers, Westminster, London. (Frederick M. Armstrong, United States.) (Complete specification.)

**3685. Improvements in and relating to ships' telegraphs and like signalling devices.** Carlo Coleatti, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**3706. Improvements in or relating to electrolytic meters, applicable to other measuring instruments or apparatus in which the (varying) level of a column of liquid is employed.** The Bastian Meter Company, Limited, Albert Edward Salisbury, Charles Orme Bastian, and George Calvert, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

FEB. 23.

**3719. Improvements in and connected with X-rays and high-frequency apparatus.** David Buchanan Selkirk, William Wotherspoon Scott, and William Cousin, 154, St. Vincent-street, Glasgow.

**3726. Improvements in or connected with electric wires.** Albert Edward Patrick, Prudential-buildings, Corporation-street, Birmingham.

**3759. An electrical railway signal.** Victor Charles Badois, Victoria-street, Windsor.

**3762. Improvements in and relating to electrical circuit-breaker mechanism.** Walter Edward Barton, 55, Chancery-lane, London.

**3784. Improvements in or relating to wireless telegraph detectors and telephone electrophone and like receivers.** Hahnemann Adolphus Cutmore, 315, High Holborn, London.

**3795. Improvements in the electric lighting of railway and tramway carriages.** J. Stone and Co., Limited, and John Robert Quain, 77, Chancery-lane, London.

**3796. Improvements in accumulator batteries.** J. Stone and Co., Limited, and John Robert Quain, 77, Chancery-lane, London.

**3815. Improvements in electric potential indicators.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**3816. Improvements in and relating to gearing especially applicable to power-operated electric switches.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**3829. Improvements in and relating to electrical ignition devices for internal-combustion engines.** John Albert Cole, 70, Chancery-lane, London.

**3830. Improvements in and relating to electrical ignition devices for internal-combustion engines.** John Albert Cole, 70, Chancery-lane, London.

FEB. 24.

**3855. Improvements connected with the starting, reversing, accelerating, and stopping of electric motors.** Ernest Sherwood Woollard Moore and William Brabiner Bennett, Prince's-chambers, Wolverhampton.

**3857. Controlling devices for electric motors.** Wallace Fairweather, 65, Chancery-lane, London. (Diehl Manufacturing Company, United States.)

**3867. Electrical apparatus for automatically controlling the pressure of steam in boilers.** Ralph Lomax and John Tomlinson, 57, Barton-arcade, Manchester.

**3876. Improvements in inverted incandescence lamps.** Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Julius Pintsch, Germany.)

**3877. An improved electric incandescence reading lamp.** Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Julius Pintsch, Germany.)

**3885. Improvements in electric trolley harps.** John Hensley, 3, Upper Vernon-street, London. (Date applied for under Patents Act, 1901, May 5, 1904, being date of application in United States.) (Complete specification.)

**3894. A new or improved accumulator plate.** Eugene Victor Gratzs, 81, High Holborn, London. (Complete specification.)

**3899. Improvements relating to motor meters for continuous and alternating electric currents.** Wilhelm Köstermann, 37, Essex-street, Strand, London.

**3912. Improvements in the manufacture of filaments for incandescing electric lamps.** Jack Randall Crawford, Clun House, Surrey-street, Strand, London.

**3913. Improvements relating to apparatus for enabling telephonic and telegraphic messages to be transmitted over the same line.** Carlo Turchi and Edmondo Bruné, 46, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, April 2, 1904, being date of application in Italy.) (Complete specification.)

**3918. Improvements in and relating to electric fans.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

FEB. 25.

**3957. An improved apparatus for the automatic ignition of gas, gaseous mixtures, or the like by means of an electric current.** George Hill, The Grove, Ashton-on-Mersey. (Complete specification.)

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**3968. Improvements in electricity meters.** Harold Thomas Brown, Electric Supply Company, Limited, Thompson's-lane, Cambridge.

**3978. Improvements in electrical alarm contacts for door locks.** Richard Blessin, 40, Chancery-lane, London.

**3979. Improvements in supporting devices for electric conductors.** Budd John Jones, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, March 14, 1904, being date of application in United States.) (Complete specification.)

**3994. Improvements in or relating to electrical troughs, conduits, or the like.** John James Bate, 6, Lord-street, Liverpool.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published March 16.*

1904.

**1494. Alternating-current dynamo-electric machines.** Latour. (Date applied for under International Convention, Jan. 21, 1903.)

**4116. Electrically-controlled lifts and hoists.** Chaudoir.

**5104. Method of increasing the discharge energy of electrical vibration systems.** Thomson. (Ges. für drahtlose Telegraphie m. b. H.)

**8077. Trolley heads of electric tramcars and the like.** Thompson.

**8401. Alternating electric current motors.** British Thomson-Houston Company, Limited. (General Electric Company.)

**8404. Alternating electric current motors.** British Thomson-Houston Company, Limited. (General Electric Company.)

**8477. Incandescent electric lampholders.** Rees.

**8686. Primary galvanic battery.** Delafon.

**8984. Manufacture of positive electrodes for galvanic batteries.** Delafon.

**9117. Dynamo-electric machines.** British Thomson-Houston Company, Limited. (General Electric Company.)

**9372. Armatures for dynamo-electric machinery.** Hills, Urquhart, and Honey.

**9373. Brushes for dynamo-electric machinery.** Hills, Urquhart, and Honey.

**9565. Electric tramway or railway vehicles.** Raworth.

**11262. Method for the transmission of sound to long distances and telephonic apparatus therefor.** Tardieu.

**11777. Electrical tumbler and like switches.** Lawton and Whatson.

**17939. Electric trolleys or collectors for electric traction.** Lauvernier.

**19242. Electric light fittings.** Lea and Mitchell.

**22326A. Controllers for electric current.** Justice. (Voltage Controller Company.) (Date applied for under Patents Rule 9, Oct. 17, 1904.)

**22342. Arc lamp electrodes.** Körting and Mathiesen Akt.-Ges. (Date applied for under International Convention, Oct. 31, 1903.)

**22813. Scraper for electromagnetic separator.** Ernst Heinrich Geist Elektricitäts Akt.-Ges. (Date applied for under International Convention, Jan. 18, 1904.)

**24675. Electric brakes for trams and other vehicles.** Ransford. (American Electric Brake Company.)

**27916. Locking apparatus for watchmen's electric controls and the like.** Hindersin.

**28469. Electric arc lamp.** Fairweather. (Marquette Electric Company).

**29063. Insulators and protective devices for overhead electric conductors.** Giraud. (Date applied for under International Convention, April 14, 1904.)

**29064. Safety devices for overhead electric conductors.** Giraud. (Date applied for under International Convention, April 14, 1904.)

**29397. Pendant electric fixtures.** Lake. (Bradshaw, Keough, Keough, and Keough.)

**29538. Electric circuit closer for fire-alarms.** Bamiller and Weisensale. (Date applied for under International Convention, May 7, 1904.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | Last price |
|---|---|---|
| **Commercial and Industrial.—** | £ | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 – | ⅝-¾ xd |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-185,000 | 1 – | 7/16-17/32 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 – | 5¾-6¼ |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 – | 5¼-5¾ |
| —— 4½ per cent. Mortgage Debentures | 100 – | 101-104 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 – | 99-101 xd |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 – | 2¼-2⅜ |
| —— 4 per cent. Mortgage Debenture Stock | 100 – | 87-89 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,751 | 2 – | ⅛-¼ |
| —— Non. Cum., 6 per cent. Pref. | 2 – | 1⅛-1⅜ |
| —— 4½ per cent. 1st Debenture Stock | 100 – | 94-97 |
| —— 4½ per cent. 2nd Debenture Stock | 100 – | 79-82 |
| Callender's Cable, Debentures | 100 – | 105-107 |
| —— Ordinary | 5 – | 10⅜-11¼ |
| —— 5 per cent. Pref. | 5 – | 5⅝-5¾ |
| Crompton and Co. | 3 – | 2¼-2⅜ |
| —— 5 per cent. Debentures | 100 – | 95-98 |
| Edison and Swan United, "A" Shares, 1-99,261 | 3 – | ⅜-½ |
| —— "A" Shares, 01-017,139 | 5 – | 1-1¼ |
| —— 5 per cent. Debentures | 100 – | 79-84 |
| —— 4 per cent. Deb. Stock, Red. | 100 – | 77-82 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 – | 1¼-1½ |
| —— 7 per cent. Cumulative Pref. | 2 – | 2¼-2⅜ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 – | 97-99 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 – | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 – | 9¼-10 |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 – | 91-96 |
| W. T. Henley's Telegraph Works, Ordinary | 5 – | 12¼-13 |
| —— 4½ per cent. Preference | 5 – | ⅝-⅝ xd |
| —— 4½ per cent. Debentures | 100 – | 109-111 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 – | 16-17 |
| —— 4 per cent. Debentures | 100 – | 100-103 |
| Parker, Thos., Limited, Ordinary | 10 – | 10-10¼ |
| Telegraph Construction and Maintenance | 12 – | 35-37 |
| —— 5 per cent. Bonds | 100 – | 102-104 |
| **Electric Lighting and Supply.—** | | |
| Bournemouth and Poole, Ordinary | 10 – | 12¼-12⅜ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 – | 9¼-10 |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 – | 11-12 |
| —— 4½ per cent. Debenture Stock. Red. | 100 – | 104-106 |
| Bromley (Kent) Electric Light and Power Co. | 5 .. | 5¼-5⅜ |
| —— 4½ per cent. 1st Debenture Stock, Red. | 100 – | 101-104 |
| Brompton and Kensington, Ordinary | 5 – | 10¼-11 |
| —— 7 per cent. Preference | 5 – | 10¼-10⅜ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 | 5 – | 9 9¼ |
| —— Nos. 60,001-80,000 | 5 – | 6¼-7 |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 – | 12¼-13¼ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 – | 105-108 |
| Charing Cross and Strand, Nos. 1-70,000 | 5 – | 7⅛-8⅛ xd |
| —— 70,001-80,000 | 5 .. | 7⅛-8¼ |
| —— 4½ per cent. Cum. Pref. | 5 – | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 – | 4 15/16-5 1/16 |
| —— 40,001-80,000 | 5 .. | 4 15/16-5 1/16 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 – | 102-104 |
| Chelsea Electricity Supply | 5 – | 6⅜-7⅛ |
| —— 4½ per cent. Debentures | 100 – | 109-111 |
| City of London, Ordinary | 10 – | 12¼-13 |
| —— 6 per cent. Cumulative Pref. | 10 – | 13¼-14 |
| —— 5 per cent. Debenture Stock | 100 – | 123-127 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 – | 103-105 |
| County of London Electric Supply, Ordinary | 10 – | 9¼-9⅜ |
| —— 6 per cent. Cum. Pref. | 10 – | 12¼-12⅜ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Red. | 100 – | 102-104 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. | 100 .. | 109-112 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 – | 6¼-6⅜ |
| —— 6 per cent. Cum. Pref. | 5 – | 6-6¼ |
| —— 4½ per cent. First Mort. Deb. | 100 – | 106-108 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 – | 2-2⅛ |
| —— 5 per cent. Debenture Stock, Red. | 100 – | 86-91 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 – | 5¼-5⅜ |
| —— 4½ per cent. First Deb. Stock, Red. | 100 – | 101-104 |
| Havana Electricity, Limited, 1-15,000 | 10 – | 9¼-10¼ |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 – | 7¼ 8 |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 – | 100-102 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 | 1 – | 9/16-11/16 |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 – | 12⅜-13¼ |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red | 100 – | 102-104 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 – | 9⅜-10¼ |
| London Electric, Ordinary | 5 – | 2 9/16-2 13/16xd |
| —— 6 per cent. Pref. | 5 – | 5⅜ 6 xd |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 – | 99-101 |
| Metropolitan Ordinary | 10 – | 18⅜-19¼ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 – | 110-115 |
| —— 4½ per cent. Cum. Pref. | 5 .. | 5⅜-5⅝ |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 – | 87-89 |
| Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb. | 100 – | 98-100 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 – | 88-101 |
| —— Preference | 4 – | 100-102 |
| Notting Hill Electric Lighting | 10 – | 14¼-15½ |
| —— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.) | 100 – | 102-104 |
| Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,510 | 5 – | 6¼-6⅝ |
| —— 4 per cent. Debenture Stock | 100 – | 98-100 |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures | 100 – | 100-102 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 – | 2⅜-3¼ xd |
| —— 4 per cent. Debenture Stock | 100 – | 79-83 |
| South London, Ordinary | – – | 4¼ 4⅜ |
| South Metropolitan Electric Light and Power Co., Ord. | 1 .. | ⅛-¼ |
| —— 7 per cent. Cum. Pref. | 1 .. | 1 13/32-1 15/32 |
| —— 4½ per cent. 1st Mort. Deb. | 100 .. | 107-110 |
| —— Ditto, June, 1904 | – – | |
| St. James's and Pall Mall, Ordinary, 101-80,080 | 5 – | 13¼-13⅜ xd |
| —— 7 per cent. Pref. | 5 – | 8¼-8⅜ xd |
| —— 3½ per cent. Deb. | 100 – | 98-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 – | 5-5⅛ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 – | 5¼-5⅜ |
| Westminster, Ordinary | 5 – | 13-13¼ xd |
| —— 5 per cent. Cum. Pref., 110,101-138,261 | 5 – | 6⅛-6⅜ |
| **Electric Tramways.—** | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 | 5 – | 5⅜-5⅝ |
| —— Ord. | 5 .. | 8⅜-8⅝ |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 – | 140-143 |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 – | 104-105 |
| Barcelona Tramways, Limited, Ord., 1-20,000 | 10 .. | 11⅜-12⅛ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 | 10 .. | 9¼-10 |
| —— 5 per cent. Deb., Red., 1-600 | 100 .. | 99-102 |
| —— 4½ per cent. Red. Deb. Stock | 100 .. | 96-100 |
| Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606 | 1 .. | ⅜-½ |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 | 1 .. | 15/16-1 1/16 |
| Belfast Street Tramways, Ord., 1-26,600 | 10 .. | 10¼-11¼ |
| Blackpool and Fleetwood Tramroad | 10 – | 12⅜-13⅛ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 – | 1¼-1⅜ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 – | 3⅝-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 – | 94-98 |
| British Columbia Electric Railway Co., Ord. Def. | 100 – | 102-105 |
| —— Ord Pref. | 100 – | 100-103 |
| —— Non. Cum. 6 per cent. Pref. | 10 – | 10-10¼ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each | 40 – | 103-105 p c |
| —— 4½ per cent. Vancouver Power Deb. | 100 – | 93-102 |
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 – | 9¼-9⅜ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 – | 10¼-11¼ |
| —— 5 per cent. Perpetual Debenture Stock | 100 – | 121-123 |
| —— 4½ per cent. 2nd Deb. Stock | 100 | 97-99 |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Buenos Ayres and Belgrano Tram. Ord., 1-100,000 | 5 | 3¼-4 |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | 5⅛-5¼ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | 5¼-5⅜ |
| —— 5 per cent. Deb. Stock, Red. | 100 | 107-109 |
| —— Prov. Cert., all paid | 100 | 102-105 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | 94-97 |
| Calcutta Tramways, Limited, 1-102,268 | 5 | 8⅜-8⅝ |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | 106-108 |
| Cape Electric Tramways Nos. 1-480,000 | 1 | 1¼-1½ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | 4⅝-5⅛ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | 101-104 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1s Mortgage Debenture Stock, Red. | 100 | 102-104 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | 9½-10 |
| —— 5 per cent. Cum. Pref. | 10 | 11-12 |
| —— 4 per cent. Debentures | 100 | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | 13-14 |
| —— 6 per cent. Pref., Nos. within 1-60,000 | 10 | 15½-16¼ |
| —— 3½ per cent. Mort. Debs., 1-3,000, Red. | 100 | 94-97 |
| Imperial Tramways Ordinary | all | 18-19 |
| —— 6 per cent. Cum. Pref. | all | 14-14¼ |
| —— 4½ per cent. Deb Stock | 100 | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000 | 5 | 3-3¼ xd |
| —— 4 per cent. Debenture Stock | 100 | 89-92 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | 8-8½ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | 10½-10⅞ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | 103-105 |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016. | 1 | 13 32 15/32 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | 31/32-1 1/32 |
| —— 4½ per cent. Deb. Stock, Red. | 100 | 104-106 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000 | $1,000 | 106-110 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 | 103-105 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 | 103-106 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000 | 5 | ¼-1½ |

| Name. | Amount paid. | Last price |
|---|---|---|
| | £ | £ |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | ·12½ |
| —— 5 per cent Cum. Pref. | 10 | 9½-9⅝ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk. | 100 | 104-107 |
| Potteries Electric Traction, Ordinary 20,001-40,00 | 10 | 8½ 9 |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | 8¼-8¾ |
| —— 4½ per cent. Debenture Stock | 100 | 102-105 |
| South Lancashire Electric Traction and Power Company | | |
| —— £250,000 Ordinary | 1 | 1 |
| —— £101,152 5 per cent. Preference | 1 | 1 |
| —— £597,170 4½ per cent. Debenture Stock | 100 p.c. | 100 p.c. |

## Electric Railways.—

| | | |
|---|---|---|
| Central London, Ordinary | 100 | 92-94 |
| —— 4 per cent. Pref. | 100 | 101-103 |
| —— ,, ,, deferred | 100 | 82-84 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | 101-112 |
| City and South London, Consolidated Ordinary | 100 | 45-46 |
| —— 4 per cent. Debenture Stock | 100 | 107-109 |
| —— 5 per cent. Pref. Stock '91 | 100 | 120-123 |
| —— ,, ,, ,, '96 | 100 | 118-121 |
| —— ,, ,, ,, '01 | 100 | 116-119 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | 10-10½ |
| —— Ordinary, 1-50,000 | 10 | 3¾-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — | 99-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | — | 98-99 |
| Waterloo and City, Ordinary | 100 | 92-94 |

## Telephones.—

| | | |
|---|---|---|
| National Telephone, Preferred | 100 | 112 113 |
| —— Deferred Stock | 100 | 106-108 |
| —— 6 per cent. Cum. First Pref. | 10 | 13-14 |
| —— 6 per cent. Cum. Second Pref. | 10 | 12-13 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | 5¼-5⅝ |
| —— 3½ per cent. Deb. Stock, Red. | 100 | 98-100 |
| —— 4 per cent. Deb. Stock, Red. | 100 | 104-106 |
| —— 4 per cent. Prov. Cert. | — | 103-105 |
| Oriental Telephone and Electric Company | 1 | 1¼-1½ |
| —— 6 per cent. Cum. Pref. | 1 | 1 3/16-1 5/16 |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week ending | 1905. | 1904. | Increase or decrease. Week. | Current year. | Miles of single track open. 1904. | 1903. | Accounts for past year. Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pass'nger | Receipts per Car mile. | Receipts per Mile of track. | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Feb. 25 | 1,015 | 1,056 | − 21 | + 3,760h | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·14 |
| Ayr Corporation | ,, 25 | 165 | 156 | + 9 | + 575 | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 356,049 | 1·03 | 10·11 | 1,770 | 5 0 |
| Barking Corporation | ,, 25 | 53 | 37 | + 17 | + 235 | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 26 | 893 | 926 | − 33 | − 818 | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,319,701 | 1·158 | 9·98 | 2,383b | 6·1 |
| Birmingham Corporation | ,, 25 | 312 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | Jan. 20 | 4,585 | 5,083 | − 498 | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | — | — | — | — | — | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10 94 | — | 4·59 |
| Blackpool Corporation | Feb. 23 | 339 | 283 | + 56 | + 6,139 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 25 | 178 | 154 | + 14 | − 84 | 16½ | 16½ | Dec. 31 | 32,021 | 2,253,981 | 600,757 | 3·34 | 12·75 | 2,001 | 7·05 |
| Bolton Corporation | ,, 23 | 1,555 | 1,517 | + 19 | + 430 | 38 | 38 | March 31 | 94,161 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·69 |
| Bournemouth Corporation | ,, 22 | 849 | 863 | − 14 | + 2,169 | 10 15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 25 | 3,553 | 3,360 | + 193 | +29,758 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 25 | 666 | 672 | − 6 | + 3,616h | 9 | 7½ | ,, 31 | — | 10,438,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 24 | 4,263 | 4,357 | − 94 | — | 51½ | 51½ | Dec. 31g | 253,150 | 44,391,459 | 6,033,528 | — | — | — | — |
| Burnley Corporation | ,, 25 | 885 | 862 | + 23 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 26 | 274 | 275 | − 1 | — | 8½ | — | March 31i | 11,574 | 2,556,134 | 282,378 | 1·08 | 9·84 | 1,570 | 7·57 |
| Cardiff Corporation | ,, 23 | 1,685 | 1,779 | − 94 | + 1,921 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 28 | 141 | 155 | − 26 | − 202 | — | — | Dec. 31g | 9,987 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 25 | 7,248 | 7,138 | + 110 | + 1,113h | 6 | 6 | ,, 31 | 362,471 | 44,953,938 | 1,292,674a | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 26 | 2,993 | 3,127 | − 129 | − 1,674h | 6½ | 6½ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Colchester Corporation | ,, 22 | 153 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 25 | 354 | 357 | + 7 | + 23 | — | — | ,, 31g | 25,657 | 6,353,323 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | ,, 24 | 194 | 200 | − 6 | − 97 | 7·23 | 7·23 | March 31g | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 25 | 157 | 151 | + 3 | — | 4½ | 4½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0·91 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | ,, 24 | 91 | 87 | + 4 | — A | 7 | 6½ | Dec. 31g | 6,234 | 588,905 | 107,164 | 3·88 | 14·09 | 952 | 7·39 |
| Dublin U. T., electric cars | ,, 24 | 3,433 | 3,490 | − 57 | — | 47 | 46 | ,, 31g | 134,643 | — | 3,429,356 | — | — | — | — A |
| Dublin S. District, Electric | ,, 24 | 700 | 654 | + 46 | | | | | | | | | | | |
| Dundee City Tramways | ,, 22 | 777 | 760 | + 17 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 25 | 623 | 598 | + 25 | + 1,811 | 10·77 | 10·75 | March 31 | 34,312 | 12,950,269 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 25 | 13,576 | 12,997 | + 579 | +26,03 h | 145 | 123 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Gloucester Corporation | ,, 23 | 209 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 22 | 2,415 | 2,114 | + 301 | + 5 01 | 33 | 30½ | March 31 | 68,283 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,069 | 8·77 |
| Huddersfield Corporation | ,, 25 | 1,113 | 1,051 | + 62 | + 4,012 | 35 | 35 | ,, 31 | 65,545 | 11,893,287 | 1,638,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | ,, 25 | 1,990 | 1,895 | + 95 | + 1,074 | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,818,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | ,, 25 | 346 | 337 | + 9 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | ,, 23 | 100 | 122 | − 22 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 15 | 1,197 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 24 | 5,238 | 4,763 | + 475 | +15,653 | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | ,, 25 | 1,726 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | ,, 18 | 9,772 | 9,257 | + 515 | + 2,156 | 103 | 103 | Dec. 31g | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | ,, 26 | 1,409 | 1,477 | − 68 | − 512h | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — e |
| London County Council | ,, 18 | 12,330 | 9,653 | +2,739 | +114,388 | 46½ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 27 | 120 | 128 | − 8 | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | ,, 23 | 91 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 25 | 10,959 | 10,575 | + 384 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Metropolitan Elec. Tramways | — | — | — | — | — A | 10 | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 25 | 96 | 92 | + 4 | + 1,353 | 2½ | — | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newcastle-on-Tyne Corpn. | ,, 25 | 3,552 | 3,326 | + 226 | — | 43 | 38½ | ,, 25 | 185,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111b | — |
| Newport (Mon.) Corporation | ,, 11 | 475 | 460 | + 25 | + 1,333 | 15 | — | — | — | — | — | — | — | — | — |
| Oldham Corporation | ,, 25 | 1,318 | 1,023 | + 295 | + 4,095 | 34½ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 25 | 1,233 | 1,302 | − 34 | + 6,129 | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·16 | 12·39 | — | — |
| Rochdale Corporation | ,, 25 | 373 | 96 | + 277 | + 6,420 | 4½ | 4½ | ,, 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 23 | 382 | 396 | − 14 | — | — | — | ,, 31 | 20,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·68 |
| Salford Corporation | ,, 27 | 3,599 | 3,511 | + 88 | + 9,269 | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 18 | 63 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 23 | 4,297 | 4,091 | + 206 | + 6,033 | 34½ | — | ,, 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 22 | 763 | 820 | − 57 | − 2,636 | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·456 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 22 | 218 | 229 | − 11 | — | 6½ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 24 | 418 | 370 | + 48 | + 8,485 | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 19 | 1,079 | 1,061 | + 18 | + 1,472 | 19 51 | 18·48 | ,, 31 | 62,506 | 14,848,958 | 1,433,463 | 1·01 | 10·46 | — | 6·08 |
| Swindon Corporation | ,, 15 | 163 | — | — | — | 3½ | — | — | — | — | — | — | — | — | — |
| Wallasey U.D.C. | ,, 25 | 601 | 550 | + 51 | + 2,381 | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·60 |
| West Ham Corporation | ,, 23 | 1,019 | — | — | — | 8·62 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 22 | 711 | 336 | + 325 | — | 7½ | — | ,, 31g | 20,878 | 4,263,066 | 417,335 | — | 12·006 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. e Train mile.
Per mile of single track. f Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1905. A Half-year's figures.
Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**Royal Institution.**—A general monthly meeting of the members of the Royal Institution was held on Monday afternoon, his Grace the Duke of Northumberland, K.G., D.C.L., F.R.S, president, in the chair. Mr. W. K. Appleton, Dr. G. H. Burford, Mr. W. S. Burns, Mrs. Close, Miss Donaldson, Dr. G. E. Haslip, Lady Hodgson, Mrs. Laye, Mr. J. B. Tapling, Lieut.-Colonel Vincent Wing, C.B., Mr. P. von Fleischl, and Mr. J. E. Wolfe were elected members.

**Telegraph Wires.**—Amongst the resolutions passed by the Association of Chambers of Commerce last week was one relating to telegraphic communication. The resolution urged the Government to establish, without further delay, additional cables between the United Kingdom and the Continent, and more direct wires between the chief commercial centres of this country and Continental Europe; and it also maintained that it was of urgent importance that the Postmaster-General should at once be empowered to lay all trunk wires underground.

**The Institution.**—The first annual dinner of the Students' Section is to be held at the Holborn Restaurant on Thursday, the 16th inst., at 7 for 7.30 p.m. Mr. H. D. Symons, chairman of the section, will occupy the chair; and the president, Mr. Alexander Siemens, has honoured the committee by accepting an invitation to attend as the guest of the evening. All students who can possibly attend are particularly requested to do so. Early application for tickets should be made to the hon. secretary, Mr. A. G. Ellis, 177, Warwick-road, Kensington, W.

**Electrically-Driven Mills in Mexico.**—The *Pall Mall Gazette* has an article on the manufacture of cotton goods in Mexico. It seems from the statements of our contemporary's correspondent that the competition both of England and the United States for low-grade cotton goods is being killed by the Mexican home industry. The success of the Mexican mills is attributed to their being electrically driven from water power and also to cheap labour. Besides this, there is a high tariff on imported material which protects the rapidly growing industry. The fact remains, however, that the millowners in Mexico have adopted electric driving and all the latest improvements. As was stated last week, Lancashire mill-owners are experimenting largely in the same direction, but the saving from electric driving will hardly make up for the Mexican protective duties.

**Therapeutics and Lay Practitioners.**—The action of a firm of chemists and surgical instrument makers in undertaking a skiagram of a case of suspected mediastural tumour, after a medical practitioner had been engaged for the purpose at a higher fee, elicits the disapprobation of the *Lancet*. Our contemporary objects, in fact, to laymen undertaking X-ray work for therapeutic purposes at all, and expresses astonishment at finding the practice followed by a firm of good standing. Some time ago a physician ventilated a grievance in the same journal arising out of the electrical treatment of patients by laymen, which complaint, as remarked on the occasion, seemed to us ill-founded; but if there was any justification for the protest then, we cannot see that it holds good in the present case, seeing that X-ray photography does not call for medical knowledge. Indeed, we rather think the boot is on the other leg, and that doctors sometimes encroach upon the legitimate sphere of X-ray photographers.

**Hydro-Electric Plants for Railways.**—A paper on "The Use of Pacific Coast Water Powers in the Electrical Operation of Railroads" was recently presented to the Pacific Coast Railway Club by Mr. Robt. McF. Doble. The author alluded to the magnificent source of power offered by the waterfalls which are distributed at frequent intervals all the way from Southern California to British Columbia, and referred particularly to the San Francisco North Shore Railway. This line is of special interest as being the only third-rail system in California, and because of its being operated from the Alto sub-station, which is the terminus of one of the longest transmission lines in the country. The author concluded his paper by enumerating the distinguishing characteristics of some of the leading hydro-electric systems of California, special reference being made to the new De Sabla power-house of the California Electric Corporation, where there is now operating an 8,000-h.p. tangential water-wheel, the largest single water-wheel ever constructed. This station regularly supplies power to San Francisco and other points over 300 miles distant.

**Canals versus Railways.**—At a meeting of the Society of Engineers on Monday Mr. B. H. Thwaite read a paper on "The Transport Possibilities of our Inland Navigable Waterways." The author indicted the railway companies for suppressing canals, and the Government for indifference to this absorption, which had resulted in a depreciation of canal properties by many millions of pounds and the destruction of a trunk system of waterways that, if restored, would go far by its low charges towards securing a revival of our agricultural prosperity. He advocated the Government confiscation and ownership of canals. Hundreds of miles of our canals were, he said, little better than elongated ditches of mud and stagnant water, and £20,000,000 would secure for the State a splendid transport property. For the carriage of cattle, agricultural products, raw material for factories, and generally for the carriage of heavy freights at slow speeds where time was not essential, he considered that canals would be of the greatest advantage. He mentioned that by electric traction 24½ tons could be conveyed for one mile for 1d. The various chambers of commerce have devoted considerable attention of late to the resuscitation of our canals, but for the present the subject has stopped short at recommendation. The railway companies prefer to keep the matter in the background, and the Government does not seem disposed to bring any pressure to bear upon them, though the proposal at least merits thorough investigation.

**Compulsory Greek.**—The university on the Cam has decided upon the retention of Greek as a compulsory subject for the entrance examination. This verdict was arrived at by the substantial majority of 507 in an electorate of 2,611. To oppose the substitution of science or mathematics for Greek, rural parsons from divers obscure corners of the kingdom made a pilgrimage to their Alma Mater, the clerical vote being very much in evidence. Were no other question involved than the contention of the compulsory Greek party that the Hellenic tongue must be the basis of intellectual culture, the attitude of that party might perhaps be tenable; but when eminent educationists declare that the 12 months' "cramming" in Greek which enables a student to pass the "Little Go" is of little or no value, the argument becomes illogical. But, apart from this, science has acquired a position of transcending importance, and it is difficult to see how without some knowledge of it anybody can to-day lay claim to the higher education. The conservatism of our ancient seats of learning is traditional, though the younger University created a departure when Girton was incorporated with it; but no one can fail to have been struck by the change in the conditions of education that has occurred during the last two or three decades.

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Greater accessibility has assembled on the Isis and the Cam, a far more diversified representation of the country's youth than was the case half a century ago, when Oxford and Cambridge turned out ecclesiastics and pedagogues who were presumed to know their Homer and Xenophon, and often did, and embryo squires who were sometimes supposed to, and generally didn't. Cherished traditions die hard, but the claims for reform daily grow in strength, and we feel constrained to believe that the vote just recorded will only defer the inevitable.

**Wireless Telegraphy.**—We have received from Mr. A. Artom an extract from the *Proceedings* of the Royal Academy of Lincey, in which his new system of wireless telegraphy is described. The feature of Mr. Artom's work consists in so arranging his oscillators as to produce circularly or elliptically polarised rays of electric power. He has been at work on this subject for a number of years, and described briefly the lines of his investigations in a communication presented to the same academy in March, 1903. The advantage of the system lies in being able to produce a more intense electromagnetic field in a given determinate direction. This secures economy in power, but what is more important, tends to prevent the reception of signals in any direction but the one in which the message is being dispatched. A history is given of the experiments carried out by the author during four stages. In each stage the distance over which the experiments were conducted was increased, until for the fourth period, which comprised the autumn and winter of 1904, signals were being sent between a station at Monto Mario, Rome, and the island of Maddalena, a distance of about 160 miles. Experimenting between these points, the author obtained clear signalling, and proved that the range could be extended to nearly 200 miles on the same line. Notwithstanding this fact, the signals could not be detected on the island of Ponza, which lies about 60 miles to one side of the direct line between the two stations. The experiments in question were carried out with temporary plant, but clearly proved the success of the author in working with circularly or elliptically polarised rays.

**Aluminium Anode Films.**—An abstract of a paper read before the American Physical Society by Mr. C. McC. Gordon on the capacity and resistance of aluminium anode films, which have been the subject of numerous investigations in recent years, appears in the February issue of that institution's *Journal*. The author remarks that the thickness, the chemical nature, the resistance, the specific inductive capacity of these films, the voltage at which they break down, and the variations in their properties with the nature of the electrolyte, are questions concerning which the evidence is varied and in many cases apparently contradictory. Most of the measurements heretofore made have been carried out with the use of direct currents. The use of alternating currents with the Wheatstone bridge possesses advantages over the direct-current methods, in that the capacity, resistance of the film, and the resistance of the electrolyte can be independently measured at the same time. The author's recent experiments with the latter method show that: (1) The capacity of the film is inversely proportional to the volts used to form the film. It is to be inferred from this that the thickness of the film is proportional to the volts applied in its formation. (2) For water solutions, the capacity of the film varies but slightly with the nature of the electrolyte, provided, of course, the electrolyte is such as to form a film at all noticeable. This is not in accord with the theory recently advanced by Mott—*i.e.*, that the films would be thinner the greater the valence of the acid radical of the electrolyte. (3) The capacity of the films formed in molten electrolytes is much less than those of water solutions. (4) The capacity of the films in molten electrolytes increases rapidly after the voltage applied to form the film is taken away, indicating a rapid dissolving of the film in molten electrolytes. (5) The resistance of the films is much less than is given by many investigators.

**The Telephone Question.**—On Monday last the Postmaster-General (Lord Stanley, M.P.) received a deputation representing municipalities owning and working telephone systems. The Lord Provost of Glasgow headed the deputation, which desired to show how such municipalities would be affected by the proposed purchase agreement between the Postmaster-General and the National Telephone Company. The meeting was private, but we understand that the following points were dealt with by the deputation: (1) That the partial purchase of the London system of the National Telephone Company and the postponement of the purchase of its provincial systems was to be deprecated, because it would enable the company to devote greater energy and capital towards crushing out the municipal telephone system in the provinces; (2) that their experience had proved that it was not essential for the telephone service to be conducted as a national monopoly, for from 97 to 98 per cent. of the total calls were local; (3) that the Post Office ought to administer the acquired national system in friendly competition with the licensed municipalities and give greater encouragement to other municipalities to enter the field; (4) that in the event of the postponement of a settlement the Post Office ought to enter into vigorous competition with the company throughout the kingdom, assisted by the co-operation of municipalities, in order to avoid the danger of an inflated price being forced upon the Government; and (5) with regard to the possibility of extending the company's license it would meet with strenuous opposition from the municipalities, it would prolong the existing unsatisfactory condition of telephone affairs in this country, enable the telephone monopoly to reach such gigantic proportions as ultimately to render a reasonable settlement of the question impossible, and create a menace to the commercial interests of the kingdom. Lord Stanley, in reply, expressed himself as being in favour of the nationalisation of the telephones, and suggested a further interview with the municipal telephone undertakers to discuss this and other points.

**Publications Received.**—"Practical Methods of Electro-Chemistry," by F. M. Perkin. (London: Longmans, Green, and Co. 6s.) The author has compiled a text-book on this subject, based upon experimental work carried out under his own supervision. It is divided into three parts, the first dealing with electrolysis and the general aspects of electro-chemistry, the second with electro-chemical analysis, and the third with electrolytic preparations. Much care has been exercised in the preparation of the volume, which should do much to promote the commendable object the author has in view—stimulating interest in this branch of science.—The *Journal* of the Franklin Institute (Philadelphia) for February contains a paper on "Rolled-Steel Car Wheels," by Mr. S. H. Vauclain. Another paper by Mr. L. M. Haupt, entitled "A Menace to the New York Harbour Entrance," deals with the peculiar physical conditions existing on the bar extending from Sandy's Hook to Coney Island, and suggests a method of so modifying the ebb current passing out at Gedney's Channel as to increase the depth by natural erosion. Mr. J. M. Matthews deals with "The Sulphur Dyes," and there is a letter from a correspondent on the proposed amalgamation of the Massachusetts Institute of Technology with Harvard

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University.—We have received a copy of the Institution's *Journal*, dated February, which contains the President's inaugural address, and the following papers, with the discussions: "Hydrodynamical and Electromagnetic Investigations regarding the Magnetic Flux Distribution in Toothed-Core Armatures," by Prof. Hele-Shaw and Messrs. A. Hay and P. H. Powell: "Studies in Magnetic Testing," by Mr. G. F. C. Searle; "The Use of Iron in Alternate-Current Instruments," by Dr. W. E. Sumpner (Birmingham). A special feature of this issue is a report of the proceedings at the St. Louis Congress, with the discussions on several of the papers. There are also the address at St. Louis to the American Institute by Mr. B. J. Arnold, president, and the inaugural addresses of the chairmen of the Glasgow, Dublin, Leeds, Manchester, and Newcastle Sections.

**Single-Phase Railway.**—The Indianopolis-to-Cincinnati single-phase railway is in operation as far as Rushville, a distance of 41 miles, and the construction of the remainder is being rapidly pushed forward. The power station from which it is intended to operate the line is located at Rushville. Energy is generated at 33,000 volts, and is reduced to 3,300 volts at the points of transformation. Within the city of Indianopolis, a distance of some three miles, the cars will be run over existing lines, and will be operated by direct current at 550 volts. Within the city of Rushville alternating current at the same potential will be employed. On intervening sections the line voltage will be 3,300 single-phase alternating current at 25 cycles. The trolley equipment is of interest as being of the type which is proposed for the London, Brighton, and South Coast Railway Company. The rails run along a private right-of-way, except where they emerge upon the highways of large towns. Along the private right-of-way the trolley wire is suspended from poles set in the centre of the grade 100ft. apart, with an iron bracket looped at the end so as to carry a large flat porcelain insulator, over the top of which runs a $\frac{7}{16}$in. steel strand cable or "messenger" wire, drawn tight. The No. 000 grooved copper trolley wire is carried 8in. under the messenger cable, to which it is attached every 10ft. with specially-made steel clamps, the construction being of the catenary suspension type. Under these conditions danger from breakages of the trolley wire is reduced to a minimum. The insulators are large and strong, and are not likely to break, but if they should, the steel cable would remain suspended from the top of the bracket. As the trolley is attached to the steel cable every 10ft., breakages will be very infrequent, and if one should occur, not more than 10ft. of the trolley would be loose. The catenary construction provides a practically level trolley with no sudden bends at the insulators, as is found with the ordinary suspension, a point which is a great advantage to fast-running cars. The trolley wire is suspended 18ft. above the top of the rail. Where the track is in the public streets, the poles are set on the sides of the streets, and the trolley is suspended from span wires; otherwise the construction is the same as along the private right-of-way. The cars are scheduled to run at a speed of 30 miles per hour, but for the through service there will be trains running at between 50 and 60 miles an hour.

**Electric Lighting in Paris.**—The technical commission appointed to report on the future *régime* of electricity in Paris has recently issued its report, which deals solely with the technical side of this important question. The conclusions of the commission are summarised as follows by the recorder, Mr. R. V. Picou. The commission considers that the most convenient technical scheme for the distribution of electricity in Paris is one which consists (*a*) in the production of high-tension polyphase currents at a frequency of 50 periods per second in several stations situated outside the city on the banks of the Seine; (*b*) the transformation of this current in sub-stations, of which those serving the central areas will distribute with continuous current on the three-wire system at 110 volts between the inner conductor and either of the outers. The sub-stations in the areas which are less densely populated will distribute alternating current at 110 volts; (*c*) the direct transformation from high voltage to low voltage on the consumer's premises will be restricted to special conditions where motive power is important, or where the demand is infrequent or irregular. In the second place, the system of charges considered the most logical consists in the adoption of a sliding scale, such that the sum received from the consumer is in proportion to that spent for supplying him. This sliding scale is to be based on the size and reading of the consumer's meter, thus avoiding any interference with the consumer's installation. Thirdly, the changes in the present systems which the execution of the programme will necessitate will have to be gradually carried out over a certain number of years, and the commission advises that the transformation should be commenced in those quarters where the demand for power is largest. In other parts of the report a number of technical subjects are treated, to which we hope to refer more in detail elsewhere. For instance, the commission advises the use of steam-turbines in the three new generating stations to be constructed, and advocates that the power of the turbo-generators should be at least 5,000 kw. The importance of having a good vacuum with turbines led to the recommendation that the station should be placed on the banks of the Seine, as the canals around Paris do not contain sufficient cooling water for the large generating works contemplated. Three independent stations are recommended, in order that continuity of supply may be assured. The other features in this report we leave for future attention.

**"Electrics."**—We have received from the South Wales Electrical Power Distribution Company, No. 1, vol. 1, of *Electrics*. This publication, issued by the company, is being circulated amongst the users of power in South Wales and Monmouthshire with the object of giving general information both as to what the company is doing and as to the use of electricity for power purposes. The information given is not of an elementary order, and is such as will appeal to the engineers responsible for commercial undertakings. There is, of course, a considerable amount of information as to what the South Wales Power Company are doing in their various generating stations and sub-stations, and the information under this head clearly shows that rapid progress is being made. We are pleased to note that in laying down their main cables the company is, wherever possible, duplicating the routes by which any consumer can be supplied. In some cases the system goes even further, and provides three ways by which the supply can be given, so that any feeder may be closed down for testing or for making connections for the extension of supply. The question of overhead mains is also being considered by the company's engineer, and routes have been surveyed from Cwmbran to Treforest, and thence on to Neath. Application is shortly to be made to the Board of Trade for permission to run these mains overhead for extra high-tension supply. If this is granted, a number of consumers will be reached who could hardly be profitably supplied by means of underground cables. The first issue of *Electrics* also gives some useful editorial notes on special applications of electricity. Amongst the uses for which it is advised is the haulage of rubbish from the South

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Wales collieries up to the top of the rubbish tips. This class of haulage gear is specially suited to electric driving, as is clearly pointed out. Another editorial article on the cost of electricity should receive the attention of would-be consumers. The object of it is to show the inaccuracy of estimates of cost arrived at by multiplying the maximum power of motors by the number of hours they are worked per week. The editor points out that the weekly cost of energy will usually represent less than one-quarter of the amount so calculated, or at the most one-half, owing to the fact that the maximum power taken is always much less than the aggregate maximum powers of the motors installed. The paper, if circulated regularly, should do much to extend the use of electricity in the districts supplied by the South Wales Electrical Power Company.

**Railway Accidents in the States.**—The report of the Inter-State Commerce Commission for the three months ending September last gives the number of people killed in train accidents throughout the United States. These returns are made from reports of the companies, which show that the number of persons killed was 411 and those injured 3,747. Including accidents sustained by employés while at work and by passengers in getting on and off cars, etc., the total number of casualties for that quarter of the year was brought up to 14,239, of which 1,032 were killed and 13,207 were injured. These figures mean that in the course of a single year, were this rate of maiming and killing sustained, the American railways would be directly or indirectly accountable for the death of 4,128 and the more or less serious injury of 52,828 people. The bulletin of the commission says that the quarter under review may, as a whole, be termed the most disastrous on record. Of the 228 passengers and 183 employés killed in train accidents, 217 cases are accounted for by six accidents, and these 217 were nearly all passengers. In one case of derailment, 88 people were killed; in one collision, 63 were killed; in another, 24; and two other collisions accounted respectively for 18 and 16 deaths. Our contemporary the *Scientific American* has an article in which enquiry is made as to why these casualties are so numerous, especially when compared with the English returns. It points out that the number of people killed and injured is not the true criterion of the safety of a railway, but rather the number of accidents which happen within a given time. Tested on this basis, the record for the three months in question show that there were 1,439 collisions and 1,321 derailments, of which 232 collisions and 137 derailments affected passenger trains. Our contemporary explains its views as to why the American railways have so many more accidents than those in this country, and lays the chief blame on the continual change in the personnel both of the employés and in the directorate of the various lines. In consequence of this there is a great want of familiarity with the local conditions, which, without doubt, contributes to the accidents. It seems to us, however, that it is to the signalling systems that the greatest number of accidents can be attributed. Even in this country, where the block system obtains, we have accidents due to the neglect of signals. In the States, where on many lines there is no attempt at block working and a penalty if drivers lose time, a premium is placed on quick running, and there seems to be little attempt to safeguard the public. These conditions and a frequent change of staff furnish the true explanation of the return in question.

**Electric Smelting of Iron and Steel.**—Mr. F. W. Harbord, A.R.S.M., F.I.C., read an interesting paper before the Faraday Society on Monday last on "Recent Developments in Electric Smelting in connection with Iron and Steel." The author was a member of the commission appointed by the Canadian Government to investigate the different thermo-electric processes for smelting iron ores and the manufacture of steel at work in Europe. His paper before the Faraday Society was in the main a *résumé* of the report of the commission describing the various furnaces which were inspected. Of the five works visited, two were in Sweden, two in France, and one in Italy. We have previously referred to the work of the commission, which dealt with the essential features of a variety of electric furnaces. The results of the investigations are ably summed up in the following conclusions, which represent the author's opinion with respect to electric smelting in the present state of the art. There is no doubt that developments and improvements will greatly modify some of these conclusions in the near future: (1) Steel equal in all respects to the best Sheffield crucible steel can be produced, either by the Kjellin or Hèroult or Keller processes, at a cost considerably less than the cost of producing a high-class crucible steel. (2) At present structural steel, to compete with Siemens or Bessemer steel, cannot be economically produced in the electric furnaces, and such furnaces can be used commercially for the production of only very high-class steel for special purposes. (3) Speaking generally, the reactions in the electric smelting furnace as regards the reduction and combination of iron with silicon, sulphur, phosphorus, and manganese, are similar to those taking place in the blast furnace. By altering the burden and regulating the temperature by varying the electric current, any grade of iron, grey or white, can be obtained, and the change from one grade to another is effected more rapidly than in the blast furnace. (4) Grey pig iron, suitable in all respects for acid steel manufacture, either by Bessemer or Siemens processes, can be produced in the electric furnace. (5) Grey pig iron, suitable for foundry purposes, can be readily produced. (6) Pig iron low in silicon and sulphur, suitable either for the basic Bessemer or the basic Siemens process, can be produced, provided that the ore mixture contains oxide of manganese, and that a basic slag is maintained by suitable additions of lime. (7) It has not been experimentally demonstrated, but from general considerations there is every reason to believe that pig iron low in silicon and sulphur can be produced even in the absence of manganese oxide in the iron mixture, provided a fluid and basic slag be maintained. (8) Pig iron can be produced on a commercial scale at a price to compete with the blast furnace, only when electric energy is very cheap and fuel very dear. On the basis taken in this report, with electric energy at 10dol. (41*s.* 8*d.*) per electrical horse-power year, and coke at 7dol. (29*s.* 2*d.*) per ton, the cost of production is approximately the same as the cost of producing pig iron in a modern blast furnace. (9) Under ordinary conditions, where blast furnaces are an established industry, electric smelting cannot compete, but in special cases, where ample water power is available, and blast-furnace coke is not readily obtainable, electric smelting may be commercially successful. The author adds that it is impossible to define the exact conditions under which electric smelting can be successfully carried on. Each case must be considered independently after a most careful investigation into local conditions, and it is only when these are fully known that a definite opinion as to the commercial possibilities of any project can be given.

**Mr. Marconi's Lecture.**—The Royal Institution was early overcrowded on Friday last, when Mr., or, rather, the Chevalier Marconi delivered his lecture on "Recent Advances in Wireless Telegraphy." The Duke of Northumberland presided, and among those present were Lord Kelvin, Lord Rayleigh, Sir Thomas Sanderson, Sir James

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Dewar, Sir W. J. Farrer, Sir James Crichton-Browne, Sir William Crookes, Prof. Fleming, and Prof. H. E. Armstrong. Mr. Marconi observed at the outset that the recent improvements in wireless telegraphy included means to prevent interference and secure independence of communication, to increase the distances over which communication was possible, and to obtain greater efficiency and accuracy. He thought the difficulty regarding liability to interference had been exaggerated by the non-technical mind; the expert telegraphist knew that the same thing was possible with ordinary telegraphy, but that it was prevented by rules and regulations devised to that end. In some instances—such as a shipwrecked vessel calling for assistance—it was a distinct advantage that the messages should be received by a number of other ships or stations; but as this interference must in some cases be recognised as a drawback, he had devised a method of obviating it. This method, as is now well known, consists of the syntonisation of the apparatus at the various stations to different periods, by which it is now possible to transmit messages to each one of them without the others being affected, and even five years ago it was possible to send and receive several messages simultaneously without one interfering with another. Mr. Marconi then dealt with receiving apparatus, and exhibited his magnetic detector, which is to supersede the coherer. He stated that the alterations effected in the detector as the result of experience render high speed and automatic transmission attainable. At first the detector had the disadvantage that it could not be made to actuate a recording or writing instrument, the current impulse with which it worked being too rapid to have any appreciable effect on the tongue of a relay, but by altering the circuits and the character of the iron employed in the magnets, the impulse had been slowed down, so that it was possible to operate a relay, and, therefore, a recording instrument. With this arrangement the lecturer stated that a speed of 24 words per minute had recently been maintained over a distance of 152 miles overland. The audience witnessed the transmission of a message, using the magnetic detector, and a Wheatstone receiver rolled out the tape with the words printed in Morse characters. Dealing with long-distance transmission, the lecturer adhered to his optimistic attitude, expressing confidence that in a short time it would be demonstrated that transmission across the Atlantic was not only practicable, but trustworthy, and the method so economical as to be within the means of the majority. Besides this, he hazarded the assertion that Lord Kelvin's prediction as to wireless communication with the Antipodes might be realised. Referring to the differences in transmission by day and night, Mr. Marconi stated that these were only noticeable over long distances, the range by night being much longer than that by day, as clear sunlight appeared to act as a fog to the Hertzian waves; but the lecturer took the opportunity of reminding the audience that clear sunlight and blue skies were not general in this country. In conclusion, Mr. Marconi gave some particulars showing how the use of his system has become extended. The announcement as to the speed atttained with the magnetic detector is interesting, especially in view of the little discussion that ensued upon Captain Lionel James's recent paper before the Society of Arts. It will be noticed that the speed mentioned is somewhat less than that which Captain James announced he had attained with the de Forest system in the Far East.

**Closing Bulkhead Doors by Electricity.**—A method of electrically operating bulkhead doors and armoured hatches on warships, which has superseded the pneumatic and hydraulic systems after years of costly experiments with the latter, is described in the *Electrical World* of New York. This apparatus, which is known as the "long-arm" system, is now in working order on the "Colorado" and "Pennsylvania," the new 13,500-ton armoured cruisers. The mechanism consists of (1) an emergency station of two parts, one a watertight case containing the mechanism for controlling the circuit running to each door or hatch gear for closing the same, and the lamps to indicate the closure, the other case containing the fuse box, in which each wire is supplied with the proper fuse; and (2) the power doors or hatch gears, supplied with the three independent mechanisms: (*a*) the switch by which a man at any door can open and close it at will from either side; (*b*) the switch, operated from the emergency station, by which the door is closed upon the approach of danger; (*c*) the limit switch, by means of which the current supplying the motor which provides the power for closing and opening the doors, is cut off when the motor has closed and locked, or has encountered an obstacle to full closure. This switch has mechanical connection with the door or hatch plate, and is so arranged that it will cut off the current from the motor, and thus prevent blowing out of the fuses. An interesting improvement of this part of the mechanism is one by which the switch is made to again close the circuit to the motor and thus start the door toward its grooves after an obstruction is removed—*e.g.*, when an inflow of water washes away coal obstructing a bunker opening. The door and hatch gear motors are direct-current, reversible, iron-clad, bipolar machines of light and compact construction for intermittent service. They are entirely enclosed in watertight cases, and capable of carrying large overloads without heating or injury. The mining is very simple, comprising one twin conductor by which the emergency station is connected with the ship's mains, one twin conductor by which the controller on each door and hatch gear is connected with the emergency station, and one twin conductor connecting the controller on each hatch gear or door with the ship's mains. To explain the operation of the system our contemporary gives a concrete example. Suppose that the "Colorado" is in danger of being rammed, or that her hull has been punctured by a torpedo. The officer of the deck or the one first aware of the danger will "press the button" of the emergency station, immediately releasing the gearing driven by a spring and controlled by an adequate escapement. This gearing then closes the circuit for operating the emergency switch in the controller of each door or hatch gear. It does not start all the motors at the same time, thus avoiding the necessity for a large supply of current. It starts the doors one after the other at intervals of about three seconds, so that 25 doors and hatch gears can be closed in 75 seconds from each emergency station without more than six motors being in operation at any one time. As each door makes a complete closure it automatically completes a circuit running to the emergency station and is there connected with a small incandescent lamp, located back of each of the discs around the edge of the emergency station. Each disc is numbered to correspond to a door, so that the officer in charge can tell by a glance at the station whether or not all the doors have closed. If any one door or hatch plate has not closed, the fact is immediately observable, and the location of the trouble is known by reference to a diagram at hand showing the location of all the power doors and hatchways. This system complies with all the regulations of the Navy Department, and presumably has been found to give satisfaction, as it is stated that 13 other cruisers and battleships now building will be similarly equipped.

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## ARMATURE WINDINGS OF THE CLOSED-CIRCUIT TYPE.

BY WM. CRAMP.

*(Continued from page 302.)*

SIMPLE TWO-CIRCUIT (OR WAVE) WINDINGS.

**General Derivation.**

We pass now to a class of winding which is essentially a multipolar development of simple bipolar *drum* windings, and although rings may be wound after the same fashion, the ring diagram does not in this case simplify the study of the drum. These windings are called by Parshall and Hobart *two-circuit* windings, and their development may be traced as follows: When in Fig. 7 we obtained from a six-pole ring winding the corresponding six-pole drum, we found that rule for connecting up which is given on page 150, and which resolves itself into connecting a conductor under a north pole to one under a south pole, and then returning to the next conductor but one under the north pole from which we started. But when this process is carried out for a multipolar machine the question immediately suggests itself, Why not start from a conductor under a north pole, pass to one under the next south pole, and then (instead of returning) pass to a conductor under the next north pole, and so on? It is rather interesting to see what will happen if we do this.

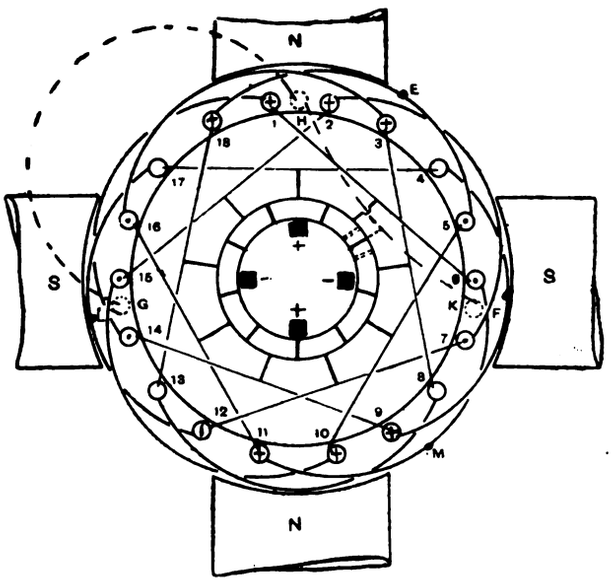


FIG. 14.

Fig. 14 is a diagram of a four-pole machine having 18 inductors on the armature. If it were a multiple-circuit winding, we should start from conductor 1, pass to 6, back to 3, and so on. Instead of this, let us start from 1, pass to 6, and then go to 11, and from 11 to 16, etc., until the winding is complete. The winding scheme is as follows:

1—6—11—16—3—8—13—18—
5—10—15—2—7—12—17—4—
9—14—1.

It will be seen that the winding closes properly—*i.e.*, is re-entrant.

From the position of the inductors in the diagram, it is also seen that at the particular instant inductors numbered 18, 1, 2, 3, 9, 10, and 11 have electromotive forces induced in one direction, whilst those numbered 16, 15, 14, 5, 6, and 7 have electromotive forces induced in the opposite direction.

Let us then ascertain what is the result of this system of connection, and where we should place the brushes.

**Use of Developments.**

In all the types of winding hitherto discussed, we have been able to see clearly the answers to these questions by reference to the corresponding ring type. Here, since this method is unsuitable, we must have recourse to what are termed developments or developed drawings. According to this method the winding is usually supposed to be cut through at one point, removed from its core, and pictured then as though laid open on a flat surface.

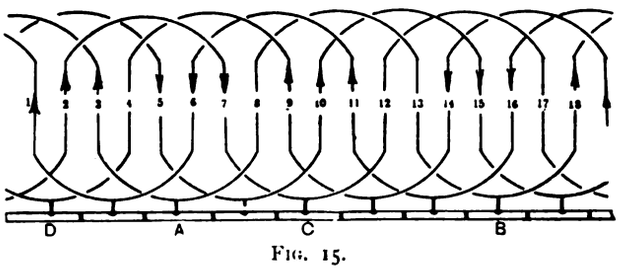


FIG. 15.

In Fig. 15 the armature of Fig. 14 has been treated in this way. But there is also a *second* development which may be carried out from this *first* development, and which is extremely useful in determining the proper brush position for any type of drum winding. (While it is very rarely necessary to employ developments for multiple-circuit windings, it should be understood that the same method is quite applicable to them.)

In Fig. 15 the inductors appear *in the order in which they lie upon the armature periphery*, and they are, therefore, numbered consecutively. The end connections are shown top and bottom, those at the bottom being supposed to be connected to the commutator.

In Fig. 16, however, the inductors appear *in the order in which they are connected* (instead of in order of position), and in this way the circuits which exist are clearly shown.

Figs. 14, 15, and 16 are related in this way. All those inductors which lie under a north pole are assumed to have electromotive forces developed in them, marked in Fig. 14 by + and in Figs. 15 and 16 by arrow heads pointing upwards. The inductors under south poles are marked . in Fig. 14, and have arrows pointing downwards in Figs. 15 and 16. Thus a development like Fig. 15, as commonly used in text-books, shows how the inductors are at any instant grouped with reference to the poles and commutator, but does not bring out clearly the circuits. Our new development (Fig. 16) brings out very clearly not only the circuits which exist in the armature, but also the

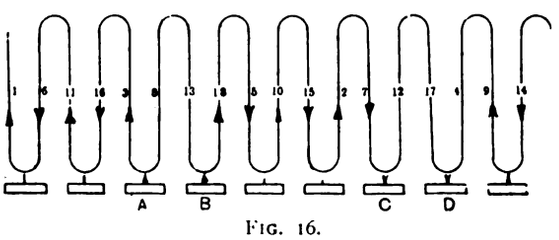


FIG. 16.

necessary places for the brushes, and explains, moreover, the reasons for so placing them.

**Necessary Brush Positions.**

In this diagram the commutator sections are connected to points A, B, C, etc., and obviously we shall need brushes for collection wherever in the winding two series of electromotive forces are in opposition. This is seen to be the case at C and at A. Now, C is the

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connection of inductors 7 and 12, A is that of conductors 8 and 3. From Fig. 14 it is seen that these two points, A and C, are not connected to the commutator at points 180 deg. apart, but at 90 deg. apart. Between these two brushes, and on either side of them, we have *five inductors in series* (see Fig. 16), and there are only two paths in parallel through the armature, yet the whole winding is effective. Contrast this with Figs. 1 and 2, in which the addition of two extra poles necessitates two extra lines of brushes, and places two more circuits in parallel with the original two, whereas here we have a four-pole machine with *only two circuits in the armature and two lines of brushes.* The effect, then, of going continually forward (instead of alternately backward and forward) has been to restrict the number of armature circuits to two, and the number of necessary rows of brushes also to two.

**More than Two Brushes Possible.**

Now, though it is clear that the brushes at positions A and C are all that are absolutely necessary to enable the full effect of the armature winding to be obtained, yet it is also clear from Fig. 16 that we might have placed the brushes upon B and D instead of upon A and C, and have obtained thereby an equally good result. But though in the second development (Fig. 16) sections B and D appear to lie next to A and C respectively, reference to the other two figures show that this is not the case. In actual position upon the commutator a brush at B falls 180 deg. from the brush at A, and similarly with D and C, so that we have another pair of brushes at 90 deg., which would be just as effective as A and C.

We may, therefore, use either of these pairs, but, on the other hand, there is no reason at all why we should not use both. With such a winding it appears that we may use either one or two negative brushes and a corresponding number of positive brushes upon the commutator; further, that this result is brought about by the system of connection, which, while it joins immediately in series those active inductors lying under the centre of each pole, involves also the immediate series connection of those commutator sections spaced approximately $\frac{360 \text{ deg.}}{2p}$ apart, where $p$ is the number of poles.

**Effect of "Two-Circuit" System of Connection.**

The very essence of two-circuit windings is this fact:

That, no matter what the number of poles, (*a*) half of the active inductors in any single winding are first joined in series (so that the sum of their electromotive forces is taken); (*b*) next, half the inactive inductors are joined to them; (*c*) then the remaining half of the active inductors are taken; and (*d*), last, the remainder of the inactive inductors, when the circuit closes. (See Fig. 16.)

Again, contrast this with a multiple-wound armature in which half the active inductors *under one pair of poles* are joined up, then the inactive inductors corresponding to these, and so on for every pair of poles.

To those studying armature windings, nothing can bring out this point more clearly than a careful consideration of the three figures just given—14, 15, and 16. Many pages of description might be written, but the explanation would have to be varied for each individual instance, and a much better understanding will be arrived at by drawing out diagrams like Fig. 16 for every troublesome case.

The question of whether we use two brushes or four in a case like Fig. 14 depends entirely upon the current to be collected. Thus for a low-voltage large-current machine four brushes would be used, while two are quite common for machines of high voltage, such as tramway motors.

There is another advantage attached to the possibility of using only two brushes with a multipolar machine, especially if these two brushes can be placed at some angle less than 180 deg., for there are many cases (such as motors in awkward positions) where *both* the upper and lower parts of the commutator are not accessible. In such cases, by placing the two necessary brushes (at 90 deg.) upon that side of the commutator which is most readily examined, we get a simple solution of a difficult problem. One frequently meets with this arrangement in tramway and railway motors.

**Effect of Increasing the Number of Poles.**

We have already explained that, with a given bipolar ring winding, if it were possible to add to the magnetic circuit a second pair of poles having the same number of lines per pole as the original pair, another pair of brushes is immediately rendered necessary, and the armature is divided into four instead of two parallel circuits. As a consequence, while the electromotive force of the machine remains the same, the current which may be taken from it (and, therefore, the output also) is doubled.

Similarly, a two-circuit drum armature, suitable to a bipolar field, if duly reconnected and placed in a four-pole field, with the same number of lines per pole, will generate twice the electromotive force that it did in the two-pole field. Since, however, it is still divided into two circuits only, it will carry the same current in both cases; so that, although the output is here doubled, it is by doubling the electromotive force.

The addition, then, of an extra pair of poles (if such a thing were possible) to the multiple-circuit armature would have a result like that of placing two similar machines in parallel; but in the case of a two-circuit armature (duly reconnected) it has a result like that of placing two similar machines in series. For this reason multiple-circuit armatures have been termed *parallel wound*, and two-circuit armatures have been distinguished as *series wound.*

**Value of Two-Circuit Windings.**

If for the armature in Fig. 14 we use all the brushes possible, we have four rows of brushes equally spaced about the commutator, which may be connected together in two pairs, when the commutator and brush gear will have *exactly the appearance of the corresponding multiple-circuit winding, and yet there will be in the armature only two parallel circuits instead of four.* This is the reason why this class of winding is called a two-circuit winding, while the other is termed multiple-circuit. Its great use is to enable us to have a multipolar machine with a large number of commutator segments and plenty of brush surface; while the total number of inductors being divided into only two parallel circuits, yields us a high voltage. Further, it has the advantage that either one pair of brushes, or as many pairs as there are poles, may be used; and since between any pair of brushes at least one inductor under every pole is connected, differences in the air-gap under different pairs of poles do not cause local currents, as is the case with multiple-circuit windings. This is an extremely important point, for, no matter how true an armature may be in its field when new, wear of the

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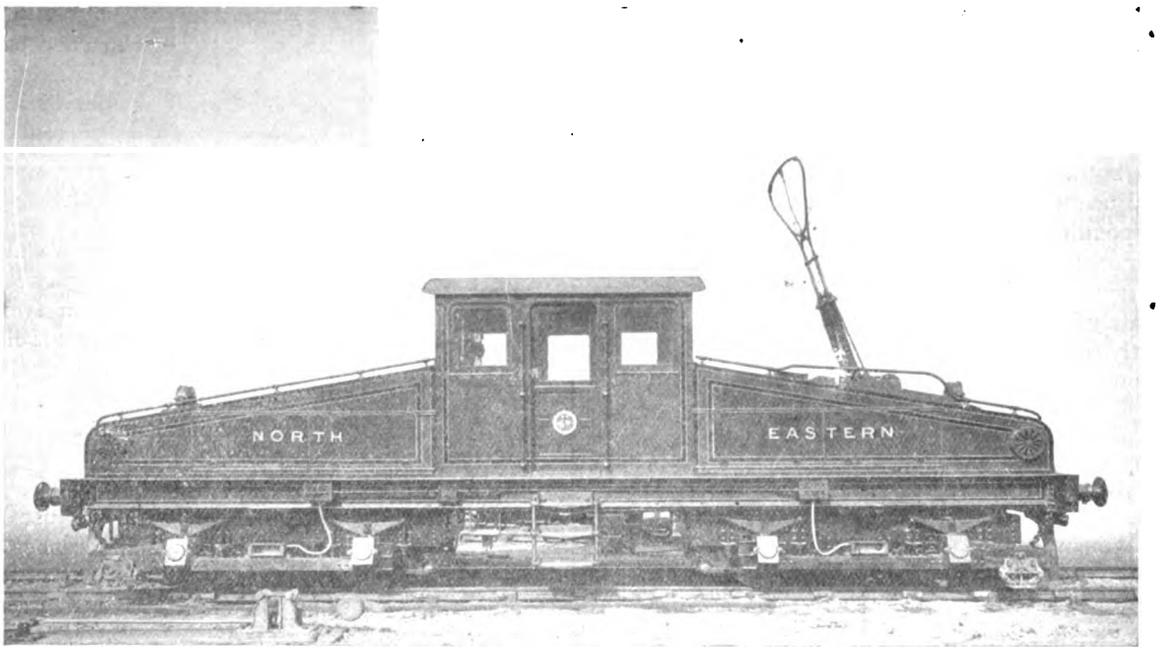
bearings is certain to decentralise it sooner or later. Now, looking carefully at any of the multiple-circuit armatures, such as Fig. 1, for instance, if the armature happens to be nearest to the lower north pole the circuit lying between $G_3$ and $G_4$ will have an electromotive force developed in it greater than that in any of the circuits which are in parallel with it. Thus there will be a tendency for a small current to flow through the armature windings alone (independently of the brushes), due to this unbalanced electromotive force. This parasitic current may rise to a large value: in all machines, in order to keep the efficiency high, the armature resistance is kept as low as possible, so that a small unbalanced electromotive force might be responsible for a fairly large current. Obviously also two-circuit windings will have an advantage in cases where large terminal electromotive force is required at a low speed—a case frequently met with in modern practice.

*(To be continued.)*

## THE NORTH-EASTERN RAILWAY COMPANY'S ELECTRIC GOODS LOCOMOTIVE.

As is well known, the North-Eastern Railway Company some few months ago completed the electrification of about




37 miles of their system, on the north bank of the River Tyne, in the immediate neighbourhood of Newcastle-on-Tyne. The whole of the regular ordinary passenger traffic over these sections of railway has for some time past been operated by electrical power, but the goods traffic has, as previously, been dealt with by the ordinary steam locomotives. Now electric traction is invading the goods section of the traffic. The branch line to connect with the Newcastle "Quayside" runs underground for a considerable distance. On account of difficulties in the ventilation of the tunnel the working of this section has been hampered, and hence it is here that electric traction for goods train haulage is first to be employed. For this purpose two very heavy electric locomotives have been obtained.

These locomotives—one of which is depicted in the accompanying illustration—are not only the first of their type, but are the largest electric locomotives ever built in the United Kingdom. They were constructed by the Brush Electrical Engineering Company, of Loughborough, whilst the electrical apparatus—including the Sprague-Thomson-Houston multiple-unit equipment—was supplied by the British Thomson-Houston Company, Limited, of Rugby and London. The locomotive illustrated herewith is of the double-bogie type with central cab and sloping ends, and weighs in running order 50 tons (2,240lb.). The motors are the G.E. 55 type with two-turn armatures and 3·28 gear ratio, one being mounted on each of the four axles. The control adopted is the Sprague-Thomson-Houston multiple-unit system, and is similar to that used for the passenger service. The following are the leading dimensions of the locomotives: gauge, 4ft. 8½in.; length over central cab, 9ft. 0¼in.; length over headstocks, 35ft.; length over buffers, 37ft. 11in.; pivotal centres of trucks, 20ft. 6in.; wheel base of each truck, 6ft. 6in.; width over cab, 7ft. 6¼in.; width over side soles, 7ft. 10⅝in.; width over all, 8ft. 8in.; height from rail to top of cab, 11ft. 9in.; height from rails to top of floor, 4ft. 3¾in.; diameter of wheels, 3ft.; diameter of axles at centre, 6in.; diameter of axles at wheel seats, 7 28in.; diameter of axles at journals, 6in.; length of journals, 10in.

The trucks are of the steel-plate frame type, in accordance with English railway practice, strengthened with steel angles and gussets, with swinging bolster built up with steel sections and steel castings. The bolster is supported on two nests of coil springs of circular section, and is provided with cast-steel wearing plates, cast-steel centre and side bearing plates. The side frames are supported on the axle boxes by laminated springs of heavy design. The axle boxes are of cast steel, machined to work in the horn plates, which are also of steel and machined, being riveted to the side frames, which are cut out to receive them. The axle boxes are provided with wings to take the shoe beams, and are fitted with heavy brasses babbited, ample provision being made for lubrication and the exclusion of dust. The brake gear is of specially heavy design, as it has to play an important part in the work which the locomotive has to regularly operate, the Quayside branch being on an exceptionally heavy gradient. Blocks are fitted to each side of each wheel, and all of the gear is heavy enough to stand operation by air pressure. The wheels are of the cast-steel disc type, balanced and fitted with rolled-steel tyres 5½in. wide by 2½in. deep on tread, held in place by retaining rings and also by eight set screws. The motors are carried on the transoms by means of cast-steel brackets in which the nose of the motor rests, being held there by a forged strap. The shoe beams are of oak, and bolted to the axle boxes, the shoes being hung outside the wheel base. All holes are drilled, edges of plates planed, and rivets hand riveted. The underframe is constructed of steel sections and ballasted with cast-iron blocks to bring up the weight desired. Each side

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sole is formed by a girder 12in. by 6in. by 54lb. and of I section. There are two centre longitudinals each 8in. by 3½in. by ⅝in. of channel section, these four longitudinals being connected at their ends by headstocks 15in. by 4in. by ½in. of channel section, whilst to the front of these is bolted oak headstocks, 15¾in. by 8in. The whole frame is firmly riveted together with steel angles and gussets, all the holes being drilled and the edges of plates machined. The underframe bolster is formed by two girders, each 6in. by 5in. by ½in., of I section, held together on the top by a plate 3ft. wide and ⅜in. thick, whilst on the lower side is a plate 17in. wide by ¼in. thick. Between the bolsters, evenly spaced, there are five cross girders, each 8in. by 3½in. by ⅝in. of channel section, backed with a plate 15in. wide by ½in. thick. On the top of the frame is a floor of fireproof wood 1⅞in. thick, fixed transversely with a top or lining floor, laid longitudinally. The draw gear, side couplings, and buffers are of the standard English pattern. The centre cab is constructed of ⅛in. steel plate and angles, and is separate to the sloping ends, which are also constructed in a similar manner, all three portions being bolted to the underframe. The cab is provided with two side windows on each side, the one at the driving corner being arranged to lower. A sliding door is fitted on each side, of ash, glazed at the top and panelled at the bottom, bearing on the outside the arms of the North-Eastern Railway Company, in transfer. The doorways are 2ft. 4in. wide and 6ft. in the clear. At the ends of the cab are two windows arranged to slide transversely. Arrangements have been made for driving the locomotive from each end of the cab, and it is, therefore, fitted complete in duplicate, with master controller, air-brake, sand and whistle valves. In the centre of the cab is fitted a cast-iron column to carry the hand-brake gear, on each side being a panel for the control and pump circuit accessories, with a main panel at one end for main and control switches, etc. Air-gauges and ammeters are also fixed in each driving position. Under the sloping ends are fixed the contactors, reversers, and rheostats, the apparatus for each two-motor equipment being fitted on its own end of the cab, the four-motor equipment being thus split up into two equipments, as far as possible, as regards location. The contactors are supported from an angle-iron framing built on the floor of the cab, the reversers and resistances being bolted to the floor, but raised above it so that the cable runways may run underneath them. The air-brake is of the quick-acting pattern, air being supplied by a B.T.H. electrically-driven compressor of the C.P. 14 type, which is hung underneath the frame. This compressor is able to compress against a pressure of 90lb. per square inch, with a cylinder displacement of 20 cubic feet per minute. The air reservoirs are fixed in the ends of the sloping cabs, as also are the sand hoppers, the sand being carried by flexible tubes to the fixed pipes on the trucks, the air-operating pipes being connected to the same at the base of the hoppers. The lighting in the cab is performed by shaded lamps fixed in each driving corner with three lights in each of the sloping ends.

There is a headlight on each end of the locomotive. All lamps are of 32 c.p., and arranged for working six in series on a 600-volt circuit. Two portable lights are also provided. As these electric locomotives operate over sections of the North-Eastern Railway which are equipped with the overhead line and the third rail, a sliding bow trolley, of special design, has been provided, which automatically reverses itself, according to the direction of travel of the locomotive, whilst the bow trolley, when not in use, can be reversed and lowered from the cab by the operation of a hand-wheel actuating a worm and wheel device. All cables are asbestos covered, and are run either in wood troughing lined with uralite or in steel tubing. Besides being fitted with the nine-wire coupler at each end for the control circuit, 'bus or main line and pump line couplers have also been provided, so that two of these locomotives can be coupled together, if necessary, and operated by one man, for dealing with heavier loads. Each of these locomotives, when operating on a 600-volt circuit, is capable of handling a 300-ton (2,240lb.) train on the level at a speed of 14 miles per hour, and of starting with a train of 150 tons (2,240lb.) on a grade of 1 in 27 under all conditions of weather, running up this grade at a speed of nine to ten miles per hour. In the course of some recent official trials with the first of these locomotives, we understand that the speeds and haulage records named above were easily exceeded. The working of the electric locomotives on the North-Eastern Railway will doubtless be watched with no little interest, as, should expectations be realised, the principle of utilising electric locomotives for hauling goods wagons on purely "goods" lines or in marshalling yards will be extended to other British railways.

## ELECTRICITY SUPPLY IN PARIS.

The Technical Commission who have reported on the future regulations for the supply for Paris give in their report some interesting calculations, both as to the cost of electrical energy under the proposed new conditions and also as to the best system of charging. The following gives in an abridged form the two sections of the Commission's report dealing with the subjects.

*Prime Cost of Electrical Energy.*—As there does not exist at the present time an enterprise comparable in size and arrangement with that advised for Paris, the estimates given below are based on extrapolation from results acquired elsewhere. This fact has made the commission very careful to guard against a too favourable view of the economical advantages from the concentration of the producing plant into a few large works. The following estimates of charges are, however, believed to be correct within close limits. It must be remembered that the figures given will not be obtained at once, but only after the stations have been at work some years. The cost of the first installations are calculated to be as follows:

| | |
|---|---|
| Generating stations for a useful maximum output of 70,000 kw. at £20 per kilowatt | £14,000,000 |
| Sub-stations with materials and buildings at £6 per kilowatt | 4,200,000 |
| Mains for high and low tension, not including services or meters, £28 per kilowatt | 19,600,000 |
| Total | 37,600,000 |
| Contingencies | 2,400,000 |
| | £40,000,000 |

This gives in round figures £56 per kilowatt of power obtainable from generating stations. This charge is very considerably below what the present installations in the city of Paris have cost. But it is higher than the mean cost of the stations recently provided.

*Cost of Working.*—The cost of working is composed, first, of the charges for the repayment of capital and the renewal of materials; secondly, of the direct cost of production and distribution of the electrical energy and the administration of the undertaking. The capital of £40,000,000 requires for interest and sinking fund over 35 years an annual charge of 6 per cent. The depreciation funds for the renewal of plant are calculated on the following basis: the renewal of the boilers in 10 years, the renewal of the machines in 15 years, the renewal of the buildings and mains in 35 years. The charge for depreciation corresponding to these lives of the respective parts gives a mean charge of 3·35 per cent. If this charge is calculated on the £37,600,000, the total fixed expenses amount to about £367,000.

The direct costs of working can be fairly calculated from statistics from other stations, which show that the works cost may be divided nearly as follows: 40 per cent. for fuel, 35 per cent. for wages, and 25 per cent. for other charges. It is also known that the cost of supervision and the general commercial expenses represent about 25 per cent. of the works cost. The Commission assume that coal at 16s. per ton will be available, and that about 3·3lb. will be required per unit generated, or 5lb. per unit sold. This gives an efficiency of distribution of 66 per cent.; adding 10 per cent. for oil and stores, the fuel charge per unit works out at 0·476d. per unit. Allowing, then, for wages and other expenses in the above proportion a total works cost of 1·187d. is obtained, or a total cost of 1·48d. per unit.

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In order to deduce from this prime cost of energy sold, it is necessary to take into account the power factor of the load. This idea of power factor is of great importance in the economical problems connected with central stations. It results from a comparison of the real output from the works with that which they would be able to produce if worked continuously. It is the quotient of the annual kilowatt-hours sold by the kilowatts of power available in the stations. This gives a certain number of hours. This power factor depends on the use made of the current, whether for light or power, and also on the business of the consumer. Its mean value is fairly well known to be as follows:

| | | |
|---|---|---|
| Lighting for private houses and offices | 200 to 500 | hours. |
| ,, shops | 500 to 750 | ,, |
| ,, cafés and theatres | 750 to 1,500 | ,, |
| ,, public lighting | 1,800 to 3,700 | ,, |
| ,, motive power | 1,000 to 3,000 | ,, |

The mean very generally obtained in enterprises not unlike those of Paris is about 750 hours. It can be improved by the extension of power consumers, but it seemed reasonable to the commission to calculate the net price on this basis. The higher use of 1,000 hours per year obtained in some present supply systems in Paris is explained by the fact that they are approaching the end of their concession. With a power factor equivalent to 750 hours' use per year the following figures of income and expenses can be obtained; the units sold will equal 70,000 kw. × 750 hours = 52,500,000 units. The cost of supply will be as follows:

| | |
|---|---|
| Interest and sinking fund | £3,400,000 |
| Renewal of plant | 1,265,000 |
| Cost of current at 1·48d. per unit | 3,250,000 |
| | £6,915,000 |

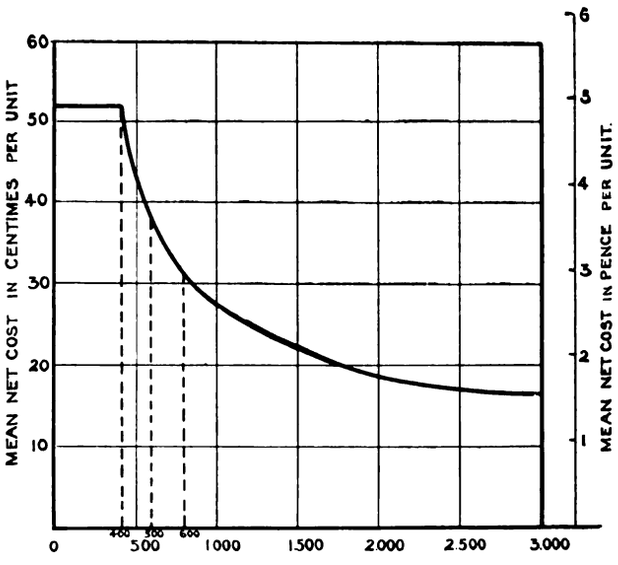
The net cost obtained by dividing this sum by the number of units works out at 3·16d. per unit. It should be remembered that this estimated price corresponds to a definite stage in the development of an undertaking which is bound to be progressive.

*Scale of Charges.*—In studying the system of charging the commission had naturally in view the net cost of production. The total cost of 1·48d. per unit sold given above corresponds to a mean of 750 hours' use of the maximum by the consumers taken as a whole. This mean ought to be considered as resulting from the different means under the various heads indicated above. It seems well determined to-day that a uniform price for all consumers is not applicable to the sale of electrical energy. In its place one looks for a scale of charges which takes account of the quality of the consumers. Instead of a uniform price, one seeks to discover a uniform sliding scale applicable to all. The commission think they have obtained such a scale by the following reasoning. When one looks for the true grounds on which a consumer should ask for a rebate on a fixed price, one quickly sees that this must solely depend on the power factor of his installation—that is to say, the number of hours during which he makes use of the electrical energy. Thus, if one considers in detail the expenses of all kinds which go to make up the net cost, one sees that these expenses are of two kinds. The first includes the fixed charges depending only on the plant installed, and in consequence on the maximum demand at any time; the second, on the contrary, are proportional to the total annual output, and in consequence to the power factor of the installation. This can be represented in a simple mathematical formula, $A - B\,x$, where A represents the fixed charges independent of the units sold, $x$ and $B\,x$ represent the part of the expenses proportional to the output.

It seems, then, reasonable to look for a formula of the same type for the scale of charges which the consumer should pay. First, a sum fixed proportional to that part of the fixed cost incurred on his behalf, say A'; and, secondly, the cost of his consumption of energy at a uniform rate, B'. This idea has already been proposed for the municipal station at Halles, but the determination of the charge A' was not then made on a practical basis. This sum, called the connection charge, is calculated on the total power of all the apparatus installed. Nothing is more variable than this power, because, for instance, it is sufficient to vary the candle-power of the incandescent lamps to change it in the ratio of 1 to 4. In order to ascertain its value and variations, it becomes necessary to demand from the consumer a statement of all modifications made in the number and candle-power of the lamps fixed. It is still necessary to verify his statements by a system of control which becomes like an inquisition; in fact, these declarations are neither made nor checked, and the real base for the charge A' absolutely vanishes.

It is, however, easy to transform the conditions by making the base of calculation the electricity meter. This is designed to record a certain nominal power which corresponds to the maximum simultaneous load on the installation. This power is fixed by the meter itself. It is invariable, and has all the qualities required to serve as the basis of the charge A'. In the case where the maximum at any time is not carried beyond the sum of the power installed, the size of the meter represents better than it that part of the fixed charges which should be borne by the consumer. Again, the choice of the size of the meter as the basis of the fixed charge dispenses with all declarations or domiciliary visits, in case modifications are carried out on the installation.

The commission add that one could equally well take as the base of this charge the indications of a maximum demand indicator, such as Wright's. The result would be equally well obtained, but if it is possible to avoid additional apparatus it is preferable to do so. The charge A' ought then to be fixed on the nominal power of the meter. The report goes on to show that any fixed charge which is independent of service rendered is objectionable to the public, hence advises than discharged A' should be replaced by higher charge for the first, N, number of hours' use of the normal power of the meter. Thus the first units supplied will be paid for at one rate until a quantity equivalent to 400 hours' use of the normal power of the meter has been reached, after that the charge will be lower. Calculations are given to determine what these rates per unit should be, with the result that the commission advise a charge of practically 5d. per unit for the first 400 hours' use of the normal power of the meter, and 1·05d. for all energy consumed over and above this.




Net Cost of Electrical Energy in terms of the Duration of Load.

The curve given herewith reproduces this scale graphically, and the commission also give formulæ for calculating the charge when the number of hours' use per year is known Thus, for 1,000 hours per year, the charge would be 2 64d. per unit; for 2,000 hours, 1 834d.; for 3,000, 1·58d.

[N.B.—This proposed system of charging is distinctly novel, but we fail to see that it really accomplishes the purpose for which it was devised. The fault lies in the assumption that the nominal power of the electricity meter represents fairly the maximum demand of any consumer. Thus, for instance, all those small consumers who have meters of 10 amperes capacity would have to pay at 5d. per

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unit for all they consume until the units are equivalent to a load of 10 amperes at 110 volts for 400 hours. Some of these consumers may never need to take over five amperes, and hence would have to do without rebate until after 800 hours' use. In the alternative, a consumer requiring at first 10 amperes and extending his lighting without notice will get a reduction to a lower rate of 1·05d. per unit much before the 400 hours have expired. In fact, the Technical Commission have adopted the Wright maximum demand system of charging, and have then spoilt it by trying to do without a maximum demand indicator.—ED., *E. E.*].

## THE VALUE OF OVERHEAD MAINS FOR ELECTRIC DISTRIBUTION IN THE UNITED KINGDOM.

BY G. L. ADDENBROOKE.

The above paper, read before the Institution of Electrical Engineers in London, deals with the general advantages of overhead mains rather than with any details in their construction. For this purpose the author gives the following two tables, showing approximately the cost of overhead conductors and underground mains employed under similar conditions.

OVERHEAD MAINS.—THREE-PHASE CABLES. ON THE BASIS OF 1 PER CENT. LOSS PER MILE.

| Particulars of the conductors. | | | Carrying capacity in kilowatts at the following voltages. | | | | Capital cost of line complete per mile, allowing 45 poles per mile at the following voltages. | | | | Capital cost of line complete per kilowatt conveyed per mile at the following voltages. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Size of cables. | Section of cables in square inches. | Weight per mile in lbs. | 6,000 | 8,000 | 10,000 | 12,000 | 6,000 | 8,000 | 10,000 | 12,000 | 6,000 | 8,000 | 10,000 | 12,000 |
| | | | | | | | £ | £ | £ | £ | s. d. | s. d. | s. d. | s. d. |
| 3 7/18 | 3 ·01292 | 3× 266 | 81 | 152 | 225 | 323 | 211 | 230 | 245 | 260 | 52 0 | 30 0 | 22 0 | 16 0 |
| 3 7/16 | 3 ·02299 | 3× 468 | 143 | 254 | 400 | 545 | 259 | 275 | 290 | 305 | 36 3 | 21 8 | 14 6 | 11 3 |
| 3 7/14 | 3 ·03588 | 3× 730 | 222 | 394 | 615 | 887 | 301 | 316 | 332 | 347 | 27 0 | 16 0 | 10 9 | 7 10 |
| 3 19/16 | 3 ·06247 | 3×1,270 | 382 | 680 | 1,060 | 1,526 | 402 | 418 | 433 | 448 | 21 0 | 12 4 | 8 2 | 5 10 |

UNDERGROUND MAINS.—THREE-PHASE CABLES. ON THE BASIS OF 1 PER CENT. LOSS PER MILE.

| Particulars of the conductors | | | Carrying capacity in kilowatts at the following voltages. | | | | Cost of main complete laid and jointed at the following voltages. | | | | Cost of line complete per kilowatt conveyed per mile at the following voltages. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Size of cables. | Section of cables in square inches. | Weight per mile in lbs. | 6,000 | 8,000 | 10,000 | 12,000 | 6,000 | 8,000 | 10,000 | 12,000 | 6 000 | 8,000 | 10,000 | 12,000 |
| | | | | | | | £ | £ | £ | £ | s. d. | s. d. | s. d. | s. d. |
| 3 7/18 | 3 ·01292 | 3× 266 | 81 | 152 | 225 | 323 | 490 | 540 | 678 | 800 | 120 0 | 71 0 | 60 0 | 49 6 |
| 3 7/16 | 3 ·02299 | 3× 468 | 143 | 254 | 400 | 545 | 520 | 635 | 725 | 870 | 73 0 | 50 0 | 36 0 | 32 0 |
| 3 7/14 | 3 ·03588 | 3× 730 | 222 | 394 | 615 | 887 | 545 | 660 | 772 | 950 | 49 0 | 34 0 | 25 0 | 21 0 |
| 3 19/16 | 3 ·06247 | 3×1,270 | 382 | 680 | 1,060 | 1,526 | 760 | 858 | 957 | 1,050 | 40 0 | 25 0 | 18 0 | 13 9 |

Commenting on these tables, the author states that "an inspection will show that at 6,000 volts between conductors on a three-phase system the cost of the overhead conductors is about half that for underground cables. If the voltage is increased, the cost of the overhead line only rises slightly while the cost of the cables increases more rapidly, so that at 10,000 volts the cost of underground is nearly three times the cost of overhead transmission. In the costs for the overhead transmission a fair sum is included for extra poles and networks when crossing roads or places to which the public have access. In these tables the costs of overhead conductors have been calculated on the basis of a single set of conductors of the sizes mentioned on a pole, but when more power is wanted a second set of conductors can usually be added at the cost for copper, insulators, arms, and erection only, whereas to lay a second cable will cost practically as large a sum as the first. Herein lies one of the great advantages of overhead distribution: the current can be taken to a works and a small-sized set of conductors put up to commence with at half the capital outlay required for laying a cable of similar section. If the use of electric energy should afterwards be discontinued for any reason, the poles and wires can be recovered and are still worth a great part of the original value, as they can be used elsewhere. If, as is probable, the use of current is extended, another set of larger conductors can easily and cheaply be erected. With a cable, if an underground main is discontinued it is worth nothing to take up. To lay a full section cable in the first instance means locking up a great deal of capital unremuneratively, possibly for some years; on the other hand, to lay a small cable first and a second larger one later is very expensive. In the first case—viz, with overhead conductors—the capital required will only be half that required in the second, and, moreover, a good proportion of it will remain in a liquid form. Thus by employing overhead conductors a power company is sinking a much smaller amount of capital in extending its mains widely during its early stages. Besides the lower cost per mile of the distributing system with overhead mains, and which in many cases would make the difference whether a supply can be given profitably or not, it is important to observe also that if it will pay to carry the current a certain distance by underground mains, it will pay to carry the current nearly twice as far with overhead conductors, which means that a power station can economically supply current over about three times the area which would be possible with underground transmission at 6,000 volts, and if the pressure is increased the relative areas shows a still greater difference. For this reason not only has a power station with overhead transmission a much larger area from which it can pick up customers and thus acquire a load quickly, but it will later on have a larger area to draw customers from, so that the advantages of additional size and concentration are also secured in a greater degree."

Elsewhere in the paper the author lays stress on this absence of danger from the use of overhead wires, as proved by foreign experience, and on the reliability of supply when the wires are properly erected and looked after. He claims that with overhead wires for transmission and distribution of energy the use of electricity could be much more quickly extended in this country to small centres of population.

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Dealing with the use of such mains in this country, Mr. Addenbrooke states that the Board of Trade have passed a series of routes designed by him, but that the Board still appear to have objections to high-pressure transmissions being erected along the sides of roads. Consequently, as things stand at present, wayleaves usually have to be obtained for carrying the mains across the neighbouring fields. In many districts there will not be much difficulty in obtaining such wayleaves, but the author would prefer to secure in this country a set of laws and regulations such as have been made in several foreign countries giving undertakers the power to obtain such wayleaves by a form of compulsory arbitration when it can be shown that the project is of public utility. The Swiss and Italian laws and regulations on this subject are given in the appendix to this valuable paper, which we regret we have not been able to reproduce in full.

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DISCUSSION.

**Mr. John Gavey** thought the paper had come at a very appropriate time, now that objections to overhead telegraph wires were being raised by local authorities, who, he hoped, would take a more liberal view in future. He would like to know whether the variation in the author's estimate of the cost of erection was to provide for varying voltages or for additional precautions at cross roads, and whether the cost of wayleaves was included in the estimates. In the latter connection there was the question of diversion of route through difference with landowners. Allowance was only made for running three wires on main-line poles. Would these suffice to maintain a continuous service year in and year out? He quoted the case of the Milan high-tension system, where 18 wires are provided, half on each side of the pole, so that one set could be switched off when repairs were needed. It would be as well to keep this phase of the subject in mind, since faults such as breakage of insulators would always occur. He did not think that extra wires in underground mains would be as expensive as the author stated, as spare ducts could be laid at comparatively small cost. Most highways had telegraph wires, so it would be necessary to guard against electrostatic and electromagnetic disturbances, which could be largely obviated by the symmetrical arrangement of the wires. One advantage of private wayleaves was that a route could be selected with as few trees as possible.

**Mr. R. S. Portheim** mentioned that his firm were intimately associated with the scheme of the North Wales Power Company, the practicability of which depended largely on the cost of transmission. The cost of equipping the company's 60-mile overhead line was under £40,000; with underground cables it would have been about £150,000, rendering the scheme commercially impracticable. The Board of Trade had adopted a very reasonable attitude in regard to carrying the wires along the highways, and the Welsh farmers had also proved exceedingly amenable.

**Mr. C. P. Sparkes** considered it was the local authorities, not the Board of Trade, who had been to blame for obstructing overhead progress. Regarding the route to be followed, the best method was to work along the main roads, avoiding, if possible, routes selected by the Post Office.

**Mr. H. M. Kensit** stated that his company's experience in acquiring wayleaves had not been a very happy one, some landowners declining to negotiate at all where the company had no compulsory powers.

**Mr. A. Blumenthal** related the experience of his company in laying a 500-volt continuous-current line which crossed a telephone line. They offered to instal the ordinary protective fuses, but the telephone people insisted upon the ordinary wires being replaced by rubber-insulated wires, the rubber of which soon wore off. He had found the authorities abroad much more rational, small protective devices sufficing to meet their regulations. Managers of Continental overhead systems had told him that they had never known of a breakage of the wire resulting in loss of life. He recommended lightning arresters of the horn type with magnetic blow-outs. Regarding stone throwing at insulators, his company had found resort to the schoolmaster or parson better than the police.

**Mr. Pooley** confessed that he at first felt apprehensive for the cablemakers, but on reflection he considered overhead wires would rather assist them, as these would be commercially practicable where underground cables were not, and underground cables, he thought, would still be necessary for distribution in large towns. He considered the author had underestimated the cost of wayleaves. Danger from overhead circuits could easily be prevented by simple devices, and faults were scarcely more likely to occur overhead than underground. When they did occur they were much easier to locate. He thought it out of the question to paint creosoted poles, as it would render them an eyesore. Pitch pine would be the best wooden poles. He hoped that when the author spoke of a cheaper system of wiring, he had in his mind a cheaper method, and not a further cut in rates, which were already low enough.

**Mr. L. Gaster** expressed curiosity as to the relative advantages of copper and aluminium for overhead wires.

**Mr. Addenbrooke,** replying, stated that, in regard to Mr. Gavey's question, the variation in cost of erection was due to the extra insulators and larger poles used in some cases. The tables given in the paper had been compiled on a three-wire basis for the sake of convenience. In America three wires had been found sufficient except for very long distances, and when more were erected the cost amounted to little more than the price of the material. In regard to running lines near Post Office wires, a great deal depended on the question of crossing, but from a pamphlet of the American Institute of Electrical Engineers he saw it was pretty generally agreed that it was quite possible to go near your neighbours without much disturbance. In some cases telephone wires were carried on the same poles as the lines transmitting power. Regarding the attitude of the Board of Trade, he explained that this had been modified as the result, he believed, of representations made by himself. At present, however, the Board would not countenance overhead lines on main roads. He had been told on the Continent that serious accidents were unknown. Regarding wayleaves, he had generally found things work smoothly, except when solicitors entered into the case—and the clerks to local authorities were usually solicitors. He did not think the cablemakers need be alarmed; there would be plenty of work for them, and they could also supply the overhead mains. He mentioned that in America and on the Continent they were reducing the number of poles by using stranded hard-drawn copper wire. Aluminium was not suitable for long spans. He concluded with an appeal for wider statutory powers for undertakers of overhead systems.

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## APPLICATION OF ELECTRICITY TO MINES.*

BY A. C. ANDERSON, STUDENT.

(*Concluded from page 305.*)

### MOTORS.

When enquiring for motors for use in mines, managers should invariably specify as clearly as possible the exact nature of the load, the maximum temperature rise permissible, and any peculiar conditions under which the machine may have to work. The question of temperature is a difficult one owing to the very different conditions prevailing in different parts of the same mine; but the engineer should know where his motors are going, and can specify accordingly. Of course, in the case of portable gear, which may be used anywhere, the worst possible case must be provided for, and an adequate factor of safety allowed. As far as possible, motors for use underground should be enclosed in motor-rooms. This is manifestly impossible in the case of coal-cutters, drills, and locomotives, where, at any rate in dangerous mines (locomotives being eliminated), the case of the motor should be its own room, so to speak. With regard to continuous-current gastight motors, it is held that inspection covers must be provided, and that this is like giving the miner an unlocked safety lamp. Why not give the miner a locked motor and make its inspection a part of the general system? Mr. Henry Hall thinks that a motor cannot be kept properly cool if it is totally enclosed; this is obviously wrong.

It is merely a question of rating. The induction motor has a slight pull here, as, though the modern continuous-current motor is practically sparkless, the frequent intense vibration in coal cutting and drilling must eventually cause some trouble with the latter type. Totally-enclosed motors for certain conditions are absolutely necessary, and, unfortunately, there seems some foundation for the assertion that anything quite enclosed is liable to neglect. They should be most carefully designed not to overheat, and should be rated carefully in accordance with the nature of the load, a special margin being allowed for coal cutters and drills, which meet with the roughest treatment. The machine is not always switched off at once when the cutter jambs. All motors should certainly be guarded from circumstances such as these by means of suitable cut-outs, preferably situated in a properly protected box, obviating serious burn-outs in the windings, which have proved so far a very frequent source of accident. Armature belts are best away in motors for stringent conditions, the conductors being held in their slots by wedges. The shunt "kick" of machines should always be taken up in the controlling gear to prevent the possibility of sparking at contacts.

Mr. Garforth, of Normanton, who has made some very interesting experiments on the risks of explosion with motors, found that gas can get through an armature shaft bearing, but not in sufficient quantity to cause an explosion internally. He also found that the internal explosion incidental to the admission of gas to the interior of a gastight case did not fire the gas outside the case. Mr. W. C. Mountain performed some experiments with motors at the request of the committee dealing with the use of electricity

* Paper read before the Birmingham Local Section of the Institution of Electrical Engineers.

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in mines. He got no explosion with a mixture of gas and air when the proportion of the former to the latter was as 1 is to 15. He was further able to increase this to 1 to 10, and even to 1 to 8, without the occurrence of any explosion. When he adjusted the brushes, with the set purpose of making the machine spark, an explosion took place when the proportion of gas to air was 1 to 10.

APPLICATIONS

(*a*) *Pumping.*—Electricity is most commonly applied in mines to pumping, a use to which it is eminently suited, especially in connection with centrifugal pumps at constant load. In the Monterrad pits of the Roche-la-Moliers and Firminy Mining Company, the workings being gassy, the motor (three-phase) has a closed circuit winding without slip-rings, and no switches are placed underground. To start the plant the generator, an inductor alternator, is fully excited, and then run up slowly, taking the pump gradually to full speed with it. Near Dortmund there are some 665-h.p. pumping sets taking current at 2,500 volts, where two methods of starting up are provided. The motor may be connected to the one of the two dynamos which is at rest and attain full speed with it. This is the simplest way. No collector rings are required on the motor, but it is first necessary to stop a dynamo. Two separate three-phase circuits must be allowed for at the switchboard—one for ordinary light and power, and one for pump motors. It was found desirable to be able to start the motor direct, and an oil-cooled starting box was put in, by which means resistance was introduced into the rotor circuit. At Horcajo, in connection with electrically-driven pumps, Heerwagen's short-circuited rotor answers very well. The stator bears nine coils, each of 42 turns; the three coils of each phase are in series, but the three phases are connected in mesh fashion. The rotor carries 360 flat copper rods, arranged in two layers, in 180 holes, and is so connected that six rods are in series, thus giving 60 circuits. The centrifugal pumps can start with zero torque, gradually increasing, and can be brought to full speed when full of water in 100 seconds. The motors are started by means of an auto-transformer giving 400 volts, the primary pressure being 1,000 volts. When the auto-transformer is switched in the first motor is joined to the starting bars, and takes at first from 200 to 240 amperes, but rapidly reaches synchronism. This point is marked by a sudden decrease in current strength, when the connections are changed over to main 'bus bars, so that motor continues to run at full pressure. The second motor is then started in the same way, and the auto-starter finally cut out.

(*b*) *Winding and Haulage.*—Electricity has not as yet come much into vogue for winding in this country, though electrically-driven haulage gears have made much headway. Of the many ingenious devices designed to meet the difficult conditions of a winding plant, the Ilgner Siemens and Halske is the best known. Here a multiphase current drives a motor direct coupled to the armature of a continuous-current dynamo, the connecting shaft carrying a heavy flywheel. The direct current from the dynamo drives the motor coupled direct to the winding drum. The energy thus stored in the flywheel is available for starting the cage. Speed variation is possible by varying the field strength of the dynamos (which should be separately excited) driving the winding motor. Under ordinary working conditions an efficiency of 60 per cent. may be looked for. This figure represents the ratio of the power available for raising the load in the shaft to that at the terminals of the motor-generator. For winding where electric driving has superseded steam the cost of working has been much reduced, the steam consumption per horse-power hour coming down to 24lb. to 26lb. on mineral raised. The constant turning moment of the electrical motor is more favourable to the life of ropes than the varying torque of steam-engines. "Dancing" of the rope is done away with, and drums can be much lighter than with steam winding plant. The Koepe pulley system of winding is specially suitable for electricity owing to the high speed. The Koepe pulley consists of a grooved pulley of large diameter mounted on a shaft coupled to the winding motor. The winding rope passes round this pulley and over the pit-head gear outside the winding shed, and is thence attached to the cages. It forms thus an endless system. The arc of contact of the rope on the Koepe pulley is so chosen that the maximum loads occurring are lifted by the friction alone between the rope and the pulley, an ample safety factor being allowed for. It has been found possible, working this system electrically, to reduce the weight of the winding pulley to about one-half the weight of the drums usually required for steam winding plant. It is best to use liquid rheostats in connection with haulage gears. Batteries are very good for levelling load on winding machinery. The braking of haulage plants is frequently accomplished by making the motor run as generators returning current to the line, but this is always backed up by hand and automatic devices. There was exhibited at Dusseldorf a winding engine where the varying load was taken up by a storage battery, and to this an Ilgner drive has now been added. About 1,000 tons are raised per day. The Ilgner drive consists of a 300-h.p. motor on a 500-volt direct-current circuit driving a steel flywheel 4m. diameter, weight about 40 tons, and a direct-current dynamo at speeds up to 350 revolutions per minute. The motor, flywheel, and dynamo are all arranged on the same shaft. The dynamo sends current up to 2,000 amperes into winding motors, whose terminal voltage increases to 500 volts. The balancing of power is effected by the variation in speed of the flywheel shaft. The plant at the Thiederhall pit, installed by Siemens and Halske, is driven by two continuous-current motors, with an equalising battery for starting and speed regulation.

(*c*) *Coal-Cutters.*—Coal-cutters should be lavishly designed for strength and reliability in working. They should be able to stand at least 30 per cent. overload for short periods, and they must be reversible. It is held by some that an arrangement of two motors in series is good for coal-cutter driving, as each machine has only half the line voltage across its terminals, and not only is the weight better distributed, but there is generally more head room. The starting switch should be enclosed in an airtight case. Provision must be made for carrying 70 yards or so of armoured cable on the motor truck, preferably coiled on a drum. The box containing the main switch and fuses should be placed where work is commenced, and cable should be paid out as the cutter advances, a sufficient length having been provided for the face of coal to be cut during a given shift. In the case of disc machines, for satisfactory working there should be a good floor and roof, and the material in which the cutter works should not be too hard, and as free from ironstone balls as possible. Messrs. Ernest Scott and Mountain have been good enough to give me some figures of a performance of one of their machines of this type at the Smithywood Colliery, near Sheffield. These are set out in the accompanying table, and show what may be done with up to date machinery.

DISC MACHINE.—Working of Coal-Cutter at Smithywood Colliery.

| Date. | Time started. | Time finished. | Min. run. | Depth of undercut. | Thickness of cut. | Material cutting. |
|---|---|---|---|---|---|---|
| | p.m. | p.m. | | ft. in. | in. | |
| Dec. 16. | 10 30 | 10.33 | 3 | 4 6 | 5 | Stones, coal mixed with stone. |
| | 10.34 | 11.34 | 60 | | | |
| | 11.46 | 12 50 | 64 | | | |
| | 1.16 | 1.33 | 17 | | | |
| | 2.20 | 2.23 | 3 | | | |
| | 2.29 | 2.31 | 2 | | | |
| | 2.33 | 3.0 | 27 | | | |
| | 3.7 | 3 33 | 26 | | | |
| | 3.36 | 3 39 | 3 | | | |
| | 3.50 | 4 2 | 12 | | | |
| | 4.26 | 4.56 | 30 | | | |
| | 5 9 | 5 20 | 11 | | | |
| | 5.21 | 5.33 | 12 | | | |
| | | | 270 | 105 yds. cut. | | |

Total hours from first switch on to last, 7 hours 3 minutes; 4½ hours actual cutting; 2 hours 33 minutes changing cutter twice, running rope out three times; average amperes, 37; average volts, 470.

(*d*) *Drilling.*—With regard to rock drills, where electricity is in keen competition with compressed air, it is to be noted that (1) with pneumatic drills there is no deafening noise of the exhaust, no power to draw back the drill when

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jammed in the borehole, and there are heavy losses in cumbersome piping. Moreover, a severe capital outlay is unavoidable owing to the large power and space required, and the plant when installed is very inefficient. (2) Electric drills are much lighter and more handy than the above, occupying but little room. They are 30 per cent. cheaper in first cost than air-drills, and the medium for transmission of energy is far more flexible and efficient. The Durkee electric drill is driven through a flexible shaft by an independent motor of 1½ h.p. The motion is given by a special crank, which gives a slow return and a quick forward or cutter stroke; the driving collar moves the drill spindle through springs so as to cushion the motor of the drill if the cutter is not striking the rock, and to allow for irregularities in the feed. The drill is rotated by the usual rifled rod and pawl. The machine weighs 230lb. without tripod, and makes 580 strokes per minute. The Marvin percussion drill of solenoid type, requiring a special alternator, needs from 20 kw. to 32 kw. at generator, and delivers 450 to 550 blows per minute. Drills of the Marvin and Van der Pode type, however, have never been a commercial success, as they get hot and require, beside a special generator, cooling arrangements, rendering them liable to get out of order. Mr. Walsh, in the *Engineering and Mining Journal* of New York, discusses electric drills working in the mines of the Consolidated Cariboo Hydraulic Company at Bullian, British Columbia; direct-current portable 1½-h.p. and 2-h.p. motors are used. Three drills averaged 312ft. of holes in 10 hours through solid rock. Cost of current was 9·37s., and lubricants 7½d.; a blacksmith at 16·64s., and a helper at 8·32s. must be added. The total cost of running the drills for 10 hours was about 131s., saving approximately 208s. on hand drilling. The power was generated by steam-engines, so that the results cannot indicate the maximum efficiency obtainable. The consumption of power was considered without reference to wages. The tests were extensive enough to give good average values. An 86in. hole, 2in. diameter, was drilled in 19·08 minutes. Total consumption of power was 940 watt-hours, or 131 per foot. Cost was 5d. per kilowatt-hour, which, at the rate of 131 watt hours per foot drilled, is equal to ·655d. per foot. The minimum cost of drilling with steam or compressed air is equal to 5d. per foot.

(*e*) *Ventilation.*—There are not many instances as yet in this country of electrically-driven fans in mines. At the Pelton Colliery, Durham, a fan by Davidson and Co., Limited, of Belfast, has replaced two steam-driven Guibal fans. The fan motor absorbs about 154 b.h.p., removing 223,054 cubic feet of air per minute. On tests of Guibal fans the two removed 199,745 cubic feet of air per minute, and absorbed about 178 b.h.p. The gain in favour of the single electric fan of upwards of 23,300 cubic feet of air per minute, with an expenditure of 24 h.p. less—a reduction of 13·5 per cent.—is very creditable. Moreover, a set of boilers, burning coal, and two steam-engines were dispensed with, and an existing boiler fired with coke over gases was used.

(*f*) *Locomotives.*—Pneumatic locomotives are very clumsy affairs when compared with the excellent types of electric ones turned out by Messrs. Thomas Parker, Limited, and others. Their excess in bulk and weight is largely due to the big cylinders of compressed air which they must necessarily carry. In consequence they are not so suitable as electric locomotives for low seams, save where considerations of firedamp make their use the more safe. There must be sparking at wheels of compressed-air locomotives when skidding at starting or on gradients. It has been proved in South Wales that these sparks will ignite gas. Electric locomotives are not much used for collieries in this country, the sparking at the trolley wire being inadmissible, but even if compressed air is employed, electric driving is best for the compressors. In upkeep of locomotives electricity is far more economical than compressed air.

## The New Rules.

As was to be expected, a large amount of discussion among mining and electrical engineers followed the publication of the new rules, and the most divergent opinions have been expressed about them. The majority of electrical engineers seem to regard the rules as too arbitrary and of a nature to stifle enterprise in the necessarily gradual perfection of detail. Colliery managers in the main think that their individual responsibility is trodden upon, many having worked to their own rules for some time past. Now it is distinctly stated in Section XI. (1) of the rules that existing plants shall continue as they were, provided that an inspector agrees to their particular method of working.

Those mining engineers who have had little or no working experience with electrical plant are of opinion that the rules are too rich in electrical terms, and express their inability to understand them. One would certainly have thought that the mine manager of to-day would have made it his business to familiarise himself with the possibilities and main details of electric transmission. I believe that there are extremists in certain districts who regard the new rules as such complication extraordinary that they are actually waiting before putting down their electrical plant to see whether the new rules are made law. In view of this professed inability on the part of some mining engineers to understand the rules, and the unwillingness of the whole of that body to leave the matter entirely in the hands of the electrical men, a solution of the problem would seem to be the formation of a joint committee in which both parties would be properly represented. With reference to the proposed rules themselves, it is surely rather a standstill policy to limit the working pressure at the face to 650 volts for motors and transformers up to 75 kw. capacity. The judgment of the engineer, leavened by the advice of the inspector, should be quite satisfactory for the particular case. The rule as it stands must hamper progress. Section I., Rule 7 (5), states that none but authorised persons shall be permitted to enter the rooms in which motors and transformers are set apart. This also applies to generating plant under Rule 16 of Section II. Yet why should commutators and collector rings be fenced? An "authorised person" would surely be competent to adjust brushes, etc., and a fence would only be in his way. A man should be bothered as little as possible when doing this class of work.

By Rule 4, Section I., all live metal shall be covered or guarded. This is surely unnecessary in machine rooms where none but the authorised person may enter, but it is wise for the workings. It has been urged in opposition that the knowledge of the danger of touching live metal is a sure preventive for experienced men. But if such metal were not adequately guarded in the workings there would be many inexperienced men subject to such danger, and even the man of experience cannot have his eyes everywhere. With regard to Rule 9, Section I., it would be extremely difficult in a mine to limit the leakage current to one ten-thousandth of the maximum supply current. The measures presented in Rule 10, Section I.—viz., the subjection of the line and apparatus to a half-hour test at twice the maximum pressure—are surely too drastic; they would probably result in leaving a permanent strain. Rule 25, Section I., is to be highly commended. It is of great importance that a good practical knowledge of treatment for electric shock should be widespread throughout a mining installation.

Rule 3, Section III.—This rule, specifying the nature of cable tests, is a good one, and should go far towards ensuring that the user shall have no trouble with his cables other than from external causes, such as falls of roof, etc. Rule 6, Section III.—The stress laid here upon the prevention of moisture creeping at the ends of cables in terminals is of great practical importance. Many have learnt from unpleasant experience that the neglect of this point breeds trouble. In respect of motors (Section V., Rule 6), this rule absolutely specifies a slow-motion starter and a properly graded resistance for all classes of motors used in mining. One cannot imagine a good maker proposing to use any other type of switch for this class of work at the present time.

Rule 5, Section VII., stating that no wire carrying a current shall be used underground to support a lamp, etc., is a little strict for experienced men, and would be almost impossible to enforce. In any case it is well to bear in mind that H.M. inspectors of mines have powers under Section 42 of the Coal Mines Regulation Act, 1887, to

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deal with any such special dangers as are not expressly guarded against in the new rules.

In conclusion, I would say that I have found the evidence given before the Commission on the Use of Electricity in Mines of great interest and value in the preparation of the paper. I would advise all interested to study both it and the Commissioners' report.

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DISCUSSION.

In the discussion which followed, **Mr. Jackson** referred to a paper which had recently been read before the Rugby Engineering Society on "The Application of Electric Power in Collieries," by Mr. G. M. Brown. This paper embodied his views to a large extent. Where slip-ring motors were used, he recommended the use of more than one brush per ring, as this reduced liability of sparking. A frequency of 50 cycles per second was usually found most convenient.

**Prof. Redmayne** (Birmingham University) said that he favoured electricity as a motive power in mines. Steam and compressed air were, however, still largely used. Compressed air would continue to be a formidable competitor to electricity so long as there was any liability to sparking troubles with electric systems. Too much stress could not be laid on this question. In many cases its occurrence might result in an explosion. The author had quoted 30 per cent. as an efficiency figure in connection with compressed-air systems. Very old plants might show this figure, but modern systems, employing isothermal compression combined with reheating, had frequently an over-all efficiency as high as 70 per cent. But thermal efficiency was not such an important consideration as simplicity of apparatus. This was an absolute necessity in mining work, owing to the conditions of space and lighting. It was a moot point whether electricity or compressed air was the better system of power to use. In the majority of instances that had come under his notice, the quality of material and workmanship put into electric installations in mines and collieries was extremely good. With respect to drilling, it was a fact that electricity had absolutely failed to compete with compressed air as a motive power. There were several electric drills, more especially of the rotary type, that would do good work, but they were not suitable for mines. They were much more complicated than pneumatic drills, and more costly in upkeep. He hoped that a suitable electric drill would be designed. The figures quoted by the author to show the relative cost of different systems of coal-cutting could not be taken as reliable. To be of any value each system would have to be tried at the same spot, as the hardness of coal varied considerably even in the same pit.

**Mr. Reavell** (Ipswich) advocated air-compressors used in conjunction with electric generators at pithead, and electric distribution to different parts of the mine. This system would reduce first cost, and result in a greater economy of working than any other. The electric power might be used for all suitable work, such as pumping, etc. But pneumatic machinery was most suitable for coal cutting, drilling, etc., and the compressed air for these could be supplied by an electrically-driven air-compressor through short lengths of pipe. Coal-cutters frequently jambed. With a pneumatic tool it was a simple matter to cut off the air supply, withdraw cutter, and make a fresh start. But in the case of an electrically-driven machine it meant the replacing of a fuse, and a consequent delay. He then showed a lantern slide illustrating a portable electrically-driven air-compressor suitable for the work he had indicated. Another advantage resulting from the use of compressed air was its storage capacity. With a system entirely depending upon electricity, the generating plant had to have a capacity capable of dealing with the whole of the equipment. He condemned compression at the pithead, as it frequently resulted in the loss of 50 per cent. of the power generated.

**Mr. Gott** said that the argument of economy in fuel consumption might easily be overdone. In most mines there was a large amount of fuel unsuitable for sale that had to be got rid of, and which the mining engineer frequently consumed himself. Wholesale waste in pipes was consequently a minor consideration compared with convenience and economy of coal-cutting. Many engineers also considered that the loss due to friction in the shaft pipes was compensated for by the head. Commutator sparking was largely due to vibration. This should be reduced as much as possible by careful design. One of the troubles of electric distribution was the fact that in the shaft cables the core was liable to slip down the insulation. This necessitated a special form of suspension. A reference had been made to the running up of motors with generators; he wondered this was not more frequently used. A point the author had omitted was the necessity of lightning arresters where overhead wires were used for lighting and power transmission at the pithead. He instanced a case in which the omission of this precaution had necessitated the replacing of the shaft cables.

**Mr. M. B. Wild** regarded the choice of system as not settled by the question as to which was the cheapest to instal in the first instance, but by what system one could pull out the greatest amount of coal with ease and safety. He found that with direct-current plants considerably more power in motors could be put below ground than with alternating-current plants for a given power of generator on surface. Again, with direct current there was no trouble due to motors falling out of step, and causing stoppages, when the generator was momentarily overloaded. Direct-current motors properly designed for secondary haulage, and a suitable reversing controller with sufficient resistances, constituted an electric haulage gear as flexible as a steam or compressed-air hauling engine. There should be no necessity to use a friction clutch, which many electrical engineers had to do to get over defective starting gear, such as liquid switches and badly designed controllers. Another objection to liquid starting switches was that the liquid very soon evaporated, thus necessitating constant attention. Further, with direct current, supposing there was a stoppage for some time on a particular road, the speed could be increased considerably, so as to bring out the coal that had accumulated. A standard speed for single or double drum gears was five miles per hour, but they worked without any trouble at speeds varying from two to eight miles per hour. With an alternating-current system the speed of the motors could not be varied. For pumping and very large haulage—such as endless rope, main and tail with long runs—no doubt alternating current would be the better system. From personal experience he had every confidence in saying that in most collieries the haulage could be done by electricity, or in very fiery mines with compressed air generated by an electrically-driven compressor, placed as near as possible to the gears consistent with safety.

**Mr. H. M. Hobart** (*communicated*): "Continuous-current and polyphase systems have both been very successfully employed in the application of electricity to mines, and the relative merits of each system for any particular case should always be weighed before arriving at a decision. As the writer is satisfied that both systems will find wide fields of usefulness in such work, he does not propose to discuss their relative merits on this occasion, having recently done so in the discussion of Mr. Holiday's paper, entitled 'A Comparison of Three-Phase and Continuous Current for Mining Purposes,' read before the Institution of Mining Engineers, June 2, 1904. In those cases where the use of polyphase currents is most suitable, it is of paramount importance to employ a low periodicity, for it is the power applications which are of chief importance in mining, and any questions relating to the quality of the lighting are of secondary importance. Moreover, it is a fallacy to regard the question of lighting at low periodicities as offering grave difficulties. The lower the periodicity the lower should be the voltage chosen for the incandescent lighting circuits, and the higher should be the candle-power per single lamp, for by these means the carbon filament employed will be of sufficiently large section to be able to store the heat and obviate material reduction of temperature between the peaks of current of successive cycles. It will necessarily follow that the luminosity will then be more constant. But the chief desideratum, that of excellence in the design and performance of the motors, is enormously promoted by the use of low frequency. This will lead to higher power factors, lower magnetising current even with larger air-gap, greater overload capacity, and also cheaper motors, since for a given output the diameters will be smaller and the lengths greater. Capacity effects in the cables will also be decreased. The squirrel-cage type should be freely used, even in motors of large capacity."

**Mr. Anderson**, in his reply, admitted that steam was still largely used, but there was no doubt that the losses in the distribution system were of a most serious character. "Economy of coal-cutting" was impossible with a "wholesale waste in pipes." Undoubtedly mining engineers, as a body, regarded fuel economy as of considerable importance. The modern electrical equipment of collieries was very good in most cases, but bad early work had been prejudicial to progress of electricity in mines. The electrical equivalent of the compressed-air storage system was the battery—a most convenient factor. It was a very difficult matter to obtain reliable comparative figures of coal-cutting performances, as the conditions of working were so various. The replacement of fuses in connection with coal-cutters driven by polyphase motors was of rare occurrence. Liquid rheostats were very good as starters. For variable-speed work the ordinary type of regulator would be used. The advocacy (Mr. Hobart's) of a low frequency was very interesting, but the low voltage necessary for successful lighting would hardly conduce to the best economy. The system of starting motors by running up with the generator added considerably to the capital outlay, as separate circuits were necessary. He agreed with the remarks that had been made about the necessity of employing machinery of as simple a nature as possible.

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## THE PROTECTION OF ELECTRICAL INSTALLATIONS BY MEANS OF LIGHTNING ARRESTERS CONNECTED IN SERIES.

The following description of a new type of lightning arrester constructed by the Allgemeine Electricitäts A.G. to designs by Mr. Gola is given in the *Elektrotechnische Zeitschrift*. If an overhead line is provided with lightning arresters, A, B, C, etc. (either of similar or dissimilar types and with varying lengths of spark-gap), at points *a*, *b*, *c*, etc., along its length, observation has proved that the action of the different arresters will be very irregular. Sometimes several will work at once, sometimes none will act. Out of a number of exactly similar arresters, perhaps only one will act, and in some cases this will be the least sensitive arrester. These occurrences indicate that the action of an arrester depends more on its position on the line than on its construction, and this may be accounted for by the wave-form propagation of the discharge. If, for instance, at a certain discharge into the line a wave summit happens to occur at *a* and a node at *b*, the arrester A will act, whilst B will remain unaffected. If all the arresters on the line happen to lie in the neighbourhood of nodes, none of them may act, in spite of the occurrence of a heavy discharge which may be quite capable

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of breaking down the insulation of the generators. A discharge in general travels along the line until it arrives at some interruption. Since the generator almost always forms one of the chief interruptions to such waves in the circuit, its position affects the whole distribution of the waves in such a way that a wave summit is formed at that point, and in this way numerous breakdowns of generators may be accounted for. If several lightning arresters are distributed along the line, it is, of course, likely that at least one will act whenever a lightning discharge occurs, though it is by no means certain. Certainty can only be arrived at by employing some form of apparatus which will ensure a wave summit occurring just at the point where an arrester is connected. Mr. Gola's arresters effect this by forming an interruption in the circuit similar to that formed by a generator. The apparatus is inserted in the line from the machine, and beside it an easy discharge path to earth is provided. The arrester has no appreciable impedance for the ordinary alternating currents, and acts as a filter or sieve which allows the generated current to pass, but not the high-frequency atmospheric discharge.

The construction of the apparatus is shown in Figs. 1 and 2. Two large covers, A and B, made of magnetic material, are separated by a rim, F, of non-arcing metal, and the whole is held together by bronze bolts. The non-arcing metal forms a rim, separating the two covers all round, and is fitted with an internal cross-piece, G. Two other covers, C C, also of magnetic material, surround the first-named covers, and are connected to them by small bolts. These outer covers carry a soft iron core, D,

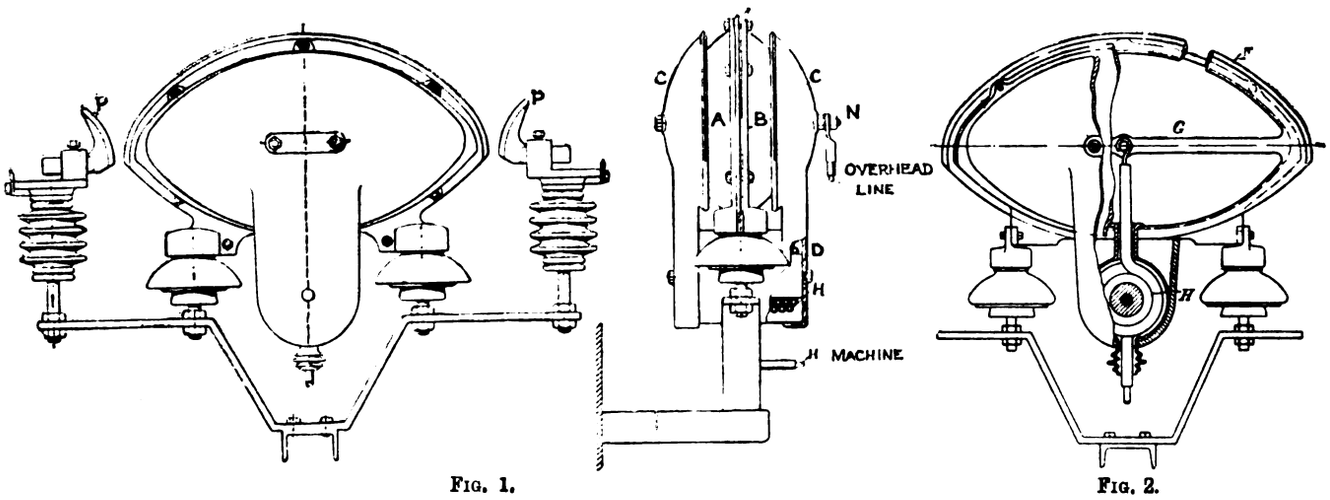


FIG. 1. FIG. 2.

surrounded by a coil, H. One end of this coil is connected to the middle point of the cross-piece, G, and the other end is brought out of the apparatus. Two separate insulators at the sides carry the earthed horns, P P, and the whole is mounted on a V-shaped arm. The length of the spark-gaps is adjustable. The incoming line is connected to the terminal, N, on one of the outer covers, C C; whilst the line leading to the machine is connected to the free end of the coil, H. The discharge must, therefore, pass from the outer cover, C, through the connecting bolts, which offer a path of very small section, to the covers, A B, traversing magnetic material, and, finally, by way of the cross-piece, G (also of small cross-section), through the coil, H. Such a path forms, as is well known, a great hindrance to the passage of high-frequency currents, and the apparatus, therefore, has a choking effect, and forces the atmospheric discharge to jump across to the carbons, P. The formation of arcs to earth after a discharge may be prevented by the insertion of carbon resistances between the horns, P, and earth.

## MANCHESTER TRAMWAYS.

The paper read by Messrs. S. L. Pearce and H. C. Gunton before the Manchester Section on Feb. 21, on "The Manchester Tramways and Power Supply," was hardly expected to provoke much comment, as the paper itself consisted largely of plain statements of fact and statistics of seemingly local interest only. The paper, however, contrary to expectations, brought together a good gathering, and provoked a lively discussion.

The CHAIRMAN (Mr. C. D. Taite) commented upon the difference in power taken by the large and small cars, and referred to the advantages of condensing, which the curves showed to be a 25 per cent. saving. He considered that the efficiency of the sub-stations was poor, and enquired if the capacity of the motor generators was to blame, and if rotary converters would not have been better? A cheerful and encouraging point was the total works costs for the lowest month in 1904, of ·27d. for Stuart-street, ·28d. Bloom-street, and ·432d. at Dickinson-street. He thought that the figures proved the possibilities of the greatest economy with large stations, to the disadvantage, by comparison, of small stations.

Mr. L. ANDREWS referred to the solid and indisputable matter contained in the paper. He drew attention to the peculiar features of the curve which combines the two loads for lighting and traction; and the load factors also showed the advantage of a combination of the two classes of supply in one station. He differed from Mr. Taite as regards the sub-station efficiencies, and pointed out that the 78 per cent. average monthly conversion efficiency was good for all-day running. He had had a very much lower efficiency on single-phase working of only 50 to 60 per cent. He calculated the cost of current generated at sub-stations to be about ·4d. per unit, and agreed with Mr. Taite as to the impossibility of touching this figure on small systems. He was not certain if the ·103d. per unit generated referred to the total cost of distribution or of delivery to sub-stations. He compared the interesting figures of ·17d. per unit on condensers against ·26d. non-condensing, the saving being perfectly convincing. The advantages of superheated steam in connection with the reciprocating tests of 19·8lb. per unit generated and 17·2lb. was apparent, but how much extra coal was used to obtain the 90deg. F.

Dr. RHODES observed that the main factor to be considered was the maximum traction, and this could vary as a ratio within wide limits to the plant capacity. The beauty of Manchester (from a strictly engineering standpoint) was its exceeding flatness, which, together with the large extent of the system, explained the efficiency of the combined station arrangement. He instanced Oldham as almost the other extreme, with its precipices of 1 in 10 and its much smaller car service.

Mr. SEATON was jocular at the expense of the tempting figures instanced, and thought that the 2lb. of coal per unit generated was incredible, because human engine builders only soared as low as 2½lb.

Mr. ORZETICH enquired regarding trouble with the switching in and out of the motor-generators from static effects? His experience was that beyond 250 kw. the size of unit could not be increased economically.

Mr. J. FRITH would have preferred to have heard more regarding the dark side of the undertaking, as the most valuable knowledge was gained from unhappy experiences. He also enquired regarding the use of compound-wound generators for combined stations.

Mr. T. W. SHEFFIELD believed that traffic considerations should govern the use of large or small cars in preference to cost per car mile.

Mr. S. J. WATSON, from practical experience, advocated combined stations. He asked for an explanation of the two ·5 cables used as traction feeders. Were they in parallel, or used as lead and return? Also, were the high-tension feeders specially regulated.

Mr. M. B. FIELD thought that the overload capacity of generators should be mainly determined by the heating effect. In one instance he noted that the station was overpowered by 50 per cent. of its plant capacity, but he considered that this was quite safe, and that motor-generators should not get out of

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phase under 100 per cent. overloads of a temporary character. Batteries would help to a certain extent in reducing the heating effect. He was curious as to the reason for the length of time (up to half an hour in Glasgow) the abnormal demand lasted after a total breakdown of the car service. In Glasgow with negative boosters he more than satisfied the Board of Trade requirements by keeping his difference of potential under one volt.

Mr. A. G. COOPER pointed out that under certain circumstances batteries could reverse a compound-wound generator, and that the requirements for regulation of feeding voltage on lighting and traction loads were somewhat different. He referred to the smaller wage item per passenger on large cars, and thought that the seven-volt limit for rail drop was quite enough.

Mr. C. C. ATCHISON despaired of obtaining figures comparable to Manchester with his gradients at Rochdale, and anticipated a figure nearer 25 kw. per car than 8·5 kw. Coventry was an example of a combined station that was successful by making use of its traction extensions to further extend its lighting area, and enquired if Manchester did likewise? Were the Manchester return feeders in parallel with the rails or were they taken straight back?

Mr. PEARCE, in reply, stated that the ·1031. was the total cost of distribution. He could give no official figures for coal on the superheating test, but the figures for the condensing tests were 3·2lb. against 4·1lb. non-condensing. Parallel running in Manchester had been quite satisfactory. Increasing the size of motor-generators was of little advantage. He had experienced no trouble upon the system, except as to mistakes in winding of machines of an easily remediable character. He used chokers for induction motors. He would like to know what Mr. Firth expected to gain by the use of compound-wound generators for lighting? His high-tension feeders ran from two to seven miles, and were not regulated. The tramway rails were nowhere connected to the generating station, the return feeders connecting them only to the sub-stations. The return feeders could be substituted for the positive feeders in case of need, and all these feeders ran together with this object. Although running in parallel upon overload with care was safe enough, he was quite satisfied with 50 per cent. as a maximum overload.

## STEAM-TURBINES.

**A paper on "The Mechanical Construction of Steam-Turbines and Turbo-Generators" was read by Mr. W. J. A. London at the Manchester Section meeting on the 28th ult., and was discussed as follows:**

The CHAIRMAN (Mr. C. D. Taite) said that the subject was of increasing interest. There were many books published on the subject, but little experience had been gained in running. He hoped the paper would be followed by others dealing with those points which time limitations had prevented enlarging upon. He wished to know if the makers of vertical turbines concurred with the comparisons given in the paper.

Mr. NEILSON thought that great credit should be given to the British Westinghouse Company for allowing so much valuable and exclusive information to be published. Few firms were given to that sort of thing.

Mr. T. L. MILLER wished to know more regarding one of the weak points of steam-turbines—the attaching of the blades. He had been greatly struck with the strongl mechanical construction of the B.T.H.-Curtis turbine, and considered the blades to be the soundest possible type, as they are cut out of the solid. The blades could be examined at any point by opening a door and revolving the disc. As regards the chance of trouble on vertical turbines where the lubricating arrangements failed, he suggested that a hydraulic accumulator feeding the footstep bearings would meet the difficulty, but did not know if this was in use anywhere. The acknowledgment in the paper of vibration difficulties was interesting, as it was commonly thought there were none. Wet steam should be guarded against, as it was liable to flood the machine and bring it to a stop. This was mostly experienced where superheated steam was not used.

Mr. BAILEY gave some dimension details of the vertical machines at Harrogate. He had experienced vibration troubles, but prevented their permanence by intercepting the conducting path *vid* metal joists, etc. Concrete was not to be trusted as a foundation, owing to its shrinkage. A girder foundation was quite satisfactory if properly designed. Some people put a couple of bare girders down under a machine, and then called it erected. They should be properly braced together, however, to ensure rigidity. He had only balanced half a dozen turbine spindles in 11 years' experience with Parsons turbines. The chance of cylinder distortion mentioned only required thicker metal to obviate. He pointed out that the Westinghouse type of double-flow turbine had been used early on by Parsons, but was eventually rejected on account of its lower efficiency and greater length. He desired to know what had been the cause of trouble in connection with the Westinghouse machines made for the Metropolitan Railway?

Mr. H. LINDLEY had also been impressed by the superior mechanical strength of the vanes in the Curtis turbines, which combined simplicity and solidity. He pointed out that the horizontal turbines were in the same boat (as regards oil-pump breakdowns) with the vertical machines. Cotton-mills in Manchester were driven by steam-turbines quite satisfactorily.

Mr. F. H. WHYSALL could say nothing on the matter from a maker's point of view, but had had a considerable experience with the running of turbo-generators, and agreed with the paper in stating that the partner that gave most trouble was the generator, although this was not an excessive amount. The Manchester Corporation machines had run for three winters satisfactorily at 6.000ft. per minute speed of commutator, which only required turning up every 20 months. Superheating had increased the working temperature from 130deg. to 150deg. F. at least, but no trouble had been caused. His experience was that vibration could be entirely eliminated by balancing the rotating parts.

Mr. SEATON pointed out that while wet steam merely temporarily slowed down turbines until got rid of, it was absolute death to steam-engines.

Dr. BOWMAN had used hydraulic accumulators instead of pumps for oil lubrication bearings. He likened the turbine to the Welsbach mantle, which has extended the use of gas by a little while, the turbine likewise lengthening the days of steam-engines somewhat.

Mr. J. FRITH was struck by the statement that carbon brushes cannot be used on continuous-current turbo-generators on account of the armature floating when running, and thus causing the brushes to dance. He pointed out that the copper brush consumption added considerably to the total costs.

Mr. MILES WALKER, as being responsible for the design of the generator portion of the machines, replied to Mr. Bailey's enquiry as to the Metropolitan Railway turbines, by stating that these machines had run without a single stoppage, and were never shut down unless required. If, however, Mr. Bailey's reference to trouble applied to the workshop experiments, he was willing to admit that a large number of practical experiments had been made to determine the best design, and, naturally, some of these had been failures. He thought Mr. Parsons was also a believer in practical experiment, from the number he had made. In any case, a reasonable man would judge a machine by its performance under working responsibility, and not by workshop experiments. Other makers of blades had been so much praised that evening that he felt bound to mention that the 50 per cent. over-speed tests upon Westinghouse machines had failed to affect a single blade. There was the disadvantage in the Curtis solid blades that if these got wiped off (as was very possible in handling and erecting them), it meant a new wheel altogether. With carbon brushes half-a-thousandth of an inch play caused chattering, but a metal brush gave flexibly.

Mr. C. C. ATCHISON agreed with the paper in distrusting a single vertical bearing on account of non-lubricating possibilities. He preferred the water-jacket bearing for turbines, and had had to employ a man and water-buckets for attending to bearings where water-jackets were not provided.

Mr. A. G. COOPER, as regards lubrication difficulties, stated that he could not bear his hands on his turbine bearings after working two hours, but considered no harm could be done if good oil was used—in fact, any degree of heat was safe up to the melting point of the metal or the carbonising temperature of the oil. He understood that Siemens made a carbon-brush machine for Bristol, but this was not perfectly successful, and the design was altered.

Mr. W. J. A. LONDON, in reply, repeated his faith in concrete foundations. The Westinghouse blades had a factor of safety of 10. As regards conductance of heat upward from Curtis turbines to generators, he pointed out that although externally this might be balanced by the fan effect, internal radiation still existed. He did not approve of the thicker metal in cylinder walls suggested—cylinders must have ribs. The works test on a 2 000-kw. machine, 27in. vacuum, no superheat, was 18 6lb. per kilowatt-hour. He could mention several stations where Parsons machines were running with bare wire binding. The spindles could easily be straightened if bent. The quality of oil used was important. Machines were often shut down by using cheap lubricant, and sometimes this had to be chipped out of the bearings. With the drop-forged blades suggested it would be impossible to get the same clearance as with the machined blades, these being polished and buffed for absolute evenness. Carbon brushes chatter, and eventually break. They might suit if made in very small pieces, so as to more closely follow the movements of the commutator.

Mr. E. W. COWAN, in proposing a vote of thanks to Mr. London, deprecated Mr. Bailey's allusion to the Metropolitan machines, and pointed out that turbine makers should hang together if they wished their type of prime mover to have a chance against other classes of engines.

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## ELECTRIC TRAMCARS v. MOTOR 'BUSES.

Competition between electric tramways and petrol-driven motor 'buses alone can decide which is the fitter to survive, but we see every reason to believe that these two rivals may in the end prove to be of mutual advantage to each other. At present the competition on paper is very severe, but there are not enough figures available respecting the cost of running and upkeep of motor 'buses to make reliable conclusions on the subject. Interesting contributions to this controversy appeared in the *Liverpool Daily Post* the other day from Mr. J. R. Salter (engineer-in-chief of the South Lancashire Tramways Company) and Mr. E. A. Rosenheim (engineer to the Liverpool Road Carrying Company), consequent upon a motion of which notice had been given by Councillor Wilson, urging that the Tramways Committee of that town should "consider and report upon the desirability of introducing self-propelled motorcars or omnibuses to work in conjunction with or apart from the present system of electric cars." The arguments advanced by the former in favour of electric cars are those which have now become familiar, but they lose nothing in force from the cogent manner in which Mr. Salter marshals them. He emphasises the economy in power when running on rails, especially where severe gradients are concerned. Again, while it is necessary on any vehicle carrying its own generating plant to provide machinery sufficient to produce the maximum effort required, an electric power station, being designed to deal with the average effort, enables the greatest possible economy and efficiency to be obtained from the plant at the lowest possible cost for production of power. On many tramway systems in this country power is produced for less than ½d. per Board of Trade unit, which will propel a car for about a mile. Then the limited seating accommodation of the motor 'buses would necessitate the number being doubled as compared with the trams, thus increasing traffic congestion and danger. Mr. Salter estimates that in some parts of the city division of Liverpool it would be necessary to have practically a continuous string of motor 'buses, which would enormously increase the perils of the pedestrian. Last year, with the trams carrying 113,000,000 passengers, only four pedestrians met their death. Mr. Salter contends that the saving on permanent way is completely neutralised by the heavier cost of constructing motor 'buses—reckoning it as three times that of the electric car—and the greater number that would be requisite. It is in the cost of operation, however, that Mr. Salter considers that the electric tram shows itself so immeasurably superior to the motor 'bus. The power costs, even providing for interest and sinking fund and depreciation upon the generating plant, are less than the cost of power for operating the motor 'bus. Again, the cost of maintenance of the motor 'bus is much greater than the cost of maintenance of the electric tramcar. The great number of moving parts in a petrol engine, the excessive vibration and jarring due to the minutest variations in the level of the road, and the fact that it is necessary, whether the motor 'bus be in motion or not, to keep the engine running, all tend to shorten the life of the vehicle, and to involve tremendous charges for maintenance and depreciation. Besides this, the smaller seating capacity of the motor 'buses means a corresponding increase in the number of motormen and conductors. Then, again, there is the question of tyres, the replacing of which he estimates will represent a cost of at least 2d. per car mile—a greater sum than is usually required to meet the whole of the maintenance charges on an electric tramway undertaking where there is a frequent service. In conclusion, Mr. Salter claims that the total operating costs with

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motor omnibuses are treble those with electric cars. Mr. Rosenheim, while admitting the advantage of the electric car in regard to seating accommodation, places the cost of the motor 'bus at less than double that of the electric car, and contends that this will leave a substantial margin in favour of the former, as regards capital costs. His estimate of £700 to £900 for a motor 'bus appears a moderate one. With respect to running expenses, Mr. Rosenheim puts the figure for the tramcar at 6d. to 7d. per mile, against 9d. per car mile for the motor 'bus. There is, of course, little available data in regard to motor 'buses, but the estimate of 9d. seems a flattering one. In regard to earning capacity, he mentions that in the case of the only motor 'buses from which data are available the earning capacity is 1s. 3d. per car mile, against 10d. for the Liverpool trams. It is premature, however, to speak positively of the earning capacity of motor 'buses, besides which the frequency of the Liverpool tram service has to be taken into consideration in making this comparison. Mr. Rosenheim concludes by denying that the cost for repairs and maintenance of tyres will be anything like so great as that asserted by the advocates of the electric car, but does not give any figures. We think the case presented by Mr. Salter, however, substantially demonstrates that the electric tram in large towns or for regular interurban traffic has little cause to fear its new rival. There are, however, cases where tramways cannot be employed without making street improvements at prohibitive cost. In such cases and for infrequent services the motor 'bus has advantages which may outweigh the higher running costs. What is really needed to settle the controversy is experience, after extended trials under commercial conditions, of the cost of upkeep of heavy motor vehicles running at good speeds. Such experience will soon be available, but in the meanwhile there is no valid reason for suspending the construction of electric tramways.

## BRIDLINGTON ELECTRICITY WORKS.

### Opening Ceremony.

The formal opening of these works took place on Thursday, March 2. The ceremony was performed by his Worship the Mayor, Alderman C. E. Field, J.P. Councillor Mainprize, the chairman of the Electricity Committee, called upon the town clerk to present the mayor with a beautifully designed gold key, bearing a suitable inscription, the arms of the borough, and his own initials. The Town Clerk, Mr. A. E. Matthewman, said that this was the first occasion since the charter day that such a presentation had taken place in the borough. In presenting the key he pointed out that the souvenir represented an expenditure of nearly £30,000, and the ceremony it inaugurated was a big event in the history of Bridlington. The Mayor briefly acknowledged the gift, emphasising in his remarks the practical method in which the consulting engineer had carried out his work. In its early days, he confessed, he had viewed the undertaking with something akin to pessimism, but from the encouragement that he had from private consumers, who numbered about 90, he ventured to prophesy that the undertaking would be a success from the very first. This it surely would be if everybody who could would come forward to assist. He emphasised the specially low rate of charge (5d. for ordinary consumers, 4½d. for users of 500 units per quarter, and 4d. for users of 1,000 units per quarter), and also was proud to state that Bridlington was the first town in the country to electrically light the streets throughout the whole borough. He then opened the door with the gold key presented by the town clerk, declared the building open, and a large number of councillors, visitors, and ladies inspected the station.

The special feature in connection with the new station is the switchboard governing the street lights, from which all the arc and incandescent lights are operated by means of solenoids placed in street boxes at intervals along the streets. The station, which is exceedingly well built and lined throughout with white glazed tiles, is very well arranged, with a considerable amount of space all round for extending when necessary.

Various refreshments were served most liberally until 5.30, when the assembly gathered in the engine-room, and the Mayor introduced Councillor Mainprize, the chairman of the Electric Lighting Committee, who in a speech delivered from the switchboard gallery held out the various advantages to be gained by using electric light, especially in a health resort, and also gave a *résumé* of the station equipment and the fine work carried out by the contractors. He further held out prospects of electric traction in the near future, emphasising the need of a tramway service from Bridlington to Flamborough.

Alderman Johnson and Councillor Andrew, whose duties consisted of starting up the two engines, then spoke at some length, and darkness was fast falling when the stop valves were at last opened, and the current was switched on by the chairman amid loud applause. The act was successful, and during the evening the streets were perambulated by appreciative crowds examining the new light.

A dinner, at the invitation of Messrs. Medhurst, Page, and Lloyd, was held after the opening ceremony at the Brunswick Hotel, which was attended by most of the councillors and a large number of contractors' representatives and visitors.

MR. A. J. BECKETT, BOROUGH ELECTRICAL ENGINEER, BRIDLINGTON.

After the toast of "The King and Royal Family," proposed by the Mayor, had been drunk, Mr. Medhurst, the consulting engineer, proposed the toast of "The Mayor and Corporation" The Mayor called upon Alderman Sawden to respond, by reason of his commanding flow of speech. The alderman sustained his reputation, and the next toast, "The Success of the Electric Light Undertaking," was proclaimed by the chairman of the Gainsborough Urban District Council.

Mr. A. J. Beckett, who has acted as clerk of works and now takes charge of the undertaking as borough electrical engineer, has had extensive experience. He commenced as a pupil of the Brush Electrical Engineering Company at the Falcon Works, Loughborough, leaving at the end of two years to go through a year's course in the Siemens Laboratory at King's College, London. He returned to the Brush Company as assistant engineer in the erection of the central stations at Hanley, Dover, and Sheffield. He then supervised for the British Insulated Wire Company the laying of mains at Southport, Leicester, Yarmouth, and Bolton. He afterwards designed and put down the entire plant for the Fairhill Brick and Tile Company, of Bedford, on the completion of which he was appointed assistant engineer at the Belfast Corporation electricity works, leaving Belfast to take up an appointment under the York Corporation, where he for four years acted as mains and works superintendent. Last year Mr. Beckett was appointed clerk of works to the Bridlington Corporation electric lighting undertaking, and on the completion of the works

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he was appointed borough electrical engineer by the unanimous vote of the Council.

## THE FOG LOAD.

A fog may be regarded as a dispensation of Providence to try the moral fibre of engineers in charge of electricity supply. The process is attended by the discovery of many of the weak points of the supply system, both in the station and throughout the network. Unless special work is proceeding on the mains, however, the stress is chiefly felt in the station, with the possible exception that spare transformers have to be switched in, and fuses commence to blow through overloads. A fog warning in a station is, in fact, equivalent to the drumbeat to general quarters on board a man-of-war previous to a hot engagement. And, particularly during the winter months, constant readiness for such a visitation is necessary. The blackness of great darkness which overspread the city of London on Friday week should act as a solemn warning to all station men who had been prematurely rejoicing that peak-load worries were over for a season. It is probable that Friday provided for most of the metropolitan supply companies a demand that was all load and no peak.

The condition of readiness for such sudden loads includes attention to two classes of essentials—those things which must not be done, and those which it is imperative to do. As regards the first class, it is necessary not to be in too much hurry to begin overhauling the plant before fine weather is assured. There is doubtless a great temptation, when the light of day grows bright, showing up the wear and tear of the winter, to lay off a boiler or engine for thorough examination and repair. It is, however, necessary to be conservative in this respect, as although it is sometimes possible in dire extremity to close a pipe with a soft wood plug instead of a blank flange, or to rig up a tangle of temporary dynamo connections, it is not so easy to throw a Willans engine together, or to put one or two hundred caps on the headers of a Babcock boiler. For the same reason it is not always true economy to be a hard taskmaster, discharging all hands not absolutely essential at the first hint of spring. If there are too many stokers, it is better policy to put the spare men on minor repairs than to turn them on to the street. It is wiser to sanction extra expenditure of polishing paste on the engine-room than to tell the greasers to look out for another job. Labour is cheap just now, but it is always convenient to have men about the place who know how to run the plant without being drilled, even if they are not so engaged for six or eight months together.

As regards the things to be done, it is advisable, first of all, to have a perfect watch kept. At the Bankside station of the City of London Company there is, we understand, an ancient mariner stationed somewhere on the roof whose duty it is not merely to watch the smoke emission of the station, but to use his weather lore for the benefit of those considerably beneath him. Indication of fog is immediately communicated to the engineer in charge of the running at the time, who is thereby enabled to prepare for excess load. Where it is impossible for stations, owing to their small size, to pay a man exclusively for this duty, it is a useful scheme to get an undertaking from three or four consumers at different parts of the town, whose occupations compel them to take notice of the weather (such as van owners, or such shopkeepers as fruiterers, who display their goods partly in the street), to ring up the station on the telephone at the approach of bad weather.

Whatever means are taken to give warning, the engineer in charge should immediately make sure of his boiler-house, as this is usually where the greatest delay takes place If automatic stoking gear is used, the mechanisms should be tried, to see that they are in working order, and if by experience it is found that a considerable time elapses before the grate is properly covered with fire in regular working order, as with some forms of coking stokers, the engineer is wise in being prodigal with fire-lighting material. It is better to waste a little coal than to have the lights low. There should, of course, be a spare boiler standing with fires banked in any case, and if a fog load is anticipated it is well to supplement this by one or two others.

In the engine-room the system of trial should be proceeding as regards such auxiliary gear as separately-driven air-pumps and other plant that may not have been in use for some time, with the steam and water valves, traps, and drains belonging to the engines. Warming steam should at once be put on the main sets, oil-cups should be filled, and as far as possible sight-feeds should be regulated before running up, and the engines barred over and placed on their turning centres ready for action. It is well for the engineer to assume that every part of the plant is going to be used, and to take his precautions accordingly. Penny-wisdom is pound-foolishness in this case. In times of peace the running staff should be trained to this "emergency drill," so that a critical situation may be dealt with promptly. Fitters and their labourers throughout the station should be warned to get the plant they are working on into condition for immediate use, and to be ready to clear out of the way at a moment's notice. Even if the plant is not used, the exercise will do the fitting staff good. The station lights should be at once seen to. A good light saves many a panic. Then, after a final exhortation to the leading stoker to keep up his "pecker" and his steam, and a warning to the head driver not to lose his head, the engineer in charge may get on to the switchboard ready to take flying shots with the synchronising gear, in the full assurance that even if the lights should after all become red-hot hair-pins, he has done his best to get ready for trouble.

It may be urged that such great preparations are expensive, and savour of panic. A real fog, however, is not to be treated lightly. More lights have been "out" through foolhardiness in the station than the outside world dreams of. A more reasonable objection is that sometimes a fog descends with such suddenness that the engineer has no time to make any preparation. In such case he must trust in Providence and see that the oil-swabs are being used.

## RESIGNATION OF MR. W. A. CHAMEN.

At a meeting of the Electricity Committee of the Glasgow Corporation held on 2nd inst., the following letter, dated Feb. 28, was received from the chief engineer, Mr. W. A. Chamen:

"I have to inform you that I have decided to accept an offer which has been made to me of a position of responsibility with the well-known firm of consulting engineers, Messrs. Bramwell and Harris, of London, Edinburgh, and Cardiff. It will be a favour to me if the Corporation can arrange to relieve me at an early date of my engagement to serve them as I have done for upwards of seven years past in the position of their chief engineer and manager of the electricity department of the Corporation, instead of waiting for the expiration of the three months' notice which under the terms of my engagement I am legally bound to give. In the meantime, I beg leave formally to give this three months' notice of the termination of my engagement, to put the matter in order. I wish to take this opportunity of expressing my sincere thanks for, and appreciation of, the courtesy and kindness I have always been able to rely upon at the hands not only of the Lord Provost, magistrates, committees, and other members of the Corporation, but also of the citizens of Glasgow in my relationship with them. In addition to my indebtedness to the Lord Provost and Corporation, and to those they represent, I cannot close my connection with Glasgow in an official capacity without tendering my regret to yourself and my brother officials of the Corporation that the offer I have received necessitates my losing the assistance they have always in our official work so readily given me, though I trust the friendly relations which have always existed between us may not be forgotten or entirely terminated."

Bailie Willock, in moving the approval of the minute spoke at some length of the excellent work which Mr. Chamen had done in Glasgow, and of how under his guiding hand their electricity undertaking had been guided past the dangers that beset such undertakings at their beginning, and their electricity department, if it had not yet reached the Bay of Plenty, it might be said to be within sight of it.

Mr. Chamen is well known throughout the length and breadth of the electrical world, and the outstanding facts in his career have been published time and again in various technical journals. He is still a young man, comparatively speaking, being just over 40 years of age. The experience which he has had both during the time he has occupied his present position and during the previous 17 years when he was with the firm of Crompton and Co., should be of great

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value to the firm of Messrs. Bramwell and Harris in the inception and development of electricity power schemes and any kindred work.

When Mr. Chamen went to Glasgow the electricity supply was all generated in one small generating station in Waterloo-street, the pressure of supply having been just recently changed from 100 volts to 200 volts on a three-wire system—*i e.*, having only 100 volts on each side. The capital expenditure at that time had reached the sum of £188,000, and the revenue was £36,000. The total horse-power available was 3,300. At the present time two large new generating stations are in operation, one dealing mostly with that part of the city which lies on the north side of the River Clyde, and the other mostly with the area on the south side of the river, there being, however, a certain amount of trunk connection between the two. The total horse-power at the present moment, including the small electricity works purchased from the Kelvinside Company some four or five years ago, is 18,330. Mr. Chamen decided to use 200lb. steam pressure, which, although common enough now, was seldom to be met with seven years ago, and various unpleasant predictions were made regarding the departure. The declared electricity pressure was raised to 500 volts—*i e.*, 250 volts in consumers' premises for lighting. Concentric three-wire mains were introduced from the start of the new work

MR. W. A. CHAMEN.

These concentric mains included one square inch triple-concentric feeders, a size of cable which up to that time had never been made, and great anxiety was expressed as to the possibility of success with it. The idea also of using concentric distributing cables at all for continuous-current work in such a large city as Glasgow was freely criticised, and trouble was predicted. In all these matters unqualified success has crowned Mr. Chamen's pioneering efforts. The latest development has been in the ordering of steam-turbines for the large extensions of generating plant now in hand. One of these turbines is arranged to drive two 700-kw. continuous-current 500-volt dynamos, and the other two are being constructed to drive alternators of 3,000 kw. capacity each, the current being three-phase with a periodicity of 25 cycles per second and at a pressure of 6,500 volts. Two sub-stations, using induction motor-generators for conversion, are already in operation, one being situated in the old generating station in Waterloo-street, from which all the steam plant was removed some two years ago. In addition to the special points already named, Mr. Chamen decided to take a departure in the matter of low-tension switchboards, arranging these with the object of preventing proximity of large differences of potential, and making a complete departure from the usual practice of cramming the whole controlling arrangements as close as possible together. The same principle has been followed as far as possible in the laying out of the new high-tension switchboard at Port Dundas. Considerable attention has been given to the question of power supply development, so that at the present time there is about 9,500 h p of motors coupled to the mains. The capital expenditure upon the undertaking is now, in round figures, £1,300,000. The revenue for the present year ending May 31 is expected to approximate £190,000.

During his stay in Glasgow Mr. Chamen has occupied various important offices in connection with technical and other societies. In the year 1901 he was made president of the Incorporated Municipal Electrical Association, the convention for that year being held in Glasgow. Up to the present time he remains one of the most active members of council of this association. He joined the Institute of Engineers and Shipbuilders in Scotland shortly after his arrival in Glasgow, and was soon made a member of council, which office he still holds at present in the capacity of one of the vice-presidents. Mr. Chamen has, of course, for many years been a member of the Institution of Electrical Engineers, and was one of those who were instrumental in starting the Glasgow Local Section of that body. He was chairman of this section for the session 1903 4. He has been appointed at various times to sub-committees of the Institution, and is also at the present time a member of the Prime Movers and other sub-committees of the Engineering Standards Committee. He is a member of the Royal Philosophical Society of Glasgow, and for the past winter he has been president of the Glasgow University Engineering Society, which body has elected him an honorary member on the occasion of his leaving Glasgow.

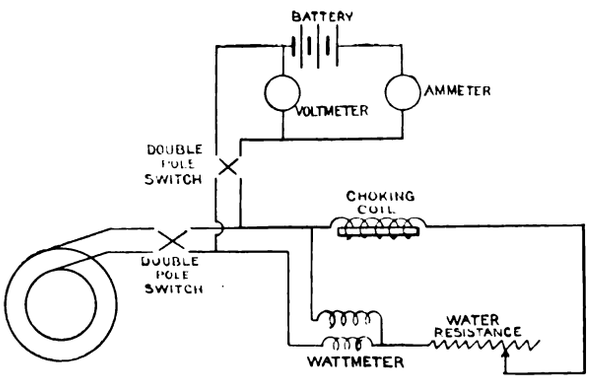
We wish Mr. Chamen every success in the new work he is about to take up.

## THE VARIATION OF POWER WITH RESISTANCE IN AN ALTERNATING-CURRENT CIRCUIT.

BY E. P. HOLLIS.

I was conducting an experiment on the variation of power in an alternating-current circuit when a remarkable phenomenon occurred which attracted my attention. A small alternator was supplying power to a circuit which consisted of an adjustable water resistance, a choking coil, and a wattmeter. The plates of the water resistance were as far apart as possible—*i e*, all the resistance was in circuit. The wattmeter was indicating very little power, and as I moved the plates nearer together the reading on the wattmeter slowly rose, but whilst I was still moving the plates nearer together the reading seemed to attain a maximum value, and then suddenly commenced to fall, and continued to do so until the plates were close together, when the wattmeter reading was practically zero.

I therefore connected up an auxiliary circuit in order to obtain the value of the resistance in circuit. This is shown in the accompanying diagram. It will be seen that if the




alternator circuit be opened and the auxiliary circuit closed, a current, A, passes through the circuit, consisting of the choking coil, water resistance, and wattmeter. If V be the drop in volts across the circuit, as indicated on the voltmeter, it follows from Ohm's law that the resistance of the circuit is given by $\frac{V}{C}$.

Now, I varied the distance apart of the plates in the water resistance, and at each position noted the power passing through the circuit as indicated by the wattmeter,

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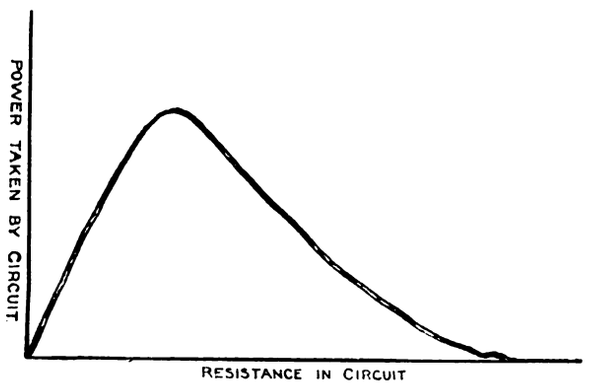
and then opened the alternator circuit and closed the battery circuit, and thus obtained the resistance of the circuit as given above. I then plotted a curve with these results, the shape of which I give below. I then proceeded to investigate the subject mathematically in order to find what was the value of the resistance in circuit at which the maximum power was taken, with the following result.




Let us consider the circuit to have a coefficient of self-induction L henrys and a resistance of R ohms. Let E be the alternating E M F. applied to the circuit, C the current passing, and cos $\phi$ the power factor.

Then the power taken by the circuit is

$$W = E\,C\cos\phi \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Now the current passing through the circuit can be expressed by

$$C = \frac{E}{\sqrt{R^2 + p^2 L^2}} \quad . \quad . \quad . \quad . \quad (2)$$

where $p = 2\pi \times$ frequency

and

$$\text{Cos}\,\phi = \frac{R}{\sqrt{R^2 + p^2 L^2}} \quad . \quad . \quad . \quad . \quad (3)$$

Substituting 2 and 3 in 1 we get

$$W = E\,C\cos\phi = \frac{E \times E}{\sqrt{R^2+p^2L^2}} \times \frac{R}{\sqrt{R^2+p^2L^2}},$$

$$= \frac{E^2\,R}{R^2+p^2L^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Now it is required to find how the power in the current varies with the resistance. To do this we must differentiate the expression 4 with respect to R—*i.e.*,

$$\frac{d\,W}{d\,R} = \frac{E^2\,(R^2+p^2\,L^2) - E^2\,R \times 2\,R}{(R^2+p^2\,L^2)^2},$$

$$= \frac{E^2\,(p^2\,L^2 - R^2)}{(R^2+p^2\,L^2)^2} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Now, the power in the circuit is a maximum when $\frac{d\,W}{d\,R} = 0$, or when $\frac{E^2\,(p^2\,L^2 - R^2)}{(R^2+p^2\,L^2)^2} = 0$. It will be seen that this expression will become zero when $p^2\,L^2 - R^2 = 0$—*i.e.*, when $R = p\,L$.

Thus *the maximum power is obtained in an alternating-current circuit when the resistance is equal to the reactance.*

## CHIMNEYS.

BY F. H. DAVIES.

As the efficient working of all natural-draught steam-raising plant is dependent greatly upon the manner in which its chimney has been designed, it follows that too much attention cannot be paid to the various minutiæ of the subject. Undoubtedly many steam installations are severely handicapped by unsuitable chimneys that, either through a false idea of economy or ignorance of the fundamental laws governing the generation of a draught, have been made too small, or are in some other way incapable of performing the necessary amount of duty. As the function of a chimney is two-fold—namely, the creation of a draught and the carrying off of the gaseous products of combustion—it must be considered under both heads, the first of which requires height and the second area. Several formulæ have been given for determining these two fundamental measurements, but as the problem is beset by many difficulties that vary considerably with local conditions, they are all of a somewhat empirical nature, being based upon observations of successful work.

The intensity of draught is dependent upon the difference in weight of the internal column of air and an imaginary external one of the same height and equal in diameter to the former at its smallest cross-section. The higher the chimney, therefore, the greater will be the force of its draught. This is measured in inches of water by the aid of a U tube, one end of which is left open to the atmosphere and the other connected to the interior of the chimney at its base. The difference in level of the water in these two legs shows the strength of the draught, which is found in practice to vary between $\frac{1}{4}$in., indicating a rather poor draught, up to 1in. or over, equivalent to a very strong one. A usual formula for finding the theoretical draught in inches of water when the height is given is the following: $7{\cdot}6\,H \times \frac{T_2 - T_1}{T_2 \times T_1}$; H being the height in feet, $T_1$ the absolute temperature of the atmosphere, and $T_2$ the absolute temperature of the chimney gases. The result will be the required figure in inches of water. In designing a chimney it is usual to fix the height more or less arbitrarily, basing it upon previous practice, and with this quantity known, it becomes easy to calculate the area from one of the usual formulæ. That due to Kent is very commonly used, and is as follows: $A = \frac{{\cdot}06\,F}{\sqrt{H}}$; where A = actual area in square feet, H = height in feet, F = pounds of coal per hour that will be consumed. From this it is obvious that the quality of the coal is a factor to be taken into consideration, as the value of F will vary with it for any given load; hence, for safety, a chimney should be designed to deal with the worst coal that is ever likely to be burnt in the furnaces. There must be, of course, a certain amount of friction between the escaping gases and the lining of the chimney, and this has been estimated to result in a layer of gas approximately 2in. thick adhering to the sides, and therefore appreciably reducing the effective area to a value below that of the actual area. The formula $E\,A = A - 0{\cdot}6\sqrt{A}$ is used for determining the effective area, A, the actual area in square feet having been found as above. Another useful formula is that due to Christie. It is handy for determining the maximum horse-power of plant that any given chimney is capable of providing draught for, and is based upon the assumption that 4lb. of coal are consumed per horse-power hour. Using the same notation as previously, it is as follows: $H.P. = 3{\cdot}24\,A\sqrt{H}$.

It is common knowledge that a draught that will suffice for the proper combustion of one kind of coal may be quite inadequate for another; hence it follows that the sort of coal most likely to be used enters into the question of height as well as that of area. Good bituminous coal requires the least draught, and therefore the lowest chimney, and small anthracite may be taken as the other extreme. Nothing under 70ft. in height is of much value with natural draught, even for a very small plant burning the best bituminous coal, and it is better by far to err upon the side of unnecessary height, as this allows more scope for forcing and in the variety of coal that may be used.

In the actual shape and building details of the chimney there is much to be considered. The nature of the materials of which it is to be composed, either brickwork or steel, its foundations, shape, stability as regards wind pressure, and other details, all of great interest and importance, enter into the question. In this country the brick chimney is by far the commonest, but in America both the stayed and self-supporting steel type are very much in vogue. They are each cheaper than a brick chimney in capital cost, but having to be repainted once a year to save deterioration through corrosion, add an amount to maintenance that in small plants is somewhat heavy and disproportionate. A well-built brick chimney requires no repairs for years, and then only such as are of a trifling nature; consequently, it is preferred by many despite its capital cost and the

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fact that the steel shaft is slightly more efficient, owing to the entire absence of the leakage that is always going on through the pores of bricks and mortar. If, however, considerations of capital cost must outweigh those of revenue, the firebrick-lined steel chimney is the thing; the unlined variety need not be considered, as owing to radiation it is inefficient in the extreme.

There are two kinds of these stacks, self-supporting and stayed; the former is preferable from the point of view of appearance, and is, indeed, the only type that can be used for large work owing to staying difficulties, but it costs rather more than the latter variety, having to be much more substantial in every way. The stayed form is generally used in small power plants, being very cheap as compared with a brick shaft, and giving equally as good results if brick lined. It is built of iron or steel in cylindrical sections, which are usually lapped and riveted, although sometimes butted with a covering piece riveted on. The foot of the chimney is bolted to a heavy ring placed upon a substantial brick base, generally as high as the building, and this forms the first stage of the shaft. Wire guy ropes, usually four in number, are taken off some three-quarters of the way up by means of a ring provided with hooks or suitable attachments, and fastened through turnbuckles to bolts sunk well into the building structure.

The design of a brick chimney is a much more complicated matter than that of its steel prototype, for here various external and internal shapes are possible, whereas the cylindrical is the only form that the latter can be adapted to. Although, perhaps, the hexagonal chimney presents the most pleasing appearance, for a given area it has a smaller capacity than a circular one, and, in addition, exposes more surface to the overturning power of the wind. It is not, however, so bad in either of these respects as the square chimney, the internal corners of which introduce considerable resistance to the outflowing gases, and the flat external faces a comparatively large area to be acted on by the wind. This overturning force is naturally one that has to be taken into full consideration, and, with a given wind pressure, it will, of course, vary with the shape of the shaft, whether round, hexagonal, or square. For this reason, a certain relation must exist between the height, width, shape, and weight of a chimney; and given these three former, the latter may be found by the following formula. Where C = a constant for the various shapes—28 in the case of round, 35 octagonal, and 56 for a square chimney—H = height in feet, D = average diameter, B = breadth of base, and W = weight in pounds, $W = C\frac{D H^2}{B}$.

The proper proportioning of the foundations of a shaft is of the greatest importance, as its future welfare largely depends upon this. All proceedings must be based upon a thorough knowledge of the bearing power of the soil, which varies much with its nature. Usual practice defines the safe weight per square foot at one ton for soft clay and two tons for stiff clay or lightly packed sand; but if the soil is at all marshy, efficient piling must be resorted to.

The external diameter at the base of a brick chimney should not be less than one-tenth of its height, and the batter or taper usually allowed is from $\frac{1}{16}$in. to $\frac{1}{4}$in. on each side. The internal diameter should not vary appreciably from base to top, and the firebrick lining that is always provided is built up straight with no batter, thus leaving an air-space between it and the outside wall. This lining generally extends from two-thirds to three-quarters of the total height, although in cases it is carried to the top. In the event of two flues entering a chimney at different sides, it is always desirable to build a feather or mid-wall between them to about a quarter of the height, so that the gases from each have a separate path to start with. If this is not done, they are liable to baffle each other as they emerge from the flues, and this may cause a considerable diminution in the efficiency of the chimney.

The usual thicknesses for the outer shell of a brick shaft are as follows: shaft up to 3ft. internal diameter at top—4in. for first 10ft. downwards, after this an increase of 4in. at every 25ft.; shaft over 3ft. and not more than 5ft. internal diameter at top—8in. to start with, increasing by 4in. for every 25ft. downwards; shaft over 5ft. internal diameter at top—12in. to start with, and same increase. The inner firebrick lining may be 4in. thick for the first 20ft. or so, increasing by 4in. at every 10ft. downwards.

## FORTHCOMING EVENTS.

FRIDAY, MARCH 10.

**Institution of Electrical Engineers (Manchester Section).**—At 7 p.m., annual dinner.

**Royal Institution.**—At 9 p.m., "The Structure of the Atom," by Prof. J. J. Thomson.

SATURDAY, MARCH 11.

**Junior Institution of Engineers.**—At 3 p.m., visit to the New Ritz Hotel, Piccadilly, to inspect the "cage skeleton system" of constructional engineering.

**Birmingham Electric Club.**—At 7 p.m., "Electric Lifting Machinery," by Mr. E. C. R. Marks.

**Royal Institution.**—At 3 p.m., "Electrical Properties of Radio-active Substances," by Prof. J. J. Thomson.

**Institution of Electrical Engineers (Students' Section).**—At 2.15 p.m., visit to Messrs. D. Napier and Sons' works, Acton Vale.

MONDAY, MARCH 13.

**Institution of Mechanical Engineers (Graduates' Section).**—"The Type of Locomotive Best Suited to Heavy Express Trains," by Mr. J. R. Bazin.

**Society of Arts.**—At 8 p.m., "Telephony," by Mr. H. L. Webb (Cantor Lecture I.).

TUESDAY, MARCH 14.

**Institution of Electrical Engineers (Glasgow Section).**—At 8 p.m., "Earthing" by Mr. W. W. Lackie (adjourned discussion).

**Institution of Electrical Engineers (Manchester Section).**—At 7.30 p.m., "Low-Tension Thermal Cut-outs," by Prof. Schwartz and Mr. W. H. N. James.

**Institution of Civil Engineers.**—At 8 p.m., "Shipbuilding for the Navy," by Lord Brassey.

WEDNESDAY, MARCH 15.

**Institution of Civil Engineers.**—At 2.30 p.m., students' visit to the sewage works at Sutton, Surrey. Train from Victoria Station, L.B. and S.C. Railway, 1.45 p.m.

**Institution of Electrical Engineers (Birmingham Section).**—At 7.45 p.m., "Commutation in a Four-Pole Machine," by Mr. J. K. Catterson-Smith; and "Notes on Heating and Sparking Limits in Variable-Speed Motors," by Mr. A. H. Bate.

**Chemical Society.**—At 5.30 p.m., general meeting.

**Royal Meteorological Society.**—At 7.30 p.m., "The Growth of Instrumental Meteorology," by the President.

**Institution of Electrical Engineers (Students' Section).**—At 7.30 p.m., "Electrical Pyrometry," by Mr. P. L. Weir.

THURSDAY, MARCH 16.

**Institution of Electrical Engineers (Leeds Section).**—At 7.15 p.m., "Power Gas," by Dr. F. H. Bowman.

**Institution of Electrical Engineers (Students' Section).**—At 7.30 p.m., annual dinner at the Holborn Restaurant.

**National Physical Laboratory.**—At 3.30 p.m., annual general meeting at Bushy House, Teddington.

FRIDAY, MARCH 17.

**Institution of Mechanical Engineers.**—At 8 p.m., "First Report to the Steam-Engine Research Committee," by Prof. D. S. Capper.

**Institution of Electrical Engineers (Manchester Students' Section).**—At 7.30 p.m., "High-Tension Switchgear," by Mr. C. R. St. John.

SATURDAY, MARCH 18.

**Institution of Electrical Engineers (Manchester Students' Section).**—At 6.30 p.m., annual dinner.

**Institution of Civil Engineers.**—On March 22, at 7 p.m., annual dinner at Merchant Taylors' Hall. Sir Guilford Molesworth, president, in the chair. The thirteenth "James Forrest" lecture will be delivered by Colonel R. E. B. Crompton, R.E., C.B., on Monday, April 10, at 8 p.m., the subject being "Unsolved Problems in Electrical Engineering."

**Royal Meteorological Society.**—An exhibition of meteorological instruments is to be held by this society at the hall of the Institution of Civil Engineers, from March 14 to 17. A brief descriptive address will be given each afternoon at 3.30.

## APPOINTMENTS VACANT.

**First Assistant Electrical Engineer,** City of Wakefield. Salary, £150 per annum. Applications by March 14. See advertisement in last issue.

**Switchboard Attendant,** Wrexham. Commencing salary, 25s. per week.

**Chief Electrical Engineer,** Bermondsey Borough Council.

**Chief Draughtsman,** Bombay, Baroda, and Central India Railway Company (carriage and wagon department). Salary, Rs.250, rising to Rs.300 per calendar month. Particulars may be obtained from Mr. T. W. Wood, secretary, Gloucester House, Bishopsgate-street Without, London, E.C. Applications by March 22.

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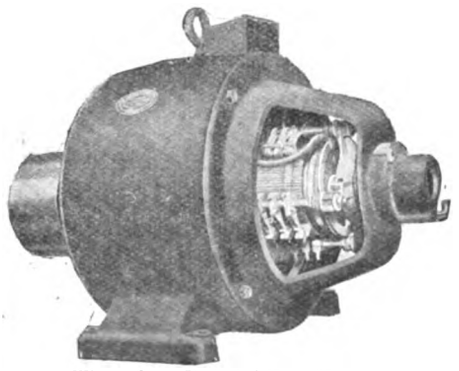
## TRADE NOTICES AND NOVELTIES.

### Witton Motors.

The General Electric Company, Limited, 71, Queen Victoria-street, London, E.C., have just issued a new edition of their catalogue of continuous-current motors. These motors have, we understand, been entirely remodelled, and have a high rate of efficiency. The firm's works at Witton, Birmingham, where they are made, is now thoroughly equipped for turning them out in large quantities. The list is illustrated, and gives particulars of the open-protected, semi-enclosed, enclosed-ventilated, and totally-enclosed types; also of crane rated motors, back-geared motors, etc. Our illustration represents the first-

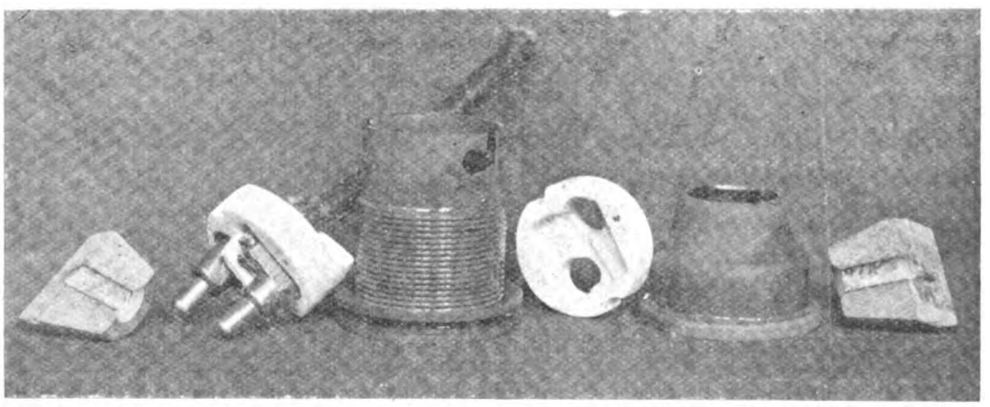


Witton Open Protected Type Motor.

mentioned type. All parts are made to gauge and strictly interchangeable. Spares can therefore be supplied quickly whenever necessary. The design of the bearings is such that the motors can be fixed on a horizontal base, a vertical wall, or overhead. We note that the measurements are given both in inches and centimetres, and the weights in pounds and kilos. The approximate power required to drive various classes of machinery is also given—a fact which should be appreciated, especially by users of small motors. At the end of the list an illustration is given showing "Witton" motors being fitted to winches for "Temperley" transporter towers destined for the Admiralty floating coal depôt stationed at Portsmouth.

### New Lampholder.

We are indebted to Messrs. Baxendale and Co., Miller-street Works, Manchester, for particulars and sample of a new cord-grip lampholder called the "Thikflex," which is being introduced by them. Referring to the accompanying illustration of its several components, it will be seen that the case of this holder is in two parts. These screw together, and interlock the cord grip, china interior, and terminals with each other, so



Parts of "Thikflex" Cord Grip Lampholder.

that it is impossible for them to be twisted, or become detached in any way whatever. The china interior, also in two parts, is so constructed that when put together the terminals, which are not permanently fixed to the china, are held quite firmly in position, and are entirely insulated from each other and from the case, no metal being exposed beyond the plungers themselves. Moreover, the terminals being separate parts, are easily wired. When the holder is wired and made up, the cord grip cannot possibly be twisted, and retains such a firm hold on the flexible that all strain is taken off the connections. The size of the cord grip allows a large variation in adjustment for different thicknesses of flexibles. These various points, it is claimed, go to make up a first-class, substantial, and efficient English-made cord-grip holder, particularly suited for factories, workshops, cotton and woollen mills, where rough usage or other severe conditions have to be encountered. Personally, we think the design is one which will find ready favour, since it obviously combines several excellent features.

### Nernst Lamps.

The latest catalogue of Nernst lamps issued by the Electrical Company, Limited, 121-125, Charing Cross-road, London, W.C., includes particulars of several recent improvements. A new pattern multiple Nernst lamp is shown on p. 10. This is a combination of three lamps in one watertight fitting, suitable for outdoor use, and is designed to replace the arc lamp where an even distribution of the light is required. The light ranges between 60 c.p. and 820 c.p., according to circuit, and whether the three burners, Luna or "A" type, are switched on separately or together. On p. 14 a new type "D" is illustrated, which is similar in appearance to the firm's "B" pattern, and, like it, will fit ordinary B C or screw holders. Being of high luminating power, this lamp is eminently adapted for street-lighting purposes when enclosed in a lantern. Improvements in reflectors for "B" type Nernst lamps are illustrated on p. 21. These reflectors are recommended for indoor use, being of very neat design. We note that progress has also been made with Express Nernst lamp fittings and electroliers. The incandescent lamps combined with these serve to give light immediately the lamps are switched on, being cut out automatically as soon as the Nernst filament is alight.

### New "Twinkling Socket."

Advertising by means of an effective electric sign has been handicapped up to the present time by the high initial cost of an installation suitable for this purpose, due to the expensive automatic switches and large amount of wiring involved. To obviate the necessity for special installation the Electrical Company, Limited, 121-125, Charing Cross-road, London, W.C., have, we understand, lately put on the market a device which they call a "Twinkling Socket." This special socket is one that can be fixed into an ordinary lampholder, and can be used for incandescent lamps of 10 c.p. or 16 c.p. and 110 or 220 volts. It is devised so that when the current is switched on the lamp is cut in and out quickly and continuously at regular intervals. If the sign be fitted with a number of these sockets a most effective result is obtained, it is claimed, each lamp being cut in and out independently, the effect being that the whole sign appears to be twinkling or flickering.

### Asbestos Strip.

We note that the United Asbestos Company, Limited, Dock House, Billiter-street, E.C., are supplying a special kind of asbestos in the form of a thin strip for insulating the sections of electric car rheostats. It is called "Salamander" insulating strip.

### Catalogues, etc., Received.

Reduction Gear.—A list issued by Messrs. J. S. Fairfax and Co., 37 and 39, Essex-street, Strand, London, W.C., describes the firm's new types of reduction gear to drive directly from a motor shaft at one of six different ratios; pulley shafts of two, three, or four pulleys, equal in diameter, each revolving at a different forward or reverse speed to its neighbour; and a compact pulley block convertible to a self-sustaining hand crane.

Roller Bearings.—A list recently issued by the Empire Roller-Bearings Company, Limited, 15, Victoria-street, Westminster, S.W., includes illustrations and particulars of the firm's speciality; also a list of the railways and tramways on which their bearings are now in use.

Injectors.—The latest descriptive list of injectors issued by Messrs. Holden and Brooke, Limited, Sirius Works, West Gorton, Manchester, includes information to assist the user in selecting the right size of injector required, the conditions governing this selection being set forth.

Ship Installations.—From Messrs. J. H. Holmes and Co., Newcastle-on-Tyne, we have received an up-to-date list of the ship and yacht lighting installations carried out by them. It serves to convey an idea of the immense amount of experience which the firm have had in this special class of work.

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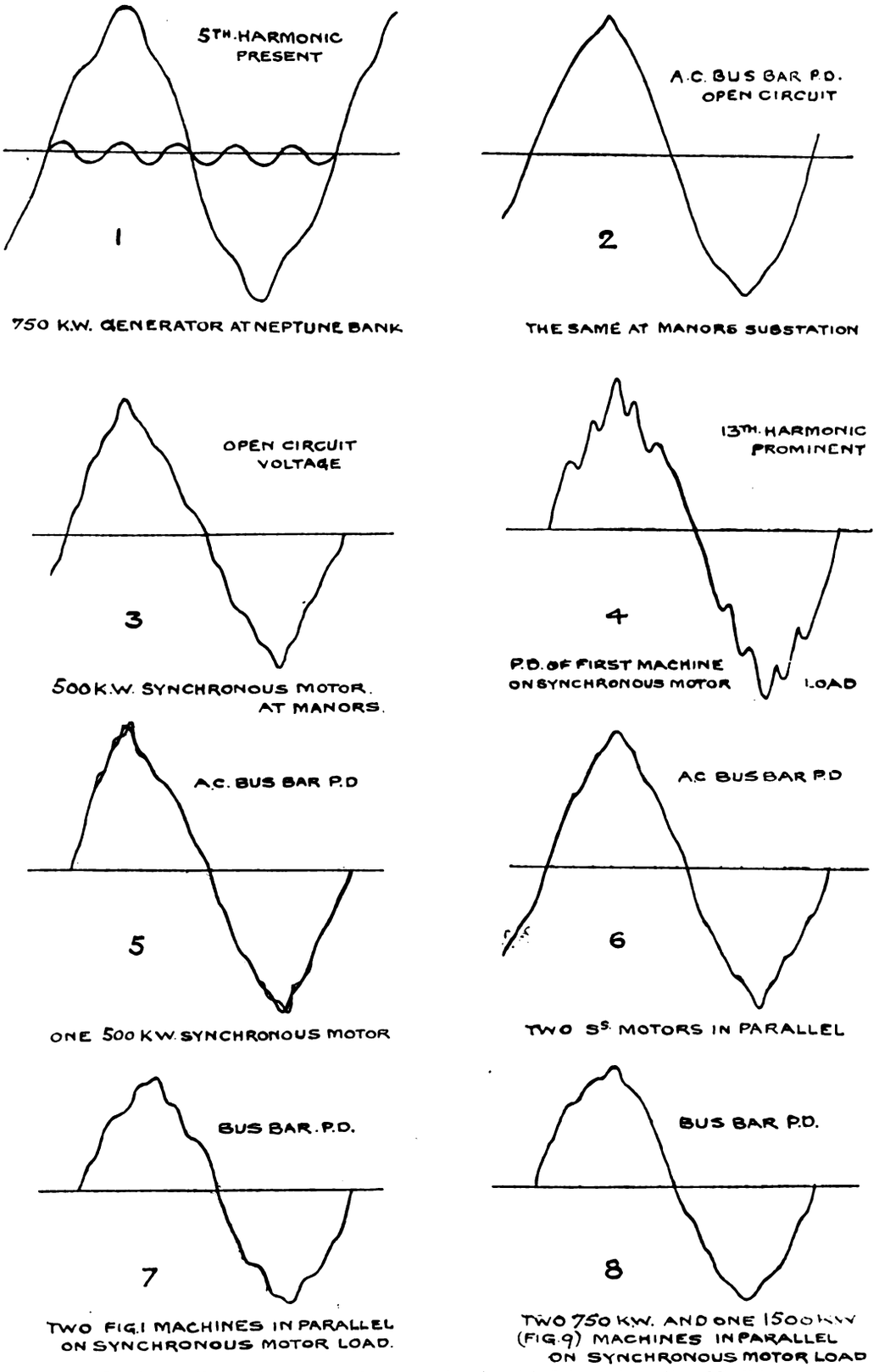
## NOTES ON SOME EFFECTS IN THREE-PHASE WORKING.*

BY W. M. THORNTON, D SC., MEMBER

§ 1. INFLUENCE OF CABLES ON TRANSMITTED WAVE-FORMS.

The behaviour of a polyphase electrical transmission system under working conditions presents many interesting problems. Through the kindness of the Newcastle-on-Tyne Electric Supply Company, I am able to give the results of some investigations with the oscillograph which were undertaken with the object of deciding, for this particular system, a few questions of importance in the regular working of the plant. The interest of the curves lies in the fact that they were taken under working conditions, in the absence of any abnormal phenomena, in the comparisons between different machines, and in the addition of a few more facts to our knowledge of polyphase working on a large scale. The tests were suggested by Mr. H. C. Leake and Mr. W. B. Woodhouse, and all the details were in their hands throughout. They were taken in three sets—in December, 1901, March, 1902, and July, 1903.

From the curves recorded I have selected those which throw light upon points of more than local interest. For example, it was desired to know whether the wave-forms at the sub-station were distorted by the mains. Fig. 1 is the voltage on open circuit of a General Electric (U.S.A.) 5,500-volt 750-kw. three-phase generator taken at the Neptune Bank power-house. Fig. 2 is the same wave at Manors sub-station, a length of three miles of three-core cable intervening. Analysis of the first curve shows that there is present a strong 5th harmonic. This machine has one slot per pole per phase, and, as is well known, six slots per period give rise to 5th and 7th harmonics in the voltage. Here the former predominates. It is clear from the second curve that there is little distortion




FIGS. 1 TO 8.—Voltage Wave Forms of Three-Phase Machines, R.M.S. Value of each Wave 5,500 Volts.

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, Feb. 27.

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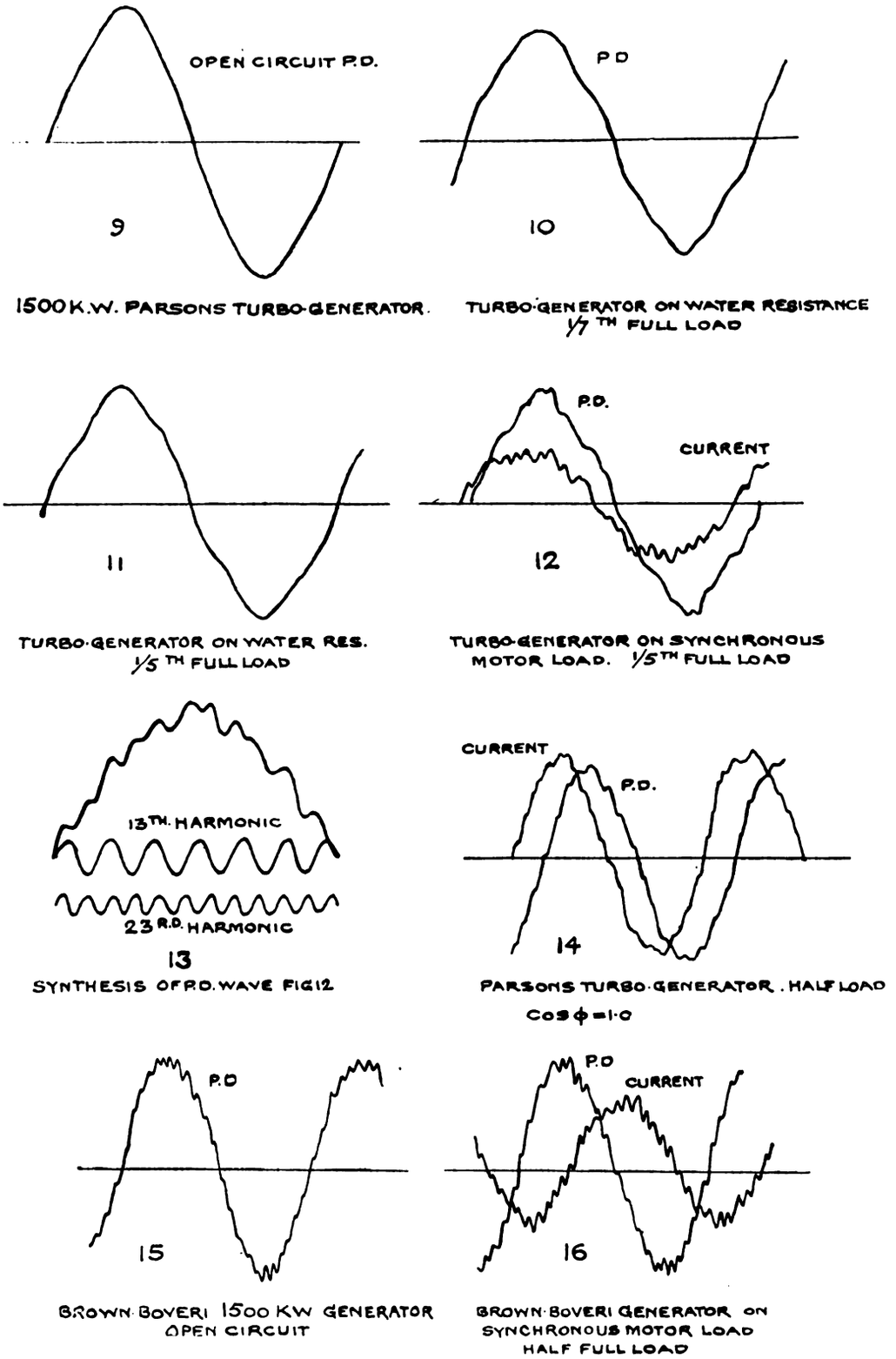
by the capacity of the cables; the tops of the waves are slightly more pointed, but there is no fear in this case of trouble arising from resonance.

§ 2. Influence of Synchronous Motor Load upon Wave-Form.

There is, however, the possibility of danger arising from the synchronous motor waves if they have strong harmonics. Fig. 3 is taken from a 500-kw. motor-generator set at Manors, driven from the direct-current side as a three-phase generator on open circuit, and is typical of all the motors in the system. alternating-current side, the ripples are smoothed out. In Curve 6 the superposition of 5th and 13th is clearly seen.

Another proof that the ripples came from the reaction of the synchronous circuit is that they appeared to run up and down the curve in time with the engine driving the generator. If they had arisen from this machine they would have been fixed, but since its phase is swinging slightly, by reason of the engine irregularity, with respect to the circuit voltage, they move along the wave, the amount of movement indicating precisely the range of the relative phase-swing between generator and




Figs. 9 to 16.

The machine has two slots per pole per phase, causing a well-marked 13th harmonic. The generator curve (Fig. 4) is the power-house wave of the same machine as in Fig. 1, but now running on a synchronous motor load at Manors. Although in this generator the 5th harmonic is most pronounced, the voltage appears with a 13th prominent, more marked, in fact, than on the motor, an effect possibly due to the mains, but more likely to the double-frequency phenomena explained in the next section. In Fig. 5, which is the 'bus-bar voltage at the sub-station when one synchronous motor is running light from the motor. The visible motion is slight on account of the small scale of the curves, or this would be a suitable method of measuring phase displacement between machines, either motors or generators, in parallel, having somewhat different wave-forms, by observing only the 'bus-bar voltage. In Fig. 5 the tips of the curves waved to and fro in time with the engine. The relative movement of the machines in this case corresponds to 17deg. of phase, the mechanical movement depending on the diameter and number of poles on the rotor of each machine.

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Even when several generators are in parallel, as in Figs. 7 and 8, the motor harmonic is able to make itself felt at the power-house, though less so as the number of machines is increased.

A still better example is the reaction upon a Parsons turbo-generator. This machine gives a very fine curve (Fig. 9) on open circuit. It has, however, two slots per pole per phase, and the 13th harmonic is now just visible in the generator wave. On a water resistance (a circular brick tank, into which dipped three iron plates forming the inside surface of a symmetrical clover-leaf pattern, rigidly connected and raised or lowered together by a single pulley), there is some distortion, which increases with load (Figs. 10 and 11). In this case, however, it is the 11th harmonic which appears, suggesting that the occurrence of either harmonic is a question of armature reaction. Fig. 12 shows the wave-form of this machine on a synchronous motor load, and there is now a pronounced 13th harmonic. The current is full of a 23rd harmonic. This cannot readily be seen in the voltage, but a wave (Curve 13) may be built up of a fundamental 13th and 23rd, which approximates in wave-form to that of Fig. 12. As the load increases the higher harmonics predominate (Fig. 14).

That these high ripples do not entirely arise from double-frequency effect of armature current reaction may be seen from Fig. 15, taken from a 1,500-kw. Parsons turbine Brown Boveri generator set on open circuit, the machine having four slots per pole per phase. In this curve a 23rd can be counted. When the machine is on load there is a slight change in the voltage wave, but the current shows the 23rd harmonic much more clearly (Fig. 16).

(*To be continued.*)

## PERSONAL.

Elsewhere in this issue will be found a reference to Mr. W. A. Chamen's resignation of the position of chief engineer and manager to the Glasgow Corporation electricity department in order to take up larger responsibilities in connection with power distribution schemes. At a meeting of the Electricity Committee held on 7th inst., Mr. Lackie, Mr. Chamen's chief assistant, was unanimously recommended for promotion to the post of chief engineer and manager, Mr. Page, the stations superintendent, being recommended for promotion to the post of chief assistant. The salary recommended for Mr. Lackie is £800 per annum, rising to £1,000, and for Mr. Page £500, rising to £600. These recommendations are, of course, subject to confirmation by the Town Council on the 16th inst. Mr. Charles A. King, permanent-way engineer of the Glasgow tramways, has been appointed to a similar position on the Metropolitan District Railway.

Mr. Duncan McLennan, of Glasgow, has been assistant mains superintendent to the Corporation of Greenock.

Mr. W. W. Alston, assistant engineer to the Bermondsey electricity and destructor department, has been appointed chief assistant engineer to the West Bromwich electricity works.

We have received the following particulars of a wedding: "Leigh-Humbert—On the 1st inst. at St. John's Church, Stanmore, by the Rector of Stanmore, Mr. Frederick A. Cortez Leigh, of the firm of Messrs. Lacey, Sillar, and Leigh, to Dorothy, only daughter of the late Sidney Humbert, of Watford."

The special committee of the Exeter City Council have reported as follows: "The committee, after careful enquiry, are fully satisfied with the competency of Mr. Munro as an electrical engineer, and are of opinion that the electrical engineer should have charge of all the works in connection with the electric light undertaking, including mains, and of the electrical equipment in connection with the tramways."

The Dover Town Council have granted a number of increases to the staff of the electricity department.

We understand that Mr. Theodore Partington, electrical engineer at Pemberton, has resigned.

The Dewsbury Town Council have decided to increase the salary of Mr. A. P. Dryburgh, assistant electrical engineer at the electricity works, from £150 to £170 per year as from April 1 next.

Mr. W. H. Vincent, borough electrical engineer, Bermondsey, has resigned.

Mr. Rycroft has been appointed chief assistant electrical engineer, and Mr. Margary mains superintendent, to the Islington Borough Council.

Mr. Ernest Hatton, general manager of the Salford Corporation tramways, has been appointed to a similar position at Newcastle-on-Tyne.

The West Ham Council have increased the salary of the tramways manager (Mr. H. E. Blain) by £50, with a further increase in August next of £50 and a second increase in February, 1906, of a further £50.

JOINT-BOXES, ETC.—From Messrs. G. Clark and Sons, Limited, Shipley, Yorks, we have a copy of their new catalogue of joint and disconnecting boxes and fittings, feeder pillars, etc., in which the designs of the various items included are clearly described and illustrated. Particulars are included of the firm's cable-jointers' collapsible tents, of which, we understand, they have supplied a large number to all parts of the world.

## LEGAL INTELLIGENCE.

### "TUBE" VIBRATION.

Before Mr. Justice Lawrance and a special jury, the case of Stockton and others *v.* the Great Northern and City Electric Railway Company was commenced in the King's Bench Division on Tuesday.

**Mr. Rawlinson, K.C.**, explained that the plaintiffs were three daughters of the late Mr. O'Brien, who took the house No. 20, Highbury-crescent, in 1895, upon a 28 years' repairing lease, determinable at the end of 7 or 14 years. He built a stable, and altogether spent £1,300 on the house before taking possession. When the defendant company's tube was constructed, serious cracks in the wall occurred as the result, it is alleged, of subsidences of the soil. The damage continued to increase until the premises were declared unsafe at the end of 1903. Mr. O'Brien died in April, 1903, and his family were afterwards obliged to leave the house, which became uninhabitable. The premises were reinstated at a cost of £1,267, but the cracks soon reappeared. In addition to this the plaintiffs claimed £450, the cost of the forced removal, £225 for depreciation, £120 for drainage, and the amount of other losses.

**Mr. H. G. Deacon**, a civil engineer, of Westminster, deposed that the damage done to the house was such as could be caused only by subsidence from a tube railway or an earthquake.

**Mr. Lankester**, for the defendant company, suggested that all houses in this district were affected by a common general movement of the subsoil, wholly irrespective of the tube railway.

After expert testimony and evidence as to fact had been given, it was agreed that the jury should view the house before the hearing was resumed.

The company, it may be mentioned, had made an offer of £400.

### JANDUS ARC LAMP AND ELECTRIC COMPANY v. ARC LAMPS, LIMITED.

In delivering judgment, as reported in our last week's issue, Mr. Justice Kekewich granted an injunction, and refused to suspend its operation pending an appeal by the defendants. From this refusal the defendants appealed, alleging that the injunction would ruin their business, and that even if they should be ultimately successful in their appeal on the merits, they would be without any redress for the injury.

**The Court**, which consisted of Lord Justice Vaughan Williams and Lord Justice Stirling, made an order suspending the operation of the injunction pending the appeal, on the terms of the defendants being treated as licensees of the plaintiffs' patent. The defendants to undertake to keep an account of their sales, and the plaintiffs to undertake to return any moneys received by them from the defendants in the event of the defendants being successful in their appeal. The order to be without prejudice to any rights.

**Lord Justice Vaughan Williams** intimated that it would be right that a similar arrangement should be made in the event of an appeal to the House of Lords.

### TRAMS AND FOG.

In the Keighley County Court last week the Corporation were the defendants in an action brought by James Ellison Haggas, manufacturer, of Ingrow, who claimed £15. 7s. for damages to his brougham.

**Mr. Watson** explained that the plaintiff's wife and children were being driven from Ingrow to Keighley last November, and the coachman and plaintiff's wife were taking every precaution, on account of the dense fog, to avoid any accident. The coachman had the lamps lighted and was driving at a walking pace, while Mrs. Haggas was on the watch, with her head out of the carriage window. The lady heard a tramcar approaching in the rear, the driver clanging his bell, and after instructing the coachman to drive to the side of the roadway, called out to the car driver to stop. There appeared to be no notice taken of the cry, and the car crashed into the offside hind wheel of the brougham and caused the damages claimed for. He submitted that the car driver was clearly guilty of negligence in three respects: (1) that he did not keep a sufficient look out; (2) that he was travelling too fast, considering the dense fog; and (3) that although he admitted the next day to Mr. Haggas that he heard Mrs. Haggas call out, he did not comply with the request. The special defence was that the driver and conductor complied with all the ordinary requirements prescribed by the by-laws by running at a speed not exceeding nine miles an hour, that the driver continuously rang his bell and had the lamps of his car lighted, and that the collision occurred by reason of the plaintiff's coachman not causing his vehicle to be removed with reasonable dispatch so as not to obstruct the tramcar. Plaintiff's counsel admitted that the car might not be travelling more than three or four miles an hour, but contended that in the circumstances that rate was exceedingly rapid; and he further contended that even if the coachman was not using reasonable dispatch in getting out of the way, the Corporation were not entitled to run into the brougham.

After hearing evidence on both sides, **His Honour** said the case was a very interesting and somewhat difficult one. He knew of no authority as to how people were bound to behave in a fog. He did not see any evidence of neglect on the part of the plaintiff's coachman. When a person was in a fog he might, without any negligence of his own, lose his way. The coachman seemed to think that he was near the kerb, and if he thought it right to stop and find out he was perfectly justified. There would be no negligence in taking that care. Defendants contended that the coachman should have heard the bell, but Mrs. Haggas with her head out of the window did not hear it until

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she spoke to the coachman. Was there negligence on the part of the driver? The man was driving carefully and in accordance with the wishes of his employers. It was said that the car must move, but he was not quite sure that that was true. It was very annoying when going by rail to find one's-self stopped for half an hour, but if the fog were bad enough that was the course taken by an engine driver. He thought that under the prevailing conditions the driver ought to have either called his conductor to walk slowly in front of him or some steps ought to have been taken so as to run the car without danger. He did not blame the driver, but in his judgment it was not right or lawful to drive through a fog at such a pace that he could not stop between the time of seeing a thing in front and running into it. He therefore gave a verdict for the plaintiff for the amount claimed.

Costs were given on the higher scale, and leave to appeal was granted.

# COMPANIES' MEETINGS AND REPORTS

## METROPOLITAN ELECTRIC SUPPLY.

The report for the year ending Dec. 31, 1904, states that the gross revenue for the year amounted to £306,540. 15s. 3d., as compared with £281,422. 5s. 8d. in 1903, being an increase of £25 118. 9s. 7d. The cost of generation, which in 1903 was £98,592. 10s. 8d., amounted in 1904 to £86,140. 14s. 1d., or a decrease of £12,451. 16s. 7d. The directors are of opinion that it would be advantageous to sub-divide the existing £10 ordinary shares into £5 shares and an extraordinary general meeting will be held immediately after the ordinary meeting to consider, and, if thought fit, to pass, resolutions authorising this to be done, and also to double the number of votes attaching to preference shares, in order to preserve the relative voting power between the ordinary and the preference shareholders. The balance at the credit of the revenue account, before providing for depreciation, is £176,837. 5s. 6d. The directors have set aside £20,000 as an addition to the depreciation and reserve fund, which, with the special additions referred to in paragraphs 4 and 5, now amounts to £216 355. 5s. 5d., carrying to the credit of the net revenue account the sum of £156,837. 5s. 6d. This sum, with the balance brought forward from last account and other receipts, makes a total of £170,982. 7s. 11d., of which, after deducting interest on debenture stocks and loans, dividend on preference shares and other charges, including interest paid to the Borough Council of St. Mary'ebone under the agreement referred to, there remains a balance of £108,157. 9s. 5d. An interim dividend of 9s. per share (being at the rate of 9 per cent. per annum) on the ordinary share capital, amounting to £45,000, was paid on Aug. 9, and the directors recommend that a further dividend of 11s. per share (being at the rate of 11 per cent. per annum) on such shares be now paid, making a total distribution for the year of 20s. per share, or 10 per cent. This will absorb a further sum of £55,000, and leave a balance of £8,157. 9s. 5d. to be carried forward to the next account. The total number of 8-c.p. lamps connected at the end of 1903 was 912,000, being an increase of 89,000 during the year. The present number connected is 930,000.

## NORTHERN COUNTIES ELECTRICITY SUPPLY.

The report for the year ending Dec. 31, to be presented at the fourth annual ordinary general meeting on the 10th inst., states that the work done shows a substantial increase on the previous year. The units sold totalled 986,873, against 344,781 for the previous year, and the gross receipts for current amounted to £12,280. 12s. 2d., against £4,979. 2s. 1d. In order to promote the more economical distribution of current and prevent the overlapping of interests in various areas in Northumberland, an arrangement has been made for the working and developing by the Newcastle upon-Tyne Electric Supply Company, Limited, of certain undertakings consisting of Whitley, Monkseaton, Earsdon, and Seghill. The revenue account, after an apportionment of charges between construction and revenue accounts, shows a credit balance for the year of £4,337. 11s. 5d. Adding balance from last year, £1,000. 12s. 4d., a sum of £5,388 3s. 9d. remains, which the directors recommend shall be disposed of thus: interim dividend already paid at the rate of 3 per cent. per annum, less income tax, £1,602. 2s. 10d.; final dividend at the same rate, less income tax, £1,649. 4s. 6d.; amount to reserve account, £1 500; preliminary expenses written off, £380; carrying forward £256. 16s. 5d. The money market being more favourable, it is proposed during the financial year now entered upon to offer the debentures, or a certain portion of them, to the shareholders at a fair rate of interest, as also the balance of the last issue of shares not yet taken up (14,537 in number).

## COUNTY OF LONDON ELECTRIC SUPPLY.

The report for the year ended Dec. 31, to be presented at the eleventh ordinary general meeting of the Company on the 16th inst., states that the revenue, including a balance from last account of £5 255. 7s., totals £90,534. From this have to be deducted (*a*) interest on the first and second debenture stock, £32,297. 6s. 2d.; (*b*) interim dividend on 30,000 6 per cent. preference shares for half-year ended June 30, 1904, less income tax, £8,568. 15s.; (*c*) interim dividend on 40,000 ordinary shares at 4 per cent. per annum for half-year ended June 30, 1904, less income tax, £7,616. 13s. 4d.; (*d*) amount carried to reserve for depreciation, repairs, renewals, etc., £19,150; leaving for further distribution £22,901. 15s. 8d. Out of this sum the directors now recommend: (*a*) that payment of the interim dividend on the 30,000 6 per cent. preference shares for the half-year ended June 30, 1904, less income tax, be confirmed; (*b*) that payment of the interim dividend on the 40,000 ordinary shares, at the rate of 4 per cent. per annum, for the half-year ended June 30, 1904, less income tax, be confirmed; (*c*) that a further dividend on the 30,000 6 per cent. preference shares for the half-year ended Dec. 31, 1904, less income tax, be declared; and (*d*) that a further dividend on the 40,000 ordinary shares for the half-year ended Dec. 31, 1904, at the rate of 5 per cent. per annum, less income tax, be declared, and that the said dividends be paid to all proprietors registered on March 3, 1905. This will absorb £18,050, and leave a balance of £4,851. 15s. 8d. to be carried forward.

## OXFORD ELECTRIC.

The report of this Company for 1904 shows a profit (including £830 brought forward from last year) of £11,803. After providing £2,050 for debenture and other interest, and writing off £608 on account of hire-purchase installations, the balance available for dividend is £9,144. The directors propose to pay a dividend at the rate of 7 per cent. per annum on the share capital ranking for dividend (whereof 2½ per cent. was paid in September last), adding £2,470 to reserve and renewal of plant account (which will then amount to £8,500), leaving £898 to be carried forward. It is estimated that at Dec. 31 last there was the equivalent of over 65,000 8-c.p. lamps connected to the mains. The number of Board of Trade units sold during 1904 was 13 per cent. larger than in the previous year. The new capital has been expended principally in erecting additional buildings for new machinery to meet the increased demand for current, in providing three transformers, and extending the supply mains in Banbury, Woodstock, Iffley and South Parks road, and St. Clement's and Walton streets.

## SOUTH LONDON ELECTRIC SUPPLY.

The report of this Company for 1904, to be submitted at the meeting to-day, states that, after making a full allowance for depreciation and preliminary expenses, the net balance is £21,884, from which must be deducted interest on borrowed capital, which absorbed £2,437, leaving a balance of £19,446. The directors now recommend a dividend at the rate of 4 per cent. on the ordinary shares, carrying forward £6,447. The number of lamps of 8 c.p. connected on Dec. 31, 1904, was 107,000, being an increase during the year of 15,098 lamps, while applications were in hand for a further 4,200 lamps. In accordance with the information given to the shareholders at the last annual meeting an issue of £50,000 debenture bonds was made in January of last year, the object being to pay off temporary loans and provide capital for necessary extension of mains and plant. The total number of units sold in 1904 was 9,205,342, an increase for the year of 4,399,861 units.

## HOVE ELECTRIC LIGHTING.

The report for the year ending Dec. 31, to be presented on the 16th inst., states that the net profits have increased, notwithstanding an indifferent season at Hove, from £11,215 in 1903 to £11,807 in 1904. With the balance brought forward from last year, and deducting debenture interest, other charges, and the interim dividend at the rate of 7 per cent. per annum, paid in October last, there remains a balance of £7,470. 18s. 1d. to the credit of net revenue account. The directors propose to place £3,000 to the reserve fund, which will thus be increased to £35,326. 12s., to declare a dividend, payable on April 15 next, at the rate of 10 per cent. per annum for the half-year on the paid-up share capital, making, with the interim dividend, 8½ per cent. for the year, and to carry the balance, £1,087. 1s. 7d., forward.

## W. T. HENLEY'S TELEGRAPH WORKS.

The twenty-sixth ordinary general meeting of this Company was held on Monday, Mr. Sydney Gedge presiding. Particulars of the account appeared in our last week's issue.

In moving the adoption of the report and accounts, the **Chairman** remarked that the Company was holding its own, partly by means of the new works and partly by giving as good work as they possibly could. He had hoped that the new works at Greenwich would be complete by this time, but various circumstances had delayed completion, and it would be six months before they were earning money.

The report was unanimously adopted, and a dividend of 15 per cent. sanctioned.

## BRITISH ELECTRIC TRANSFORMER.

The annual meeting of this Company was held on Monday, when the report, of which we gave particulars last week, was adopted.

## NOTTING HILL ELECTRIC.

The annual meeting of this Company was held on Tuesday at Winchester House, Sir William Crookes presiding. Particulars of the account appeared in our last week's issue.

The **Chairman** said that the rate of progress was being maintained this year, and they anticipated a normal increase of revenue of from £4,000 to £5,000.

The report was adopted.

## NEWCASTLE ELECTRIC SUPPLY.

The annual meeting of this Company was held last week, Dr. Merz presiding. Particulars of the report appeared in our issue of the 24th

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ult. The report was adopted, and a dividend of 5 per cent. on the preference shares and 8 per cent. on the ordinary shares was declared. The provisional agreement for the purchase of the shares in the County of Durham Electric Power Distribution Company, Limited, was approved.

## NEW COMPANIES REGISTERED.

**Ferranti Limited.**—Capital, £130,000. Objects: to take over all or part of the undertaking, assets, and liabilities of Ferranti Limited, incorporated in 1901, to adopt an agreement between Ferranti Limited, of the first part, J. M. Henderson, the liquidator thereof, of the second part, and this company of the third part, to acquire any other electrical, mechanical, or sanitary engineering business, and to carry on the business of contractors for the erection of central stations for the supply of electricity for motive and other purposes, workers of such stations, constructors of railways, tramways, motorcars, of waterways and appliances appertaining thereto, telephone, telegraph, and electrical apparatus manufacturers, suppliers of electric power and electric generators, lamps, engines, etc. Registered office: Hollinwood, near Manchester.

**Electromobile Hiring Company, Limited.**—Capital, £8,000. Objects: to let out to hire, sell, and deal in electric and other motorcars and carriages, to carry on the business of automobile store and garage keepers, suppliers of electricity and other motive power, etc.

### Lien Registered.

**Langdon-Davies Motor Company, Limited.**—Lien registered Feb. 24, for £5,000 4½ per cent. debentures, issued in exchange for a like amount of debentures previously issued by the vendor company. No trustees. Charged on the undertaking and all the property, present and future, including the uncalled capital for the time being.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Salamanca.**—The Municipality requires tenders for public electric lighting. Tenders by March 14.

**Hoylake.**—The Council invite tenders for 250-kw. steam alternator, with piping, etc. Tenders by March 21.

**Hornsey.**—The Town Council require tenders for cables, meters, junction boxes, etc. Tenders by March 27.

**Oporto.**—The Municipal Authorities require tenders for lease of their electric tramways. Tenders by March 15.

**Cartagena.**—The Public Works Department, Madrid, require tenders for electrification of the local tramways.

**Leeds.**—The Corporation require tenders for the complete equipment of two sub-stations. Tenders by March 14.

**Sofia.**—The District Finance Commissioners require 15,000 insulators, elements for batteries, etc. Tenders by April 3.

**Barcelona.**—The Municipality require tenders for arc lighting of La barriada de San Gervasio de Cassolas. Tenders by March 15.

**Jawea (Province of Alicante, Spain).**—The Municipal Authorities require tenders for public electric lighting of the town. Tenders by March 12.

**Bucharest.**—The Post and Telegraph Department require tenders for 14 000 large, 8,000 medium, and 3,000 small insulators. Tenders by March 16.

**Fulham.**—The Borough Council invite tenders for the supply of electrical stores for year ending March 31, 1906. Tenders by 4 p.m. on March 15.

**Zurich.**—The Swiss Electricity Works (Schweizer Electricitätswerke) require tenders for 294,600 incandescent electric lamps. Tenders by March 15.

**Madrid.**—The Post and Telegraph Department, Carretas No. 10, require tenders for 32,000 zinc cylinders for Colland batteries. Tenders by March 15.

**Shoreditch.**—The Council invite tenders for their yearly contracts in the electricity works and other departments. Tenders by March 14. See advertisement in last issue.

**Bucharest.**—The Roumanian Government Railways require tenders for telegraph poles as follows: 2,000 7m. long, 2,000 8m. ditto, and 500 9m. ditto. Tenders by March 10.

**Liria.**—The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

**Norwich.**—The Corporation require tenders for rubber-covered wires and accessories, underground cables, and incandescent lamps. Tenders by March 20. See advertisement.

**Plymouth.**—The Corporation invite tenders for the supply of electricity meters, transformers, and cables (paper insulated). Tenders by March 18. See advertisement in last issue.

**Johannesburg.**—The Corporation require tenders for 30 direct-current arc lamps with lanterns. Tenders by March 13 to Messrs. Mordey and Dawbarn, 82, Victoria-street, S.W.

**Laventhem (Belgium).**—The Municipality require tenders for erection of central station, laying of mains, etc. Particulars (3s. 4d.) may be obtained from the Secretary of the Mayor of that place.

**Swansea.**—The Corporation invite tenders for the wiring and supply of sundry fittings for an installation of electric light at the new police and fire brigade station. Tenders by 12 noon on March 11.

**Madrid.**—The Post and Telegraph Department, Calle de Carretas 10, require tenders for telephone and telegraph apparatus, estimated at 35,337·50 pesetas. Tenders by March 10. This includes 50 Morse receivers.

**Keighley.**—The Electricity Committee invite tenders for the following plant: (Contract No. 9) one Lancashire boiler; (10) one 300-kw. direct-current steam dynamo, high-speed enclosed engine. Tenders by 10 a.m. on March 27.

**Antwerp.**—Tenders will shortly be invited by the Belgian State Railways for the installation of electric light in their local railway station. Specification No. 619 may be obtained from the Government Railways Office, Brussels.

**Swindon.**—The Corporation invite tenders for annual supply of incandescent and Nernst lamps; cables; fuse boxes, service boxes, and feeder pillars; lubricating oils and grease; and direct-current meters. Tenders by March 21. See advertisement in last issue.

**Great Western Railway.**—The directors invite tenders for the supply, delivery, and erection of plant in connection with their electricity generating station at Park Royal and proposed sub-stations and distributing centres at various places. Tenders by March 13.

**Madrid.**—Der Compania Electrica Madrilena de Traccion propose to extend their electric tramways from the Barquillo-street to Olivide-place. The concession for the works will be dealt with by the Public Works Department, Madrid, April 2. Tenderers for same must deposit a guarantee of £96.

**Switzerland.**—M. R. Vontobel, of Winterthour, and M. Charles Probst, of Lucerne, have obtained a concession for the construction of a narrow-gauge electric railway from Meiringen to Gletsch. The total cost of the enterprise is estimated at £241,600; £19,600 is to be expended on rolling-stock.

**Stockport.**—The Corporation invite tenders for the team and manual labour and the supply of sand, drain boxes, and drains (only) in laying the permanent way of about 3½ miles of double line of tramway, including laying of special work in junctions and crossovers. Tenders by noon on 13th inst.

**Dublin.**—The Corporation invite tenders for the following contract, comprising supply and erection of two electric motors. Specifications may be seen at the Engineer's Office, City Hall, Dublin, or at the offices of the consulting engineer, Mr. G. Chatterton, 6, The Sanctuary, Westminster. Tenders by March 14.

**Edinburgh.**—The Corporation invite tenders for the annual supply of arc lamp carbons, cast-iron pavement and road boxes, electricity meters, house service fuse-boxes, earthenware trunking for laying electricity cables on the solid system, bitumen, and arc lamp globes. Tenders by March 13. See advertisement in last issue.

**Gloucester.**—The Electricity Supply Committee invite tenders for three Lancashire boilers and accessories, one 600-kw. generating set and accessories, electrically-driven surface-condensing plant to deal with 30,000lb. of steam per hour, steam, exhaust, feed, drain, condensing water, and sundry pipes, valves, etc., and an electrically-driven boiler feed pump, the whole bound up in one specification. Tenders by March 16. See advertisement in last issue.

**Shanghai.**—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Pook and Co., 63, Leadenhall-street, E.C. Tenders by March 31, 1905.

**South Shields.**—The Electricity Supply Department invite tenders for the supply, delivery, and erection of the following plant: (Contract No. 67) one multitubular marine-type boiler, with chimney and mountings; (68) two medium-speed open-type vertical engines for two 550-kw. direct-current traction generators; (69) two 550-kw. direct-current traction generators; (70) traction switchboard; tramways department—(Contract No. 4) electric tramcars, complete with "Brill" trucks, for the Corporation. Copies of specifications, conditions, form of tender, also form of contract, can now be obtained from Mr. J. H. Cawthra, M.I.E.E., borough electrical engineer, South Shields, on payment of £2. 2s. for each contract, which sum will be returned on receipt of a bona fide tender for each contract. Tenders to Mr. J. Moore Hayton, town clerk, Court-buildings, South Shields, by noon on March 13.

### RESULTS OF TENDERS.

**Stepney.**—The Borough Council have accepted the tender of Jessop and Appleby Bros., Limited, Leicester, for an electrically-driven wall jib crane, at £150.

**London, S.W.**—The Chelsea Electricity Supply Company have accepted the tender of J. Greenwood, Limited, at £11,865, for erection of a new generating station, Manor-street, Chelsea.

**Newton Abbot (Devon).**—The Guardians have accepted the tender of Messrs. E. and E. Taylor, Alfreton-street, S.E., at £166, for supplying and fixing an electric lift, to carry a load of 10cwt., at the workhouse.

**East Ham.**—The Borough Council have accepted the tender of Dick, Kerr, and Co., Limited, Abchurch-yard, Cannon-street, E.C., for supply and delivery of five double-deck roof-covered tramcars, complete with the electrical equipment.

**Burslem.**—The Electric Lighting Committee have sealed the following contracts: Grant and Son, erection of electric lighting station,

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destructor buildings, etc., at £3,745, and destructor chimney, at £850; Crompton and Co., switchboard, at £598, and arc lamps, at £443.

**Bournemouth.**—The Town Council have accepted the tender of J. G. White and Co., 22A, College-hill, Cannon-street, E.C., at £38 964, for Contract No. 1—(Section A) steel grooved girder rails, etc.; B) permanent-way construction and railbonding; (C) wood blocks and granite sett edging.

**Yarmouth.**—Messrs. Jno. Russell and Sons, Limited, of Crown Tube Works, Wednesbury, have secured the order for poles in connection with the Great Yarmouth tramways, through the British Electric Equipment Company, of 11, Queen Victoria-street, London, E.C., the length of route being four miles.

**Bridlington.**—The Corporation have accepted the following tenders for the installation of electric lighting (1) on the Prince's-parade, (2) in the Victoria Rooms and (3) in the town hall: (1) S. Dixon and Son, Limited, Boar-lane, Leeds, £346; (2) and (3) R. Bailey and Sons, Quay-road, Bridlington, £42. 2s. and £22.

**Colchester.**—The Town Council have accepted the tender of Davey, Paxman, and Co. (1) for Paxman's "Economic" steam boiler, 9ft. 9in. by 14ft. 6in., capable of evaporating 10 000lb. of water per hour, with pressure of 180lb. per square inch, at £605; and (2) for pipework for connecting up such boiler with the main steam range, at £155.

# BUSINESS NOTES.

## TRACTION.

**Reading.**—The Corporation have decided to adhere to the present hours of Sunday running.

**Yarmouth.**—A commencement has been made with the reconstruction of the Gorleston line.

**Halifax.**—The Corporation have decided to purchase two motor 'buses to serve the out districts.

**Ilford.**—The Urban District Council have decided to place £2,500 out of tramway profits to the credit of the general district fund.

**Brighton.**—The Corporation have refused consent to the application of the Sussex Motor Road Company for power to run a service of motor 'buses to Worthing.

**London Traffic Commission.**—The *Morning Leader* understands that the report of this commission will recommend a large extension of electric trams in the Metropolis.

**Newcastle.**—Extensions in Ridley-street and Scotswood-road are estimated to cost £5 549 with side poles, or £5,239 with centre poles, according to a report just issued by the Corporation.

**Aldershot and Farnborough.**—These two authorities have decided to apply for the recission of the light railway order on the ground that the company have not substantially proceeded with the work.

**Calcutta.**—It is reported that the extension to Alipore is being held up owing to the refusal of Government to allow the line to pass over Kalighat Bridge, or to contribute towards the widening of it.

**Nottingham.**—The Tramways Committee have promised to take into consideration the question of reducing fares, but Alderman Brownsward took the opportunity of deprecating constant applications for such concessions.

**West of Fife.**—It is reported that if the local authority insist upon their stipulations as to width of road and the sum to be annually paid by the promoters, the latter will abandon the scheme. A conference will probably be held.

**Bettws-y-coed.**—The Board of Trade have decided that a level crossing cannot safely be allowed in the district of Bettws-y-coed where the Snowdon and Bettws-y-coed light railway will pass over the Llugwy River near the Pontypair Fall. The Urban District Council are making alternative suggestions to the company.

**Wolverhampton.**—A breakdown on the Tettenhall-road section is reported to have occurred on the 1st inst. The supply of current failed, and subequently a fuse was blown in a feeder pillar. Telephonic communication with the officials at Cleveland-road resulted in the service being restored with all possible promptitude.

**Colchester.**—The Corporation have received a communication from the Board of Trade stating that the proposed position of the tramways in Military-road may be adopted, subject to the condition that there shall be everywhere a clearance of 15in. between the kerb and cars running on the lines. Provision has been made for this.

**Aberdare.**—Protests were made at a public meeting by the inhabitants of Hirwain against the Aberdare Council's tramway scheme. The chairman stated that the trams would not serve the district in question, and resolutions were carried urging the exemption of the inhabitants of Hirwain from contributing to the cost of the scheme.

**Stockport.**—The Corporation have decided to purchase 10 uncovered cars, with Brill trucks, interchangeable with the Brill trucks under the cars now in use, the car bodies to be obtained from the Brush Company and the equipment from the British Thomson-Houston Company. The electrification of the Edgeley route has been postponed in order that the question of motor 'buses may be considered.

**District Railway.**—The employés have held meetings to protest against the new rates of pay offered by the company, which are: motormen, 7d. per hour, rising to 8½d.; conductors, 5d., rising to 6d.; and gatemen, 4d., rising to 4½d. The directors are to be asked to receive a deputation. It is alleged by the employés that the new rates will mean weekly reductions of 13s. 6d., 4s., and 6s. 6d. respectively, calculated on the basis of a six-day week, with 10 hours per day.

**Tipton.**—At the monthly meeting of the Urban District Council it was reported that the tramways company had written declining to adopt ½d. fares between Great Bridge and Dudley Port and between Dudley Port and Sedgley-road. They also consider that the state of traffic did not warrant a 10 minutes' service, but the 15 minutes' service would be augmented when occasion demanded. The Council decided to ask the company to run a 10 minutes' service after 12 noon daily.

**Underground Electric Railways Co.**—At a special meeting of this company on Friday last, Mr. Charles T. Yerkes stated that the company, having sold £2,500,000 of debentures of the Baker-street and Waterloo Railway Company, the Great Northern, Piccadilly, and Brompton Railway Company, and the Charing Cross, Euston, and Hampstead Railway Company, the shareholders would not be asked to sanction the proposed increase of the borrowing powers of the Underground Company.

**Parliamentary Bills.**—The London County Council (Tramways) Bill, the Baker-street and Waterloo Railway Bill, the Charing Cross, Euston, and Hampstead Railway Bill, the Edgware and Hampstead Railway Bill, and the Great Northern, Piccadilly, and Brompton (No. 1) Bill were read a second time in the House of Commons on Tuesday. Mr. Whitmore's instruction to the committee on the London County Council (Tramways) Bill, to omit the proposed new lines over Westminster and Blackfriars Bridges, stood over.

**Darlington.**—The loss upon the tramways formed the main theme of discussion at a meeting of the Corporation last week. This is expected to be £1,900. Alderman Bartlett, the chairman of the Finance Committee, characterised the charge of 1¾d. per unit made by the electric department for the motive power for the tramways as unfair. It was a tacit understanding by the committee when the Corporation took over the horse tramways from the Imperial Tramways Company that the charge would not be more than 1½d. per unit.

**Glasgow.**—The Corporation Tramways (Consolidation) Bill came before the examiner at the House of Commons on Friday last. After the usual procedure, the Bill was found to comply with the Standing Orders, and was marked as such, but some time afterwards it was discovered that the assent of Partick had not been received. This made it necessary for the examiner to report that the Standing Orders had not been complied with. It will now rest with the Standing Orders Committee to say whether the Standing Orders should be dispensed with.

**Blagdon and Pensford.**—The following resolution was unanimously carried at two public meetings in the neighbourhood: "That this meeting is of opinion that the proposed light railway will greatly conduce to the prosperity and trade development of the district, and will also greatly assist the mining and agricultural and other industries, and be a great advantage to the public, and pledges itself to support the proposed railway by every means in its power." A memorial to the Light Railway Commissioners praying for the order was numerously signed.

**Swansea.**—At the meeting of the Tramway Committee the town clerk explained that the company wished a proviso inserted that if the Corporation made default in the supply of electricity, the company should not be held responsible. As regards licensing omnibuses, the Corporation were not at any time to allow any mechanical omnibus to ply for hire, and so compete with them. Eventually it was arranged to return the agreement to the company, leaving over certain points for further consideration. The Board of Trade are expected to inspect the new lines in about two weeks.

**Burton-on-Trent.**—At the meeting of the Tramways Committee the report of the electrical engineer of Jan. 27 last, on the subject of extending the capacity of the tramway generating plant to deal with the additional service of cars which the Burton and Ashby Light Railway call for, was read, and it was resolved that the electrical engineer obtain tenders for a 100 kw. continuous-current dynamo, to be coupled to the shafts of No. 1 alternator, together with the necessary switchboard and connections for the same. Messrs. Kincaid, Waller, Manville, and Dawson have in hand the preparation of the specifications for coupling up the two systems.

**Pontypridd.**—The completed portion of the system of electric tramways in course of construction by the Urban District Council was opened for traffic on Monday. The route now opened extends from Treforest, through Pontypridd to Coedpenmaen, Norton Bridge, and Cilfynydd. Three double-deck cars started soon after 11 o'clock from opposite the District Council offices. The journey was made without mishap, and as the gaily-decorated cars passed from point to point loud cheers were raised. Subsequently a luncheon was served at the New Inn Hotel, at which a large number of guests, the members of the Council, and others interested in the welfare of the town were present. The undertaking will cost, when completed, about £110,000.

**Cavehill and Whitewell.**—The report of this tramway company contains the following passage in reference to electrification: "The directors are glad to be able to state that a contract has been entered into between the company and the British Electric Traction Company, Limited, for the immediate reconstruction of the tramways for working by electric traction. It is provided that the work shall be completed by July 31 next, at which date it is intended that the system shall be ready for electrical running. In the event, however of any delay occurring from unforeseen causes the British Electric Traction Company have agreed to guarantee a dividend at the rate of 6 per cent. per annum on the existing issued shares of the company from July 31 next until the commencement of the working of the tramways by electric traction."

**Manchester.**—The Board of Trade have decided to adopt the recommendations of Colonel von Donop on the question of the distances at which the tramcars should be apart when running, and also as to the restriction which should be placed on the use of the lines in Portland-street, Peter-street, and John Dalton-street. This will allow the cars

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in the central parts of the city to approach each other very closely. In the outer districts a distance of 25 yards is to be maintained between the cars. In Portland-street the Corporation proposed that between 9 a.m. and 7 p.m. cars should only run on one of the two sets of lines (south side) in cases of emergency, and in relieving traffic down adjacent streets, in which case there shall be a distance of 50 yards between following cars. This is agreed with by the Board of Trade, who think that, as a matter of fact, there need be no restriction as to running.

**Belfast.**—Messrs. White and Co. are experiencing great difficulties in the reconstruction of the system, owing to the action of the labourers, or a section of them. No sooner had a uniform rate of 6d. per hour been conceded than the men knocked off again. It appears the difficulty arose among the squad on Shankhill-road, and these, suddenly throwing down their tools, marched in a body along the whole route, ordering the others to cease work. The contractors invoked the aid of the constabulary, but the latter remained passive spectators of the open picketing which followed. Nearly a thousand men are idle in consequence. The Lord Mayor has been asked to negotiate for a settlement. The *Belfast News Letter* says the strike is the work of a handful of agitators, who will neither work themselves nor allow others to do so. Among the great bulk of the men themselves there is said to be a strong feeling of resentment against the originators of the strike. Sunday running has been confirmed.

**Llanelly.**—An extraordinary meeting of the Urban District Council was held last week to consider the opposition to the South Wales Electric Power Company's Bill. The chairman (Mr. D. James Davies) explained that the promoters of the Bill had an interview with representatives of the Council in November, when Mr. Graham Harris intimated that they were willing to step into the shoes of the British Insulated Wire Company, who had by agreement undertaken to carry out a system of electric light and traction in the district. They were then informed that the promoters would settle with the tramways company, and afterwards with the Council. Since they had seen it reported that they had purchased the tramway undertaking, but negotiations between the Council and the promoters of this Bill had not been concluded. Delay had occurred owing to Mr. Graham Harris going to Egypt, but before he went he asked their clerk to prepare an agreement, and after it had been thoroughly considered this had been submitted. They had not received any reply to it so far. He wished it to be distinctly understood that the relations between the parties were friendly. The Council had considered it expedient to put in a protective petition against the Bill, and the petition would be withdrawn upon an agreement being fixed up. He moved a formal resolution in line with the object of the meeting, and this was carried.

**Beckenham.**—It is reported that the scheme for the construction of tramways in Beckenham, for which the Urban District Council obtained an Act of Parliament in 1903, may be abandoned. The tramways were to have cost £28,000, and the scheme also involved street widenings to the amount of £62,550. By an agreement with the British Electric Traction Company, which was ratified by Parliament, the tramways when completed were to have been leased to the company, who were to pay the Council interest on the capital expenditure and also to repay the interest and sinking fund on the necessary loan. The company were also to cover the cost of necessary street widenings up to a total of £31,000, and at the end of 28 years to have handed the tramways in perfect working order over to the Council free of cost. When the ratepayers were originally appealed to they decided by a majority of 1,689 in favour of trams, but since then a number of members of the Council appear to have become enamoured of the motor 'bus, and it is stated that the Council now propose to cancel the agreement with the company for another, in which the company, when the tramways in the neighbouring district of Penge are ready, is to provide a service of motor 'buses. A report embodying these proposals has been received by the Council, but in view of the fact that the ratepayers had decided on a poll in favour of trams, it was decided that the full acceptance of the report should be held over for a fortnight.

**London County Council.**—Tuesday's agenda contained the following report and recommendation of the Highways Committee: "We have had under consideration the question of the steps to be taken to provide adequate accommodation for the repair and overhauling of the electric cars used on the Council's tramways. At the present time the cars are comparatively new, and the repairs which have been necessary have consequently not been of an extensive character, and these have had to be done at the particular depôts from which the cars are operated. We think, however, that, having regard to the great increase in the Council's tramways system, more adequate arrangements should be made at an early date for the repair and overhauling of the rolling-stock. In our opinion the present system of executing repairs at the several car-sheds does not properly meet the needs of the tramways undertaking. We consider that special repair shops should be provided in some central position where the cars could be periodically overhauled and where spare parts, which at present have to be obtained from the car manufacturers, could be made. It is probable that by direct production in the Council's own workshops, equipped and operated in a thoroughly economical and systematic manner, spare parts could be supplied at a cheaper rate and with greater dispatch than hitherto, a very important item in the maintenance expenditure of a tramways undertaking. In the first instance, buildings of sufficient capacity to meet present requirements might be erected, and they might subsequently be extended if required. We will report at a later date upon the proposal to erect new buildings specially for the purpose, as it will take some time to frame a comprehensive scheme that will meet the demands of the undertaking as it is likely to be developed in the future. In the meantime, however, it is of importance that more satisfactory provision than now exists should be made for the repair of cars, as an instalment of the larger scheme. A large car-shed, capable of accommodating nearly 300 electric cars, is being erected by the Council at New Cross-gate. This car-shed is in a comparatively central position as regards the Council's electric tramways, and we think that a portion of it should be temporarily equipped as a workshop for the repair of cars. For this purpose it will be necessary to provide plant, tools, and machinery, the cost of which is estimated at £5,000. If our proposal for the establishment of a special large central repair depôt, capable of dealing with the overhauling and maintenance for about 1,000 cars be carried into effect at some subsequent date, a considerable quantity of additional plant and equipment would be required. It would then be possible, however, to transfer from the New Cross car-shed the plant now proposed to be obtained, as this would form part of the complete equipment of the permanent repair depôt. By this means no loss would be incurred in the purchase of the plant required for the temporary equipment of the New Cross depôt. We propose, subject to the Council authorising the necessary expenditure for the purchase of the plant, machinery, tools, etc., to obtain prices from selected firms for the supply of the materials, the work being of a nature which makes that course desirable. We accordingly recommend 'that the estimate (No. 4,393) of £5,000, submitted by the Finance Committee, be approved; that expenditure, on capital account, not exceeding that amount be authorised for the provision of plant, machines, tools, etc., required for the equipment of a repair depôt at New Cross for the rolling-stock used on the London County Council tramways; that the Highways Committee be authorised to take all necessary steps for obtaining and installing the plant, etc., referred to; and that the seal of the Council be affixed to any necessary documents in connection with the matter.'" The receipts for the week ended Feb. 25 amounted to £12,091 as against £9,780 last year, and for the period from April 1 the total was £600,448 against £466,822.

## LIGHTING AND GENERAL.

**Loughborough.**—An electrical exhibition is to be held in April.

**Whitehaven.**—The consumption of electricity is increasing, and the receipts are correspondingly larger.

**Aspull.**—The District Council are conferring with the Lancashire Electric Power Company re the supplying of the township with energy.

**South London Electric Supply Co.**—A dividend has been declared of 4 per cent. on the ordinary shares for the year, carrying forward £6,446.

**Dewsbury.**—Application is to be made for sanction to a loan of £10,000 for additional plant and cable required at the electric light station.

**Bradford.**—The scheme for putting in additional fuse boxes is being proceeded with, and a special box has been designed for the purpose.

**Direct Spanish Telegraph Co.**—A dividend at the rate of 4 per cent., tax free, on the ordinary shares, for the half-year ended Dec. 31, is payable on April 1.

**Shetland Cable.**—Telegraphic communication between Shetland and the south, which was interrupted by the severe storm of Jan. 14, has now been restored.

**Tredegar.**—The District Council are negotiating with the Tredegar company with regard to the supply of electrical energy in bulk for public lighting purposes.

**Huntingdon.**—The Corporation have decided to consider the question of electric lighting, and have instructed Mr. Warden-Stevens, of Westminster, to advise on the matter.

**Hull Telephones.**—At the last meeting of the East Hull Social and Literary Society, Councillor J. Grindell, J.P., who presided, delivered an address on municipal telephones.

**Barnsley.**—The Town Council have completed the purchase from the Chatterley-Whitfield Collieries of land in Scotia-road for the refuse destructor and electric lighting station at £4,340.

**Change of Address.**—Mr. J. H. Rhodes, civil and consulting electrical engineer, M.I.C.E., has removed to 16, Park-lane, Leeds, and 22, Abingdon-street, Westminster, London, S.W.

**Bridlington.**—A letter from the Electricity Committee drawing the attention of the Guardians to the desirability of having the house lighted by electricity has been referred to the Visiting Committee.

**Southall-Norwood.**—The Urban District Council are opposing the Bills of the Metropolitan Electric Supply Company, Limited, and the Administrative County of London and District Electric Power Company.

**Darlington.**—The electrical engineer in his last report stated that to meet the increasing demand for current there would have to be extensions of the works, and the cost, if what he proposed were carried out, would be £2,000 to £3,000.

**London Gazette.**—The partnership between George Hubert Woods and Randal Beresford Slacke, carrying on business as electrical engineers at Blackburn under the style of G. H. Woods, Slacke, and Co., has been dissolved by mutual consent.

**Torquay.**—The post-card poll, referred to in our last issue, has resulted as follows: cards issued, 6,392; returned, 6,171. In favour of the scheme, 416; against, 5,069—majority against, 4,653. The number of inhabitants at the last census was 33,625.

**Tonbridge.**—The Electric Lighting Committee's last report shows that three applications for light, equivalent to 88 8-c.p. lamps, have been received during the month. The number of consumers to date totals 125, equivalent to 4,705 8-c.p. lamps.

**Thornhill.**—The Yorkshire Electric Power Company have made arrangements for a bulk supply with the Pudsey Corporation, the Mirfield Council, the Liversedge Council, and a supply is now available from the company's station at Thornhill.

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**Lichfield.**—The Lichfield Gas Company and the Tamworth Gaslight and Coke Company have withdrawn their opposition to the passage through its committee stage in the House of Commons of the Shropshire and Worcestershire electric power scheme.

**Halifax.**—A report of the electrical engineer on the lighting mains and estimate of the cost of recommendations contained in the report, has been approved and adopted by the Electricity Committee. We understand that considerable expenditure is suggested.

**Liverpool.**—The Town Council have adopted a report of the consulting engineer as to charges for electrical energy. It appears that while a reduction is made in the cost per unit for tramway purposes, the ordinary consumer cannot obtain lower charges at present.

**North African Telephones.**—A new trunk line connecting Algiers with Constantine has just been completed. Arrangements are being organised for completing a grand trunk system of North African telephones by carrying the Oran line eastwards from Algiers as far as Tunis.

**Charing Cross and Strand Electricity Supply Co.**—From the 8th inst. the style and title of this corporation has been altered to the Charing Cross, West-end, and City Electricity Supply Company, Limited, in accordance with the special resolution of the corporation dated Feb. 3, 1905.

**Ripon.**—The City Council have adopted a resolution strongly urging adherence to the policy embodied in the Telegraphs (Telephones) Act, Act, 1899, which is based on the encouragement of municipalities and other local authorities and companies to provide local telephone services in connection with the Government trunk service.

**Johannesburg.**—It has been decided to replace all overhead telephone wires by underground wires. The cables will contain from 104 to 612 wires, and will be laid in 3½in. earthenware ducts, aggregating seven miles. The Village Main Reef Mine requires a three-phase generating plant with a capacity of 900 h.p. for hauling purposes.

**Blaydon.**—An amended proposal for the supply of electrical energy has been received by the Council from the County of Durham Electrical Power Distribution Company, Limited. The company have been asked for a price for street-lighting for 50-c.p. incandescent lamps, and also for a copy of their agreement with the Whickhaw Council.

**Melton Mowbray.**—An exhibition promoted by the Melton Mowbray Electric Light Company is being held in the corn exchange. The profits are to be devoted to the funds of the Leicester Infirmary. Numerous electrical appliances in lighting, heating, and power are on view, and various musical attractions are provided.

**Whitechapel.**—Messrs. R. W. Cunningham and Co. having asked the Guardians to permit them to advance the amount of their estimate for the installation of the electric light at Section No. 2 of the infirmary by 10 per cent., owing to the increase in the price of materials since the tender was sent in, the Guardians have resolved to hold the firm to their tender.

**Hampstead.**—At the last meeting of the Borough Council it was stated that the rate of 3s. 7d. in the £ (the same as for the half-year just ending) would have been increased by 1d. but for the fact that the Council has for the first time, included in the estimates a transfer of electric lighting profits in aid of the rates. This amounts to £2,000 this year, and to £2,060 for next year.

**French Cables.**—The Under-Secretary of Posts and Telegraphs is about to lay two new submarine cables, which have been voted by the French Government. One will be from Pontianak, the capital of the western division of Dutch Borneo, to Saigon in French Cochin China, and the other will be from Madagascar to the island of Réunion, which lies about 420 miles east of Madagascar.

**Carn Brea (Cornwall).**—An electrical exhibition is being held here. Among the varied purposes for which electricity is used as a motive power in this district the following may be of interest: air-compressor, forge and cupola blowing pulveriser, engineer's workshop, woodcutting, corn grinding and chaffcutting, butchers' machinery, bakers' machinery, lift, magnetic separator, pumping, etc., aggregating 240 h.p.

**York.**—Sufficient applications for current having been received, a cable is to be extended at an estimated cost of £250. Some of the street arc lamps are to be replaced by enclosed lamps, and additional lamps will be erected. It is also proposed to divide the lamps into series of two in lieu of 10 as at present, so that in case of the blowing of a fuse only two lamps will be affected instead of the whole series of 10 as heretofore.

**Hammersmith.**—The loan of £18 482 on account of the cost of installing the additional electrical machinery has been completed. Some additional land has been transferred to the electricity department. The premises of 19 additional consumers, representing a maximum of 370 8 c p. lamps, have been connected to the mains, and 35 consumers have been disconnected. The present number of consumers taking current from the mains is 1,555.

**Parliament.**—The following Bills have been read a second time: (1) in the House of Lords—Tyneside Tramways and Tramroads, Central Electric Supply, County of London Electric Supply Company, Mexborough and Swinton Tramways (Extension of Time), Oldham and Saddleworth District Tramways. (2) House of Commons—Andover Lighting and Power, Whitechapel and Bow Railway, and Weybridge and Walton-upon-Thames Electric Supply Bill.

**Colchester.**—The Council have passed a resolution strongly urging the Local Government Board to sanction the entire loan referred to in our last issue. The output of electricity in units in January, 1905, was 111,554, against 55,781 in the corresponding month of 1904 and 39,342 in 1903; the number of consumers at the end of January was 637, against 414 in 1904 and 334 in 1903; the total number of 8-c.p. lamps connected in 1905 is 30,601, against 25,174 in 1904 and 20,013 in 1903.

**Fans and Blowers.**—Messrs. John Gibbs and Son, ventilating and electrical engineers, Duke-street, Liverpool, are exhibiting at the Liverpool Motor Show their new "Peerless" blower, direct driven by their patent dust-proof motor, adaptable for blowing forges or removing dust from polishing wheels. They are also exhibiting a variety of electrically-driven ventilating fans and their patent quick-break safety starting switch, a most ingenious arrangement for minimising the possibility of accident with electric motors.

**Telegraph Revenue.**—The gross amount received during the last year by the Post Office in respect of telegrams, private wire rentals, special wire rentals, and other sources was £4 208,426. From this sum the amount paid to cable companies, £529,520. and telegram moneys refunded, £4,748, must be deducted, leaving £3 674,137. The amount expended by the telegraph section of the Post Office in salaries, rent, and other respects during the same period is £4,693,897, the balance of expenditure over receipts thus being £957,702.

**Sheffield.**—A committee, consisting of the Lord Mayor (Alderman Joseph Jonas), Aldermen W. E. Clegg and George Senior, and Councillors C. F. Bennett, A. Cattell, W. T. Gent, W. C. Fenton, J. C. Whiteley, J. W. Crowther, and C. R. Nowill, has been appointed to consider the means of giving a cheaper supply of electric current, to report on the advisability of closing one or more of the existing generating stations, as to the utilisation of surplus heat from the destructors for the production of current, and upon the question of electric supply generally.

**Gorleston.**—A cable has now been laid below the river bed between Yarmouth and Gorleston for electric lighting, traction, and power purposes generally. At first a ditch was dug to a depth of 7ft. by the new dredger "Sir Harry Bullard" of the Port and Haven Commissioners, which was hired by the Corporation, thus saving a large expenditure on excavating. The cable has been manufactured by the Callender Cable Company, and is a combination of three cables heavily armoured, the whole having a circumference of 9in. The cable starts from Yarmouth, and it comes ashore into a sub-station beside the steps up Ferry-hill. The sunken cable is to be covered up with soil to the depth of 7ft., and the Port and Haven Commissioners have issued a prohibition against vessels dropping their anchors in its vicinity.

**Aston.**—The Electricity Committee have resolved to abolish the two-rate system of charge, and in substitution thereof have adopted the following rate of charges for the supply of electrical energy for lighting purposes—viz., consumption under 300 units per quarter, 3½d. per unit; 300, but under 600, 3½d.; 600, but under 1,000, 3½d.; 1,000, but under 1,500, 3d.; 1,500, but under 2 000, 2½d.; 2 000 units and upwards, 2½d. Lighting accounts will be made payable quarterly, with a discount of 5 per cent. for payment within one month from date of issue of the account. The committee reserve to themselves the right to adopt the time-switch system for all consumers having an irregular load. They are about to purchase and fix a Worthington double-ram packed feed pump of approximately 3,000 gallons capacity, together with a cooling tank for the soft water, at a cost not exceeding £250. The committee having considered the question of supplying incandescent lamps to consumers, have authorised the electrical engineer to purchase 5 000 lamps for the purpose of retailing same as required, and, further, have authorised him to purchase Nernst lamps for the same purpose and maintain same if required.

**Stock Exchange.**—The Stock Exchange Committee have appointed March 15 special settling day for Havana Electricity Company's scrip (fully and partly paid) for £150,000 5 per cent. debentures, and have ordered the undermentioned securies to be quoted in the official list: City of Buenos Ayres Tramways Company's (1904) 243,708 shares of £5 each, fully paid, Nos. 1 to 241,671, 243,656 to 244,142, and 246,451 to 248 000; and £174,000 4 per cent. debenture stock, in lieu of the shares and debenture stock of the City of Buenos Ayres Tramways Company, Limited, now quoted; and Havana Electricity Company's scrip (partly paid) for £150,000 5 per cent. debentures. Applications have been made to the committee to appoint a special settling day in and to grant a quotation to Henley's (W. T.) Telegraph Works Company's further issue of 5 000 ordinary shares of £5 each, fully paid, Nos. 35,001 to 40,000. The committee has also been asked to allow the following securities to be quoted in the official list: Bournemouth and Poole Electricity Supply Company's further issue of 4,500 ordinary shares of £10 each, fully paid, Nos. 22 501 to 27,000, and £80 000 4½ per cent. debenture stock; and Western Telegraph Company's further issue of £44,435 4 per cent. debenture stock.

**Pontypridd.**—An electric lighting and tramways scheme has just been completed. The cost on the electric lighting and generating station was about £55,000, and that of the tramways about £60,000, excluding the Rhondda section about to be constructed. The generating station is combined with a refuse destructor. The tramways are 3ft. 6in. gauge on the overhead system, and 3½ miles are equipped, while an extension of 1½ miles is under construction. The whole of the works were carried out by the consulting engineer to the Council, Mr. R. P. Wilson, of 66, Victoria-street, Westminster, Mr. W. S. King being his resident engineer. Since December last Mr. J. E. Teasdel, the Council's engineer and manager, has been occupied in organising the staff and in administrative work. The contractors were: overhead equipment, British Insulated and Helsby Cables, Prescot; track and pipe work, pumps, water-softener (Sinclair's), R. W. Blackwell and Co., London; underground cables, W. T. Henley and Co., London; buildings, Hughes and Stirling Bootle, Liverpool; engines, Coombe, Barbour, and Co., Belfast; dynamos, Greenwood and Batley; switchboard, Ferranti Limited; balancers, British Westinghouse Company; arc lamps, Johnson and Phillips; tramcars, British Thomson-Houston Company, Rugby (Brush Company, Loughborough, sub-contractors for car bodies).

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**Bridgend.**—The report of the electricity department for the quarter ended Dec. 31 shows total receipts £311, as against £296 for the corresponding quarter of 1903. The number of units supplied by the power company was 37,430, as against 31,700, being made up as follows: public lighting, 19,692, against 15,361; private lighting, 16,692, against 15,439; sub-station, 598, against 400; unaccounted for, 448, against 50.

**Dartmouth Electrical Exhibition.**—The electrical exhibition held at the Subscription Rooms closed on Saturday evening last after a most successful run of four days, 2,801 persons having passed through the building between three o'clock on Wednesday afternoon and 10 p.m. on Saturday. The sum of £65. 6s. 11d., receipts from various causes, has been handed over to the Dartmouth and Kingswear Cottage Hospital. Mr. St. John Brown, of Newton Abbot, sang several songs at the exhibition last week.

**Telephone Operators' Union.**—The employés of the National Telephone Company are organising a union on similar lines to that among the Post Office workers in view of the transfer, six years hence, of the telephonic system to the Government. The movement originated in Liverpool, and at a largely attended meeting on the 4th inst. the objects and methods of the proposed association were discussed. It will be protective, and possess insurance features. Delegates were present from a number of towns.

**St. Andrews.**—An arrangement has been made under which the Town Council will erect four arc street lamps, and the electric supply company will supply current for keeping them—viz., four 10-ampere street arc lamps—burning for 1,500 hours at their full power, also do all repairs and maintenance and supply special cable to connect the lamps and between the lamps for the sum of £9. 1s. 3d. per lamp per annum, the Town Council to supply and own the complete arc lamp-posts. This offer is to hold good for five years.

**Anglo-Chinese Telegraph Convention.**—Mr. Berrington, director of the traffic branch of Indian telegraphs, has gone to Shanghai to assist in negotiations for the renewal of the Anglo-Chinese Telegraph Convention of 1894, the Chinese Government having notified under the terms of agreement a desire for the modification of the clauses referring to the maintenance of the line on the Chinese side of the Burmo-Yunnan frontier and the rates charged. The line in Yunnan beyond the Bhamo border is reported to be in want of repair.

**Southwark.**—The Borough Council have decided upon the following new scale of charges for current: Lighting—6d. for the first 1½ hours of average maximum demand and 1d. for any quantity afterwards, with discounts; flat rate, 4½d. per unit, with discounts. Power—3d. for the first hour of maximum demand and 1d. for any quantity afterwards, with discounts; flat rate, 2½d., with discounts. Discounts—2½ per cent. on quarterly bills of £50 or under, 5 per cent. on bills between £50 and £100, 7½ per cent. for £100 and £200, and 10 per cent. over £200.

**Grimsby.**—The Public Lighting Committee have decided that an extension of the electric plant is necessary to be prepared for the demand of 1907, and have left it to the engineer to prepare a scheme. The capacity of the plant at the present time is sufficient to deal with the equivalent of 46,000 8 c.p. lamps connected to the mains (after allowing for the public lighting). On Feb. 9 the equivalent of 42,000 8-c.p. lamps was connected, and, at the normal rate of increase, by December next the number connected will be about 43,000, and by December, 1906, 57,000. A temporary draughtsman is to be appointed.

**Football.**—On Saturday last the engineering works of the G.E.C., Witton, sent their football team to London to play Robertson Lamp Works, and after a somewhat exciting game Birmingham team ran out the winners by five to two. After the game they were invited by the Robertson Lamp Works to a tea provided by the president of the Robertson Lamp Works Club, Mr. C. Wilson, and after that a dance, which had been postponed from Wednesday. Mr. C. Wilson, in a speech, said that it was the first inter-works game that had ever taken place in the history of the G.E.C., and he hoped it would not be the last.

**Assessment of a Yorkshire Electric Light Works.**—Although the premises were still in the hands of the contractors, and would not be in working condition for some time to come, the new generating station of the Yorkshire Electric Power Company at Thornhill, near Dewsbury, was some time since assessed at a rateable value of £1,200. We understand that the company thereupon sought the advice of the Machinery Users' Association, with the result that their valuer, Mr. Humphreys-Davies, appeared before the Assessment Committee last week, and obtained a reduction of the rateable value from £1,200 to £10, until such time as the station should be profitably occupied.

**Wrexham.**—At the last meeting of the Electricity Supply Committee a letter was read from Mr. Ash, complaining that certain statements reported in the public Press referring to work done by him when an employé in the electricity department were inaccurate and calculated to do him harm. It was decided that Mr. Ash be informed that no blame attached to him in regard to the discharge of his duties up to the time when his voluntary resignation took effect, there being no ground for dissatisfaction as far as the committee had ascertained as to his capacity. The electrical engineer's report showed that in January there had been used for tramways and lighting, etc., 51,381 units as compared with 41,581 in January, 1904. Five new consumers had been connected.

**Metropolitan Asylums Board.**—Mr. A. C. Scovell presided on Saturday at the meeting of the Board held at the offices, Victoria-embankment. The Local Government Board wrote forwarding copies of an order authorising the execution of certain works for the purpose of lighting the Belmont Asylum by electricity and the provision of telephones and fire-alarms at a cost not exceeding the sum of £6,450 and the borrowing of that amount, which should be repaid in 10 years. It was resolved that application be made for sanction to the Managers inviting tenders for the installation of proposed systems of electric lighting, telephones, and fire-alarms at the Southern Hospital from nine selected firms, and to their entering into a contract or contracts for the execution of the necessary works, without in the first instance advertising for sealed tenders. It was stated that at the present moment the engineer-in-chief was not in a position to give a definite estimate of the cost of these works (full provision for which had been made in the expenditure sanctioned by the Local Government Board in connection with the erection of the hospital), but he anticipated the cost approximately at £9 000, of which the underground mains alone would account for about £3,000. It was decided that, subject to the assent of the Local Government Board, the plan of the proposed new boiler-house, destructor, and chimney shaft at the Eastern Hospital be approved, and that the Works Committee be instructed to take steps for the execution of the necessary work.

**Exeter.**—The City Council, in committee on Wednesday, considered the following interim report of the special committee appointed to consider the management of the electric light undertaking: "The special committee have elected Councillor Dunn chairman of the committee, and at three lengthened meetings have fully and carefully enquired into the matter referred to them. The committee are not yet prepared to report fully upon the general reference, but having regard to the special reference relative to the general competency of the chief officer, they beg leave to present this interim report. The committee, after careful enquiry, are fully satisfied with the competency of Mr. Munro as an electrical engineer, and are of opinion that the electrical engineer should have charge of all the works in connection with the electric light undertaking, including mains, and of the electrical equipment in connection with the tramways. Having regard to the extent of the works and the growth of the undertaking, the committee are of opinion that this is sufficient to fully occupy the time of the electrical engineer, and that some other arrangement should be made, by a readjustment of the present staff, with regard to the supervision and control of what may be called the mercantile side of the undertaking by an officer who should be in direct communication with the committee. The committee recommend that, having presented this report bearing testimony to the competency of Mr. Munro as an electrical engineer, that the matter should be again referred to them in order that they may report upon the general question of the management of the undertaking."

**Finchley.**—The Electricity Committee in their last report stated that they had had under consideration a report of the electrical engineer upon the progress of the electrical undertaking, and an estimate of the cost of the further extensions to buildings and plant which were necessary to cope with the increasing demand for current. They pointed out that the original loan of £35,000 provided for the supply of current to the equivalent of 10,000 8 c.p. lamps for private lighting and 600 8-c.p. lamps for street-lighting. The further loan of £16,600 made provision for the doubling of this output—*i.e.*, 20,000 8 c.p. lamps for private lighting and 1,200 8 c.p. lamps for street-lighting. There were connected, or applied for, at the present time the equivalent of 18,845 8 c.p. lamps for private lighting and 1,324 8-c.p. lamps for public lighting; and, in addition, 150 centre poles which were now being connected up. The engineer further estimated that during the current year at least the equivalent of a further 10,000 8 c.p. lamps would be applied for; additions and conversions of public street lamps to the number of 600 8 c.p. lamps would also be necessary, making in all a grand total of 31,370 8 c.p. lamps, or 10,170 8 c.p. lamps in excess of the capacity of the existing plant. The committee considered that arrangements should be made for extensions at once. Application is to be made for sanction to the borrowing of £23,500, made up as follows: machinery, £5,450; water supply, £2,180; buildings and sub-station, £6,750; mains, £5,370; service connections, £2,200; contingencies, office, and inspection expenses, and loan charges, £1 500. The committee have been authorised to invite tenders. The electrical engineer has reported that the work in connection with the centre-pole lighting was now in active progress, and would probably be completed in about a fortnight. Following on the recommendation adopted at the last meeting of the Council as to the acquisition of the undertaking of the Finchley Electric Light Company, the committee are, pending completion, supplying to the company in bulk.

**Annual Staff Dinners.**—The annual works dinner of the Croydon Corporation electricity works staff was held at the "Greyhound" on Feb. 24, the chief engineer, Mr. A. C. Cramb, being in the chair, supported by Mr. W. Burr, chief assistant engineer (vice chairman). A good programme of songs, recitations, and instrumental music was ably rendered by various members of the staff at the smoking concert which followed. An interesting little ceremony took place during the evening, the same being a presentation of a handsomely fitted travelling bag to Mr. C. W. Salt, who was leaving to take up a higher position at Bradford.—The first annual staff dinner of the Anchor Cable Company, Limited, Leigh, was held in the White Horse Hotel on Feb. 27, Mr. R. H. Harvey, the manager, being in the chair. After dinner songs were rendered by members of the staff an enjoyable evening being brought to a close with singing of "Auld Lang Syne" and the National Anthem.—The Fulham electricity undertaking held their second annual dinner at the King's Hall, Fulham, on the 3rd inst. Mr. A. J. Fuller, the chief engineer, took the chair, and about 70 members of the staff were present. A very enjoyable evening resulted, and it is interesting to notice that the whole of the musical programme was carried out by those in the Council's employ. The chief toast of the evening was "The Undertaking," proposed by the Chairman, who said it was a pleasure to him to be able to record a steady increase in the output and revenue, and a steady decrease in the cost of production, and these, he explained, had enabled the Council to sanction the reduction of the price for lighting current to 3½d. per unit with a small discount, which he was sure would induce further business. With reference to the destructor, the Chairman said that by reason of its efficiency it had become famous, and reminded them that approximately 35,000 tons of refuse per annum were destroyed

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in Fulham at an average price which was at least 10d. per ton cheaper than the best results obtained elsewhere. In conclusion, he thanked the staff and all in any way connected with the department for the loyal support given and interest shown, and said that it was owing to the fact that all were pulling together to make the undertaking an even greater success that such a pleasing state of affairs could now be recorded. This toast was replied to by Mr. R. M Prescott (town clerk) and Mr. Councillor A. J. Warner (chairman of the Establishment Committee). Mr. G. T. Meek (superintendent of the destructor) proposed the toast of "The Chairman," which was enthusiastically received with musical honours.

## PROVISIONAL PATENTS, 1905

FEB. 27.

**4003. Improvements in dynamo-electric and electro-dynamic machinery.** James Grey Bell, 17, St. Ann's-square, Manchester.

**4040. Improvements in or relating to electric motors.** James Burke, 111, Hatton-garden, London. (Complete specification.)

**4041. Improvements in or relating to electric tools.** William Obed Duntley, 111, Hatton-garden, London. (Complete specification.)

**4062. Improvements in sparking plugs operating with magneto-electricity, for gas or oil engines.** Theodore Ferdinand Rene, 65, Chancery-lane, London. (Complete specification.)

**4075. Transformer for electrical metal-working apparatus.** William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Thomson Electric Welding Company, United States.) (Complete specification.)

**4076. Apparatus for welding and performing other metal-working operations by electricity.** William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Thomson Electric Welding Company, United States.) (Complete specification.)

**4089. Improved method of constructing electric accumulators and secondary batteries.** William Holloway Fellows and Edward Thomas Pickup, 173, Fleet-street, London.

**4097. Improvements in electromagnetic devices.** Hermann George Pape and Jacob Bender, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**4100 Improvements in electrolytic apparatus.** William Phillips Thompson, 322, High Holborn, London. (The Decker Manufacturing Company, United States.) (Complete specification.)

**4102. Improvements relating to electric tramways with conduit current supply.** Albert Newman Connett, 322, High Holborn, London.

FEB. 28.

**4109. Improvements in and connected with galvanic batteries.** Edward John Wade, 16, Elm-street, Gray's-inn-road, London.

**4122. Improvements in and relating to electrical switches for arc lamps and other circuits.** Sydney Hughes, 96, Buchanan-street, Glasgow.

**4127. Improvements in automatic electric warning signals for railways and the like.** Joseph Henry Hollyer, Rashwood House, Droitwich.

**4131. Improvement in telephone cables.** Alfred Whalley, Ashville, Helsby, near Warrington.

**4166. Telephone apparatus.** Robert Bines, 46, Lincoln's-inn-fields, London. (Complete specification.)

**4167. Telephone systems and apparatus.** Robert Bines, 45, Lincoln's-inn-fields, London. (Complete specification.)

**4168. Telephone transmitters.** Robert Bines, 46, Lincoln's-inn-fields, London. (Complete specification.)

MARCH 1.

**4233. Improvements in electric ignition devices for internal-combustion engines.** Frederick Millington and Albert Hugh Miller, 322, High Holborn, London.

**4237. Improvements in and relating to electric fuses.** Alfred Schwartz, 3, Brown-street, Market-street, Manchester.

**4249. Improvements in or connected with dynamos or electrical machinery, including their external circuits, with special reference to the regenerative system of electrical tramcar control.** Henry Winram Dickinson, 5, Salisbury-road, Wimbledon, London.

**4260. Improvements in the manufacture of electric cables.** Charles James Beaver and Ernest Alexander Claremont, 4, Bloomsbury-square, London.

**4273. Improvements in apparatus for automatic electric advertising and like purposes.** Guy Carey Fricker, 46, Lincoln's-inn-fields, London. (Complete specification.)

**4298. Improvements in or relating to joining belts, wire, or other ropes, cords, wires, electric cables or conductors, tyre wires, or the like, or for attaching terminals or other suitable end pieces thereto and means for affixing such attachments.** Arthur Henry Edwards, Birkbeck Bank-chambers, Chancery-lane, London.

**4307. Improvements in secondary electric batteries.** Pascal Marino, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**4303. Improvements in or relating to apparatus for obtaining constant voltage from dynamos working at varying speeds.** Maurice Eyquem, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, March 3, 1904, being date of application in France.) (Complete specification.)

**4305. Improvements in electric motor-starting rheostats and switches.** Henry Boultbee Brooks, 18, Buckingham-street, Strand, London.

MARCH 2.

**4313. Further improvements in apparatus for the automatic ignition of gas, gaseous mixtures, or the like by means of an electric current.** George Hill, The Grove, Ashton-on-Mersey. (Complete specification.)

**4315. Improvements in electric gas lighters.** George William Somerville, 68, Owen-street, Accrington.

**4321. Improvements in sparking plugs for electrically-fired internal-combustion engines.** Herbert Lewis, Wilfrid Hill, and Jack Whitfield, 24, Temple-row, Birmingham.

**4343. Improvements in and relating to arc lamps.** John Frederick Wakelin, William Bunn, and Charles Weston, 5, Tottenham-street, Tottenham Court-road, London.

**4354. Electric time switch.** Hilding Lübeck, 44, Grange-park, Ealing, London. (Date applied for under Patents Act, 1901, April 3, 1904, being date of application in Germany.) (Complete specification.)

**4362. Improvements relating to electric circuit systems.** Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (The Direct-Line General Telephone Company, United States.) (Complete specification.)

**4375. Improvements relating to dynamo-electric machines.** Robert Pohl, Felix Pohl, and the Phœnix Dynamo Manufacturing Company, Limited, 322, High Holborn, London.

**4379. Improvements in and relating to the supply and regulation of the electric energy employed in the operation of arc lamps used in searchlights and like apparatus.** The British Thomson-Houston Company, Limited, 83 Cannon-street, London (The General Electric Company, United States.)

**4384. Improvements in receivers for wireless telegraphy.** Guglielmo Marconi, John Ambrose Fleming, and Marconi's Wireless Telegraph Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

MARCH 3.

**4389. Improvements in and relating to magneto-electric generators for igniting the charge in internal-combustion engines and the like.** John Carlaw, 96, Buchanan-street, Glasgow.

**4395. Improvements in magnetic separators for ores and other materials.** Joseph Mansell Moss, 6, Bank-street, Manchester.

**4431. Automatic signals for loop-line signal arms and bells the whole worked by electric tramcar automatically.** George William Burden, 58, Uxbridge road, Hanwell, London.

**4456. Improvements in and connected with conduits for electric conductors or cables.** Thomas Easton Devonshire, 47, Lincoln's-inn-fields, London.

MARCH 4.

**4491. An improved drum for winding or coiling wire rope—copper, iron, or steel—electric cable, lead tube, hemp, or cotton rope.** David Muckley and Albert Payne, 112, Hood-lane, Little Sankey, Warrington.

**4497. Improvements in brakes for electrically-driven machinery.** Frederic Osmond Hunt, 19, Houndgate, Darlington.

**4513. Improvements in electric clocks or the like.** Frederick Augustus Chandler and Bshue Bonniksen, 18, Hertford-street, Coventry. (Complete specification.)

**4529. Improvements in the control of the electromotors on electric railway cars.** Francis Lydall, Queen Anne's-chambers, Broadway, Westminster, London.

**4540. Improved means for alternatively driving from a reciprocating engine and a rotary engine.** The Elektrizitäts Actien-Gesellschaft vormals W. Lahmeyer und Co., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, March 4, 1904, being date of application in Germany.) (Complete specification.)

**4541. Improvements in or relating to microtelephones.** Elektromilitära Aktiebolaget, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, March 8, 1904, being date of application in France. (Complete specification.)

**4544. An improved process for the electrolytic manufacture of metallic wire or strip.** Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

**4545. Improvements in the electrolytic production of metallic strip.** Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

**4567. Improvements relating to electrically-driven air-pumps.** Max Soblik, 18, Southampton-buildings, Chancery-lane, London.

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## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published March 23.*

1904.

**4937. Arc lamps.** Andrews and Manufacturing Electric Company, Limited.

**5064. Electrical and automatic working of signals, points, and crossing gates on railways.** Daboo.

**5294. Electric alarms.** Kiewert.

**5374. Electric gear for controlling lifts or hoists.** Björnstad.

**6690. Electrically-controlled lifts.** Bush.

**7428. Apparatus for moving electrically the points on electric tramways and railways.** Tierney and Malone.

**7660. Electric arc lamps.** Levis. (General Electric Company.)

**7676. Telephonic communication.** Lee.

**8064. Working of single lines of railway on the electric staff or other electric systems.** Jacobs.

**8922. Automatic electric switches and circuit breakers for controlling motors.** Haywood and Brounger.

**9660. Starting devices for electric motors.** British Thomson-Houston Company, Limited. (General Electric Company.)

**9841. Commutators for dynamo-electric machines.** British Thomson-Houston Company, Limited. (General Electric Company.)

**9842. Resistance units and methods of making same.** British Thomson-Houston Company, Limited. (General Electric Company.)

**9844. Vapour electric apparatus.** British Thomson-Houston Company, Limited. (General Electric Company.)

**9884. Controller for electric motors.** Soar and Joel.

**10019. Dynamo-electric machines.** British Thomson-Houston Company, Limited. (General Electric Company.)

**11604. Dynamo-electric machines.** Wilson. (Date applied for under International Convention, June 1, 1903.)

**11832. Vapour electric apparatus for rectifying alternating electric currents and other purposes.** von Recklinghausen.

**12976. Lining and insulating of chambers or cases carrying switches or fuses or both.** Ward and Goldstone.

**21995. Intercommunication telephone systems.** Birnbaum and White.

**22326. Controllers for electric motors.** Justice. (Voltage Controller Company.)

**23001. Automatic electric switches.** Scott.

**23182. Electric fire-alarms.** Hopkinson. (Date applied for under International Convention, April 15, 1904.)

**25378. Electric spark-gap apparatus for use with high-frequency currents, particularly adapted for therapeutic work.** Lake. (Electro-Radiation Company.)

**25382. Rotary spark-gap apparatus for use with high-frequency currents.** Lake. (Electro-Radiation Company).

**26098. Electric current-controlling systems.** Eastwood. (Date applied for under International Convention, June 4, 1904.)

**26917. Electrodes for arc lamps.** Whitney. (Date applied for under International Convention, Dec. 10, 1903.)

**27297. Means for lighting and extinguishing gas lamps by electricity.** Giorgi.

**27702. Method of winding for asynchronous electrical machines for producing a variable number of poles in the proportion of 1 : 2** Siemens Schuckert-Werke G. m. b. H. (Date applied for under International Convention, Feb. 13, 1904.)

**27842. Electric percussive tools.** Newton. (American Inventions Company.)

**28458. Incandescent electric lamp.** Howorth. (Guest and Hills.)

**28797. Apparatus for indicating the number of a telephone subscriber.** Andersen. (Date applied for under International Convention, March 30, 1904.)

**28824. Electric lighting arrangements for internal-combustion engines.** Renault. (Date applied for under International Convention, Feb. 2, 1904.)

**29142. Space telegraphy.** Stone. (Date applied for under International Convention, Feb. 23, 1904.)

**29143. Space telegraphic receiving systems.** Stone. (Date applied for under International Convention, Feb. 23, 1904.)

**29144. Space telegraph systems.** Stone. (Date applied for under International Convention, April 11, 1904.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ¾-¼ xd |
| Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 7/16-17/32 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | – | 5¾-6¼ |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | – | 5¼-5¾ |
| —— 4½ per cent. Mortgage Debentures | 100 | – | 101-104 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 99-101 xd |
| British Westinghouse Elec. and Manuf., 5 per cent. Pref., 275,001-375,000 | 5 | – | 3¼-3½ |
| —— 4 per cent. Mortgage Debenture Stock | 100 | – | 88-91 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,751 | 2 | – | ½-¾ |
| —— Non. Cum., 6 per cent. Pref. | 2 | – | 1¼-1⅜ |
| —— 4½ per cent. 1st Debenture Stock | 100 | – | 92-95 xd |
| —— 4½ per cent. 2nd Debenture Stock | 100 | – | 79-82 |
| Callender's Cable, Debentures | 100 | – | 106-107 |
| —— Ordinary | 5 | – | 11 11¼ |
| —— 5 per cent. Pref. | 5 | – | 5¼-5⅜ |
| Crompton and Co. | 5 | – | 2¼ 2⅜ |
| —— 5 per cent. Debentures | 100 | – | 96-98 |
| Edison and Swan United, "A" Shares, 1-99,251 | 5 | – | ¾-1 |
| —— "A" Shares, 01-017,159 | 5 | – | 1-1¼ |
| —— 5 per cent. Debentures | 100 | – | 81-86 xd |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 77-82 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | – | 1¼-1⅛ |
| —— 7 per cent. Cumulative Pref. | 2 | – | 2⅛-2¼ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | – | 97-99 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | – | 9¼-10 |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | – | 91-96 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | – | 13 13¼ |
| —— 4½ per cent. Preference | 5 | – | ⅝-⅝ xd |
| —— 4½ per cent. Debentures | 100 | – | 109 111 xd |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | – | 16-17 |
| —— 4 per cent. Debentures | 100 | – | 100-103 |
| Parker, Thos., Limited, Ordinary | 10 | – | 10-10¼ |
| Telegraph Construction and Maintenance | 12 | – | 35-37 |
| —— 5 per cent. Bonds | 100 | – | 102-104 |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary | 10 | – | 12¼-12⅜ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | – | 9¼-10 |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | – | 11-12 |
| —— 4½ per cent. Debenture Stock. Red. | 100 | – | 104-106 |
| Bromley (Kent) Electric Light and Power Co. | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. 1st Debenture Stock, Red. | 100 | – | 101-104 |
| Brompton and Kensington, Ordinary | 5 | – | 10¼-11 |
| —— 7 per cent. Preference | 5 | – | 10¼-10⅜ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 | 5 | – | 9 9¼ |
| —— Nos. 60,001-80,000 | 5 | – | 6¼-7 |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | – | 12¼-13¼ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 105-108 |
| Charing Cross and Strand, Nos. 1-70,000 | 5 | – | 7⅛-8⅜ xd |
| —— 70,001-80,000 | 5 | .. | 7⅜-8¼ |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 4 15/16 5 1/16 |
| —— 40,001-80,000 | 5 | .. | 4 15 16-51 16 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | – | 103-105 |
| Chelsea Electricity Supply | 5 | – | 6⅜-7¼ |
| —— 4½ per cent. Debentures | 100 | – | 109-11 |
| City of London, Ordinary | 10 | – | 12¼-13 |
| —— 6 per cent. Cumulative Pref. | 10 | – | 13⅜-14¼ |
| —— 5 per cent. Debenture Stock | 100 | – | 123-127 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | – | 103-105 |
| County of London Electric Supply, Ordinary | 10 | – | 9¼-10 |
| —— 6 per cent. Cum. Pref. | 10 | – | 12¾-12⅞ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 103 105 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. | 100 | .. | 110-113 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | – | 6¼-6¼ |
| —— 6 per cent. Cum. Pref. | 5 | – | 6¼-6⅜ |
| —— 4½ per cent. First Mort. Deb. | 100 | – | 106-108 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 2-2¼ |
| —— 5 per cent. Debenture Stock, Red. | 100 | – | 86-91 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | – | 5¼-6 |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | – | 101-104 |
| Havana Electricity, Limited, 1-15,000 | 10 | – | 9¼-10¼ |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | – | 7⅛ 8 |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 101-103 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 | 1 | – | ⅜-⅜ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | – | 12⅜-13½ |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red | 100 | – | 102-104 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅜-10¼ |
| London Electric, Ordinary | 5 | – | 2 9/16-2 13/16xd |
| —— 6 per cent. Pref. | 5 | – | 5⅞ 6¼ xd |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | – | 99-101 |
| Metropolitan Ordinary | 10 | – | 18⅜-19¼ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | – | 110-115 |
| —— 4½ per cent. Cum. Pref. | 5 | .. | 5⅜-5⅜ |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | – | 97-99 |
| Midland Electric Power Dis., Ld., 4½ p c. 1st Mort. Deb. | 100 | – | 98-100 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | – | 98-101 |
| —— Preference | 4 | – | 100-102 |
| Notting Hill Electric Lighting | 10 | . | 14¼-15¼ |
| —— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.) | 100 | | 102-104 |
| Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,310 | 5 | – | 6¼-6¼ |
| —— 4 per cent. Debenture Stock | 100 | – | 98 100 |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures | 100 | – | 100-102 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 | – | ⅞-1 xd |
| —— 4 per cent. Debenture Stock | 100 | – | 79-83 |
| South London, Ordinary | | – | 4¼ 4⅜ |
| South Metropolitan Electric Light and Power Co., Ord. | 1 | .. | ¾-1 |
| —— 7 per cent. Cum. Pref. | 1 | .. | 1 13/32-1 15/32 |
| —— 4½ per cent. 1st Mort. Deb. | 100 | .. | 107-110 |
| —— Ditto, June, 1904 | | .. | |
| St. James's and Pall Mall, Ordinary, 101-80,080 | 5 | – | 13¼-14 xd |
| —— 7 per cent. Pref. | 5 | – | 8¼-8⅜ xd |
| —— 3½ per cent. Deb. | 100 | – | 98-100 |
| Urban Electric Supply Co., Ordinary, 8-30,077 | 5 | – | 5 1/16-5 3/16 |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5¼-5¾ |
| Westminster, Ordinary | 5 | – | 12⅜-13¼ xd |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | – | 6¼-6⅜ |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 | 5 | – | 5⅛-5⅜ |
| —— Ord. | 5 | .. | 8¼-8⅜ |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | – | 140-143 |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 104-106 |
| Barcelona Tramways, Limited, Ord., 1-20,000 | 10 | .. | 12-12½ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 | 10 | .. | 9¼-10 |
| —— 5 per cent. Deb., Red., 1-600 | 100 | .. | 99-102 |
| —— 4½ per cent. Red. Deb. Stock | 100 | .. | 96-100 |
| Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606 | 1 | .. | ⅜-⅝ |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 | 1 | .. | 15/16-1 1/16 |
| Belfast Street Tramways, Ord., 1-26,600 | 10 | .. | 10⅛-11¼ |
| Blackpool and Fleetwood Tramroad | 10 | – | 13⅛-13⅜ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | – | 1¼-1⅜ |
| —— 5 per cent. Cum. Pref., Nos. 1 75,000 | 5 | – | 3⅜-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 91-96 |
| British Columbia Electric Railway Co., Ord. Def. | 100 | – | 105-106 |
| —— Ord Pref. | 100 | – | 100-103 |
| —— Non. Cum. 5 per cent. Pref. | 10 | – | 10-10¼ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each | 40 | – | 104-106 p s |
| —— 4½ per cent. Vancouver Power Deb. | 100 | – | 93-102 |
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 | – | 9¼-9⅜ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | – | 10¼-11¼ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | .. | 121-123 |
| —— 4½ per cent. 2nd Deb. Stock | 100 | | 97-99 |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Buenos Ayres and Belgrano Tram. Ord., 1-100,000 | 5 | 3¾-4 |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | 5¾ 5⅞ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | 5¼-5½ |
| —— 5 per cent. Deb. Stock, Red. | 100 | 107-109 |
| —— Prov. Cert., all paid | 100 | 102-105 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | 95-98 |
| Calcutta Tramways, Limited, 1-102,268 | 5 | 8⅜-8¾ |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | 106-108 |
| Cape Electric Tramways Nos. 1-480,000 | 1 | 1¼-1¼ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | 4⅝-5¼ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | 101-104 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | 102-104 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | 9½-10 |
| —— 5 per cent. Cum. Pref. | 10 | 11-12 |
| —— 4 per cent. Debentures | 100 | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | 13-14 |
| —— 5 per cent. Pref., Nos. within 1-60,000 | 10 | 15¼-16¼ |
| —— 5½ per cent. Mort. Debs., 1-3,000, Red. | 100 | 96-97 |
| Imperial Tramways Ordinary | all | 18-19 |
| —— 6 per cent. Cum. Pref. | all | 14-14¼ |
| —— 4½ per cent. Deb Stock | 100 | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000 | 5 | 3-3½ xd |
| —— 4 per cent. Debenture Stock | 100 | 89-92 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | 8-8½ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | 10-10½ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | 102 104 |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016. | 1 | 13/32 15/32 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | 31/32-1 1/32 |
| —— 4½ per cent. Deb. Stock, Red. | 100 | 105-107 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000 | $1,000 | 105-110 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 | 101-104 xd |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 | 103-105 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 31,001-74,000 | 5 | ¼-1½ |

| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | -12½ |
| —— 5 per cent Cum. Pref. | 10 | 9¾-9¾ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk. | 100 | 104-107 |
| Potteries Electric Traction, Ordinary 20,001-40,00 | 10 | 9 9¼ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | 8¼-9¼ |
| —— 4½ per cent. Debenture Stock | 100 | 102-105 |
| South Lancashire Electric Traction and Power Company —— £250,000 Ordinary | 1 | 1 |
| —— £101,152 5 per cent. Preference | 1 | 1 |
| —— £597,170 4½ per cent. Debenture Stock | 100 p.c. | 100 p.c. |
| **Electric Railways.—** | | |
| Central London, Ordinary | 100 | 93-95 |
| —— 4 per cent. Pref. | 100 | 101-103 |
| —— ,, deferred | 100 | 83-86 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | 110-112 |
| City and South London, Consolidated Ordinary | 100 | 45-46 |
| —— 4 per cent. Debenture Stock | 100 | 107-109 |
| —— 5 per cent. Pref. Stock '91 | 100 | 120-123 |
| —— ,, ,, ,, '96 | 100 | 118-121 |
| —— ,, ,, ,, '01 | 100 | 116-119 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | 10-10½ |
| —— Ordinary, 1-50,000 | 10 | 3¾-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — | 99-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | — | 98-99 |
| Waterloo and City, Ordinary | 100 | 92-94 |
| **Telephones.—** | | |
| National Telephone, Preferred | 100 | 112½-113½ |
| —— Deferred Stock | 100 | 106-108 |
| —— 6 per cent. Cum. First Pref. | 10 | 13-14 |
| —— 6 per cent. Cum. Second Pref. | 10 | 12-13 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | 5¼-5¾ |
| —— 5½ per cent. Deb. Stock, Red. | 100 | 99 101 |
| —— 4 per cent. Deb. Stock, Red. | 100 | 104-106 |
| —— 4 per cent. Prov. Cert. | — | 103-105 |
| Oriental Telephone and Electric Company | 1 | 1¼-1¼ |
| —— 6 per cent. Cum. Pref. | 1 | 1 3/16-1 5/16 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905 | 1904. | Week. | Current year. | 1904. | 1903 | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Car mile. | Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Mar. 4 | 1,080 | 1,103 | − 23 | + 3,737 *h* | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·14 |
| Ayr Corporation | ,, 4 | 182 | 156 | + 26 | — | 8 | 8 | ,, 15 | 14,160 | 3,201,585 | 316,049 | 1·03 | 10·11 | 1,770 | 5 0 |
| Barking Corporation | ,, 4 | 56 | 38 | + 18 | + 252 | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 5 | 950 | 830 | + 60 | − 953 | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,319,701 | 1·158 | 9·98 | 2,383 *b* | 6·1 |
| Birmingham Corporation | ,, 4 | 387 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | — | — | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | — | — | — | — | — | 24 | 23 | — | — | — | — | — | — | — | — |
| Blackpool Corporation | ,, 2 | 293 | 269 | + 30 | + 6,178 | 17½ | 17½ | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10 94 | — | 4·59 |
| Blackpool-Fleetwood Trams. | ,, 4 | 217 | 200 | + 17 | − 63 | 16½ | 16½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Bolton Corporation | ,, 5 | 1,674 | 1,531 | + 143 | + 624 | 38 | 38 | Dec. 31 | 32,021 | 2,253,984 | 600,757 | 3·34 | 12·75 | 2,001 | 7 05 |
| Bournemouth Corporation | ,, 1 | 873 | 734 | + 92 | + 2,251 | 10·15 | 10½ | March 31 | 94,161 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·89 |
| Bradford Corporation | Feb. 25 | 3,555 | 3,360 | + 195 | +29,738 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | Mar. 5 | 753 | 653 | + 100 | + 2,716 *h* | 9 | 7½ | — | — | — | — | — | — | — | — |
| Bristol Tramways Company | Feb. 24 | 4,263 | 4,357 | − 94 | — | 51½ | 51½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Burnley Corporation | Mar. 4 | 942 | 881 | + 61 | — | 10·60 | 10 | Dec. 31 *g* | 253,150 | 44,331,439 | 6,033,528 | — | — | — | — |
| Burton Corporation | ,, 5 | 295 | 274 | + 22 | — | — | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | Feb. 25 | 1,685 | 1,779 | − 94 | + 1,921 | 8½ | — | March 31 *g* | 11,574 | 2,556,134 | 232,378 | 1·08 | 9·81 | 1,570 | 7·57 |
| Carlisle Tramways Company | Mar. 4 | 137 | 157 | − 20 | − 225 | — | — | Dec. 31 *g* | — | — | — | — | 7·17 | — | — |
| Central London Railway | ,, 4 | 7,224 | 7 248 | − 24 | + 1,089 *h* | 6 | 6 | ,, 31 | 362,471 | 44,933,938 | 1,292,674 *a* | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 5 | 2,954 | 3,285 | − 331 | − 1,995 *h* | 6½ | 6⅝ | ,, 31 | 165,003 *a* | 19,069,319 *a* | — | — | — | — | — |
| Colchester Corporation | ,, 1 | 142 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. T. and L. Company | Feb. 25 | 374 | 367 | + 7 | + 29 | — | — | ,, 31 *g* | 25,657 | 6,353,323 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | Mar. 3 | 198 | 189 | + 9 | − 83 | 7·23 | 7·23 | March 31 *g* | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 4 | 165 | 151 | + 12 | — | 4½ | 4½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0·91 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | Feb. 24 | 91 | 87 | + 4 | — *h* | 7 | 6⅔ | Dec. 31 *g* | 6,211 | 888,905 | 107,164 | 3·88 | 14·09 | 952 | 7·39 |
| Dublin U. T., electric cars | Mar. 3 | 3,584 | 3,410 | + 174 | — | 47 | 46 | ,, 31 *g* | 134,643 | — | 3,429,356 | — | — | — | — *h* |
| Dublin S. District, Electric | ,, 3 | 731 | 660 | + 71 | | | | | | | | | | | |
| Dundee City Tramways | ,, 1 | 779 | 778 | + 1 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 6 | 630 | 557 | + 73 | + 1,783 | 10·77 | 10·75 | March 31 | 34,312 | 12,950,259 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 4 | 14,084 | 12,907 | +1,177 | +28,265 *h* | 145 | 123 | May 31 *g* | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 *b* | 7·40 *d* |
| Gloucester Corporation | ,, 1 | 207 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | Feb. 22 | 2,415 | 2,114 | + 301 | + 5,011 | 33 | 30½ | March 31 | 68,283 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,059 | 8·77 |
| Huddersfield Corporation | Mar. 4 | 1,207 | 1,079 | + 128 | + 4,140 | 35 | 35 | ,, 31 | 65,545 | 11,893,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | ,, 4 | 2,090 | 1,954 | + 136 | +11,210 | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | Feb. 25 | 346 | 337 | + 9 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | Mar. 1 | 102 | 120 | − 18 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 1 | 136 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 4 | 5,303 | 4,628 | + 680 | +16,359 | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | ,, 4 | 1,204 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | Feb. 25 | 9, 87 | 9,203 | + 184 | + 2,278 | 103 | 103 | Dec. 31 *g* | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | Mar. 6 | 1,420 | 1,449 | − 29 | − 541 *h* | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185 *a* | 1·82 | 19·30 *a* | 5,110 | — *a* |
| London County Council | Feb. 25 | 11,631 | 9,780 | +1,851 | +115,239 | 46½ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | ,, 27 | 120 | 128 | − 8 | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | ,, 23 | 91 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | Mar. 4 | 11,755 | 10,422 | + 934 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Metropolitan Elec. Tramways | — | — | — | — | — *h* | 10 | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 4 | 102 | 88 | + 14 | + 1,332 | 2½ | — | March 31 | 5,209 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newcastle-on-Tyne Corptn. | ,, 4 | 3,517 | 3,400 | + 117 | — | 45 | 38½ | ,, 25 | 135,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111 *b* | — |
| Newport (Mon.) Corporation | Feb. 11 | 465 | 460 | + 25 | + 1,333 | 15 | — | — | — | — | — | — | — | — | — |
| Oldham Corporation | Mar. 5 | 1,351 | 995 | + 351 | + 5,054 | 34½ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 4 | 1,285 | 1,285 | + 101 | + 6,529 | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·15 | 12·39 | — | — |
| Rochdale Corporation | ,, 4 | 412 | 97 | + 315 | + 6,735 | 4½ | 4½ | ,, 31 *g* | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | — |
| Rotherham Corporation | ,, 2 | 375 | 370 | + 5 | — | — | — | ,, 31 | 20,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 7·66 |
| Salford Corporation | ,, 6 | 3,779 | 3,453 | + 326 | + 9,595 | — | — | — | — | — | — | — | — | — | 6·68 |
| Scarborough Tramways Co. | ,, 4 | 63 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 5 | 4,442 | 3,938 | + 504 | + 6,507 | 7⅞ | — | — | — | — | — | — | — | — | — |
| Southampton Corporation | ,, 1 | 761 | 793 | − 32 | − 2,663 | 34½ | — | ,, 25 *g* | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southend-on-Sea Corporation | Feb. 22 | 218 | 229 | − 11 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Stockport Corporation | ,, 24 | 418 | 370 | + 48 | + 8,485 | 6¼ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | Mar. 6 | 1,105 | 1,016 | + 89 | + 1 602 | 11½ | — | — | — | — | — | — | — | — | — |
| Swindon Corporation | ,, 1 | 151 | — | — | — | 19 5½ | 18·48 | ,, 31 | 62,506 | 14,848,958 | 1,433,463 | 1·01 | 10·46 | — | 6·08 |
| Wallasey U.D.C. | ,, 4 | 658 | 551 | + 107 | + 2,191 | 3¾ | — | — | — | — | — | — | — | — | — |
| West Ham Corporation | ,, 2 | 1,063 | — | — | — | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·60 |
| Wolverhampton Corporation | ,, 1 | 639 | 333 | + 256 | — | 8 62 | — | — | — | — | — | — | — | — | — |
| | | | | | | 7½ | — | ,, 31 *g* | 20,873 | 4,263,066 | 417,335 | — | 12·005 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1905. *h* Half-year's figures. Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**New Publications.** — "Rateable Machinery," by G. Westall (London: Philip Allen and Co. 5s.). Nobody who is not a member of the legal profession would care about wading through the standard text-books on the subject of rateable machinery, and the author's concise review of the general principles regulating this matter, supplemented by abstracts of important cases, should prove of great utility.—Report No. 14 of the Engineering Standards Committee (price 2s. 6d.) The latest report of this committee deals with the standard specification for structural steel for marine boilers, which the main committee approved after the subject had been carefully investigated by a sub-committee.

**Cantor Lectures.**—On Monday last Mr. Herbert Laws Webb delivered the first of a series of four lectures on telephony at the Society of Arts. The importance of this industry, which has grown up within the past quarter of a century or so, was shown by the fact that over 5,000,000 telephones were in use, and a quarter of a million of men employed. The lecturer briefly described the acoustical requirements for telephony, and showed the evolution of the apparatus employed, how Reiss had made his investigations with interrupted currents, and how necessary for clear speaking were undulating currents. The names of Elisha Gray, Graham Bell, Edison, Hughes, Hunning, Blake, and others were mentioned, and their work in the development of the apparatus described. The voice of the lecturer was greatly assisted by screen illustrations, and excepting that, as in all these cases, the matter is too much for the time, the audience must have been edified at the clear and simple way in which the lecturer treated his subject.

**Electrification on the Brighton Line.**—One of the features in connection with the electrification of the Brighton Company's suburban service will be the type of car. As most of the traffic will probably be terminal, and in order to utilise the full carrying capacity of the line, it will be essential to reduce stoppages at the termini to a minimum. Besides adopting the multiple-unit system, end gangways on the cars will be substituted by sliding side doors along the whole length of the train, to facilitate the discharge of passengers. This arrangement is similar to that introduced on the Illinois Central Railway described in our issue of May 20 last. Instead of a centre aisle there will be a gangway down each side of the seats. This design entails a certain loss in seating accommodation, but it is stated that a later contrivance enables the seats to slide, so that the gangway on the other side from the platform can be utilised, the arrangement being reversed for the return journey. The doors will be operated by compressed-air motors, power being supplied by the Westinghouse brake reservoirs, and it will also be possible for passengers to open them independently.

**Glasgow Wiring Rules.**—The new issue of wiring rules by the Glasgow Corporation Electricity Department reflects the views on the earthing question expressed by Mr. W. W. Lackie in his paper before the Local Section of the Institution of Electrical Engineers. Thus the principal alteration in the new wiring rules is that dealing with the bonding and earthing of metal-sheathed conductors and metal tubes and conduits. The Corporation now most distinctly insist that all metal tubes into which insulated electric light wires are pulled must be connected together by means of properly screwed sleeves or couplings, or securely soldered together so as to form a permanently continuous conductor from end to end of the system. Also, where iron pipes are used for protecting insulated electric conductors, it is necessary always to keep these iron pipes clear of gas-pipes by means of a distance-piece, and special attention is drawn to the fact that this distance-piece is always fixed securely in position. There is a slight addition to the rule concerning the insulation of paper and jute-covered cables, and the undue use of flexible on installations is discouraged. Bare terminals on motors and accessories connected therewith are also prohibited, and these must be covered in some way.

**Royal Institution.**—Prof. J. J. Thomson delivered on Saturday the first of three lectures upon "The Electrical Properties of Radioactive Substances." Discussing the behaviour of a gas that was being ionised at a definite rate, the lecturer showed that the number of electrified particles could not increase indefinitely, because simultaneously with their production a process of destruction was going on. If a gas while being ionised was exposed to an electric field, some of the ions would be removed by being driven against the plates connected with the battery, and the greater the force the larger the number that would be so treated. The number of ions produced by the radioactive substance in a given time was not, however, indefinitely large, and therefore the conducting power of the gas would reach a limit beyond which it would be unaffected by any increase in the strength of the electric field. The current passing would thus reach a constant value, known as the saturation current. This current was most important in the study of radioactive substances, because it represented a perfectly definite quantity, and its measurement constituted the most delicate method of detecting a radioactive substance. On Tuesday next, March 21, at five o'clock, Prof. W. E. Dalby will deliver the first of two lectures at the Royal Institution on "Vibration Problems in Engineering"; and on Thursday, March 23, at the same hour, Prof. R. Meldola will begin a course of two lectures on "Synthetic Chemistry" (experimental). The Friday evening discourse on March 24 will be delivered by Sir Oliver Lodge, the subject being "A Pertinacious Current," and that on March 31, by Prof. J. Wright, will be entitled "The Scientific Study of Dialects."

**American Electro-Chemical Society.**—The annual meeting of this institution is to be held at Boston, Mass., on April 25, 26, and 27, and we give below the preliminary list of papers that has been announced. A plentiful supply of current for demonstrations and exhibition purposes will be available While limitations of space will not permit of a general invitation to manufacturers to display their products, the committee offer to make all possible arrangements for such exhibits on application being made to the secretary-treasurer, Prof. H. P. Talbot, Massachusetts Institute of Technology. The headquarters will be at the Hotel Lenox. The papers are as follows: "Microstructure of Silicon and its Alloys," by Mr. A. B. Albro; "The Migration and Coagulation of Colloidal Suspensions," by Mr. J. C. Blake; "Chromium," by Mr. H. R. Carveth; "Treating Low-Grade Ore and Tailings by Electrolysis," by Mr. Ernst Fahrig; "Billitzer's Method of Determining Absolute Potentials," by Mr. H. M. Goodwin; "An Optical Method of Observing Diffusion in an Electrolyte," by Mr. C. Hambeuchen; "Removing Solvents during Electrolysis," by Mr. Carl Hering; "A Low-Voltage Standard Cell," by Mr. G. A. Hulett; "Osmosis," by Mr. L. Kahlenberg; "Some Experiments with the Reduction of Titaniferous Ores into Steel and Titanate of Iron," by Mr. A. Lodyguine; "Experiments with the Reduction of Different Oxides of Lead by Electric Current," by Mr. A. Lodyguine; "Some Results of Experiments with the Electro-deposition of Metals on Aluminium,"

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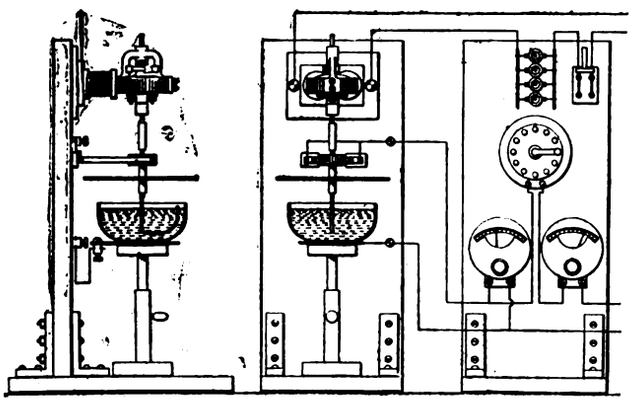
by Mr. A. Lodyguine; "The Interdependence of Atomic Weights and Electro-chemical Equivalents," by Mr. A. Reuterdahl; "Conduction in Electrolytes," by Mr. J. W. Richards; "Water Powers of the Canadian Hinterland," by Mr. C. C. Richardson; "Electro-deposition of Silver," by Mr. R. C. Snowden; "Adherence of Nickel to Nickel," by Mr. R. C. Snowden; and "A New Diaphragm Cell," by Mr. C. P. Townsend. Papers are expected from Messrs. W. D. Bancroft, C. F. Burgess, A. J. Rossi, and others.

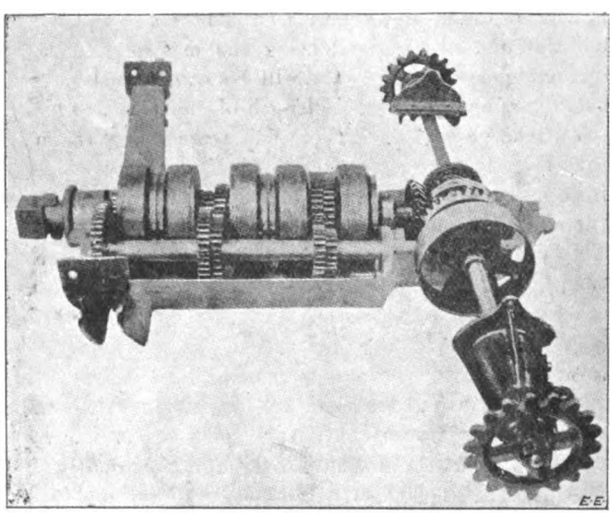
**Rotating Anode for Rapid Electro-Analysis.**—It has been found by Mr. N. M. Hopkins that by using a rotating anode for the electro-analysis of metals they can be completely precipitated in a few minutes, whereas with a stationary anode it is necessary to employ such feeble electric currents that several hours are occupied in the



process. He gives a description of the apparatus in the *Scientific American*. The outfit is exceedingly simple, as will be seen from the accompanying diagram. It consists of a vertical board firmly bolted to a heavy base by angle irons, and supporting an electric motor mounted with its shaft in a vertical position. Although this motor has practically no work to do in rotating the platinum wire in the solution, the use of a very small motor is to be deprecated, as it cannot be operated in connection with a lighting circuit, even by using a lamp bank. Directly under the commutator, upon which copper or preferably carbon brushes feed, is a large metal disc to prevent any minute particles from falling into the solution. The platinum dish should rest upon a sheet of platinum supported on an adjustable stand, in order that the dish may be quickly lowered to remove the anode. The necessary instruments for maintaining the proper electrical conditions are shown in the extreme right of the illustration. The author is contributing a series of articles upon "Experimental Electro-chemistry," appearing bi-weekly in the *Scientific American Supplement*, where a more detailed account of electro-analysis is given, and where those interested in this subject will find certain recent laboratory data. It may be stated, however, that the effect of the rotating anode is to maintain a homogeneous electrolyte by preventing concentrating changes due to differential ion velocity.

**Faraday Society.**—The first annual general meeting of this institution was held on the 6th inst., the treasurer, Dr. F. Mollwo Perkin, presiding. Allusion was made in the report to the enthusiastic efforts of Mr. Sherard Cowper-Coles, to which the formation of the society was largely due. At his suggestion an informal meeting was held, at which a provisional committee, consisting of Mr. J. Swinburne, Mr. W. R. Cooper, Mr. Cowper-Coles, Dr. F. G. Dorman, Dr. Perkin, and Mr. H. V. Simpson, the latter of whom has since been succeeded as secretary by Mr. F. S. Spiers, was appointed. Having extensively circularised the profession, it was decided to create an organisation for the study of electro-chemistry and kindred subjects under the title of the Faraday Society. The arrangement by which an exchange is made with the American Electro-chemical Society of the literature issued by the respective bodies has given mutual satisfaction. There is, however, one feature in the history of the society which the council cannot look back upon with gratification, the membership roll having remained practically stationary. We trust there will be a substantial response to the reiterated appeal of Sir Joseph Swan for wider support, in order to increase the range of efficiency of the society's operations. The officers for the ensuing year were elected as follows: president—Lord Kelvin, O.M., G.C.V.O., F.R.S.; past-president—Sir Joseph Wilson Swan, F.R.S.; vice-presidents—Prof. A. Crum-Brown, F.R.S.; Sir William Huggins, K.C.B., P.R.S.; Sir Oliver Lodge, F.R.S.; Ludwig Mond, F.R.S.; Lord Rayleigh, O.M., F.R.S.; Alexander Siemens, Pres.I.E.E; James Swinburne, M.I.C.E.; treasurer—Dr. F. Mollwo Perkin; council—George Beilby, Bertram Blount, W. R. Cooper, Sherard Cowper-Coles, Prof. A. K. Huntington, Dr. R. A. Lehfeldt, W. Murray Morrison, M.I.C.E., Dr. W. S. Squire, Dr. O. J. Steinhart, Prof. Ernest Wilson. The meeting concluded with votes of thanks to the retiring president (Sir Joseph Swan), the honorary auditors (Messrs. L. Gaster and T. M. Lowry), and to the Institution of Electrical Engineers for the free use of their library for the monthly meetings.

**Magnetic Change-Speed Gear.**—Suggestions have been made from time to time for the substitution of the ordinary cone friction clutch in motorcars by magnetic clutches, and the Société la Magnétie, of Paris, has designed such an arrangement, which is described in the *Car*. The change-speed lever is dispensed with, the speed being regulated by an electric controller, which replaces the sliding gear. The device consists of two steel plates for each speed, the plates being located opposite each other, with a short interval between them. One of them is hollowed out to contain the coil through which it is magnetised by a dynamo or accumulators.



This causes attraction between the plates, which adhere to each other. The pinions remain in gear, but are free to revolve round the first-speed shaft, except when the two plates corresponding to each speed are attracted towards each other. The first-speed pinion is attached to one of the plates, the other plate being attached to the first-speed shaft, so that when the two plates adhere to each other the first-speed pinion corresponding to them becomes solid to the first-speed shaft and drives the second-speed shaft, which, in turn, actuates the differential gear. This method has been found to greatly facilitate changes of speed, which

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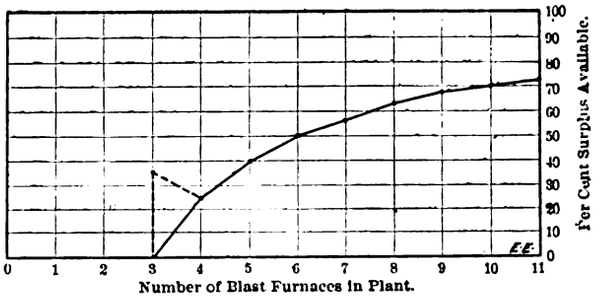
are accomplished without shock or noise. It is stated that a change can be made from the third speed to the reverse motion without any difficulty or danger, the reverse motion acting in this case as a brake until the car has stopped and reversed. If this device carries out its early promise, it will materially assist in disposing of the trouble with the cone friction clutches.

**Electric Lifting Machinery.**—Mr. Edward C. R. Marks read before the Birmingham and District Electric Club on the 11th inst. an interesting paper on this subject, in which he has specialised. The lecture was illustrated by a large number of lantern slides showing various types of electrically-driven lifting gear. Referring to overhead travelling cranes, the author traced the development of electrical driving from the single-motor crane exhibited at the Paris Exhibition in 1889 to the three-motor crane, which may be looked upon as standard practice nowadays. Further on in the paper, however, a description was given of a heavy crane in which four motors were used, there being two connected with the lifting gearing—*i.e.*, a small motor for light loads and a large one for heavy load. Referring to the gearing for such cranes, the author, while alluding to the simplicity and compactness of worm gearing, preferred under ordinary conditions spur gearing with machine-cut teeth as being more satisfactory. In very heavy cranes, however, the spur wheel on the parallel shaft is frequently made with machine-moulded teeth. When dealing with the question of the electric motors, the conclusions of Mr. A. P. Head, given at the engineering conference held in London in 1903, were quoted to the following effect: "The most suitable form of electric energy is continuous current at 220 to 500 volts. This is superior to alternating current on account of the greater starting torque and acceleration given by the former. The operations of a crane involve a rapid succession of startings and stoppings; continuous current occupies an unimportant fraction of the time, and loads are very variable. Alternating-current motors, while efficient at full load, can have a strong starting torque only at the expense of efficiency. Continuous current, on the other hand, admits of easier regulation of motors, is cheaper in wiring, and can be stored in batteries to equalise a variable load. Series-wound motors, which automatically run faster with lighter loads, should be used if they are coupled permanently to the gearing. They should withstand 100 per cent. overloading for short periods, and much higher loads momentarily without damage, which conditions are fulfilled by the ordinary tramway type. Where motors run continuously, with clutch connections to the gearing, they should be shunt wound." Mr. Marks seems to prefer the lower voltage of 220 for such work, owing to the danger from shocks when working at 500 volts. At the conclusion of the paper some interesting information was given of a large quantity of electric lifting apparatus recently manufactured by various manufacturers throughout the country. Concerning these, some useful figures were collected of the overall efficiency of overhead cranes, passenger lifts, jib cranes, etc. These efficiencies varied from about 55 per cent. up to over 80 per cent., and in one particular instance an electric winch is described, of which the efficiency is as high as 84·6 per cent. at full load and 83·1 per cent. at half-load. The question of brakes on lifting gear was also thoroughly gone into by the author, who spoke highly of the electrically-controlled band brake, such as is met with very frequently. Such a brake designed to hold up the load if the current is interrupted is an invaluable feature in electrically-driven apparatus. This electric brake is, however, frequently supplemented by a mechanically-operated one, especially in the case of jib cranes, when the barrel is not always in gear with the motor. The illustrations made the lecture a most interesting one, and it was highly appreciated by the members of the club.

**Power Gas for Blast Furnaces.**—There appears in the March number of the *Electro chemical and Metallurgical Industry* of New York an interesting article by Mr. F. du P. Thomson on the commercial possibilities of blast-furnace gas for the development of electric power. The author deplores the fact that until recently all the pioneering work in this field has been done on this side of the Atlantic. He attributes the inactivity of American engineers to the fact that they have had for the last four years an enormous volume of remunerative business to deal with, so that any money available was worth more as working capital than if used in providing more economical means of operation. The author looks into the question of how much power there would be available in connection with a given number of blast furnaces, assuming the blowing engines for these furnaces to be themselves worked by means of gas-engines. In reference to guarding against any reduction in the output when one or two furnaces are under repair, he finds that the surplus gas available increases rapidly with the number of blast furnaces in the plant. This is represented in curve form in the accompanying figure. After




dealing with the practical details of purifying the gas for use in gas-engines, figures are given to show the advantage of using such engines in connection with the blast furnaces themselves. The author then goes into statistics as to the cost of electrical energy obtained from blast-furnace gas. Such figures have been given before in our columns, and have been supplemented by results obtained in actual practice. It is interesting, however, to quote Mr. Thomson's net results, which are as follows: With a plant consisting of four 1,000-kw. units, of which one is to be used as spare, working with a load factor of 50 per cent. over 24 hours a day, he calculates that the total cost per unit will be about ½d. In this cost he allows 5 per cent. as interest and 8 per cent. for sinking fund, and assumes that each of the units is capable of working up to 50 per cent. overload. The cost per kilowatt-year of station capacity is then about £9, which, with the load factor in question, would allow of electric power being used over a considerable area. His other calculation gives for much the same plant, worked with an 80 per cent. load factor, but without any overload capacity, much lower figures. In this case he assumes that the same units will be rated as of 1,500 kw. capacity, and the cost per unit comes out as low as 0·219d. In these calculations no allowance is made for the gas taken from the blast furnaces, which at the present time is running to waste. The author estimates that the return to the blast-furnace owner if the power were utilised would be equivalent to 1s. 3d. per ton of iron produced in the first calculation, or to about 3s. per ton with an 80 per cent. load factor. The editor of our contemporary supplements these calculations by an interesting one which shows that the output of pig iron in the United States for 1904 was 16½ million tons. On Mr.

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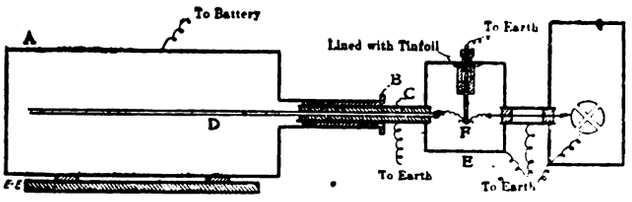
Thomson's figures the surplus gas from the furnaces producing this iron should develop nearly 900,000 h.p., which is almost one-half of the capacity of the electric central stations in the United States as given in the census report of 1902. The point for electrical engineers to remember is that while cheap power can be produced by the waste gases from blast furnaces, it is only by high-voltage transmission that this power can be conveyed to consumers in the surrounding areas. There is, undoubtedly, a large field in this country for this class of installation, but a substantial reduction in the prime cost of gas engines would help matters.

**Sensitive Quadrant Electrometers.**—Prof. J. C. McLennan, of the University of Toronto, recently delivered an address on the use of sensitive quadrant electrometers, an account of which appears in the *Electrical World*. Prof. McLennan stated that in making measurements upon the conductivity of a gas by means of a highly sensitive electrometer, such as the Dolezeleck type of instrument, considerable delay and inconvenience was frequently experienced on account of the disturbance imparted to the needle by simply breaking the earth connection to the free quadrants. Such disturbances are in great measure due to electrostatic effects caused by the approach of the observer's body, or even his hand, in the process of breaking the earth connection; and in order to avoid them, it has become the practice to surround the electrometer and the testing apparatus with earth-connected metallic screens, and also to make and break the earth connection to the quadrant by keys of a special form, which the observer can operate from a distance by means of strings or other connections. In using different keys, however, Prof. McLennan found that, with electrometers of high sensitiveness, small though relatively important initial disturbances still existed, and arose from a variation in the capacity of the measuring system caused by the action of the key itself when the earth connection was broken. In order to overcome this defect, it was only necessary to take special precautions in the construction of the key to reduce this variation in capacity to a minimum. The general arrangement of apparatus adopted in measuring the conductivity of a gas is shown in the accompanying diagram. The receiver, A, which contains the




gas whose conductivity is to be measured, rests on insulating supports, and is connected to a battery of small storage cells. It is provided with an ebonite plug, B, which carries an earth-connected brass tube, C. This tube in turn also carries a second ebonite plug, which supports the exploring electrode, D. The tube, C, and the electrode, D, penetrate a small wooden box, E, lined with tinfoil, also connected to earth, and connection is made at F with the contact key of special form. The electrometer is supported in a box of wood lined with tinfoil connected to earth, and its free quadrants are connected to the key, F, by a wire supported by ebonite plugs in an earth-connected brass tube, which at one end penetrates the box containing the key and at the other that containing the electrometer. The key of special form consists of two brass parts, as shown in the accompanying diagram, held by means of an ebonite support with their parallel faces as close together as possible without touching. The whole is supported against the tinfoil lining on the top of the box by a nut, which keeps the upper brass part always connected to earth. Both of the brass parts are pierced by a small opening less than a millimetre in diameter, and the earth connection to the quadrants is made or broken by inserting or withdrawing a fine rigid steel wire, which moves freely through this opening. It will be seen that with this device the earth connection can be broken with practically no variation in the capacity of the measuring system. By using this key and making the arrangements described above for screening off electrostatic induction, it has been found quite immaterial whether the earth connection is broken by hand or by means of strings operated from a distance. In either case the process is not followed by any disturbance of the needle. All initial oscillations are stated to be entirely eliminated, and the needle, although starting from rest at the moment the contact is broken, almost immediately assumes a steady rate, and its motion may be taken as a measure of the conductivity of the gas at the instant the quadrants are freed.

**Steel Cars on the New York Subway.**—In the equipment of the new steel cars for the New York Subway special attention has been paid to the design and protection of the car wiring, which is described in the *Street Railway Journal*. The adoption of car bodies employing steel exclusively, not only for framing, but also flooring, made it impossible to support the wiring beneath the floor by any of the usual methods. As it was desired to keep all the wiring and other equipment as far as practicable beneath the car body, it was necessary to construct mechanical supports for the large amount of wiring required and for the 12 rheostatic steps, and in this connection the following considerations had to be studied: safety from fire, which prohibited the use of wood; protection of wiring against abrasion; the use of insulation having an ample margin of safety with reference to the potential employed; and the reduction of the insulation to a minimum, the need of the last being emphasised by the fact that though the risk from any possible burning of wire insulation was negligible, there remained the chance of a panic through smoke from burning insulation. An insulation of very high grade and moderate thickness was therefore selected for the wiring, the insulation of conductors of the larger sizes being $\frac{1}{8}$in. thick, while that of the smaller

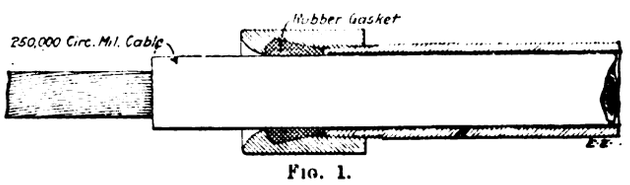



FIG. 1.

conductors is $\frac{3}{64}$in. The specifications called for not less than 30 per cent. of pure Para rubber. This insulation is covered and protected by a single "weatherproof" braid, and in the case of all the wires carrying comparatively heavy current, this braid is covered by a heavy coating of asbestos. The company decided to employ metal pipe conduits, thoroughly grounded, so as to secure the advantages of mechanical strength, durability, protection of wires against injury, and the consequent low maintenance cost. It was foreseen that unless some provision was made for holding the wires rigid at their outlets from the conduits, chafing and insulation would result at these points from the vibration of the cars, even with the usual smooth-edge outlet bushings. A special type of outlet bushing was, therefore, designed for covering the ends of all conduits, and combining the advantages of gripping the wires so tightly that movement would be impossible, while furnishing additional insulating properties at the gripping point. Fig. 1 shows a section of cable fitted with this bushing and

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a soft rubber gasket. Another interesting feature is the collecting shoe, which is of the slipper type. It is pivoted at a distance of 9in. from the contact rail centre, being held normally in its lower position by a spring on the pivot shaft. The wearing surface of the shoe is carried from the hinged portion by two slender prongs, webbed as indicated in Fig. 2. The prongs of the shoe are purposely made somewhat weaker than the balance of the casting, so that in case of meeting with an obstruction the breakage will occur at that point, throwing the shoe out of service, instead of breaking the supporting hanger and subjecting the contact rail to possible short-circuit. The shoe is arranged with a limit stop, the maximum possible drop

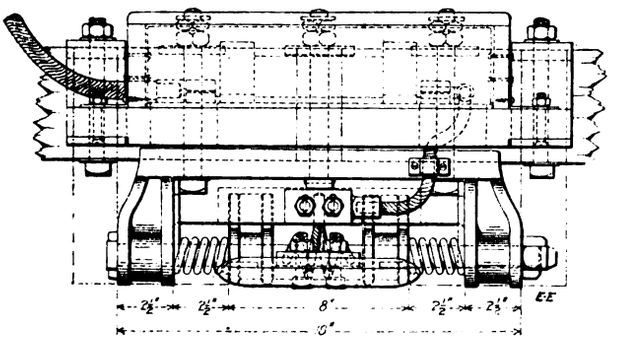

FIG. 2.

being 1½in., though a ⅛in. shim is used to reduce the drop to approximately 1in. The pivoted shaft for mounting the shoe is fastened in place by a key for quick removal. With express trains five motorcars and three trailers are used, and for the local service three motorcars and two trailers, each motorcar being equipped with two 200-h.p. motors.

**Solid-Forged Car Wheels.**—There appears in a recent issue of the *Street Railway Journal* an interesting description of a solid-forged and rolled steel wheel for tramway purposes. This wheel is being manufactured by the Standard Steelworks of Philadelphia, which company has installed a special plant for making the same. The object of the company is to prepare a wheel which shall successfully replace the steel-shod cast-iron wheels or the cast-iron wheels with chilled tyres which have been so largely used up to the present. In the manufacture of this new type the whole wheel is treated with as much care and forged as thoroughly as a tyre bloom, and is subsequently rolled to the required form and size, which so increases the strength of the hub and web that a much lighter design is permissible, reducing largely the weight in comparison with steel-tyred wheels. The method of rolling and arrangement of rolls is illustrated diagrammatically in Fig. 1, from which it will be seen that the arrangement is such that heavy work can be put on the tyre of the wheel. The steel used in the manufacture of these wheels is made from the acid open hearth of composition similar to that used for steel tyres of medium grade of hardness—that is, from ·60 to ·65 carbon. The method of manufacture has, however, appeared to increase the density of structure of the steel, so as to give better wearing qualities than would the steel tyres of the same chemical composition. The billets of steel from which each wheel is made are cut from long vertically-poured ingots, of which only the lower sections are used. These billets are first forged under a 5,000-ton hydraulic press into wheel blanks, which are then rolled into shape in the specially designed mill. This gives a good structure to the steel. The next process is the curving of the web of the wheel to the form shown in the illustration (Fig. 2), which is done in a smaller hydraulic press All the machinery required is electrically driven and arranged for the convenient handling of the wheels in their various stages of manufacture. The machining to be done after the wheels have been rolled and pressed is not much, and consists of facing the hubs and rims and truing the threads to the exact diameter. From

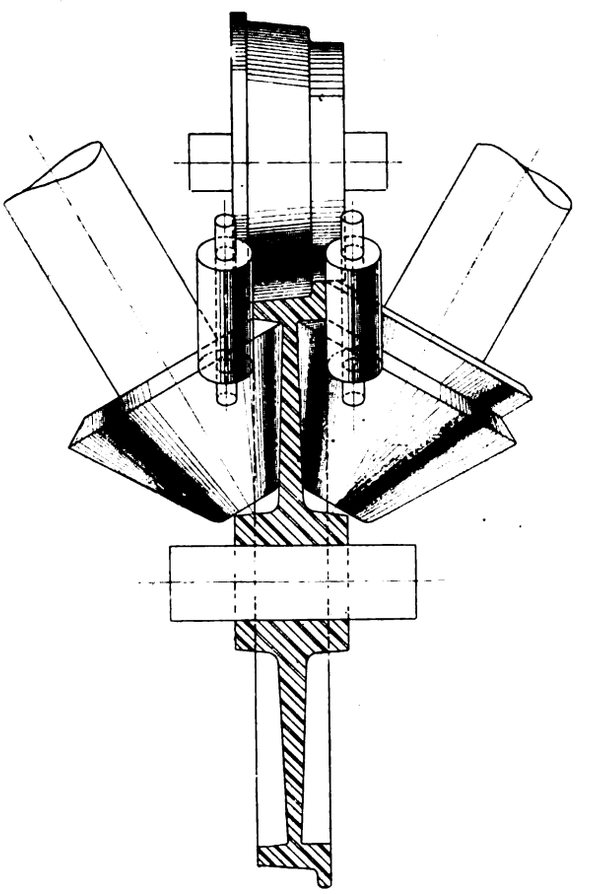

FIG. 1.

figures given in the article before us, we gather that samples of steel cut for these wheels have the high elastic limit of about 52,600lb. and an ultimate strength of about 124,000lb. per square inch. The weight of the finished

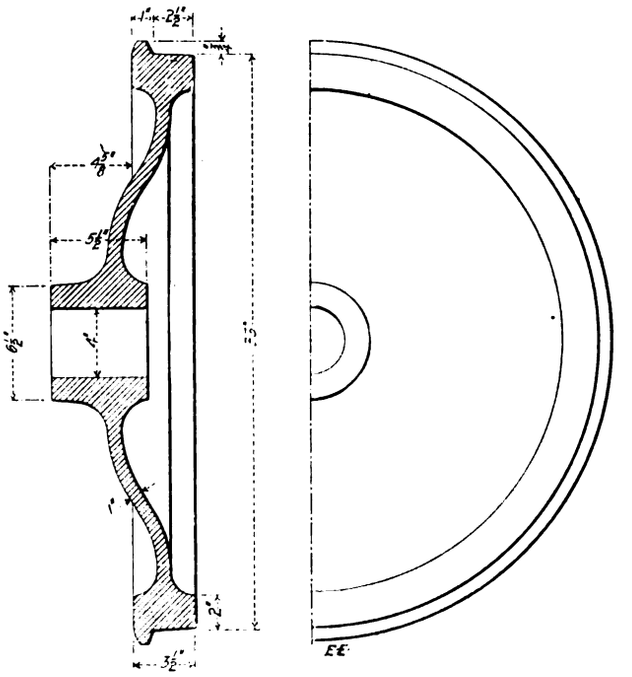

FIG. 2.

wheel, which is suited to freight as well as passenger traffic, is about 425lb. There is no doubt that wheels so formed must be more expensive than those which they replace, but we should expect a much longer life and more satisfaction in service.

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## ARMATURE WINDINGS OF THE CLOSED-CIRCUIT TYPE.

BY WM. CRAMP.

*(Continued from page 332.)*

**Appearance of the Two Forms of Drum Armatures.**

It has been said that the commutator and brush gear of a two-circuit machine may present exactly the same appearance as that of a multiple-circuit machine, but there is one difference in the armature itself which enables us usually to tell at a glance whether an armature is of the two-circuit or multiple-circuit form, particularly when it is bar wound—*i.e.*, with one pair of inductors per commutator section. It is this: since the two-circuit winding goes continually forward from pole to pole, the connection at one end of any inductor is practically parallel to that at the other end; but these two connections run in opposite directions around the armature periphery; so that, on the whole, the inductor with its two end connections will present somewhat the appearance of a distorted letter Z (thus ⥨). With the multiple-circuit winding we pass alternately forward and backward along the armature periphery, so that each inductor with its end connections has the appearance of a distorted letter ⊔ on its side (thus, ⊐); and this difference is commonly visible in modern dynamos.

**Rules for Two-Circuit Simplex Windings.**

We can now set to work to develop the rules which govern this class of armature.

It is better, perhaps, to commence with the idea of *distance-pitch*, so as not to lose sight of the most general case. For the same reasons as those given for multiple-circuit armatures, it is necessary to connect an inductor under the centre of a north pole with an inductor under the centre of a south pole. This would give for a machine with $p$ poles a distance-pitch $= \frac{1}{p}$ of the circumference (or, to make matters more clear, for a four-pole machine each end connection would span one-fourth of the periphery). In such a case, however, after $p$ connections the winding closes, so that for any large number of inductors we must take a different pitch if we wish to connect them into one winding.

We may at once repeat that here, just as much as in the case of multiple-circuit windings, the armature connections are assumed to be regular, so that the pitch at either end of the armature does not change throughout, though the two ends may have pitches differing from one another. Now we may, I think, safely assume that the two following points are obvious enough to need no demonstration.

1. If we consider the distance-pitch to be measured around the armature periphery, then since, after a definite number of such pitches the winding closes (or we return to our starting point), it follows that the length of the distance-pitch multiplied by the number of such pitches is equal to some multiple of the armature circumference in the same measure. This may be calculated in two ways. If we say that the armature is "so many" inches in circumference, then the distance-pitch in inches × the number of connections made = some whole multiple of the armature circumference. On the other hand, if, instead of measuring the armature circumference in inches, we say that it consists of "so many" inductors, then the distance-pitch would be measured by the number of inductor spaces which one connection spans, and thereby becomes what we have hitherto called the "number-pitch." Thus we have the average number of inductor spaces spanned by one end connection × the number of end connections = some *whole* multiple of the total number of inductors. This shows clearly also the close connection existing between distance-pitch and number-pitch.

2. Since the last connection must naturally join on to that end of conductor No. 1 which is open or unconnected, there must be an even number of end connections, or just as many at one end of the

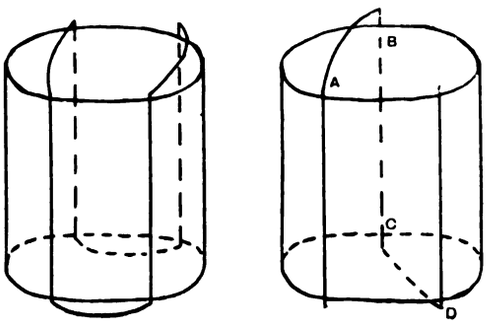


FIG. 17.

armature as at the other. Now, the total number of end connections is obviously equal to the total number of inductors, therefore there *must also be an even number of inductors*. Reference to such a simple diagram as Fig. 17 will soon prove the truth of this statement. It is easily seen that it is impossible to connect any armature with an *odd* number of inductors (such as that shown with 3, Fig. 17) by any regular system whatever. We get connections A B and C D, but then we should have to connect right across the armature from E to F, which, of course, is inadmissible, since it involves the equivalent of inserting another inductor. The armature with 4 inductors, however, connects quite easily. We see, then, that there must be an *even* number of inductors, and that except in the rare case when the number of inductors is equal to the number

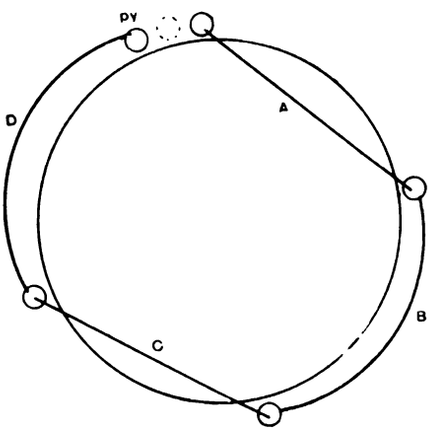


FIG. 18.

of poles, the number-pitch must *not* be equal to $\frac{w}{p}$. If the number-pitch is the same at both ends of the armature, we call it $y$; or if it be different at the two ends, let $y$ = the mean of the two values $y_1$, $y_2$: then we must arrange $y$ so that after having made $p$ connections, we arrive, not at inductor No. 1, but at the nearest inductor to it. For it is clear that the nearer we are to No. 1, after having made $p$ connections, the more nearly will $y$ be equal to $\frac{w}{p}$, which is, as has been shown, an advantage. Referring now

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to Fig. 18, which represents a four-pole armature, we make the four connections A, B, C, and D, and note that if A and C are at the front of the armature (or commutator end), B and D will be at the back. We also note that the connection which closes the winding must be at the opposite end of the armature to connection A.

Taking at first $y$ as nearly as possible equal to $\frac{w}{p}$, D will be connected to either the last inductor, or to No. 2. In any case, when we have made these four connections, the total number of inductor spaces *spanned* will be $4y$; consequently, if we have arrived at the last inductor, the total number of inductors is equal to $4y + 1$, and if we have arrived at No. 2 it is equal to $4y - 1$, or in the general case

$$w = py \pm 1$$

for such a winding.

Now, since $p$ is of necessity an even number, $(py \pm 1)$ must be an odd number. But we have seen above that $w$ must be an even number, consequently the formula

$$w = py \pm 1$$

is not tenable, a fact which becomes more clear if we try to connect up an armature fulfilling its conditions; for we find ourselves in the difficulty shown in its most simple form in Fig. 17.

**Meaning of "Creep."**

It is convenient here to introduce a word to denote the difference between the number of the inductors up to which the $p$-th (or in this case the fourth) connection brings us, and inductor No. 1.

This difference (representing the amount which the armature winding has progressed) is frequently called the "creep" of the winding. It is clear that it is equal to the figure after the "$\pm$" sign in the formula above. We have tried a creep = 1, and find that it gives an impossible arrangement: we may now take it equal to 2. The formula then is

$$w = py \pm 2,$$

which obviously fulfils the condition, that there is an even number of inductors.

Taking, again, a four-pole case, four times (or generally $p$ times) the mean pitch brings us to the inductor marked $py$, so that

$$w - 2 = 4y.$$

Whence, since $w$ = an even number, $y$ = either (1) a whole even number or (2) an odd number and a half or (3) an odd number.

Thus, if $w = 24$, $y = 5\frac{1}{2}$. Whence $y_1 = 5$ and $y_2 = 6$.
if $w = 26$, $y = 6$.
if $w = 30$, $y = 7$.

The first of these cases is inadmissible, since it does not agree with the first axiom on page 366. In the second case, just as for multiple-circuit windings, only half the number of inductors would be included if $y$ were an even number. We may, however, remedy this by using two pitches, both odd numbers, the mean pitch remaining an even number; thus if

$$y = 6$$

we take

$$y_1 = 7$$
$$y_2 = 5$$

The third case is the commonest of all, and the best generally; since it gives like connections at the two ends of the armature, which from the point of view of regularity and of ease in design is always an advantage.

In this way we arrive at a general formula for simple two-circuit windings:

$$w = py \pm 2,$$

in which, if the connections are to be the same at both ends, $y$ must be an odd number.

Referring now to Fig. 14 we have a four-pole case with a number-pitch of 5.

From the formula

$$w = 4 \times 5 - 2$$

the number of inductors = 18, and we see that after making four connections we arrive at inductor No. 3, giving the winding scheme shown on page 330.

An example of a winding arranged with the end connections differing by two is given in Fig. 19.

The scheme is 1—8—13—20—3—10—15—22—5—12—17—2—7—14—19—4—9—16—21—6—11—18—1.

$$y_1 = 7 \quad y_2 = 5 \quad w = 4 \times 6 - 2 = 22.$$

**Similarity between Multiple and Two-Circuit Windings.**

It is of interest to compare such schemes as those of Figs. 14 and 19 with similar windings for multiple-circuit armatures.

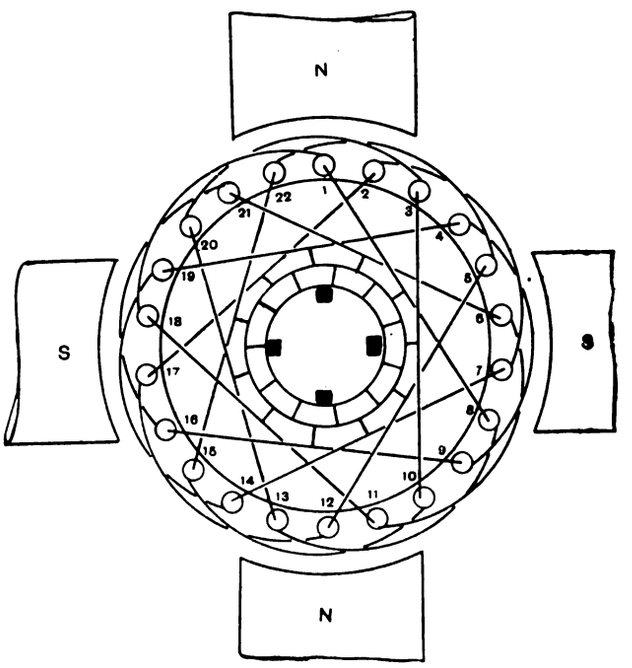


FIG. 19.

For simple windings of the latter type we found that the second connection should bring us to inductor No. 3. Similarly we now find that in these windings the $p$-th connection should bring us to inductor No. 3, or to that which corresponds to it—viz., the last inductor but one. Other points of similarity there are between the two classes of windings, and they will be pointed out as they occur.

*(To be continued.)*

## DISTANCE-CONTROL SWITCHES AND THEIR LAY-OUT IN STATIONS.

BY W. E. WARRILOW, A.M.I.E.E.

(*Concluded from page 231.*)

**Motor-operated switches have found considerable favour in America, whence the best-known type—that of the General Electric Company—has been introduced into this country and exploited by the British Thomson-Houston Company. It is the practice of this company to place all its large switches in separate brick compartments as a sure safeguard against damage to the neighbouring gear. In**

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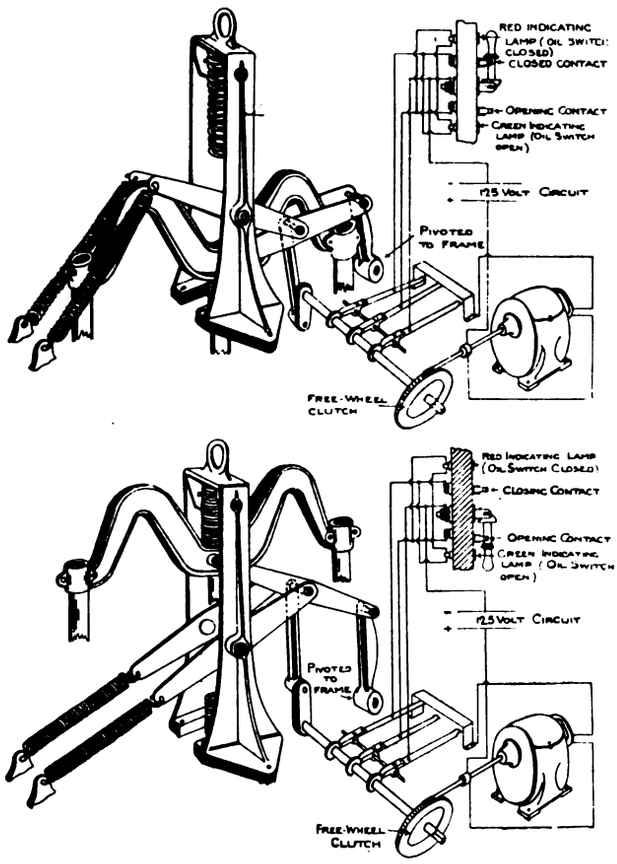
addition, the phases are similarly separated to confine any trouble arising in one limb to that member only.

The switch (Figs. 24 and 25) is almost identical with that described in Fig. 20, save that it is operated by a motor




FIGS. 24 AND 25.—Motor-Operated Oil Circuit Breaker in perspective, showing Motor and Connections (B.T.H.).

instead of by pull magnets. This motor serves to wind up the controlling springs when throwing in the switch, at the same time placing the knuckles of the lever system on a dead centre. The motor, which always runs in one direction, when used for opening the switch, breaks

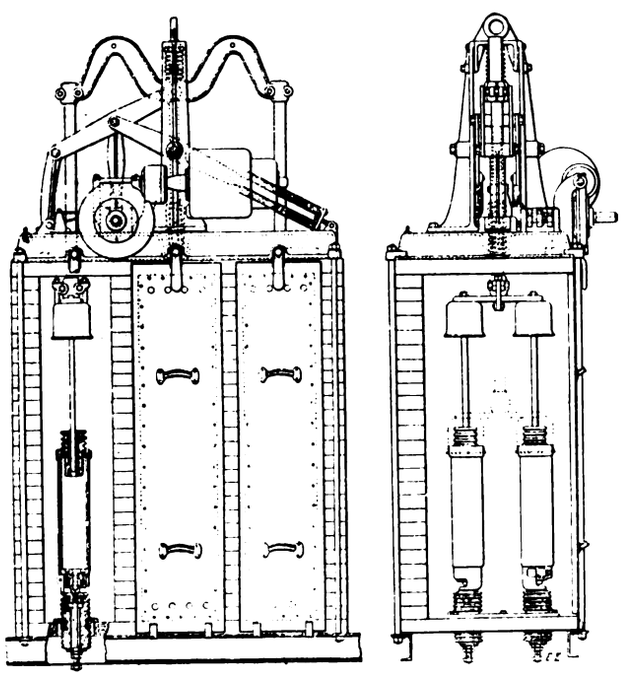
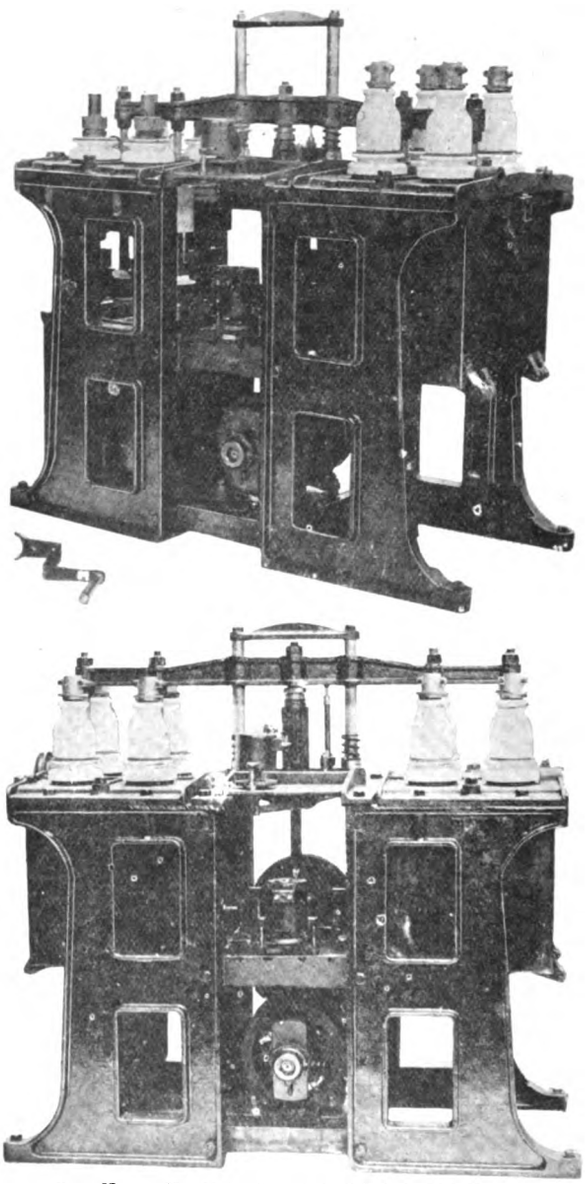


FIG. 26.—View of complete Motor-Operated Circuit Breaker, showing Contacts (B.T.H.).

this knuckle when the springs smartly open the switch, the over-running clutch permitting this sharp rotation of the first-motion shaft, independently of the motor. Three cams on this shaft operate three contacts in such a way as to signal to the operating board the position of the switch (by lighting red and green lamps) and keep the motor running should the control switch be released, a circumstance followed at once by its flying to the off position. In this case, however, the contact on the extreme right keeps the motor circuit closed long enough for it to put in the switch; the cam trips it once the switch is closed. A section through the complete switch is shown in Fig. 26, and in this the contacts can be clearly seen. The cable terminal is at the bottom of the switch and quite clear of the oil-chamber. Figs. 24 and 25 will explain the connections and on and off positions of the switch. It will be noticed that, in addition to the controlling springs, there are buffer springs which damp the blow of the cross-head when the switch is opened or closed.

In Figs. 27 and 28 are two views of a new oil switch, the design and production of Dick, Kerr, and Co. The principle of this is almost identical with that shown in Fig. 10 (p. 51), save that the operating is done entirely by a motor controlled



FIGS. 27 AND 28.—Motor-Operated Oil Switch (Dick-Kerr).

from a separate board. Tripping coils for overload and no-voltage release are fitted, and quick break is obtained by a falling weight. In one view the oil-tank is shown lowered to expose the contacts. A switch of this class is self-contained, and need not be enclosed in brick chambers. The lay-out of electro switchgears of this description is subject to much modification, and it is doubtful if any standards will ever be adopted for assembling the various apparatus. Now that circuit breakers, comprising one circuit unit as opposed to switch and fuse, are the recognised practice, less difficulty is experienced in making-up the complete gear. Four main sections can, however, be counted upon (1) the 'bus bars, (2) the switches, or circuit breakers, (3) the operating board, (4) the instrument and relay transformers. In very large plants a fifth

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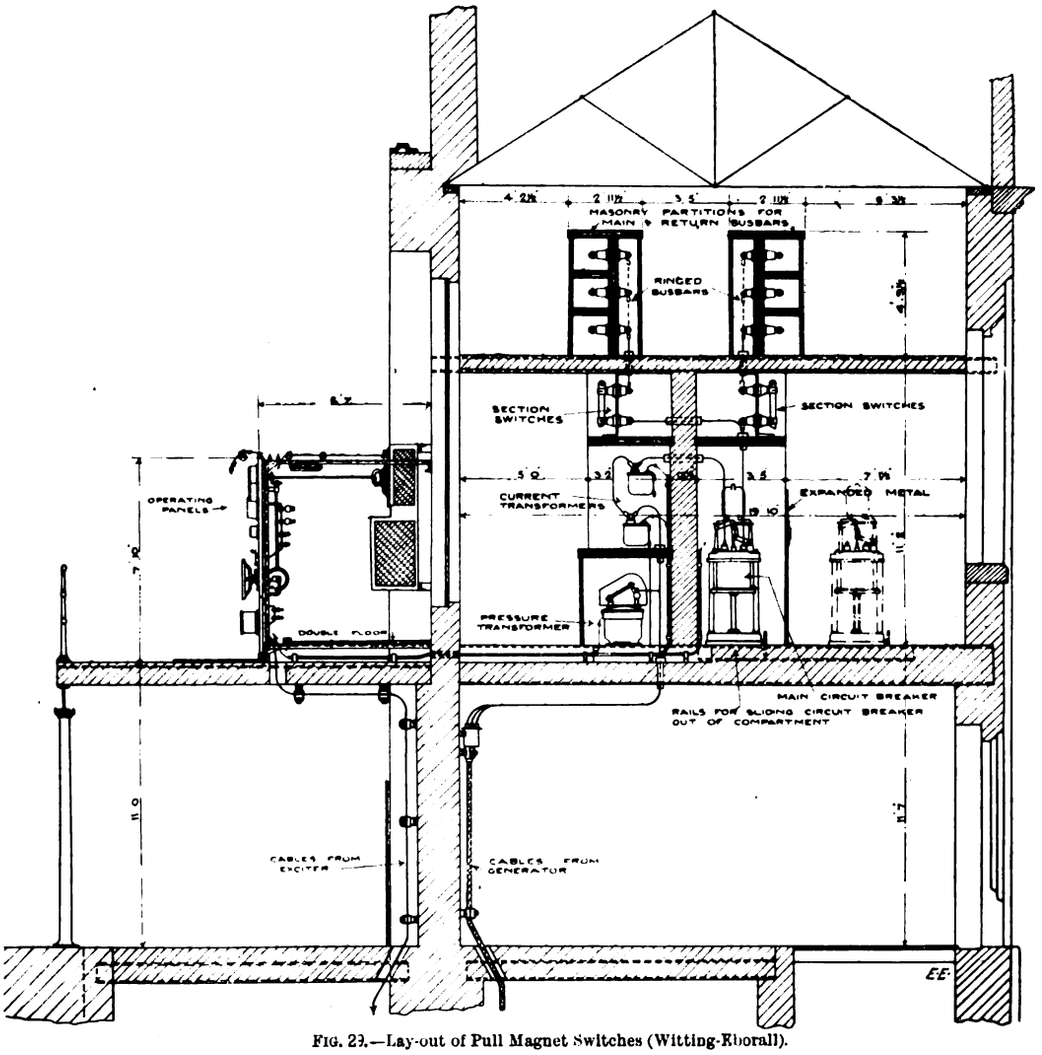


FIG. 29.—Lay-out of Pull Magnet Switches (Witting-Eborall).

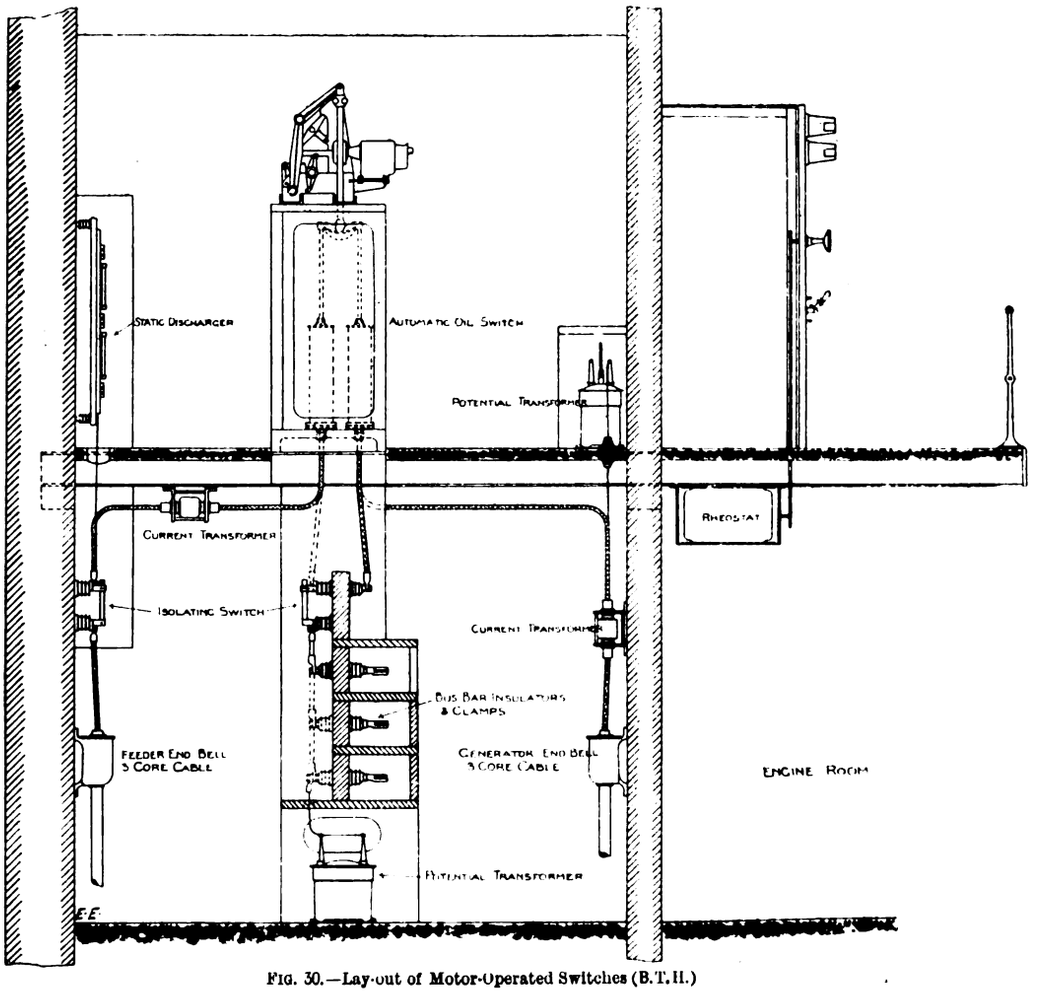


FIG. 30.—Lay-out of Motor-Operated Switches (B.T.H.)

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may be found in the cable section—a precaution necessary for isolating an important member in the system of energy transmission. Where the voltage is not excessive, care must be taken with the cables, but they need not necessarily be confined to a separate vault.

In Fig. 29 a lay-out of Messrs. Witting-Eborall's pull-magnet switch is shown. The gear requires two floors, one for the controlling gear, high-tension switches, etc., and the other for the high-tension 'bus bars, these latter being at the top of the whole. The high-pressure apparatus is in a separate switch house, and only the controlling board projects into and forms part of the engine-room. The wall of the latter divides off all high-tension gear from the operator, and ensures his complete isolation. As in previous cases with mechanical control, the exciter circuits, low-tension instruments, and control switches only are allowed on the operating board. The high-tension portion is divided by a wall up one side of which pass the generator cables, trifurcated into tails leading through the instrument transformers and main switch to two selector switches, permitting the use of either of two sets of 'bus bars which surmount the whole board. The oil switch can be drawn out to the position shown, for complete inspection, after the cables have been disconnected.

In Fig. 30 the B.T.H. lay-out is shown for the switches described by Figs. 24 and 25. Here a distinct contrast will be noticed in comparison to the lay-outs described above. The high-tension gear is again divided off as before and the control gear placed on a gallery to command the engine-room. In the high-tension room, however, the switches and 'bus bars are placed in the centre in two tiers, while the cables enter and leave the various panels by way of the walls. Referring to the diagram, the generator cable passes up the right-hand wall, through its dividing box and current transformer, and then crosses to the centre under the floor of the switch-room to the switch terminals (which are conveniently below the switch), thence through selector switches to the 'bus bars, these being below the switches. Feeder connections are taken from the 'bus bars through the oil switches, thence through cable bends to section switches on the left-hand wall to the cable terminal box as before. Potential transformers for wattmeters, etc, are placed below the main 'bus bars. Where duplicate bars are provided at the point directly below the switch, selector switches are fitted, permitting the switching of either set of bars to the particular generator or feeder circuit. A glance at this lay-out will at once indicate that the chief item likely to cause trouble, the circuit breaker, is placed in a position which, in case of switch failure, will ensure the damage being confined to the switch itself. The 'bus bars and cables are well out of the way, and as "shorts" are the least likely to occur on these, seeing that they are so completely isolated and partitioned, their location below the switch and in company with the cables should occasion the minimum of anxiety.

It is now considered that the oil circuit breaker is completely reliable, but provision must be made for the exception to that rule determining the factor of safety of any apparatus. In any high-tension switchgear the arc-producing portions of the gear should be mounted above everything else, so that when accidents happen, which they may readily do in large power plants, these parts must "fizzle out in splendid isolation" without shutting down the whole gear.

## ELECTRICAL TRANSMISSION.*

BY G. W. WORRALL, M.SC., M.ENG.

There is probably sufficient energy in a flash of lightning to light the city of Liverpool for a month, and sometimes the spontaneously generated earth currents are sufficient to seriously disturb the regular working of the telegraph line. But this native form of electricity has not yet been brought under sufficiently systematic control to serve the general purposes of man as a prime source of power. It is a fortunate circumstance, however, that this power may be generated under conditions which bring it under the absolute control of the engineer. The generation of the commercial electricity of to-day is brought about by the motion of a conductor across a magnetic field. To produce this motion involves the expenditure of some kind of natural energy. The kinds of energy most readily obtainable at present are the chemical energy of fuels and explosives, and the potential energy of the waterfall. One advantage of transforming these natural energies into electrical energy is in the facility with which the latter may be transmitted, almost regardless of distance, to those points at which there is the greatest demand for its use, and this with the least possible loss. Thus the modern engineer finds it to his advantage to transform natural energy into electrical energy, and electrical energy into mechanical energy. The selection of the natural energy to be thus transformed is a matter of no inconsiderable importance. For the advantage of one kind over another depends not only upon which kind is nearest to the point of demand, but also upon which kind will most economically meet the exigencies of the demand. For instance, suppose that the maximum demand greatly exceed the average demand, then the natural energy should be such as may be drawn upon to a greater or less extent, and without entailing continuity of the upkeep charges necessary to meet the maximum demand. The waterfall fulfils this condition better than other sources of energy, because the plant required for its utilisation is considerably less, and the cost of the energy is a less serious factor. On the other hand, when the demand is more nearly uniform, the generating plant is more fully utilised, and it may be more economical to use such sources of energy as are near at hand than to have an expensive long-distance transmission system to obtain the cheap energy of the waterfall.

These considerations bring us at once face to face with the all-important question of the efficiency of transmission, and to clear the ground one may pardon the statement of the truism that the most efficient transmission is that which is accompanied by the least loss. If R = the resistance of the line and C = the current flowing, then the loss of power in the line = $C^2$ R watts. Hence to obtain the highest efficiency it is essential that the value of the current be low. And as the power transmitted = potential difference on the line × the current, the potential difference must be high. Perhaps next in importance to ensuring the highest efficiency in transmission is to deal with the problem which affects the producers of most commodities—*i.e.*, the ever-varying demand on the source of supply. The parallel system of distribution deals with the problem by maintaining the potential difference constant and varying the current according to the demand. The constancy of the potential difference is maintained by numerous generators connected in parallel, all generating the same potential and capable of being switched in and out at will. The same obtains with regard to the demand. The motors utilising the current being connected in parallel, and thus are all at the potential of the line. In this arrangement of motors there would be a great danger from the high potential were it not that the electricity is transformed from a high potential to one at which it may be more safely handled.

The question next in importance is the form of the current best adapted to these processes of generation and transformation. The two forms of current in general use are the alternating and the continuous. Alternating may be generated at high tension by a single machine, while to generate continuous current at high tension several machines are required, and these in series. The transformation of alternating current from a high to a lower tension may be effected by a stationary transformer or by a motor-generator connected directly across the line, while that of the continuous is only possible by the employment of several motor-generators, the motors in series and the generators in parallel. These advantages have caused alternating current to be generally considered to be the best adapted for high-tension transmission. It must not, however, be thought that continuous current is entirely without advantages, and these principally consist in the facility with which the generators may be switched in and out of circuit, the simplicity of the switchgear which may be employed throughout the entire installation, the facility

* Paper read before the Liverpool University Engineering Society on Tuesday, Feb. 21, 1905.

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also with which the speed of the motors may be regulated and varied, and the partial absence of such phenomena as inductance and capacity. These advantages have probably led the Edison Continental Company, contrary to general practice, to select continuous current for a somewhat important installation they have equipped at Paris. In this case current is generated at 4,400 volts by groups of two machines in series and transmitted to a distance of 6 km., where it undergoes transformation to 130 and 260 volts by means of motor-generators which are arranged so that there are two motors in series and the generators are in parallel.

The partial freedom from inductance possessed by continuous current is perhaps the greatest advantage so far named. For the presence of inductance is a serious drawback to the use of alternating current, its presence, of course, being due to the very alternation itself, and its action being to oppose current changes and to reduce their value. Now, as the phenomena of inductance and capacity have just been referred to, it may not be out of place here

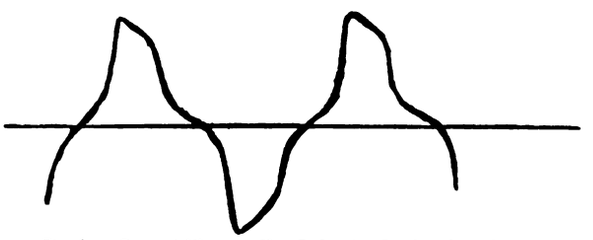

FIG. 1A.—Current Wave on Non-Inductive Load No Inductance. No Capacity.

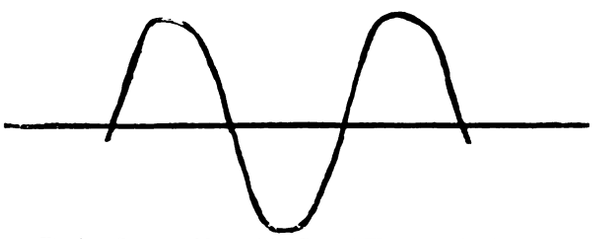

FIG. 1B.—Same machine as (A). Current Wave on Inductive Load. No Capacity.

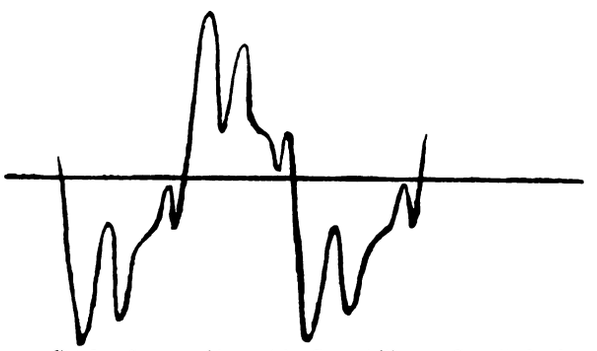

FIG. 1C. Same machine as (A). Current Wave on Capacity Load. No Inductance.

to consider their respective effects in high-tension transmission generally. These effects are broadly due to the tendency of inductance to retard current changes and the tendency of capacity to emphasise them. Thus, in switching on, inductance retards the rise of current, while the capacity of the line causes a rush, and the danger of this rush may be averted by a temporary increase of the inductance. The effect of inductance upon the wave-shape of the alternating current is to cause it to approach the ideal, while the effect of capacity is to further distort it, as shown in the oscillograph records (Fig. 1). In switching off, the inductance may produce such a high E.M.F. as to seriously endanger the insulation of the line, and its disturbing effect upon neighbouring telephone and telegraph wires is well known. The existence of capacity causes the line to remain charged after the circuit has been broken, and in the case of alternating current the potential of this charge may be even higher than that in the normal working. Both in switching on and switching off the combined action of inductance and capacity may produce dangerous electrostatic surgings in the line. All these effects as regards inductance, however, may be minimised by such transposition of the conductors as that the effects in alternate lengths tend to neutralise each other, and also by placing the conductors in close proximity to each other. But as regards capacity, the effects are emphasised by the close proximity referred to, which latter is a necessary part of underground work. And the capacity effects of the materials used in insulation are so much greater than those of air, that for long-distance transmission aerial lines are alone practicable.

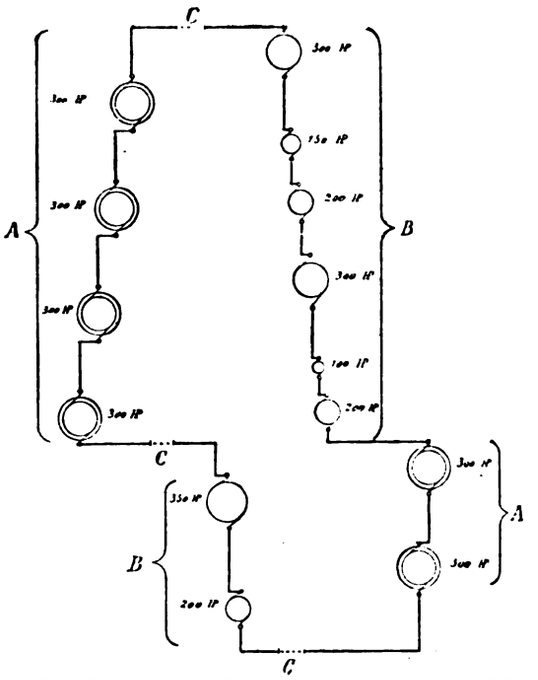


FIG. 2.—Thury Series System of Transmission. A A, generators; B B, motors.

Thus much on the subject of inductance and capacity, and to enter on this discussion has been somewhat of a digression, and it would scarcely be proper to leave the discussion of the respective advantages and disadvantages of alternating and continuous current for high-tension transmission which has been based upon general experience without referring to the special experience of M. Thury, a Swiss engineer,

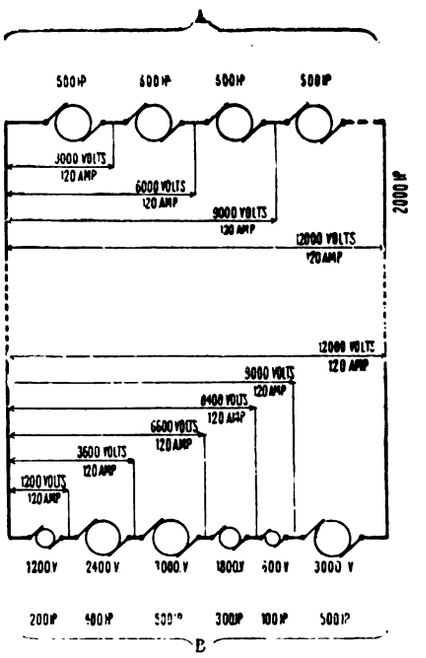


FIG. 3.—Diagram showing Distribution of Voltage on the Thury Constant-Current Series System.

and giving a brief description of, and cursorily remarking upon, the system by which he utilises continuous current for the same purpose. The principle of the system is to generate continuous current at very high tension and constant current, to transmit it to the nearest point of demand, continue it in series through all the points of demand to be supplied, and to return it through an insulated line. Thus as each consumer takes his quotum of energy from

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the line the tension is lowered. Not only are the points of demand in series with each other, but the groups of motors, or other users of the energy, are themselves in series with each other, so that the tension drops as the current passes through each piece of apparatus in succession. Each piece of apparatus on the line carries the full main current, and the whole of the apparatus is in one single series. The current is generated by machines so

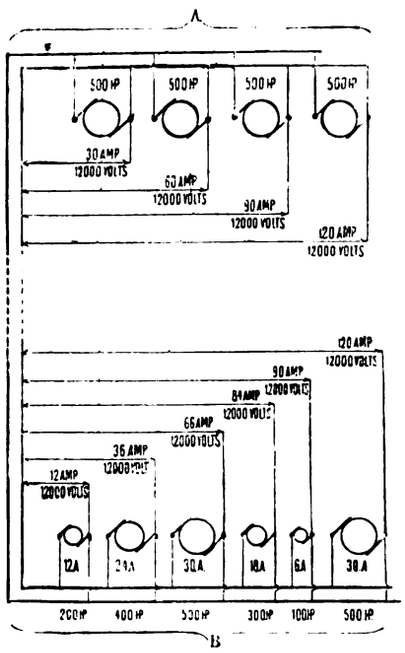


FIG 4.—Diagram for the same Generators and Motors on the Parallel System.

connected in series that as it passes through each machine in succession it is raised in potential by a maximum of about 2,000 volts. Thus 10 machines in series generate a maximum of about 20,000 volts, and the number of machines that may be employed is limited only by the insulation of the line. The variations in demand are met by varying the total potential difference on the line. Small variations are provided for by a regulator, automatic in action, which varies the total potential difference by

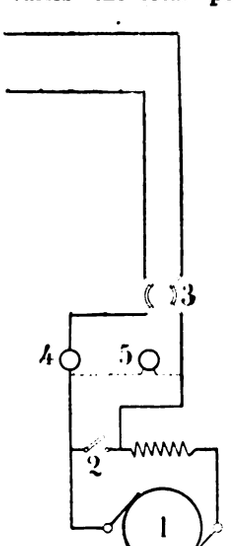


FIG. 5.—Switchgear required for each Generator on the Thury Continuous-Current System. 1 is the generator, 2 the automatic regulator, 3 the short-circuiting switch, 4 the amperemeter, 5 the voltmeter.

adjusting the speed of the entire set of machines running. Large variations in demand are provided for by switching individual machines in and out of circuit, which is effected respectively in each case by disconnection from the automatic regulator referred to, stopping and short-circuiting, and by practically the reversal of the process. It might be thought that the switching of an individual machine in and out of circuit would seriously disturb the entire system. This, however, is provided against by the automatic regulator, which serves to diminish or increase the speed of the machines remaining in, so that they collectively take the total load while an individual machine is being switched in or out.

It has been stated that the most efficient transmission is that which is accompanied by the least loss, and judged by this standard alone the transmission of electricity by the system now under consideration would be found wanting; for while in the parallel system the loss is in some degree proportional to the energy transmitted, in this application of the series system, of which constancy of current is a necessary part, the loss is the same whether the load be large or small. There is no system, however, without its disadvantages, but many of these may be outweighed by the one great advantage claimed for this system by M. Thury, and which consists of connecting in series power-houses of waterfalls situated long distances apart and the points of demand which lie between, which points may be individual factories or cities, and all as they occur *en route* (Fig. 2). Thus electricity at high tension is transmitted from the power-house of a fall to the nearest centre of industry, where, as has been shown, it loses potential. Therefrom and by a continuation of the same conductor to the next power-house *en route*, where it gains potential, and in the same manner through points of further

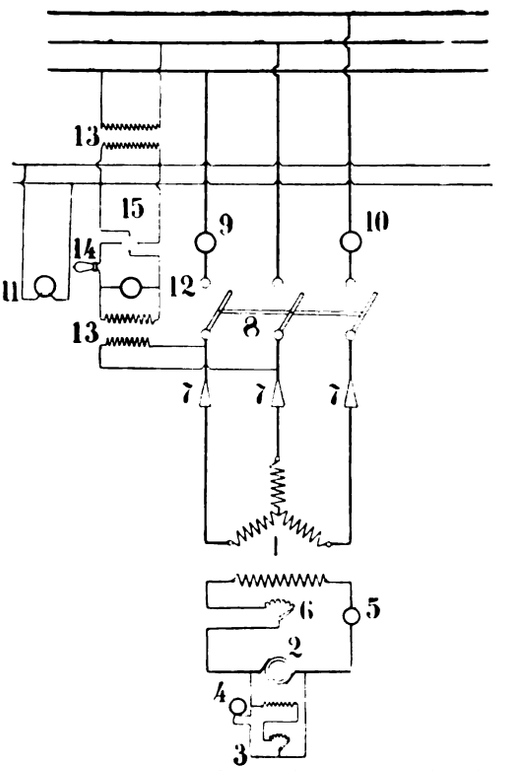


FIG. 6.—Switchgear, etc., required for each generating unit with the Three-Phase System. 1 is the Generator, 2 the exciter, 3 the exciter rheostat, 4 the exciter voltmeter, 5 the exciter amperemeter, 6 the alternator field rheostat, 7 the fuses, 8 the three-pole switch, 9 and 10 the amperemeters, 11 and 12 the synchronising voltmeters, 13 the two synchronising transformers, 14 the synchronising lamp.

demand and points of further supply, forming a huge loop closing at the point from which it started, and this without danger to life or property unless it be possible for the line to become accidentally connected to earth, as it will be remembered that only one line passes through the point of demand. Dwelling for a moment on this system of high-tension transmission, an imaginative mind can scarcely fail to see foreshadowed the decentralisation of industries and the reoccupation of rural hill and dale, where industries may be again pursued in pleasure and health to all. Thus much about M. Thury's generators and transmission, and a word about the motors to close.

Judging from theory, and without experience of the system, the behaviour of these motors would seem to be somewhat peculiar, for, unlike motors of other systems, the armature current would be constant as well as the field, with the result that the driving torque would be constant also. If this latter were less than the torque applied to the pulley, the motor would stop, and if the opposite were the case, the motor would race. These theoretical conclusions appear to have been realised in practice, for the inventor describes

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a special form of automatic regulator for adjusting the driving torque to that applied to the pulley. The action of this regulator is to shunt the field coils by a resistance, and thus to vary the strength of the field directly with the torque required, equalising the driving torque to that applied to the pulley, and thereby maintaining the speed constant. He further claims that the action is initiated by the speed of the motor itself, and that the regulator may be adjusted to any given speed within certain limits. It will be remembered that short-circuiting is applied to individual generators to disconnect them from the series to which they belong, and the same method is applied to the motors. The short-circuiting is effected by means of a by-pass, which under normal conditions is worked by hand, but which, when the current abnormally rises, is operated automatically. It may, however, be mentioned that in a system in which the current is constant, abnormal rising is infrequent, and overloading is never the cause, so that, contrary to experience with parallel systems, the armatures of these motors are not thereby liable to danger. If M. Thury's expectations are realised in practice, the constant-current system of high-tension transmission, which has for some time been considered impracticable, is established again, and not the least of its advantages is that every motor upon the line, independent of its relation to the source of energy, is supplied with the full amount of power it can take.

[An interesting account of a transmission between Lyons and Moutiers about to be installed on the Thury system will be found on p. 217 of our issue for Feb. 17. In this case voltages up to 57,000 will be needed at full load, but the system will be earthed, so that one-half of this voltage between any part of the line and earth will never be exceeded.—ED *E. E.*]

## A NEW OPERATING DEVICE FOR AUTOMATIC REGULATORS.

The usual method of automatically regulating the voltage of a circuit involves the rise of a delicate relay or contact voltmeter device for the purpose of setting the regulating apparatus (cell switch or resistance switch) in operation. A rise or fall in voltage from the normal deflects the voltmeter and closes a local circuit which starts the regulator in the correct direction for producing the required change in voltage. As soon as the normal voltage is reached again the contact is broken at the voltmeter, and the regulator comes to rest in its new position.

For direct-current circuits the voltmeter often takes the form of a solenoid connected across the voltage to be regulated, and acting on a tubular iron plunger suspended inside it by means of a spring. This plunger carries a contact arm free to make contact with one or the other of two fixed terminals, according to the position of the plunger in the solenoid. The position of the plunger is determined by the opposing actions of the magnetic pull due to the solenoid and the pull of the spring, and a definite position corresponds to every voltage across the solenoid. Any change in voltage causes one or the other of the forces to preponderate to an extent depending on the amount of the voltage change, and the plunger takes up a new balanced position. If a contact is to be closed by this movement, it is clear that the plunger must be arrested before the new balanced position is reached, if there is to be any force available for making the contact. On this account only a fraction of the net increase in pull can be actually employed. Further, the total net increase in pull will itself be very small, because the apparatus must be sensitive enough to act under voltage changes of the order of 1 per cent., so that only something like $\frac{1}{2}$ per cent. of the total ampere-turns in the solenoid can be employed for actually making the contact. The smallness of the actuating forces makes all such apparatus very delicate, and the distances moved through are also very small, so that only very small currents can be dealt with at ordinary voltages. Similar objections apply to contact devices of the Deprez type, in which a coil carrying the current moves in the field of a permanent magnet, and also to those of the Ferraris type, used for alternating currents, in which a metal disc moves under the action of a revolving field against the action of a controlling spring. These objections have led to numerous attempts to solve the problem in other ways, but without much practical success hitherto.

The *Elektrotechnische Zeitschrift* describes a new device, recently put on the market in Berlin, which would seem to overcome most of the difficulties. In this instrument two ordinary horseshoe electromagnets are employed, one to cause increase in voltage when required, and the other to cause decrease in voltage. A single electromagnet would be useless alone, because of the wide difference which would exist between the exciting voltage, which just caused the armature to be attracted up, and that which just allowed the counteracting spring to draw it off again. On the other hand, an electromagnet can be relied on to make satisfactory contact when once the correct actuating voltage is reached, for as soon as the magnetic pull overbalances the pull of the spring the armature moves towards the magnet, and so reduces the air-gap and increases the flux, which still further increases the pull. The armature is therefore drawn on with a rapidly increasing force, in spite of no further increase in voltage occurring, until it comes into actual contact with the magnet, or, at any rate, until the required electrical contacts are securely made. By employing two independent magnets this desirable result can be ensured for both decrease and increase of voltage from the normal, the magnets being set so that at normal voltage the armature of one of them is just on the point of being attracted up by the magnetic pull, and that of the other is just on the point of being pulled off by its spring.

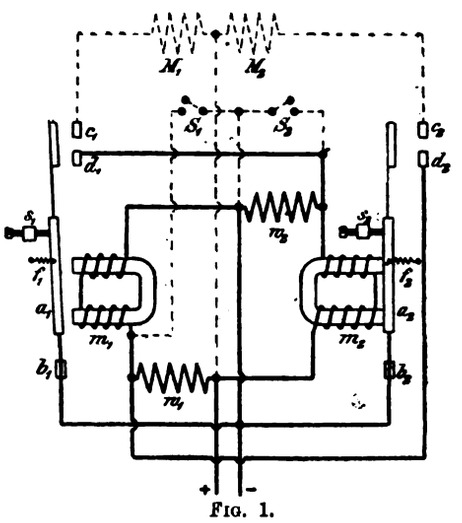

FIG. 1.

The actual connections employed with this apparatus are shown diagrammatically in Fig. 1. $m_1$ and $m_2$ are the two magnets connected to the supply (+ −) through the resistances, $w_1$ and $w_2$. $m_1$ makes contact when the voltage is above the normal, and $m_2$ when it is below the normal. The diagram shows the conditions existing at normal voltage. The adjustment of the screw $s_1$ and the spring $f_1$ determine the upper limit of voltage, and the adjustment of the screw $s_2$ and the spring $f_2$ determine its lower limit. Suppose that an excess voltage occurs. The first effect will be the drawing up of the armature $a_1$, connecting $b_1$, $c_1$, and $d_1$. This sends a current through the voltage adjustment apparatus, $M_1$, by means of which the circuit voltage is lowered, and at the same time the auxiliary switch, $S_1$, is closed. This short-circuits the magnet winding of $m_1$, and so allows the armature $a_1$ to fly back under the action of the spring $f_1$ into its normal position. This return opens the contacts $c_1$ $d_1$ and brings the voltage adjustment gear, $M_1$, back to its normal position and opens the switch $S_1$ again. In this way the original state is reached once more, with the exception that, in the meantime, the voltage has been lowered by the required amount, and so the armature $a_1$ will not be drawn up again. If, on the other hand, the voltage falls below the normal, the armature $a_2$ will be allowed to fall, and contact will result between $b_2$, $c_2$, and $d_2$, and the regulating apparatus, $M_2$, will be energised. This raises the circuit voltage, and at the same time closes

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switch $S_2$, which short-circuits the resistance $w_2$ in series with magnet winding $m_2$, and so strengthens this magnet sufficiently to ensure the armature $a_2$ being drawn up once more. This opens the circuit of $M_2$ and allows the voltage adjustment gear to return to its normal position, and also opens the switch $S_2$, thus reaching the original condition again, with the exception that the current round $m_2$ is somewhat increased by the rise in voltage effected. The contacts $d_1$ $d_2$ form a safety device for ensuring that both armatures shall never operate at the same time—for instance, owing to sudden voltage variations or to mechanical vibration of the instrument. When $a_1$ is drawn up, the operation of $a_2$ is prevented by the short-circuiting of the resistance $w_2$ through $d_1$ $b_1$. When $a_2$ is down, the operation of $a_1$ is prevented by the short-circuiting of the magnet winding $M_1$ through $d_2$ $b_2$.

The sensitiveness of the apparatus depends entirely on the accuracy of its construction. With the ordinary care obtainable in a manufacturing workshop, and the employment of flat steel springs for the armature supports, fine-thread adjustment screws at $s_1$ $s_2$, and long springs at $f_1$ $f_2$, (ensuring their being stretched by only a small fraction of their length), voltage regulation within a fraction of 1 per cent. can be depended upon. Such accuracy is seldom required in practice—*e.g.*, with cell switches the minimum steps which can be employed are of 1·9 volts each—but the fact that the instrument is capable of such fine adjustment ensures accurate results, whatever the limits may be for which it is set. The contacts consist of copper and carbon, and are so solid in construction, and the pressure with which contact is made is so great, that the instrument can deal with currents of several amperes at 220 volts, and so can be used without additional relays for the operation of quite large motors. The large forces employed prevent the ordinary vibrations met with in engine-rooms affecting the working at all, as they are liable to do in the case of the ordinary contact voltmeter devices, so that the apparatus can safely be mounted direct on the switchboard.

## TEMPERATURE CURVES AND THE RATING OF ELECTRICAL MACHINERY.*

BY RUD. GOLDSCHMIDT, ASSOCIATE MEMBER.

### I.—Short Time Rating.

It is a well-known fact that the energy lost in electrical machines is converted into heat, which causes the temperature of certain parts to rise above that of the surrounding atmosphere, and results in a dissipation of heat by means of radiation or convection. If no dissipation took place at all, the temperature would simply continue to increase in proportion to the time until either the insulation was burnt or the metal was melted. Given the specific heat of the material, the calculation of the temperature rise under any given conditions is a very simple matter, and in the case of the two materials, copper and iron, since their specific heat is nearly the same, we may assume an average value.

As a thermal unit, the kilowatt-hour or watt-second is a more convenient one than the B.Th.U. to adopt, and by this means we obtain the following practical method of measuring the specific heat of copper and iron: "3·5 watts lost in one cubic centimetre of copper or iron raise its temperature 1deg. C per second, supposing that no radiation takes place"; or in British units, "32 watts lost in one cubic inch of copper or iron raises its temperature 1deg. F. per second." If we call the watts lost in the unit volume $W_v$, the initial temperature increase per second V, and the watts per unit volume for the unit of temperature increase per second—that is, 3·5 in C.G.S. and 32 in British units—$C_v$, then

$V$ = initial temperature increase,
$W_v$ = volume watts,
and $C_v$ = rise constant.

The connection between these values is then given by the formula:

$$\text{Temperature increase per second} = \frac{\text{Volume watts}}{\text{Rise constant}},$$

or,

$$V = \frac{W_v}{C_v}$$

In many cases in practice an instrument is used for a few minutes only, and not more than once or twice a day, for instance, with apparatus such as starting transformers, the choking coils of single-phase motors, the small motors used for starting synchronous motors, etc. In these cases it is useless to apply the well-known "watts per square inch" rule for calculating the temperature, and it is a mistaken idea in designing these machines to take into consideration the providing of any cooling surfaces. The heat developed during the time the apparatus is in use is almost entirely spent in heating up the material, and the average temperature attained is too low and the time too short to dissipate any appreciable amount. In many other respects, as will be seen later on, it is of much practical value to study closely the behaviour of machines without taking account of the heat dissipated, but considering only "the initial temperature increase."

We may suppose a choking coil or starting transformer to be so dimensioned that if used only once a day for a period of, say, five minutes (=300 seconds) as a maximum, the temperature rise in any part will not exceed 16½deg. C. The frequency is to be 100 cycles per second, and we may assume that the excessively long starting period of five minutes is due to the fact that heavy weights have to be accelerated with a very low starting current. The temperature increase per second is $\frac{16\frac{1}{2}}{300} = 0{\cdot}055$deg. C. Since a rise of 1deg. C per second is caused by 3·5 watts per cubic centimetre, the energy lost in one cubic centimetre must in this case be $3{\cdot}5 \times 0{\cdot}55 = 0{\cdot}19$ watt. Considering first the question of the heating of iron parts, we have only to look at a hysteresis curve, showing the hysteresis loss per cubic centimetre at different flux densities for the particular iron we are going to use. This curve shows that at 100 periods the flux density corresponding to 0·19 watt loss per cubic centimetre (3·1 watts per cubic inch) is about 15,000 C.G.S. per cm.² (16 Kapp lines per square inch).

With regard to the heating of the copper winding, we must consider the following facts: A copper wire 100cm. in length and 1mm.² section has a resistance of about $\frac{1}{55}$ ohm; its volume is one cubic centimetre. To cause a rise in its temperature of 0·055deg. per second 0·19 watts must be lost in the wire. The current causing this loss in $\frac{1}{55}$ ohm can be obtained directly by Joules's law—

$$C^2 \times \tfrac{1}{55} = 0{\cdot}19, \text{ or } C = \sqrt{0{\cdot}19 \times 55} = 3{\cdot}2 \text{ amperes.}$$

The current per 1mm.² section would therefore be 3·2 amperes, or 2,000 amperes per square inch. Now to obtain a temperature rise of 16½deg. C. in five minutes we found that, quite independently of the size and surface of our apparatus, the flux density in the iron must be 16 Kapp lines per square inch, and the current density in the copper 2,000 amperes per square inch. We have, therefore, with the aid of an example, been enabled to formulate the following rule: "Machines which are to work only for a short time, with interruptions sufficient to allow them to cool down to the temperature of the atmosphere, must be so designed that the flux density and copper density do not exceed a certain amount, independent of size and cooling surface."

We can further conclude from our example that with short-period apparatus the flux density is practically only limited by the permeability of the iron, and not by the heating, since it is possible even under the severe conditions of a frequency of 100, a five minutes' starting period, and a permissible temperature increase of only 16½deg. C., to work at the high flux density of 15,000 C.G.S. per cm². In the example a current density of 3·2 amperes per mm.² correspond to $W_v = 0{\cdot}19$ watt per cubic centimetre, and to a temperature increase of 0·055deg. C. per second. As the watts are proportional to the square of the current density, we can deduce direct a general rule for calculating volume watts and initial temperature increase from the current density. If we denote the current density by the symbol $i$, we have

$$W_v = 0{\cdot}19 \frac{i^2}{3{\cdot}2^2} = 0{\cdot}019 \times i^2 \text{ watts per cubic cm.}$$

* Paper read before the Institution of Electrical Engineers.

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$$V \text{ per sec.} = 0{\cdot}055 \times \frac{i^2}{3\,2^2} = 0{\cdot}0055 \times i^2 \text{ deg. C. per sec.}$$

or,

$$V \text{ per min.} = 0{\cdot}0055 \times 60 \times i^2 = 0{\cdot}33 \times i^2 \text{ deg. C. per min.}$$

For convenient use tables are appended, giving the temperature rise per minute at different current densities:

TABLE I.—Copper Heating.

| Amps. per square millimetre. | Temp. rise deg. C. per minute. | Amps. per square inch. | Temp. rise deg. F. per minute. |
|---|---|---|---|
| 0·5 | 0·08 | 250 | 0·09 |
| 1 | 0·33 | 500 | 0·36 |
| 1·25 | 0·50 | 750 | 0·82 |
| 1·5 | 0·75 | 1,000 | 1·45 |
| 1·75 | 1·0 | 1,250 | 2·25 |
| 2 | 1·3 | 1,500 | 3·25 |
| 2·25 | 1·5 | 1,750 | 4·4 |
| 2·5 | 2·0 | 2,000 | 5·8 |
| 2·75 | 2·5 | 2,250 | 7·2 |
| 3 | 3 | 2,500 | 9 |
| 3·5 | 4 | 3,000 | 13 |
| 4 | 5·3 | 4,000 | 23 |
| 5 | 8·3 | 5,000 | 36 |
| 6 | 12 | 6,000 | 52 |
| 7 | 16 | 8,000 | 93 |
| 8 | 21 | 10,000 | 145 |
| 10 | 30 | 20,000 | 210 |
| 15 | 75 | — | — |
| 20 | 130 | — | — |
| 25 | 205 | — | — |

TABLE II.—Heating of Nickeline.

| Amps. per square millimetre. | Temp. rise deg. C. per minute. | Amps. per square inch. | Temp. rise deg. F. per minute. |
|---|---|---|---|
| 0·2 | 0·34 | 100 | 0·37 |
| 0·4 | 1·35 | 300 | 3·3 |
| 0·6 | 3·1 | 500 | 9·2 |
| 0·8 | 5·5 | 700 | 18 |
| 1 | 8·5 | 1,000 | 37 |
| 1·5 | 19 | 1,500 | 83 |
| 2 | 34 | 2,000 | 150 |
| 2·5 | 53 | 3,000 | 300 |
| 3 | 77 | 5,000 | 920 |
| 3·5 | 105 | 7 000 | 1,800 |
| 4 | 135 | 9,000 | 3,000 |
| 5 | 210 | — | — |
| 7·5 | 480 | — | — |
| 10 | 850 | — | — |
| 15 | 1,900 | — | — |
| 20 | 3,400 | — | — |

TABLE III.—Heating of Iron.

| Amps. per square millimetre. | Temp. rise deg. C. per minute. | Amps. per square inch. | Temp. rise deg. F. per minute. |
|---|---|---|---|
| 0·5 | 0·5 | 250 | 0·55 |
| 1 | 2·0 | 500 | 2·2 |
| 1·5 | 4·5 | 750 | 5·0 |
| 2 | 8·0 | 1,000 | 8·8 |
| 2·5 | 12·5 | 1,500 | 19·7 |
| 3 | 18 | 2,000 | 35 |
| 4 | 32 | 3,000 | 79·5 |
| 5 | 50 | 4,000 | 140 |
| 7½ | 112 | 6,000 | 315 |
| 10 | 200 | 10,000 | 880 |
| 15 | 450 | 15,000 | 2,000 |
| 25 | 1,250 | 20,000 | 3,500 |
| 35 | 2,450 | — | — |
| 50 | 5,000 | — | — |

Table II. shows the same figures for nickeline wire with a specific resistance 25 times that of copper, and Table III. gives those for iron with a specific resistance equal to six times that of copper. The figures will be found useful in the calculation of starting resistances, the formula being $V = 8{\cdot}5 \times i^2$ deg. C. of temperature rise per minute for nickeline wire, and $V = 2{\cdot}0 \times i^2$ deg. C. for iron.

In determining the section of the wire by means of these data, we are sure of an ample margin of safety as the loss of heat by dispersion has not been taken into account. To be quite accurate, however, a slight increase should be allowed in the temperature values in these tables to compensate for the increase of resistance with rising temperature. We see that for a starting period of one minute with a temperature rise of 70deg. C. per minute, the current density of

$$i = \sqrt{\frac{70}{8\,5}} = 2{\cdot}9 \text{ amperes per mm.}^2$$

(= 1,900 amperes per square inch) in nickeline wire must not be exceeded. A starting transformer or other short-time apparatus would under these conditions have the current density of

$$i = \sqrt{\frac{70}{0\,33}} = 14{\cdot}5 \text{ amperes per mm.}^2$$

(= 9,300 amperes per square inch) in the copper. As already mentioned, the limit of the flux density in the iron is practically unaffected by heating.

There is still to take into account the effect of the insulation. In a field coil consisting of average-sized wire the cotton insulation forms about 5 per cent. of the total weight, and owing to the close contact between the wire and the insulation, both will quickly attain the same temperature. Considering the field coil as a whole, we have no longer to deal with the specific heat of the copper alone, but with that of copper plus, say, 5 per cent. cotton. Assuming cotton to have six times the specific heat of copper, the average value of the specific heat for the coil is $1 + 0{\cdot}05 \times 6 = 1{\cdot}30$ times higher than that of copper alone. The average temperature increase per second might therefore be found to be $\frac{1}{1{\cdot}30} = 0{\cdot}77$. It should be noted that the temperature is lower with field coils of thin wire containing much insulation, and having a higher specific heat than with those having thick wire.

Up to the present it has been assumed that the apparatus gives out no heat to the surrounding atmosphere, but the extent to which this assumption is permissible depends on the kind of machine. With a totally enclosed stationary machine the heat dissipated is only a small percentage of that stored in the heated body itself, say during the first hour of heating. The temperature curve up to this point is an absolutely straight line, or, practically speaking, the temperature increase for the second half-hour is very nearly the same as that during the first half-hour. The following are approximate values for the time during which the apparatus can be considered as giving out no heat:

| | | |
|---|---|---|
| Revolving machines, | open | 20 minutes. |
| ,, ,, | totally enclosed | 40 ,, |
| Stationary ,, | open | ½ hour. |
| ,, ,, | totally enclosed | 1 ,, |
| Starting resistances, and generally single wires | | ½-2 minutes. |

## II.—THE TEMPERATURE CURVE.

Having dealt with the simplest case first, we will now proceed to the other extreme. The temperature of an apparatus will be supposed to have attained a constant value. Theoretically, this state can only be obtained after an infinite time, but actually it is so nearly arrived at within a few hours that a small fluctuation in the temperature of the atmosphere leads to perfect constancy. Under these conditions, the temperature reached by the heated body is sufficient to dissipate all the heat developed, and no further storing of heat—*i.e*, increase of temperature—will take place. This constant temperature is dependent on the lost watts, on the ventilation, on the cooling surface, and on the temperature of the surrounding atmosphere.

For the sake of simplicity we will assume in the whole of the following investigations that the air is at zero temperature. With a given amount of ventilation the difference in temperature between machine and atmosphere is directly proportional to the watts dissipated from one square inch of surface. For instance, in a field coil of an ordinary continuous-current generator, in order to obtain a temperature rise of 90deg. F. (50deg. C.) above that of the atmosphere, measured by resistance rise, about 4¾ square inches (= 30cm.²) cooling surface are required for every watt lost. In other words, a difference in temperature of 90deg. F. dissipates 0·21 watt from every square inch of surface, or $\frac{1}{4\,7\,5}$ watt per square inch per 1deg. F. rise. To state this in C.G.S. units, $\frac{1}{1\,5\,0\,0}$ watt is dissipated by one square centimetre of surface for an increase in temperature of 1deg. C. Henceforward we shall only employ C.G.S. units, and thus apply the factor $\frac{1}{1{,}500}$, which we will denote by the symbol $C_h$ (heating constant). The watts dissipated per unit of surface we will call "surface watts," symbol $W_s$. Surface watts = heating constant × temperature difference.

$$W_s = C_h \times t.$$

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With the definitions of volume watts ($W_v$) and surface watts ($W_s$), the rise constant ($C_v$) and heating constant ($C_h$), it will be possible to solve any problem in connection with the temperature rise of electrical machines, for intermittent or continuous load, without complex mathematical calculations. And it is proposed to follow the method previously employed of demonstration by the aid of a definite example, which will take the form of a field coil with a heating constant $C_h = \frac{1}{1500}$ and a rise constant $C_v = 4{\cdot}5$. In determining $C_v$, the cotton insulation has been allowed for by increasing the figure from 3 5 to 4·5. The surface watts are assumed

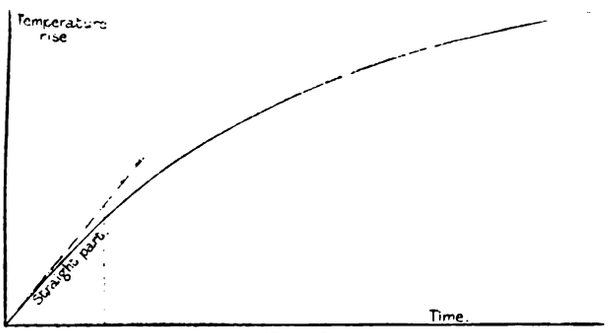


FIG. 1.

to be $W_s = 0\ 033$ watts per square centimetre, corresponding to a final temperature

$$t_f = \frac{\cdot 033}{\frac{1}{1500}} = 50\text{deg. C.}$$

The current density may be 1·7 amperes per mm². The initial temperature increase according to Table I., without taking into account the cotton insulation, would be 0·71deg. C. per minute. We have assumed in this case that the cotton insulation raises $C_v$ in the ratio 4·5/3·5. Consequently

$$V = 0{\cdot}71 \times \frac{3{\cdot}5}{4{\cdot}5} = 0\ 55\text{deg. C. per minute.}$$

When the final temperature of $t_f = 50$deg. C is reached, the heat developed—*i.e*, that amount which would increase the temperature 0·55deg. C. in one minute, neglecting cooling—is completely dissipated in the atmosphere in the same time of one minute. The whole of the 0·55deg. C rise per minute is neutralised by the cooling action. From this fact we may deduce the method for calculating the temperature at any desired instant. For example, at a given moment the body may have a temperature of, say, $t = 35$deg. C in excess of that of the atmosphere. Then the cooling action is less than that in the final state in the ratio of 35/50, and thus compensates for $35/50 \times \cdot 55 = 0{\cdot}39$deg. increase per minute. These 0 39deg. are completely neutralised by the cooling action, therefore, at the instant when the temperature of the body is 35deg. C in excess of the air temperature, the temperature increase per minute is 0·55 − 0 39 = 0 16deg. C. Thus we obtain the rule: "If the temperature of the body has attained, say, $\alpha$ per cent. of the final temperature, the increase of temperature per minute is $(100 - \alpha)$ per cent. of the initial increase."

Assuming that the temperature at a certain instant was known to be 35deg. C., this rule enables us to calculate the

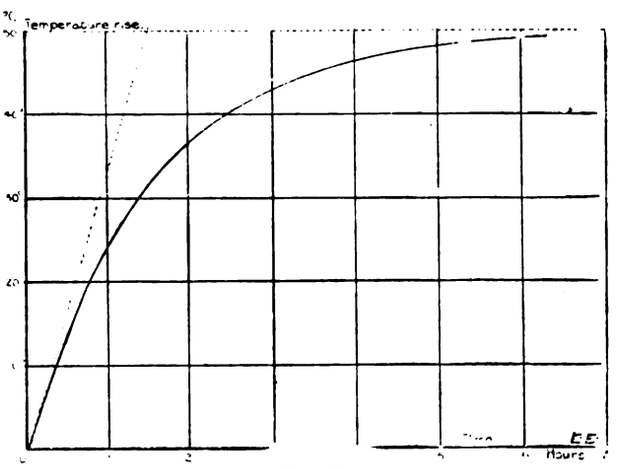


FIG. 2.

temperature, say, 20 minutes later. At the beginning of this 20 minutes' period the rise is, as we have just seen, 0 16deg. per minute. If the rate of increase were the same right through, after 20 minutes the temperature would be $0\ 16 \times 20 = 3\ 2$deg. C. higher—that is, it would now be 38·2deg., but the average temperature during the 20 minutes would be $\frac{38\ 2 + 35}{2} = 36\ 6$deg.—so that the corrected rise is

$$\frac{0{\cdot}55}{50}\ (50 - 36{\cdot}6) = \frac{1}{91} \times 13{\cdot}4 = 0{\cdot}15 \text{ per minute,}$$

or a total of $0{\cdot}15 \times 20 = 3$deg. The corrected temperature after 20 minutes would accordingly be 35 + 3 = 38deg. This value differs so little from the uncorrected one (38·2 deg.) that further correction is unnecessary.

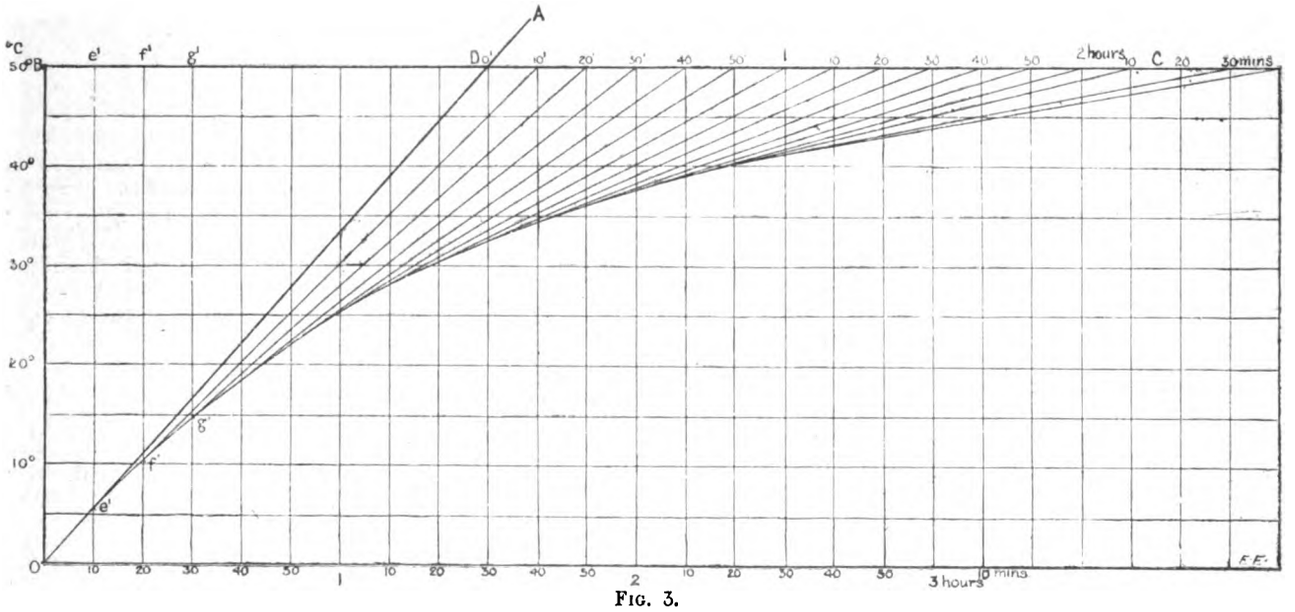


FIG. 3.

The full temperature curve may be calculated in the following manner: We first record our constants once more:

Surface watts, $W_s = 0{\cdot}033$ watts per sq. cm. of surface.
Current density, $i = 1\ 7$ amps. per sq. mm.
Heating constant, $C_h = \frac{1}{1500}$ watt per sq. cm per degree.
Rise constant (with cotton), $C_v = 4{\cdot}5$.
" " (without cotton), 3·5.
Final temperature, $t_f = \frac{W_s}{C_h} = 1{,}500 \times 0\ 033 = 50$deg. C.

Initial temperature increase from Table I. for a current density of 1·7 amperes per square millimetre = 0·71deg. per

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minute without cotton, or $0.71 \times \frac{3.5}{4.5} = 0.55$deg C. per minute with cotton. The temperatures at intervals of 20 minutes, as determined by these data, are given in Table IV.

TABLE IV. (See Curve, Fig. 2.)

| Time. | Temperature in the beginning of the 20 minutes' interval, $t_1$. | Uncorrected temperature increase $E_1 = \left(1 - \frac{t_1}{50}\right) \times .55 \times 20 = 11 - .22 \times t_1$ | Average temperature during the interval, $t_m = t_1 + \frac{E_1}{2}$. | Corrected temperature increase $E = 11 - .22 \times t_m$. |
|---|---|---|---|---|
| Hrs. Min. | | | | |
| 0 0 | 0 | 11 | 5.5 | 9.8 |
| 0 20 | 9.8 | 8.8 | 14.2 | 7.9 |
| 0 40 | 17.7 | 7.1 | 21.2 | 6.3 |
| 1 0 | 24 | 5.7 | 26.8 | 5.1 |
| 1 20 | 29.1 | 4.6 | 31.4 | 4.1 |
| 1 40 | 33.2 | 3.7 | 35 | 3.3 |
| 2 0 | 36.5 | 3 | 38 | 2.6 |
| 2 20 | 39.1 | 2.4 | 40.3 | 2.1 |
| 2 40 | 41.2 | 1.9 | 42.2 | 1.7 |
| 3 0 | 42.9 | 1.5 | 43.6 | 1.4 |
| 3 20 | 44.3 | 1.2 | 44.9 | 1.1 |
| 3 40 | 45.4 | 1 | 45.9 | 0.9 |
| 4 0 | 46.3 | 0.8 | 46.7 | 0.7 |
| 4 20 | 47 | 0.6 | 47.3 | 0.6 |
| 4 40 | 47.6 | 0.5 | 47.8 | 0.5 |
| 5 0 | 48.1 | 0.4 | 48.3 | 0.4 |
| 5 20 | 48.5 | 0.35 | 48.7 | 0.3 |
| 5 40 | 48.8 | 0.3 | 48.95 | 0.25 |
| 6 0 | 49.05 | — | — | — |

These results can be obtained even more easily in a simple graphical way (see Fig. 3). Draw line O A to represent the initial rise, which in our case is 11deg. per 20 minutes, and B C at a distance O B equal to the final temperature (50deg. C. in our case) parallel to the axis of the abscissæ. The lines cut one another at the point D. We next divide both the axis of the abscissæ and line D C (starting from point D) into intervals of 10 minutes, and draw verticals through every division point on this axis. The first of these verticals cuts O D at the point *e*. Join point *e* with point $10^1$ on line D C. Line $e - 10^1$ cuts the 20 vertical at *f*, then join *f* with $20^1$ on line D C. Line $f - 20^1$ cuts the 30 vertical at *g*. Join *g* with $30^1$ on D C, and so on. In this manner we get a number of lines which "envelop" the temperature curve. To construct this curve we have chosen intervals of 10 minutes only, whilst with the analytical working 20-minute intervals were used. The greater exactness is necessary because we now neglect the "correction" taking $E_1 = E$, and thus regard the cooling action as being dependent on the initial temperature of the interval. A comparison with the calculated values shows that the graphic method gives results which are sufficiently accurate for practical purposes. The two lines O D and D C determine the whole temperature curve. Therefore the form of all curves is similar, and having once plotted one it is applicable to all other cases. The only alterations necessary are the scales of temperature and time.

*(To be continued.)*

## MESSRS. EVERETT, EDGCUMBE, AND CO.

### REMOVAL OF WORKS TO HENDON.

In our issue for Dec. 16, 1904, we gave an illustrated description of many of the specialities of this firm, and some views of their workshops at Great Saffron-hill. We then mentioned the fact that the growth of the business had compelled the firm to build larger works at Hendon. These are now in full swing, and afford a striking proof of the rapid expansion of the company. Thus the business of Messrs. Everett, Edgcumbe, and Co. was founded, as our readers may remember, in 1900. After 18 months the expansion of the business was so great that a move into larger premises in Great Saffron-hill had to be made, and now, after three more years, the growth of the business has necessitated another exodus. A large site was obtained last autumn on the Edgware-road near Hendon, and in October the erection of a factory was begun. Four and a half months later the building was complete and ready for occupation, and now we hear that the work is in full swing there. The whole of the building has been carried out by the firm themselves, and they may be congratulated upon a very smart piece of work. The new factory is known as the "Collindale Works, Hendon, N.W," and will be devoted exclusively to the manufacture of electrical measuring, testing, and controlling instruments.

Offices have now been taken on the first floor of 87, Victoria-street, where not only can the various instruments be seen and examined, but also a member of the firm will almost always be found to discuss and give expert advice upon any question relating to the measurement or control of electrical energy.

Personal attention is the essence of success in such a business, and we are pleased to hear that Mr. G. J. Lemmens has joined the firm. This gentleman's extensive experience in instrument matters will greatly strengthen their position. After the 25th of this month all communications should be addressed either to the works at Hendon or to 87, Victoria-street, S.W.

## FORTHCOMING EVENTS.

FRIDAY, MARCH 17.

**Institution of Mechanical Engineers.**—At 8 p.m., "First Report to the Steam-Engine Research Committee," by Prof. D. S. Capper.

**Institution of Electrical Engineers (Manchester Students' Section).**—At 7.30 p.m., "High-Tension Switchgear," by Mr. C. R. St. John.

**National Physical Laboratory.**—At 3.30 p.m., annual general meeting at Bushy House, Teddington.

SATURDAY, MARCH 18.

**Institution of Electrical Engineers (Manchester Students' Section).**—At 6.30 p.m., annual dinner.

MONDAY, MARCH 20.

**Society of Arts.**—At 8 p.m., "Telephony," by Mr. H. L. Webb (Cantor Lecture II.).

**Institution of Electrical Engineers (Newcastle Section).**—"Electrically-Driven Lifts," by Mr. F. O. Hunt.

TUESDAY, MARCH 21.

**Institution of Civil Engineers.**—At 8 p.m., paper to be further discussed, "Shipbuilding for the Navy," by Lord Brassey, K.C.B. The succeeding paper will be "Coolgardie Water Supply," by Mr. Charles Stuart Russell Palmer.

**Royal Institution.**—At 5 p.m., "Engineering Problems," by Prof. W. E. Dalby (Lecture I.).

THURSDAY, MARCH 23.

**Institution of Electrical Engineers.**—At 8 p.m., discussion on "The Effect of Heat on the Electrical and Mechanical Properties of Dielectrics" and "On the Temperature Distribution in the Interior of Field Coils," by Mr. E. H. Rayner, M.A., communicated by Dr. R. T. Glazebrook, F.R.S.; and "On Temperature Curves and the Rating of Electrical Machinery," by Mr. R. Goldschmidt.

**Royal Institution.**—At 5 p.m., "The Reasonableness of Architecture," by Mr. T. G. Jackson, F.S.A. (Lecture I.).

FRIDAY, MARCH 24.

**Physical Society.**—At 5 p.m., at University College, "Note on the Voltage Ratios of an Inverted Rotary Converter," by Mr. W. C. Clinton; "On the Flux of Light from the Electric Arc with Varying Power Supply," by Mr. G. B. Dyke; "The Application of the Cymometer and the Determination of the Coefficient of Coupling of Oscillation Transformers," by Prof. J. A. Fleming, F.R.S.; exhibition of cymometers and other instruments.

**Institution of Civil Engineers.**—At 8 p.m., students' meeting. "The Wanki to Victoria Falls Section—Victoria Falls Railway," by Mr. C. T. Gardner; and "Design of a Double-Line Plate-Girder Railway Bridge," by Mr. H. S. Coppock.

**Royal Institution.**—At 9 p.m., "A Pertinacious Current," by Sir Oliver Lodge, F.R.S.

**Electro Harmonic Society.**—At 8 p.m., smoking concert in King's Hall.

SATURDAY, MARCH 25.

**Royal Institution.**—At 3 p.m., "Electrical Properties of Radioactive Substances," by Prof. J. J. Thomson, F.R.S. (Lecture III.).

**Institution of Electrical Engineers (Manchester Students' Section).**—Visit to Liverpool and Southport Electric Railway. Leave Victoria Station at 2.10 p.m.

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**Institution of Civil Engineers.**—The thirteenth "James Forrest" lecture will be delivered by Colonel R. E. B. Crompton, R.E., C.B., on Monday, April 10, at 8 p.m., the subject being "Unsolved Problems in Electrical Engineering."

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THE
# ELECTRICAL ENGINEER.

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### TO CORRESPONDENTS.

*All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

*All communications intended for the Editor should be addressed* C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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## STANDARDS FOR ELECTRICAL INSULATION.

The Engineering Standards Committee issued last year an interim report dealing with the standardisation of electric generators and motors, both for the direct-current and alternate-current systems. We published this report in our issue for Aug. 12, 1904, and expressed the hope that the standard sizes in it would be adopted by all English electrical manufacturers. This report was incomplete, because the committee could not lay down the safe limit of temperature either for continuous or intermittent working. In order to ascertain this a very extensive series of experiments have been carried out at the National Physical Laboratory by a sub-committee under the chairmanship of Dr. Glazebrook. The reference to this sub-committee included investigations on (1) the maximum temperature to which the insulating materials at present used in the manufacture of electrical apparatus could be exposed for lengthened periods of time without electrical or mechanical deterioration; (2) the permissible rise in temperature deduced from these experiments; (3) the relation between the mean temperature of any coil obtained by measurement of rise of resistance and the maximum temperature of the hottest portion of the same coil. The investigations on the first and last points have been carried out by Mr. E. H. Rayner, and were communicated last week by Dr. R. T. Glazebrook to the Institution of Electrical Engineers. We give elsewhere in this issue a brief *résumé* of this report, which indicates the vast amount of labour involved in the researches. The work has been carried out partly at the National Physical Laboratory and partly at the works of those manufacturers who have co-operated with the committee by providing the field-magnet coils to be experimented on. The figures actually obtained are, however, the more valuable because they have all been arrived at under similar conditions and under the supervision of the same skilled expert, which renders them strictly comparable. Up to the present the experience as to the safe limits for heating has been of the trial and error order, with the result that each manufacturing firm has accumulated information for their own use, and this even is frequently of an unreliable nature. As a result the temperature rises specified in enquiries for electrical plant are usually on the safe side. Also the method laid down of ascertaining the rise of temperature from the exterior of the insulated windings of a machine, is no criterion as to whether the interior portions of these windings may not reach a temperature which may be damaging to the insulation. It seems probable, however, that even these accepted limits for the temperature rise of dynamo conductors may be considerably increased without any ill effects resulting. The figures given as to experiments on a number of different field coils, both when in the laboratory and when placed on the dynamos under normal working conditions, are most valuable. After careful analysis they will enable a designer to avoid in future dimensions for coils which entail a large difference between the mean temperature of the coil and the maximum temperature in any one part. It seems, from the results given, that this difference seldom reaches 25 deg. C., and that it can be kept within much lower limits if certain precautions are adopted in the design of the former or coil. The work done to ascertain the change in the electrical and mechanical properties of the usual types of insulating material when subjected to high temperatures for extended periods is even more valuable. It is clearly shown from the figures that it is the mechanical properties of the materials which break down under heating The power to withstand a high voltage test is not so affected, and we return to the old problem of finding an insulating material whose mechanical properties

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shall remain satisfactory under all conditions of working. The figures given in the report help largely in the selection of insulation from this point of view. Indirectly there is a great deal of light thrown on the troubles which manufacturers of electrical machinery have had to surmount. For instance, the influence of moisture on the insulating properties of various materials is enormous. Experiments were therefore made to show how far the use of insulating varnishes would affect the other properties of the materials commonly used. Again, the absorption of moisture by the cotton covering of insulated wire was experimented with and figures obtained which show what an important department the drying ovens are in an electrical manufactory. With these figures before them, the Engineering Standards Committee will be able to draw up some general conclusions on temperature rating which will, we think, greatly assist English manufacturers in their competition against foreign firms. It is well that before these conclusions are issued there should be a free discussion on the facts, such as is to take place at the Institution next week. It is also well that there will be under discussion at the same time the most valuable paper by Mr. R. Goldschmidt on "Temperature Curves and the Rating of Electrical Machinery."

## TRAMS OR MOTOR 'BUSES.

In the first issue of the *Commercial Motor* Mr. Manville writes in defence of electric trams, Colonel Crompton in favour of the motor omnibus. However, when the matter is well considered the main conclusions of these great authorities are easily reconcilable. Both agree that under favourable conditions trams are excellent, both agree that under favourable conditions motor 'buses are better than trams—the line of demarcation is not, and cannot rigidly be, drawn, and in the middle way the fight in the future will wax fast and furious. Colonel Crompton makes two points which should never be forgotten: (1) cost per passenger car mile is determined by the average number of persons carried, not by the maximum that can be carried, and (2) that the kind and condition of road surface has much to do with the maintenance cost of motor 'buses. Mr. Manville very properly points out that electric trams use their own road beds, and wear and tear only their own portion of the roads, which they have to maintain.

# CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

## MR. MARCONI'S LECTURE.

SIR,—Your note in your issue for March 10 on Mr. Marconi's lecture at the Royal Institution shows some misunderstanding as to what Mr. Marconi said with regard to speed of working, which you will perhaps permit me to correct.

The speed of 24 words a minute, over a distance of 152 miles, which Mr. Marconi quoted, is not a new result, but relates to some stations which have been working for more than a year, and represents the average speed of those stations doing commercial work. As it happens, the messages sent are in Dutch, and they are transmitted by operators ignorant of that language. The 24 words a minute is not the maximum speed attained by the stations, but the average working speed under commercial conditions calculated over a long period. Probably the average working speed would be slightly higher were the messages transmitted in a language comprehended by the operators. The maximum speed attained in transmission by the stations in question is from 30 to 35 words a minute, the speed being limited by the capacity of the operator to read by sound.

The arrangement shown by Mr. Marconi at the Royal Institution lecture was the magnetic detector plus a recording instrument. The magnetic detector is capable of receiving impulses at a very high speed, but as hitherto it has not been found practicable to work in conjunction with it recording apparatus, no messages have been sent by its means at a higher speed than that at which the fastest sound-reader is capable of reading. When a recording apparatus is connected to the magnetic detector and an automatic transmitter used at the transmitting station, the average speed is very much higher than 30 or 35 words a minute. Probably the speed shown at the Royal Institution was about 60 words a minute, but it is not practicable with the comparatively primitive arrangements possible in a lecture hall to achieve the best results, and when the new arrangement is worked between commercial stations a considerably higher speed can be attained.

The speed of the De Forest instruments mentioned by Captain Lionel James, if higher than the speed of the stations to which Mr. Marconi referred as working at 24 words a minute, was higher solely because more expert sound-readers were employed. There are no wireless telegraph instruments of any kind other than those referred to by Mr. Marconi at his lecture which are capable of working at a higher speed than 30 to 35 words a minute.—Yours, etc.,

H. CUTHBERT HALL,
Managing Director, Marconi's Wireless Telegraph Company, Limited.

## THE LIFE OF NERNST BURNERS.

SIR,—I send you herewith records I have kept of two installations in Gloucester where Nernst lamps are used. The lamps are ½-ampere B type, on 220 volts continuous-current Corporation supply. The deplorable results obtained with the new-type U-filament burner, as compared with the old-type burner, are very marked. In both cases the lamps hang perpendicularly, and are well up out of reach.

Taking the installation with the old-type burners first. The records date from June 1, 1903, to March 7, 1905. Nine lamps are in use, with 200-volt burners and 30-volt resistances, and all renewals have been made with old-type burners. Four of the lamps have been lighted 1,056 hours, and five lamps for 2,420 hours, during the above period of 88 weeks. This gives a total of 16 324 lamp-hours, and 20 burners have been renewed; $\therefore \frac{16,324}{20} = 816{\cdot}2$ hours' average life of burner. Five resistances have also been renewed within the period.

We now come to the installation (a church) with the new U-type burners. The record dates from the first use of the lamps—Oct. 2, 1904, to March 7, 1905. Thirty lamps are in use, with 210-volt burners and 20-volt resistances. The lamps have been lighted a total of 66 hours during the above period of 22 weeks. This gives a total of 1,980 lamp-hours, and 21 burners have been renewed; $\therefore \frac{1,980}{21}$ = 94 3 hours' average life of burners. Two resistances have also been renewed. More than half of the burners in this case had the heating coil broken, and in the remainder the filament had shorted on to the heating coil.

The Nernst lamps will have to be discarded in the latter installation if they do not give better results. A remedy is badly wanted, or the makers will have reason to deplore their retrograde movement in compelling the use of the unreliable U-type burner in place of the earlier burner which had proved its serviceable qualities.

I would also add that, even if old-type burners could be obtained, they cannot be inserted in the new-pattern B lamp, as the casing of the latter is not sufficiently large in diameter to take them.—Yours, etc., WAWAMIEE.

[Our correspondent has had exceptionally bad experience with the new type of Nernst lamp, which is not in accord with what we hear of the performance of these lamps in other places. We wonder if the position of the church is at the end of a feeder, or if the curve of voltage variation on Sundays will explain the trouble.—ED. *E. E.*]

## APPRENTICESHIP.

SIR,—Having a son who will leave school next summer, and who intends going in for electrical engineering, I should

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be much obliged if you could give me some information about a firm at Loughborough, the name of which is Falcon. The boy is at school in Leicester, and is 16 years of age Also if you could inform me what you would consider a reasonable premium in apprenticing a youth to that trade.—Yours, etc., W. EDGERS.

[The information our correspondent requires as to the premium pupil system at the Falcon Works and elsewhere he should obtain direct from the different firms. We cannot pass editorial opinions on such personal matters, or on the amount of premium which may have to be paid.—ED. *E.E.*]

## THE CHANT OF THE MAINS MEN.

When the meter will not mete, and there's fireworks in the street,
And the navvy with the pick comes limping in,
When the neutral and the negative are coupled up consecutive
'Cause the jointer mixed the whisky with the gin,
Let us warble "Rule Britannia," and include "God save the King"
(And the brolly trickles water down your back).
For we've only got to test, and to do our very best
To deserve our little modicum of tin, tin, tin,
To deserve our little modicum of tin.

When the network's done a short, and the insulation's nought,
And the telephone is kicking up a din,
When the penny's in the slot, but the lights have gone to pot,
And the Gas Concern is trying not to grin,
Chant the Hallelujah Chorus, ask Bill Bailey to return
(And the Megger's disappeared Idunnowhere).
For we've only got to test, and to do our very best
To deserve our little modicum of tin, tin, tin,
To deserve our little modicum of tin.

When the ganger's gone to quod, after pinching copper rod,
And the Wright's Demand complaints are coming in,
When the pilot volts are low, and the fuses start to blow,
And the copper losses make your hair grow thin,
Let us shout the "Deathless Army," let us dance a Highland Fling
(And we shan't get any rise at all this year).
For we've only got to test, and to do our very best
To deserve our little modicum of tin, tin, tin,
To deserve our little modicum of tin.

## MANCHESTER SECTION DINNER.

The fourth annual table-gathering of the Manchester Section of the Institution of Electrical Engineers was held on the 10th at the new Midland Hotel. Over 200 members and friends took part in the proceedings, and the new arrangement of small tables and clique-parties was of great promise for a record in social frivolity as well as in point of numbers; but, alas! the good example of last year's function, as to limited verbosity, was not followed, and this, together with the indistinctness of some of the speakers, produced a general apathy as to the official proceedings, which was increased by the unfortunate proximity of the American bar to the banquet hall.

Mr H. A. EARLE, in proposing "The Institution," was retrospective in commenting on the changes in the appearance of members' hair since he first knew them; he dilated upon the advantages of the periodical gatherings (without referring to the jovial after-meetings), and did not forget the standard topic of standardisation.

Mr. W. M. MORDEY, in replying as an ambassador from the village section, referred in complimentary terms to the high standard of the papers and discussions in Manchester. As a member of the body of men known to some as "insulting" engineers, he considered that this class should be standardised, if it would prevent the great competition that now existed among them, and he believed that this standardisation will come in time. The President of the Institution had been invited to become chairman of the committee appointed by the Institution of Civil Engineers which was to consider the question of the international standardisation of electrical matters. He referred to the progress of the Institution of Electrical Engineers, and the 5,700 at present on the muster roll. He looked to the youthful members to improve on the older ones, but trusted they would not replace the extinct volcanoes too soon. Mr. Swinburne had remarked that new members spent their time in trying to show old members how much they knew, and old members spent theirs in trying to prevent the new members from finding out how much they themselves did not know.

Mr. C. D. TAITE referred to that hardy annual castle-in-the-air, the Institution of Electrical Engineers' own building, and commended the advantages of membership to the meeting. Some men had said that there was no honour in becoming a member, but he pointed out that the new rules for admission were not so easy-going as formerly, and that the status of membership had gone up.

Dr. E. HOPKINSON proposed "Our Guests," which was responded to by the MAYOR OF SALFORD and Mr. F. E. PRIEST.

Mr. J. S. RAWORTH proposed "The Trade of Manchester and Salford" in his usual felicitous terms, the MAYOR OF SALFORD again treating the audience to a lengthy display of his oratorical gifts in reply.

The capital musical programme that was arranged by Mr. P. C. Pope had to be shortened, to the disgust of those who had come on pleasure bent, Mr. Pope's own later contributions being sacrificed. Mr. E. Hastings, although considerably bothered by the ceaseless devotion to business throughout his performance of the polyglot waiters, was in splendid form in his Corney Grain sketches; and Mr. R. L. Gamlen's songs also pleased. A flashlight photograph of the diners was taken during the evening.

## REPORT ON TEMPERATURE EXPERIMENTS CARRIED OUT AT THE NATIONAL PHYSICAL LABORATORY.

The following abstract of the paper read by Mr. E. H. Rayner, M.A., A.M.I C.E, before the Institution of Electrical Engineers on the 9th inst. deals only with the class of experiment performed. The results of the trials on the various insulating materials and field coils are so extensive that any condensation is impossible. The first part of the work was to determine the effect of heat on the electrical and mechanical properties of dielectrics. For this, samples of the materials to be tested were subjected to temperatures varying from 75deg. to 100deg. C. in an electric oven. Other samples were heated in an oven from 100deg. to 125deg. C., and a third set were subjected to temperatures from 125deg. to 150deg. The four samples of each material were then subjected to high alternating pressures and the disruptive voltage obtained. The alteration in the mechanical properties due to baking at the above temperatures were ascertained by two methods. The force required to punch a hole $\frac{1}{2}$in. in circumference was ascertained. The specimen was then bent round cylinders of gradually decreasing diameter until it broke or was badly cracked. The diameter of the cylinder was decreased to $\frac{1}{16}$in., and if the sample stood this it was bent backwards and forwards up to 10 times, or until it broke. Comparative figures are given of 32 different substances, although in several cases the thickness of the material is the only variant. For each of these the disruptive voltage after the different baking processes are given, and in another column the volts per millimetre of thickness are added. The variation in the disruptive voltage with the increase in temperature to which the substance is subjected is never more than 20 per cent. from the mean. The results, however, as regards the mechanical properties of material clearly show a very great decrease of strength due to the baking. The brittleness as revealed by the bending test is greatly increased.

Trials as to the insulation resistance of these materials show that there is little relation between the ohmic resistance and the disruptive pressure. The insulation

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resistance increased very rapidly with heating, owing to moisture being driven out of the specimens. It was also found that in many instances the insulation resistance decreased largely with an increase in the testing voltage. The experiment shows that heating was the most effectual way of removing this moisture from the body of the dielectric. Other experiments on the same lines were carried out with a dozen different substances which had been treated with a Berrite varnish. It is interesting to compare these results with those on the same substances unvarnished.

The second part of the investigation was to determine the temperature distribution in the interior of field coils of continuous-current generators. For this purpose thermo-electric couples were inserted within the windings of the coils by the manufacturers of the same. The junctions used were of iron-eureka, as this combination has a high thermo-electric voltage and a fairly straight-line law over the range required. The junction wires were No. 25 gauge, each being double silk covered, and the pair again covered with a single layer of silk. The actual junction was made between the wires by a silver solder. The result was a very compact flexible arrangement for the measurement of temperature at a point. The voltage was recorded by a sensitive moving-coil galvanometer by R. W. Paul, which, by the adjustment of resistance in series, was made to read directly in degrees Centigrade. With this arrangement temperatures can be read to within 0·2 of a degree, and the curves given are said to be accurate to well within 1deg.

We believe it is the first time that low-temperature researches have been carried out with such thermo-junctions, and the report shows what a valuable method it is of determining temperatures at exact points. A number of these thermo-junctions were inserted in each of the nine different field coils experimented with. As a rule five were placed on a median cross-section of the coil and three on the opposite side as a check. The five thermo-junctions were placed on the cross-section where the highest temperature was expected to occur. As a rule the second thermo-junction from the core recorded the highest temperature. Other thermo junctions elsewhere in the coil enabled the distribution of temperature to be still further studied. The results for each coil are plotted by the author in the form of curves, which are interesting as showing the temperature gradients. With the nine coils in question no less than 30 different sets of experiments were made. In some of these the coils were actually in place on the dynamos for which they were designed, and the machines were running at normal speeds either at full or no load. In each case records were taken of all the electrical and mechanical quantities involved. These are presented in the form of two tables, and a number of results are calculated from them. For instance, there are columns which show the watts per square inch of cooling area, the temperature on the surface of the coil, the maximum internal temperature, and also the mean. Perhaps the most interesting column is that numbered 18, which gives the difference between these two latter temperatures. The figures in this column vary between 2deg. and 36deg. C., but under normal working conditions 25deg. C. is not exceeded. The table is completed by columns which give the quotient of the maximum internal rise by the watts per square inch of cooling surface. This figure is one which will be of great service to designers. In the course of the experiments it was found that sometimes the resistance of a field coil rose during the first few hours of use, and then fell to a very considerable extent. Experiments made with cotton-covered wire suggest that the fall in resistance was due to short-circuiting caused by water driven out of the cotton by the rise in temperature. As has been recently shown, such moisture may cause further damage due to electrolysis. The formers on which the different coils were wound and the protection of the winding were variants which enable useful deductions to be made from the figures given. The actual figures contained in the report will be obtainable from the Engineering Standards Committee in due course at a small charge, which will go towards defraying some part of the high cost of the experiments.

## NOTES ON SOME EFFECTS IN THREE-PHASE WORKING.*

BY W. M. THORNTON, D.Sc., MEMBER.

(*Concluded from page 351.*)

### § 3. Presence and Origin of 23rd Harmonic.

The presence of this high harmonic of large amplitude in normal three-phase working has not, I believe, been previously observed. Since it appears in the open-circuit voltage, it must arise in the movement of the magnetic lines across each slot. Every line is first retarded by the slot, then suddenly snaps across it. The voltage induced in the wires within the slot is, therefore, not sinusoidal but of the following form (Fig. 17A), the zero line being taken to cut off equal areas above and below. This wave-form can be produced by the superposition of two curves, one twice the frequency of the other, as shown at *b*; so that, since by the mechanical motion of the poles the first distorted form, *a*, is produced, the result on the main voltage will

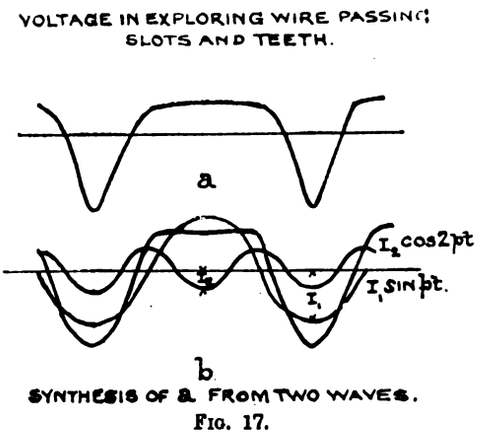


Fig. 17.

be two ripples, corresponding, in the case of a machine with two slots per pole per phase, to 12th and 24th disturbances, *both of which must always occur*. Their magnitude depends upon the relative reluctances of slot and air-gap, a short gap favouring the production of the higher harmonics. A low flux density in the teeth, giving them higher permeability and so causing the lines to be held by them a little longer, may also be a source of these high harmonics. Their greater prominence in the Brown-Boveri generator is probably aided by the surface winding of the magnet rotor and a low density in the armature teeth. The practical importance of this is that in a wide network of mains trouble is much more likely to arise from machines with short air-gaps or low saturation on account of this high harmonic. In addition to which, every harmonic increases the "copper" loss in the circuit.

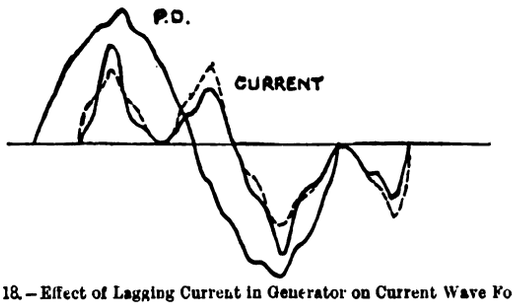


Fig. 18.—Effect of Lagging Current in Generator on Current Wave Form

The effect of harmonics upon cable losses is a matter for further investigation. Steinmetz has found that dielectric hysteresis follows the same law as that in iron, the energy loss per second being proportional to the frequency and to the 1·6th power of the voltage. Thus if there are two similar wave-forms, one having one-twentieth the amplitude of the other, but 23 times its frequency, the loss from that with the higher frequency will be as much as 20 per cent. of that from the other having 20 times its amplitude. Of course, a harmonic only causes fluctuation and not reversal of stress, but the high index 1·6 may make the former as important as reversal of the same amplitude about zero.

### § 4. Current Wave in Under-Excited Generator.

As an example of the effect of under-excitation upon the output current of a machine running in parallel, Fig. 18 is given. This is the current in one of the windings of a turbo-generator with a light load. There are here two effects—the dip in the curve and the swing of the ordinate between the dotted limits.

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, Feb. 27.

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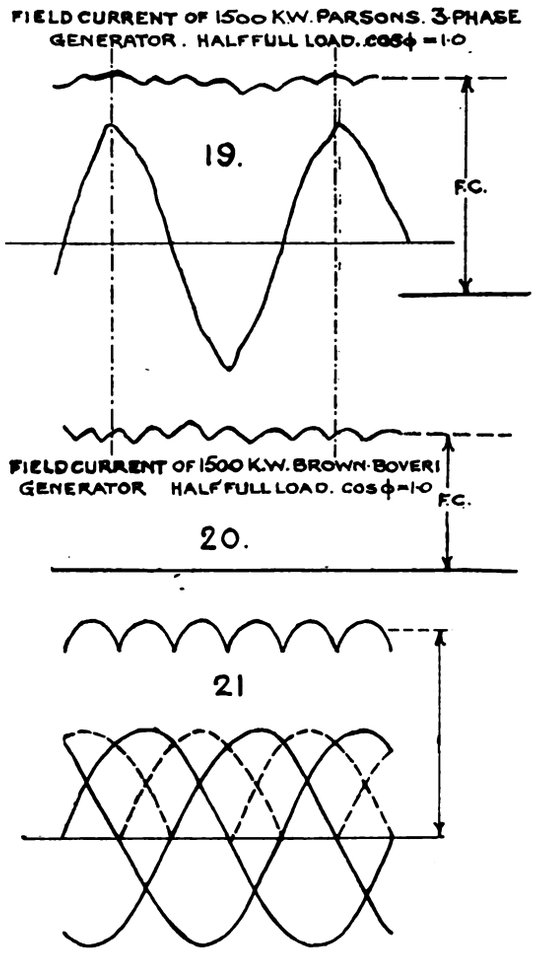
The curve shows a very strong 3rd harmonic in phase with the generated wave, and nearly equal to it in amplitude, added to



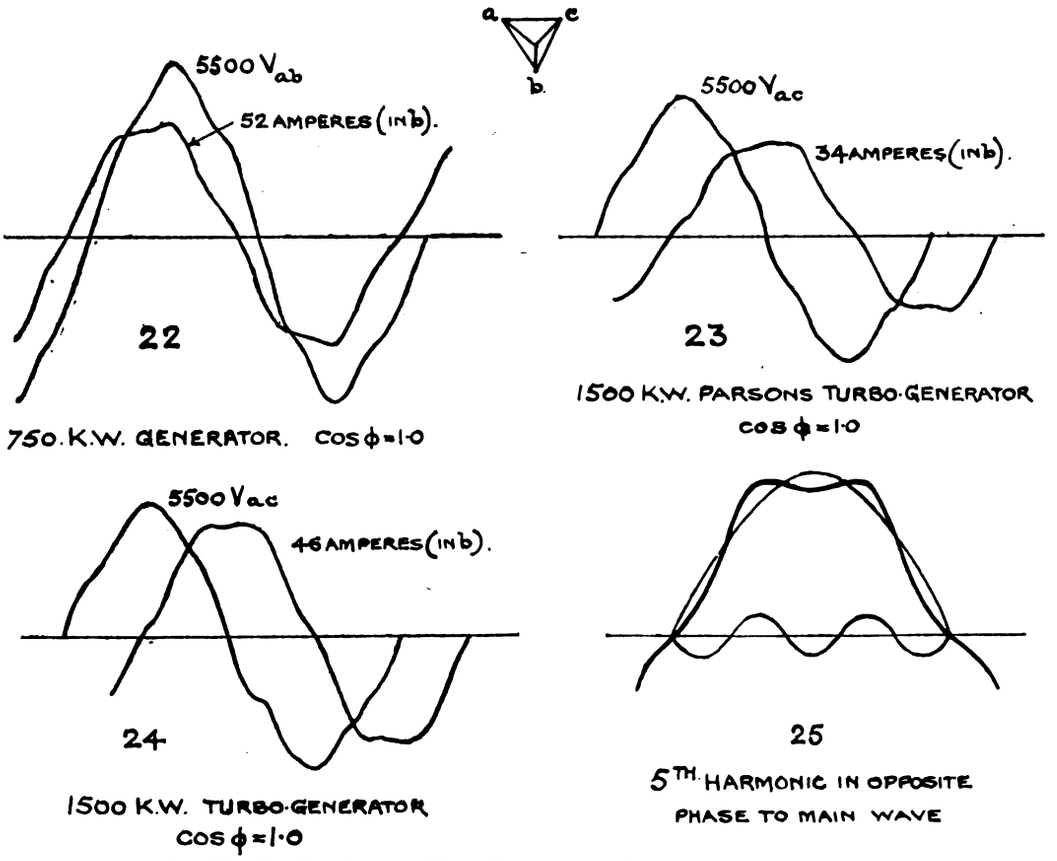

FIGS. 19 TO 21.—Effect of Armature Reaction on Exciting Current of Three-Phase Generator on Load.

windings—so that the magnetising current component is ·37 of the whole. It is well known that hysteresis in iron distorts magnetising current waves by giving rise to harmonics, of which the 3rd is the most important. In the given curve the distortion is aided by the way in which the machines were connected. When generator windings are joined "three-wire star," no 3rd harmonic can exist; but when the neutrals of generator and motor are earthed, the ordinates of the 3rd harmonic in each phase are added, and a triple-frequency current flows in each winding and to earth. Moreover, the magnetising component of the current in a motor reacts in opposite phase to that in a generator with regard to the voltage. A 3rd harmonic in the motor is, therefore, in phase with one in the generator, and a triple-frequency current circulates through the machines. As the excitation was raised, the dip in the curve disappeared at about quarter full load, and the current became approximately sinusoidal.

### § 5. Periodic Variation of Exciting Current in Three-Phase Machines.

The reaction of a large demagnetising component upon the field circuit must in the above case have been very marked. Unfortunately, no record of this was taken at the time, but some fifteen months later I obtained Fig. 19, which is the exciting current of the same machine with a load of 160 amperes. There are here six well-defined waves per period superposed on the continuous exciting current. These arise from the double-frequency magnetising effect of the current in each phase in turn. The existence of these three-phase field disturbances has been disputed, but that they probably exist in all machines and do not depend upon a particular design, is seen by their being equally pronounced in the Brown-Boveri generator (Fig. 20).

The calculation by which the back ampere-turns of armature reaction are found in theory to be perfectly steady, assumes that "the effect of a constant current in the armature coils varies as a sine curve when their position is reckoned from the centre of a pole." The influence of the breadth-coefficient of the winding is also neglected. That these assumptions are only approximate, which is all they are said to be, and do not represent the true facts, is here shown to be the case. The following diagram (Fig. 21) may help to make the origin of these ripples clearer. The lower halves of the curves have been reversed to show their action, irrespective of coil position. The positive and negative maxima lie under opposite poles, and the effect on the magnetic circuit is cumulative. Note the correspondence between the general shape of this ripple and that of the actual current, and that the former are most marked in the Brown-Boveri machine. On open circuit the field current is practically straight.




FIGS. 22 TO 25.—Wave Forms and Power Factors of Three-Phase Generators on Water Load.

which is a 13th. To explain the origin of the 3rd, it must be first noted that the curve is lagging with regard to the bus-bar voltage by an angle of 53deg.—that is, 23deg. in the

### § 6. Power Factor of Large Generators on a Water Load.

There has been some discussion recently upon the fairness of testing large alternating-current generators on a water load, on

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account of the lead said to be produced by the capacity effect of the electrolyte. The following curves (Figs. 22, 23, 24) may therefore be of interest. By careful measurement of Fig. 22 it is found that the angle between voltage and current on the paper is 28½deg., but this is caused by the presence of a harmonic which has the effect of bringing the curves nearer on the zero line. Taking the equivalent sine wave, the angle is exactly 30deg. Again, with the Parsons turbine the angle is 90deg. at 34 and at 46 amperes. The possible error in these measurements—due to the oscillograph cam—is about 3deg. Since the cosine of 87deg. is ·998, the power factor of large generators on a water load may, therefore, be taken as unity, with a possible error either way of one-fifth per cent.

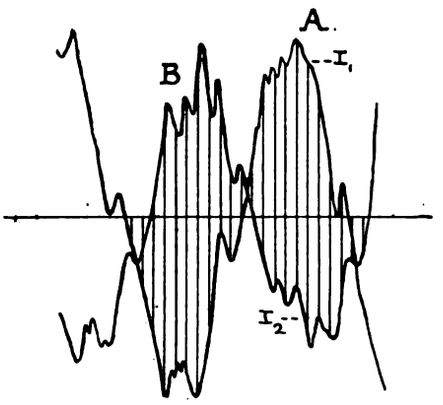


FIG. 25.—For corresponding Voltage Wave Form see Fig. 6 in phase with A. Cos $\phi$ = ·95.

The tops of the current waves are in all three cases flattened. This has nothing to do with the liquid resistance, but is caused by the 5th harmonic having changed its phase by 180deg., as may be seen by comparing Fig. 25 with Fig. 1. In the generator wave this harmonic was nearly in phase with the fundamental; now it is opposite to it at the start of the period. As a generator the machine was connected "four-wire star"—*i.e.*, with neutral point earthed—but now the water resistance forms a mesh across the line wires, and the earth connection on the generator is removed. It can be shown that the phase position of an *n*-th harmonic changes when the connections are changed from four-wire star to mesh, either by 180deg. or not at all; in this case by 180deg. But why should the Parsons machine, which has apparently only higher harmonics than the 5th, show the latter in the current? The answer is, I believe, to be found in the field ripples of the preceding section. There are six of them to a period, produced by armature reaction, and their further reaction upon the armature current is brought out in a striking manner by this shift of phase due to mesh connection. The distortion of the current wave observed in Curve 22 is the result of having only one slot per pole per phase. It is similar to the sweeping forward of the magnetism in continuous-current generators, and with the two slots of the Parsons machine is less marked.

### § 7. Phase Swinging.

The influence of unequal turning moment in generators is a subject which in this section at least is somewhat stale. There is, however, an interest attaching to the following curves on account of the reversal of current. Fig. 26 was taken at Manors when two 500-kw. motor-generators were running light in parallel, but with no direct-current load, from a single generator at Neptune Bank driven by a marine-type triple-expansion engine.

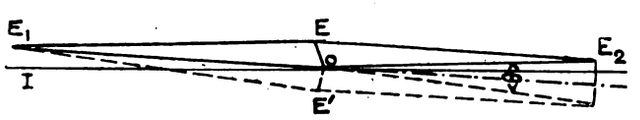


FIG. 27.—Generator Voltage Steady, Motor Swinging through Angle $\theta$.

The corresponding wave-form of the generator is Fig. 1 above. The voltage shows 5th and 13th harmonics, and was practically steady except for the small sliding movement of the ripples. The current wave presented the most remarkable appearance. It seemed a living thing, swinging as it did from one position (A) to the other (B) at 100 times a minute, the tops of the waves shooting out like tentacles. It is a very suggestive example of phase swinging, the more so because there is little sign of a lateral movement. The curves collapsed on themselves and sprang out in the reverse direction. To explain this, let O $E_1$, O $E_2$ (Fig. 27) represent the voltage vectors of a generator and synchronous motor respectively, running light with a power-factor nearly unity. The resultant voltage, O E, is therefore small. If now, by reason of the unsteadiness of the engine speed, the vector O $E_1$ is set swinging, the motor vector will follow, and if the disturbance is great, may swing past the zero line. As it approaches opposition to O $E_1$, O E falls to zero and increases to some opposite maximum O $E^1$ at the end of the swing. The steady position of O $E_2$ is usually above the zero line; the value O $E^1$ will therefore be less than O E. The current in the circuit is proportional to O E, and by inspection of the curves we see it diminish from a maximum, $I_1$, pass through zero, and increase to a lesser maximum, $I_2$. By measurement of Fig. 26 it is found that the relative angle of swing was six times the steady phase displacement between motor and generator; its absolute value cannot be determined from the curves. The power factor of the circuit was ·95. In the lower position (B) the 11th harmonic is prominent, and in the upper there is added to it—conspicuous at the maxima—a smaller 23rd or 25th.

### § 8. Phase Displacement and Load.

There is one more effect to which I wish briefly to refer. The measurement of the steady phase displacement between, say, two alternators in parallel, or a synchronous motor and its generator, depending upon excitation and load, has not hitherto been experimentally possible, though the general effect is well enough known. If a small white patch is placed on the side of one of the revolving poles of a synchronous motor, and this is illuminated by an arc alternating at the frequency of the circuit, the effect is a white line, but if it is observed through a fine slit cut in the edge of a disc driven by a small synchronous motor it appears stationary. On raising the excitation of the motor it moves forwards to a new position, and backwards if it is lowered, the amount of phase displacement corresponding to a change in either of the vectors O $E_1$ or O $E_2$. The great advantage of this new method is that it gives the actual movement of the rotor, and the influence of armature reaction in alternators in lowering the *generated* voltage can now be observed. For the O $E_1$ and O $E_2$ are not the terminal but the generated volts in the respective machines, and there is no phase displacement unless these change.

For the direct observance of phase swinging the method is very useful. When load is thrown on or off a motor or generator, the rotor appears to make torsional oscillations on the shaft, usually dying out in about half a minute. The time of oscillation at different excitations can be found, and the risk of hunting on any particular circuit determined. The fluctuation of current, and therefore of torque, by the variation of generator speed can also be readily seen. The arrangement is in effect an optical tachometer, and by the use of an enclosed revolving drum on which sensitised paper is mounted continuous photographic records could be obtained.

## PHYSICAL SOCIETY.

At the meeting of this society on March 10, Dr. R. T. Glazebrook, past-president, in the chair,

A paper on "**Direct-Reading Resistance Thermometers, with a Note on Composite Thermo-couples,**" was read by **Mr. A. Campbell.** The paper describes two methods by which the reading of a resistance box in connection with a platinum resistance thermometer gives directly the actual temperature without the use of any formula or table. In the first method the variable resistance in the measuring arm of the Wheatstone's bridge is shunted by a suitable resistance. When this shunt has the proper value, the change of resistance in the measuring arm necessary to give a balance is proportional to the change of temperature of the platinum to a good degree of accuracy up to 1,000deg. C. A more exact method—that of the "rectifying loop"—is somewhat similar. In it the measuring arm consists of a closed loop of resistance, one end of the arm being a fixed point on the loop, while the other end is a slide which can be moved along the loop. The total resistance of the arm is connected by a simple parabolic law with the excess, X, of the slider reading over a zero reading. Thus $R = A + BX + CX^2$. The author shows how the resistance of the loop and the zero reading may be calculated so as to make this parabolic formula identical with that giving the temperature resistance variation of any specimen of platinum. When the resistances have these values, the reading X will be proportional to the temperature (Centigrade) of the platinum. In an appendix the author points out that for measuring small temperature differences up to 100deg. or 150deg., the most useful thermo-couples are iron-nickel or iron-constantan. The voltages given by these are nearly, but not quite, proportional to the differences of temperature. In order to make the proportionality more exact, he proposes to use a "composite" (triple) junction by putting in parallel with one of the usual wires a wire of a third metal—*e.g.*, copper; by adjusting the relative resistances of the branches of this parallel circuit the temperature-voltage curve of the combination can be practically rectified.

**Mr. W. Duddell** expressed his interest in the paper, and asked the author if he had considered the question of putting a constant resistance in series with the rectifying loop. By so doing, it would be possible to simplify the mathematical processes involved in the method. With reference to the author's note on composite thermo-couples, he asked if Mr. Campbell could give any information regarding the variation of the thermo-electric properties of constantan with the percentage of nickel and copper present in the alloy.

**Prof. Callendar** said he admired the rectifying-loop method of reducing the direct readings to the gas scale, and thought it would be useful in practical work, especially at high temperatures, but for the most accurate scientific work at moderate temperatures he thought

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the corrections would be too complicated, and that trouble would be saved by adopting the ordinary method. It was most important in practice to secure accurate compensation of the leads, which could be ensured in a satisfactory manner only by making the leads and the ratio arms equal. Instead of making the loop resistance equal to $k$ R, as proposed in the paper, it would be necessary to make it equal to R, and to write $x = c + m\,t$ or its equivalent. The method suggested by Mr. Duddell of adding to the loop a resistance in series equal to $R_0$ would simplify the algebraic relations of the coefficients, giving $m = a\,R_0$ and $n = a^2\,R_0/b$ but would prevent the thermometer reading on the loop below 0deg. C. For many purposes this would not matter seriously. Neither the loop method, nor the three lead arrangement subsequently proposed by the author, could be used with a bridge wire, as both involved plug or sliding contacts of negligible resistance. The three-lead arrangement also precluded the possibility of making an insulation test of the leads at any time. With regard to composite thermo-couples, he did not think the arrangement would be useful except for very moderate ranges of temperature on account of the irrationality of the curves, which could not be satisfactorily represented by parabolic formulæ. He had himself employed a similar arrangement with resistance thermometers, combining wires of different materials in series, such as platinum and gold, or platinum and iron, so as to eliminate the $b$ term. This was a simple and fairly reliable way of rectifying the curve, since the resistance variation of most metals followed approximately parabolic formulæ, and the sign of $b$ was positive for many metals but negative for platinum. It was difficult, however, to find a suitable metal capable of standing high temperatures without change.

**Dr. Chree** pointed out that the resistance of the coils and shunt would vary somewhat with temperature unless made of some material with a negligible temperature coefficient. This would presumably necessitate some correction to the reading in the ordinary case. He asked Mr. Campbell whether a change in the total resistance of the wire due to temperature affected in any way the accuracy of the calculations.

The **Chairman** expressed his interest in the paper and in the usefulness of the methods described for ordinary work, but pointed out that for the most accurate work it was advisable to work with the simplest possible form of apparatus and to apply the necessary corrections at the end. With regard to the question of compensation raised by Prof. Callendar, the mathematics given in the paper would embody his suggestion if $x_0$ were given a suitable value instead of being made equal to unity. The constantan wires referred to by Mr. Campbell had been tested over a large range of temperature, and it had been found that a constantan-iron couple gave a linear formula.

**Mr. Campbell**, in reply to Prof. Callendar, said it would be possible to arrange the rectifying loop with plug contacts instead of sliders; with 25 ohms in the measuring arm, sliders cannot cause serious error. In reply to Mr. Duddell's second question, he did not know if any of the other copper-nickel alloys gave better thermo-electric results (against iron) than constantan. In both of the rectifying methods the temperature coefficient of the measuring arm caused no more error than in the ordinary method. In further answer to Prof. Callendar's and Mr. Duddell's remarks, he mentioned that for both methods he had indicated clearly in the paper that when once the ratio of the resistances of the zero reading and the total loop (or the shunt) was found from $\alpha$ and $\beta$, then the absolute values of these resistances may be altered in any ratio desired. The bridge can thus have equal or unequal arms at will.

## TRADE NOTICES AND NOVELTIES.

### Gear Shield.

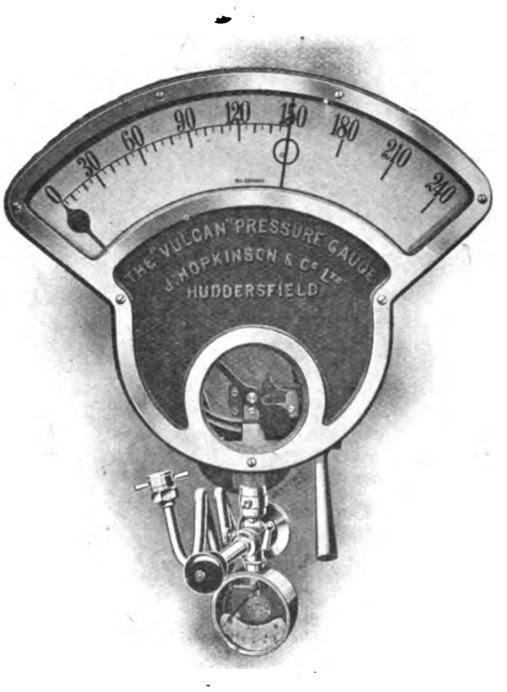
Mr. Fred. J. Down, M.I.E.E., 6, 7, and 8, Crutched-friars, London, E.C., calls our attention to a material called gear-shield, supplied by him for preventing wear on gears. It is claimed that gear-shield increases the life of gears by one-half or more, and makes them almost noiseless in working, acting as a cushion on the wearing surfaces and preventing metallic contact between the teeth. It contains no oil or grease and yet lubricates perfectly, effects great economies on tramway and railway motor gears, is largely used in American steel and iron work, and can be supplied in a slightly modified form for preserving steel and fibre ropes. Recent testimonials, of which we have copies, add considerable weight to these claims.

### Bevel-Edged Files.

From the makers, Messrs. Wright, Bindley, and Gell, Limited, Penistone-road, Sheffield, we recently received some particulars of their "Holderness" bevel-edged millsaw files. Each edge consists of three flat surfaces, thus enabling the teeth to be cut to a uniform depth. This, it is claimed, greatly prolongs the useful life of the files, and enables saws to be sharpened better and in less time than with the ordinary round-edged type of file.

### Hopkinson's "Vulcan" Sector Gauge.

Messrs. J. Hopkinson and Co., Limited, Huddersfield, are placing on the market a new and extremely novel form of steam-gauge and siphon. The "Vulcan" swivel siphon and pressure gauge is shown in the accompanying illustration, with the siphon disconnected and the pump attached for testing. The combination of gauge and siphon is designed to permit of the steam-gauge being tested with the boiler at rest. With this end in view the siphon is in the form of a copper coil with ample cooling surface, and can be easily detached and blown through without disturbing or in any way interfering with the gauge. This easy detachment of the coil forming the siphon is, then, one of the special features of the new arrangement, as it permits of the gauge being tested by a separate pump without dismounting the gauge. Further, the support for the gauge being independent of the coil, it follows that the weight of the gauge is a matter of indifference, and advantage is taken of this to use a sector-shaped gauge whose working parts are of unusually strong mechanical design. The combination can be swung round to any angle, which makes it possible to read a number of gauges from one position. The figures are marked on a white opal dial, and to make the reading at the working pressure more distinct, each increment up to the working pressure is marked, but beyond the dial is graduated for testing purposes only, in readings of, say, 40lb. As the dial is opaque, it can be illuminated from behind, and the position of the finger can therefore be readily distinguished at night or when the gauge is fixed in a dark place. As regards the siphon, this is made of the best high-pressure bronze, and fitted with Hopkinson's patent safety plug, the special feature of which is that the thread is not likely to be stripped by adjusting the packing nut, and it therefore cannot blow out. The "Vulcan" sector gauge should certainly prove very useful in electric lighting and power stations. Further particulars and illustrations of the instrument are contained in a pamphlet just issued by Messrs. J. Hopkinson and Co., Limited.




Hopkinson's Sector Gauge.

### Catalogues, etc., Received.

RADIATORS.—Numerous patterns of heat radiators, both of the luminous and Prometheus type, are illustrated in a list recently issued by the Sun Electrical Company, Limited, 118-120, Charing Cross-road, W.C.

HELLESEN'S DRY CELLS.—Hellesens Enke and V. Ludvigsen, Copenhagen, Denmark.

## INSTITUTION OF ELECTRICAL ENGINEERS.

The following candidates were elected at the extraordinary general meeting on March 9:

*Associate Members.*—W. T. Fraser, South Wales Electrical Power Distribution Company, Royal-chambers, Queen-street, Cardiff; R. C. Goldston, Tramway Depôt, Frost-hill, Liversedge, Yorks; C. L. Goolding, 335, Liverpool-road, Islington, N.; A. L. Hamkens, Byron House, 32 85, Fleet-street, E.C.; C. G. Hampson, Devonshire-avenue, Roundhay, Leeds; J. H. Hardy, Municipal Technical School, Halifax, G. W. O. Howe, M.Sc., 101, Victoria-avenue, Hull, Yorks; A. D. Jaffé, Strandtown, Belfast; E. G. Love, 20, St. Albans-avenue, Halifax; A. Press, 203-208, Temple-chambers, Temple-avenue, E.C.; J. R. Walker, 52, Hailsham-avenue, Streatham Hill, S.W.

*Students.*—F. C. Davies, The Laurels, Oakdale-road, Nether Edge, Sheffield; E. Graves, 12, Flodden-road, Camberwell, S.E.; M. Gregory, Ivy Cottage, Chequerhent, Bolton-le-Moors; P. F. Harris, Central Technical College, Exhibition-road, S.W.; G. J. Jackson, Westbourne, St. Annes-on-the-Sea; B. P. Walker, care of Messrs. Siemens Bros. and Co., Stafford.

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## IMPROVED DRAWING APPLIANCES.

No apology need be made here for calling attention to a number of ingenious novelties designed by Prof. D. A. Low, and supplied by Messrs. Longmans, Green, and Co., 39, Paternoster-row, London, E.C., for use in connection with geometrical and mechanical drawing. The accompanying illustration (Fig. 1) shows a face view of a 60deg. set-square, and an enlarged cross-section of the sides of the frame. This set-square has a body of strong tough white wood, edged with transparent celluloid. It is framed and faced with thin white

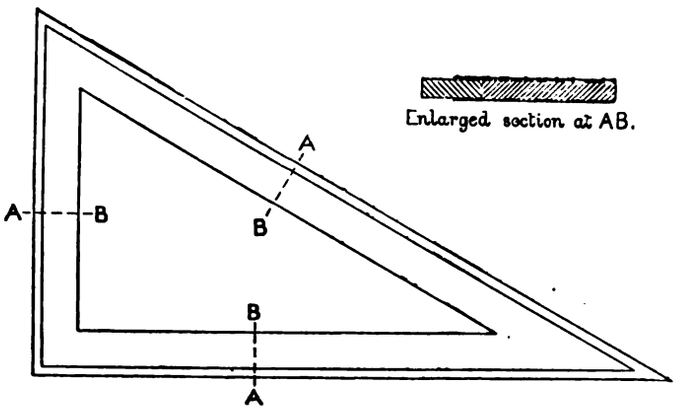


FIG. 1.

polished celluloid, and is exceedingly light and convenient to handle. Moreover, the faces which come in contact with the paper being smooth and white, any speck of ink or dust is at once seen and can easily be wiped or washed off. A special feature is that the thin celluloid facings leave off within about one-tenth of an inch of the drawing edges, so that when a square is resting on the drawing paper these edges stand above the paper to the extent of one-hundredth of an inch. This slight elevation above the paper does not interfere with accuracy in drawing, and it is found that in inking in it reduces very considerably the chances of blotting or smearing. Several sizes of tee-squares are made on the same principle. Fig. 2 illustrates an adjustable protractor set-square. This instrument consists of a right-angled

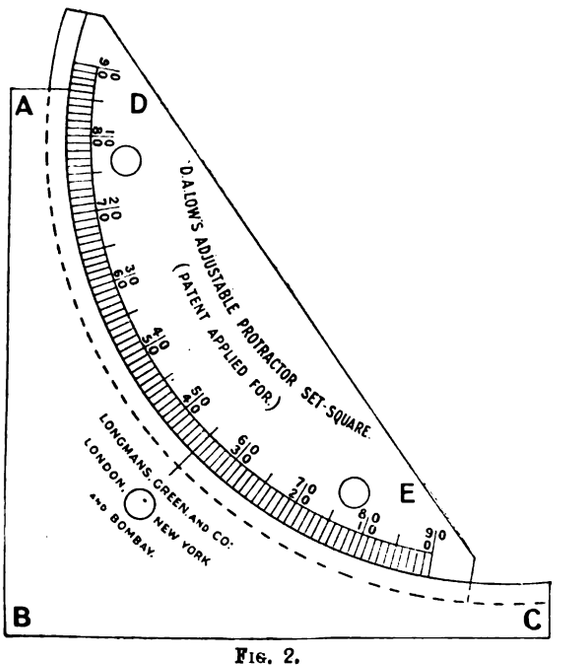


FIG. 2.

part, A B C, and a segmental part, D E, the circular edge of which has a tongue which fits into a corresponding groove on the part A B C as shown. The circular edge of D E is graduated in degrees, so that the straight or drawing edge may be set to any angle from 0deg. to 90deg., to A B or B C. The diameter of the protractor circle is 7in., and the edges A B and B C are about 4½in. long. The whole is made of white celluloid, and the total thickness is only one-sixteenth of an inch. Like an ordinary set-square, this instrument will be most generally used in conjunction with a straight-edge or tee-square. Our next illustration, Fig. 3, shows a vector set-square. This instrument consists of two arms, A B and B C, at right angles to one another, and a movable arm, D E, hinged to A B C. It is used in the same way as the adjustable protractor set-square already described, but has no protractor. Fig. 4 shows an instrument for measuring the areas of irregular figures, and specially useful for determining the mean effective pressure from indicator diagrams. It consists of a piece of clear transparent celluloid 6½in. long and 3in. wide, upon which is printed a series of equidistant longitudinal lines, intersected at right

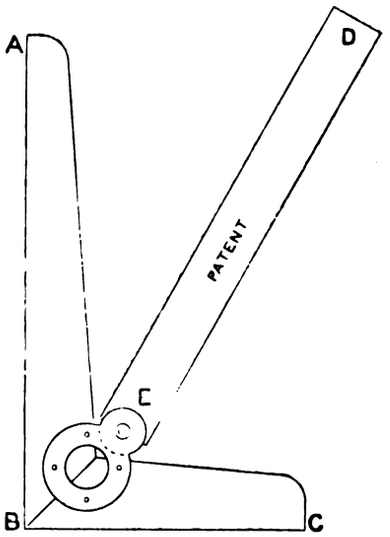


FIG. 3.

angles by a series of equidistant transverse lines. Very little practice with this instrument enables the mean effective pressure from an indicator diagram to be determined with sufficient accuracy for all practical purposes.

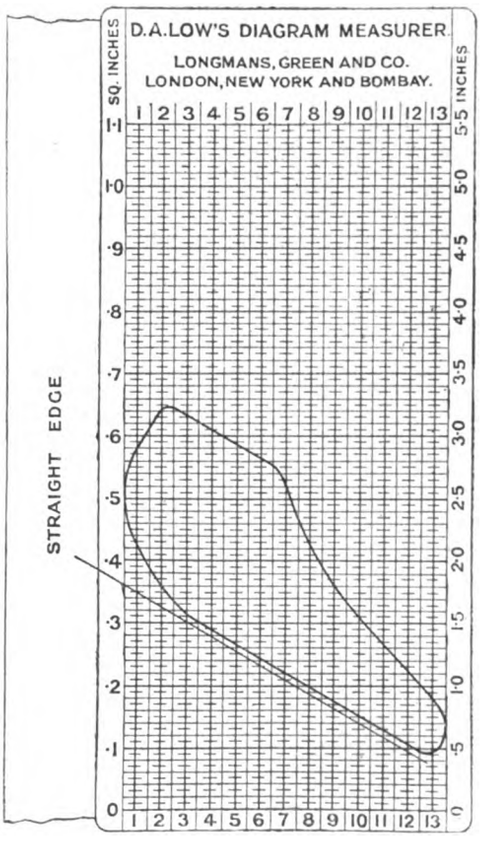


FIG. 4

Further particulars of the above-mentioned and other improved drawing appliances of the same class are contained in a descriptive pamphlet issued by Messrs. Longmans, Green, and Co. Samples of the instruments sent for our inspection are exceedingly well made, and we have no hesitation in recommending them to teachers, students, and draughtsmen.

## ELECTRICAL CONTRACTORS' CONFERENCE.

The members of the Electrical Contractors' Association had a conference in Glasgow, commencing on Monday night, 13th inst., and continuing throughout Tuesday, 14th. On Monday

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evening the Glasgow local branch of the Scottish section of the association held their second annual dinner in the Grosvenor Restaurant, Glasgow, Mr. Thomas Wright being in the chair, and Messrs. Wm. McWhirter and W. C. Martin acting as croupiers. Among those present were Messrs. W. R. Rawlings, president of the association; E. L. Berry, chairman of the London section; McDermott, chairman of the Northern section; Finlay, chairman of Edinburgh section, etc.

Mr. E. G. TIDD, in proposing the toast of "The Electrical Contractors' Association, Glasgow Branch," said that this was the day of the great syndicate for the monopolising of particular industries - the day of the incorporation of particular trades for the achievement of their common aim. In the case of the electrical contractors, such an association was both necessary and desirable; necessary for the protection of the members of their profession from the various factors which tended to hamper them in their work, and desirable in so far as their meetings together gave increased facilities for that free exchange of ideas which was always so beneficial to technical men.

The CHAIRMAN, in reply, said that they were only the Scotch branch, but he thought they would be considered a very reliable and solid branch. He thought that they would be of great service not only to the trade in Scotland, but also to their friends in England. In 1900, they in Scotland formed an association of their own, first for social interests, then for trade interests, and, thirdly, to promote uniformity in regard to their methods of work. The first thing they had done after they came into existence was to meet with the manufacturers and try to come to an understanding with them. Three years later their English friends had done exactly the same thing. The manufacturers, however, were a very elusive body, and they found it difficult to get a hold of them. They were still trying, however, and had hopes of success. Another thing they had tried to do was get alongside the architects and the consulting engineers, but they had never been very successful with either of them. The grudge they had against these gentlemen was that while they (the electrical contractors) had to bear the responsibility of wiring installations properly, it very often happened that when they were nearing the end of their work they found that some third party had been called in to supply the fittings. In regard to municipal trading, they had had that to deal with also. There had been a moment of misunderstanding between the Electricity Committee and themselves, the former having thoughtlessly put clauses into a Bill that gave them almost unlimited power to do anything they liked in the way of wiring. The Electricity Committee thought that the electrical contractors were just going to become their own executioners, but being fair-minded men they at once took these clauses out when the matter was put properly before them. In a similar manner they had already instructed all their Scottish M.P.'s to vote against the pernicious London County Council Powers Bill. As an association they objected to municipal trading *in toto*. They objected as ratepayers to the men whom they sent to represent them using ratepayers' money to deprive these same ratepayers of their livelihood. They were resolved, therefore, to do all in their power to help their English friends in their present fight against municipal trading. As an association they were doing all they could to put a stop to cheap work. Much of this was still carried out in all their large cities, and the only way to get quit of it was to have higher ideals of how work ought to be done. To have their work well done with the best materials would be the best means of gaining and retaining the confidence of the public whom they served, as it would be the strongest argument against the municipal trader.

Bailie WILLOCK, in replying to the toast of "The Corporation of Glasgow," proposed by the CHAIRMAN, said that for the moment incandescent gas was likely to hold its own against electricity for street-lighting. For the lighting of side streets it could do more than hold its own. He hoped that they would set to work to bring about some improved device whereby street-lighting by electricity could compete with gas more effectively from the point of view of economy.

Mr. W. C. MARTIN proposed "The Chairman of the Association and Representatives from other Branches," to which Mr. Rawlings and Mr. McDermott replied.

Mr. RAWLINGS said that in London they were practically working along the same lines as those described by Mr. Wright. They were trying to get manufacturers to stop giving trade discounts to Tom, Dick, or Harry; and although the Manufacturers' Association had retired from the treaty which they had had with them, they believed that their efforts had been instrumental, to a great extent, in putting a stop to this evil. If the manufacturers did not come to terms with them he thought there would be but little doubt but that they would start their own supply house. With the Cablemakers' Association, he was glad to say, they had already come to a highly satisfactory arrangement. With regard to the London County Council Bill he was sure they would get it thrown out entirely.

Mr. MCDERMOTT also spoke.

"The Glasgow Corporation Electricity Department" was toasted by Mr. MCWHIRTER, who gave a brief sketch of the department's history, and spoke of the unfailing courtesy with which they were treated by the officials of that department. They regretted that it should have been necessary for Mr. Chamen to transfer his splendid abilities from the Corporation service to that of the firm of Messrs. Bramwell and Harris, but in Mr. Lackie the electricity department would have a worthy successor to Mr. Chamen as chief engineer.

Mr. LACKIE, in replying, said he could assure them that so long as they did their work well they need not fear the municipal trader. The electricity department recognised that the contractor and the undertaker were interdependent the one upon the other, and they in the electricity department tried to work accordingly.

The other toasts were "The Guests" and the "Chairman," proposed by Mr. R. D. LIVINGSTONE and Mr. J. M. DAVIES respectively.

On Tuesday various places of local interest to electrical men were visited, including the turbine steamer "Virginian," and the municipal buildings, where the Lord Provost (Sir John Ure Primrose) received the company. The Corporation power stations were also visited, and in the evening the members of the association were present by invitation at the meeting of the Glasgow Local Section of the Institution of Electrical Engineers, where a discussion took place on Mr. Lackie's paper on "Earthing."

## PERSONAL.

In succession to Mr. W. H. Willans, deceased, Mr. R. B. Martin, M.P., has been elected on the Board of the Notting Hill Electric Lighting Company, Limited.

The Whitby Urban District Council have appointed Mr. J. Hawes, 20, New Bridge-street, London, as assistant electrical engineer at a commencing salary of £104, rising by annual increases of £4 to £120 per annum.

The Swindon Town Council have appointed Mr. T. Medcalf traffic manager of the tramways.

The marriage of Chevalier G. Marconi (of Bologna) and Hon. B. O'Brien took place yesterday at St. George's, Hanover-square.

Mr. G. E. Smith, engineer and manager of the electric light works at Dartmouth, at a dinner given by him to the staff last week, on behalf of the staff presented his assistant, Mr. H. C. Babb, with a handsome writing case, as a token of the esteem in which he is held, and Mr. Babb, in his turn, presented the manager with a case of pipes on behalf of the staff.

The Leicester Corporation Tramways Committee have increased the salary of the chief electrical engineer, Mr. T. R. Smith, from £250 to £300 for the present year, and to £350 at the beginning of next year. The salary of Mr. T. Tyson, chief assistant engineer, has also been increased from £160 to £200 per annum, dating from Jan. 1, 1905.

## APPOINTMENTS VACANT.

**Chief Electrical Engineer**, Bermondsey Borough Council.

**Chief Draughtsman**, Bombay, Baroda, and Central India Railway Company (carriage and wagon department). Salary, Rs.250, rising to Rs.300 per calendar month. Particulars may be obtained from Mr. T. W. Wood, secretary, Gloucester House, Bishopsgate-street Without, London, E.C. Applications by March 22.

# LEGAL INTELLIGENCE.

### AUTOMATIC TELEPHONE COMPANY v. MARGOWSKI.

Mr. Justice Walton on Tuesday granted the defendant a stay of execution for 10 days, on condition that if an appeal was entered in the meantime £100 should be paid as security for costs. He gave defendant permission to see the documents without taking them out of the custody of the court.

### GREAT NORTHERN AND CITY RAILWAY.

In the King's Bench Division on the 10th inst., before Mr. Justice Lawrance and a special jury, Mrs. Stockton, Mrs. Arnold, and Miss O'Brien, three sisters, recovered £2,000 as compensation for structural damage caused to their residence, 20, Highbury-crescent, by the construction of the Great Northern and City Railway Company's tube.

### STATION UNDER A CHURCH.

Mr. Justice Farwell on Tuesday, on an application of the Ecclesiastical Commissioners, made an order for the payment of a sum of £170,000 Indian stock paid into court by the City and South London Railway Company for the right of making a station under St. Mary Woolnoth Church, at the top of Cornhill, E.C.

**Mr. George Borthwick**, for the Ecclesiastical Commissioners, explained that the company were authorised to make an underground electric railway and to take the church and certain adjoining lands. That Act of 1893 was qualified in 1896, and provision was then made that the railway company should not take any part of the church forming part of the property, but they might purchase, take, and use

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the surface of the other part of the land, and might acquire an easement, with the right of using the subsoil under the church. This they did, and the church was supported by a steel plate.

**Mr. P. B. Abraham** said the railway company had been authorised to take the church, and afterwards certain learned bodies, which had nothing whatever to do with the matter, discovered that it was a very wonderful church, which ought not to be destroyed, and in consequence of their petition Parliament gave instructions to a committee to try and make some arrangement by which the church could be saved. The result was the provisions alluded to in the Act of 1896. The church had been preserved without breaking even a pane of glass. The company had spent £30,000 to £40,000 in making supports for the church, and had given it back in a much better condition than it was before. The cost of making the tunnel and station, 120ft. below the church, was £136,000. The intention of Parliament was not to put the company into a different position, but simply to oblige certain learned bodies who had no interest in the question. The company bowed to the decision, and had nothing more to do with the matter. He thought they had paid sufficiently for what they had got.

## TEMPORARY TRAMRAILS.

On Friday, at the King's Bench Division, Mr. Justice Lawrance and a special jury gave £860 damages to James Beale, a fishmonger, of York-road, Battersea, against Messrs. W. Griffiths and Co., for personal injuries sustained by the upsetting of a vehicle, caused, as he alleged, by the temporary rails laid in connection with the Southwark electric tramways not being properly laid and secured.

Mr. Clavell Salter, K.C., and Mr. Clarke Hall appeared for the plaintiff, and Mr. M'Call, K.C., and Mr. Crawford for the defendants.

## THE UNDERGROUND TELEGRAPH CABLES DISPUTE.

In Hamilton Sheriff Court on the 8th inst., Sheriff Thomson heard parties on a note by the Lord Advocate to the Sheriff to have decided the difference which has arisen between the Postmaster-General and the District Committee of the Middle Ward of Lanarkshire in connection with the laying of the underground telegraph cable from London to Glasgow in the highway at Bothwell. Recently an action of interdict was raised by the Middle Ward Committee against the Lord Advocate and the Postmaster-General, the question between the parties being as to the position in which the telegraph cable pipes should be laid, while that under the note is as to whether or not a difference has arisen which should be decided by the Sheriff or settled by an action in court. Mr. Henry Johnstone, K.C., with whom was Mr. J. C. Pitman, advocate, appeared for the Lord Advocate, and Mr. A. P. Smith, writer, Hamilton, appeared for the Middle Ward Committee. After a debate lasting over two hours, the Sheriff made avizandum.—*The Scotsman.*

## TRAMWAY COLLISION.

At Dudley County Court, on Monday, before Judge Howland Roberts, the Dudley, Stourbridge, and District Electric Traction Company, Limited, brought an action against the London and North-Western Railway Company to recover £1. 9s. 1d. in respect of damages to an electric car, caused through a collision of one of the company's cars with a van belonging to defendant company. It appears that the motorman admitted that the car was travelling at a greater speed than was allowed, and his Honour gave a verdict for the defendant company.

## SWANSEA TELEPHONES.

At Swansea County Court on Tuesday the National Telephone Company sued Richard Wilson, Hawarden-buildings, Treharne-road, Landore, butcher, for £4. 16*s.* 6d. in respect of two 10-party lines rental. Mr. Philips (Ingledew, Son, and Philips) was for plaintiffs, and Mr. Stobo Andrews defended.

**Mr. Philips** said he was suing under a guarantee to pay rent.

**Mr. Andrews** objected to the action for rent, as no instruments had been placed or wires run. He submitted the guarantee could only come into effect once the instruments were placed, or they had refused to let them carry out the contract. If that was right, defendant had committed a breach of contract. The company could not charge rent until the instrument was there.

**His Honour** held they could, as they had signified they were ready to carry out the work. According to the agreement, defendant made himself liable to pay rent as soon as the company gave notice they were prepared to put the telephone in. That notice had been given, but it was not reasonable to ask a tradesman to wait nine months before they began making arrangements. There would be judgment for the defendant, with costs.

# COMPANIES' MEETINGS AND REPORTS

## BROMPTON AND KENSINGTON ELECTRICITY SUPPLY.

The directors' report for the year ended Dec. 31, 1904, states that the revenue account shows a credit balance of £28,270. 12*s.* 7d., which, with the balance of £4,179. 8*s.* 1d. brought forward, £384. 2s. 11d. balance of interest received, and £109. 18s. surplus on sale of securities, makes a total of £32,944. 1s. 7d. After deducting £2 096. 10s. 1d. for interim dividend on the 7 per cent. cumulative preference shares, and £6,303. 14s. 7d. interim dividend at the rate of 9 per cent. per annum for the half-year to June 30 on the ordinary shares, the directors recommend that the sum remaining — viz., £24,543. 16s. 11d.—be dealt with as follows: to credit of depreciation account, £8,000; to payment of dividend on the preference shares for half-year ended Dec. 31, £1,909. 19s. 4d.; to payment of dividend on the ordinary shares for half-year ended Dec. 31 at the rate of 11 per cent. per annum, making 10 per cent. for the year, £7,973. 4s. 1d.; to directors' additional remuneration, £676 9s. 4d.; leaving to be carried forward a balance of £5,984. 4s. 2d. Owing to the price per unit having been reduced, whereby the consumers have benefited to the extent of nearly £4,000, the profits show a slight decrease for the first time in the history of the Company.

## BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY.

The report of the directors for the year ended Dec. 31, 1904, states that the capital expended during the year under review amounted to £31,404. 18s. 5d., making the total expenditure at Dec. 31 last £318,294. 9s. 8d. In December last the balance of the ordinary shares was allotted *pro rata* to the shareholders at a premium of £1 per share, and the balance of the debenture stock was disposed of at par. In order to provide further funds as necessity arises for the development of the Company's business, the directors propose to increase the share capital of the Company from £300,000 to £500,000 by the creation of a further 10,000 preference shares of £10 each, and a further 10,000 ordinary shares of £10 each. The directors also propose to increase the borrowing powers of the Company from £150,000 to £300,000. The balance to credit of net revenue account is £15,764. 13s. 9d. This is arrived at by deducting from the balance brought forward from last year the final dividends on the 4½ per cent. and 6 per cent. preference shares, and the dividend for the year on the ordinary shares; adding the balance from this year's revenue account and deducting all interest charges and reserves for redemption funds. Out of the above-mentioned balance of £15,764. 13s. 9d. the full dividends for the year on the 4½ per cent. and 6 per cent. preference shares to Dec. 31, 1904, have been paid, and the directors now recommend the payment of a dividend on the ordinary shares of the Company at the rate of 7 per cent. per annum for the year ended Dec. 31 last. This will absorb £14,721. 13s. 3d. and leave a balance of £1,043. 0s. 6d. to be carried forward. Application has been made to the Board of Trade, with the consent of the local authorities concerned, for a provisional order for Wimborne and the surrounding districts, with a view to supplying same from the Company's station in the Bourne Valley. The total applications received at Dec. 31 last amounted to the equivalent of 121,589 8-c.p. lamps, being an increase of 21,051 for the year, as compared with an increase for the previous year of 19,542. The total number of Board of Trade units sold for lighting, power, and traction purposes was 1,703,329, being an increase of 183,327 units for the year. The Richmond (Surrey) Electric Light and Power Company, Limited, continues to make satisfactory progress. A dividend at the rate of 7 per cent. has been declared on the ordinary shares of that Company in respect of the year ended Dec. 31 last.

## LONDON ELECTRIC SUPPLY.

**Mr. Robert H. Benson,** presiding at the annual meeting on Feb. 23, expressed great regret at the absence of Lord Crawford, who, as usual, was obliged to spend the winter abroad. After referring with satisfaction to the strong cash position of the Company and to their unused capital powers, he concluded by moving the adoption of the report, which appeared in our issue of Feb. 17, and the payment of the dividends recommended.

**Sir W. H. Preece** seconded the motion.

**Mr. R. Stewart Bain** (the managing director) stated that during the year they completed a new trunk main route from their Blackfriars station to their Trafalgar station, *via* Westminster Bridge, thus giving them two routes, the other route being across Charing Cross Bridge. The average price received per unit sold still showed a decrease, and, owing to increased competition, the decrease was likely to continue. The cost per unit sold showed a decrease of no less than 50 per cent., owing to the large increase in their units sold and to the economy effected in their generation costs by means of their condensing plant. The increase in the efficiency of their system still continued. The prospects for the present year were distinctly favourable.

The motion was unanimously adopted.

## HARROW ELECTRIC LIGHT AND POWER.

**Mr. J. N. Stuart,** chairman of the Company, occupied the chair at the annual meeting on March 9. A report was carried in which was shown that, notwithstanding a great reduction in price, as shown by a comparison of the average price obtained in the two years—namely, 6·25d. in 1904 as against 7·28 in 1903, or nearly 14 per cent.—there was a surplus of £3,099. 13*s.* 8d. carried to net revenue account. The amount at credit of the latter account including £387. 12s. 3d. brought forward from 1903 amounts to £2,600. 17s. 4d., after payment of debenture and other interest and the interim dividend on preference shares. Out of this sum the directors have decided to transfer to depreciation account an additional sum of £944, the balance shown in last year's accounts as the deficiency in that account for past years, and to recommend the payment of the following dividends: final preference dividend, £365. 18s. 6d.; dividend on ordinary shares at 4 per cent., £1,051. 18s. 6d.; leaving a balance to carry forward of £239. 0s. 4d. The growth of consumption has responded to the reduction in price, the number of new lamps being 3,381, against 1,769 in 1903, and the number of units consumed having increased by 30,371 to a total o 259,833. The working expenses again show a reduction, the works

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costs to 1·66d. per unit against 1·87d. in 1903 and 2·24d. in 1902. The total costs amount to 2·61d. per unit in 1904, against 2·87d. in 1903, and 3·43d. in 1902. A considerable sum, amounting to £4,745. 2s. 9d., has been spent on capital account, for condenser and superheaters (which were in use only partially towards the end of the year, so that the full benefit of the plant will not be felt until in the ensuing year) as well as for additional mains, meters, etc. The directors issued fresh capital during the year to the extent of £1 910, which they consider sufficient for the present requirements of the company.

## SCARBOROUGH ELECTRIC LIGHT.

**Mr. J. E. Ellis, M.P.**, who presided at the last general meeting, said the amount spent on capital account during the year amounted to no less a sum than £16,368. That was a very large sum for so small a concern, and for a district which comprised a comparatively small number of inhabitants. About 75 per cent. of the £16,000 had been spent on tramway plant, about 15 per cent. had gone in new improvements in the works for lighting and for things of that kind, and the remaining 10 per cent. was due to the acquisition of a field adjoining the works for possible extensions, and completion of the offices in York-place. On the credit side they had received during the year £10,426, which was, of course, a very much less sum than they had spent. Turning to the revenue account, they would see that on the debtor side £8,476 represented the outlay, and on the credit side they had a sum of £13,230, leaving a balance of £4,754. On the credit side of the revenue account occurred an item of £1,001 derived from premiums. The result of the year's working was that, after placing £1,500 to depreciation, they had a net divisible balance of £5,648. The directors recommended that a dividend be paid of 6 per cent., which would absorb £5,143, and leave a balance to be carried forward of £505. That was a larger balance than usual. They might have made the dividend a little higher, but they thought it advisable not to do so, because no one could tell what effect the lowering of the charges would have, and there were other reasons why it was better to carry forward a substantial balance.

The report and a dividend of 6 per cent. were adopted, and Mr. J. E. Ellis was re-elected chairman.

## WESTMINSTER ELECTRIC SUPPLY.

**Mr. Boulnois, M.P.**, who presided at the last general meeting, stated that the supply of current had increased to an equivalent of 711,679 lamps. He referred to the Administrative County of London Electric Power Bill, and thought it was hard that such an attempt should be made to oust companies in London who had borne the burden and heat of the day and to allow this company to come in and pick up the plums. By the irony of fate they were being assisted in opposing the Bill by the London County Council and the municipalities. The whole of the companies in London, with one exception, were also opposed to it. The Westminster Company would give most strenuous opposition.

**Mr. Hayes Fisher, M.P.**, seconded the adoption of the report (which appeared in our issue of Feb. 17), and it was carried.

A dividend of 15 per cent. for the half-year, making a total of 14 per cent. for the year, was declared.

## METROPOLITAN ELECTRIC SUPPLY.

The eighteenth ordinary general meeting was held on Tuesday at Winchester House. Mr. W. Harrison Cripps presided. The report (which appeared in our columns on March 10) and dividends equal to 10 per cent. per annum on the £10 ordinary shares, were carried.

An extraordinary general meeting was held subsequently, when resolutions were passed—on the motion of the Chairman, seconded by Mr. J. Carr-Saunders—for dividing each of the £10 ordinary shares into two shares of £5, and for doubling the number of votes attaching to the preference shares in order to preserve the relative voting power between the two classes of shareholders.

## HART ACCUMULATOR.

At the sixth ordinary general meeting of the Hart Accumulator Company, Limited, Mr. G. W. Kidd, the chairman of the Company, presided.

The **Chairman**, in moving the adoption of the report (which appeared in our issue of Feb. 25, and which was carried), congratulated the shareholders on another successful year's business, in spite of keener competition and general depression of the trade.

A dividend of 12½ per cent., less income tax, on the issued ordinary capital of the Company was carried.

## OLDHAM, ASHTON, AND HYDE ELECTRIC TRAMWAY.

The report (which is to be presented to the meeting to-day) shows a total of £29,349 and an expenditure of £22,877. The directors propose placing to depreciation and reserve fund £1,000, and after paying a dividend on the ordinary shares at the rate of 7 per cent. per annum for the six months ended Dec. 31, 1904, making 6 per cent. for the year, leave to be carried forward £142.

## SOUTH METROPOLITAN ELECTRIC LIGHT.

At the last general meeting of this Company Mr. Henry St. John Winkworth (deputy-chairman) presided, in the absence, owing to ill-health, of the chairman, Sir John Willox. The report (which appeared in our issue of Feb. 25) was carried. A dividend on the ordinary shares at the rate of 15 per cent., making 12½ per cent. for the year, was carried.

Mr. Percy Randall was re-elected a director, and the auditors Messrs. Deloitte, Dever, Griffiths, and Co., having been reappointed, a vote of thanks to the chairman, directors, and staff closed the proceedings.

## NORTHALLERTON ELECTRIC LIGHT AND POWER.

Mr. John Hutton, M.P., who presided at the annual meeting on the 22nd ult., said that they had made substantial progress during the past year. The balance-sheet (which was adopted) showed that they had sold 1,033 more units this year.

## CITY OF LONDON ELECTRIC.

**Mr. Joseph B. Braithwaite, jun.**, who presided at the annual meeting of the 8th inst., said that Mr. Herring's forecast last year that he hoped an additional dividend would be possible this year had been borne out. The result was mainly due to the exertions of the engineering staff, who had succeeded in still further reducing the cost of manufacture of electricity.

The **Chairman** then moved and **Mr. Frederick W. Reynolds** seconded the adoption of the report, which appeared in our columns on March 3.

It was stated that, with the exception of a small piece of ground which they held on a 999 years' lease, the property which they possessed at Southwark, where their generating station was erected, was all freehold.

## SOUTH LONDON ELECTRIC SUPPLY.

Mr. George Ellis presided at the annual meeting on the 10th inst., and said that the expectation expressed at their last annual meeting as to the probable increase in lamps connected had been fulfilled, the exact number on Dec. 31, 1904, being 107,000. Since then a large number of additional lamps had been connected to the mains and applied for, there still remaining a balance of nearly 7,000 lamps of 8 c.p. awaiting connection.

The report (which appeared in our issue of the 10th) was adopted.

## NATIONAL ELECTRIC CONSTRUCTION.

The report of the directors to Dec. 31, 1904, states that the gross profit for the period under review is £29,351. 3s. 1d., from which has to be deducted expenses of administration, allowances on contracts, etc., amounting to £9,411. 15s. 1d., leaving a balance of £19,939. 8s. From this has to be deducted the balance carried forwarded at Dec. 31, 1903—viz., £3,537. 10s. 4d.—leaving a credit balance of £16,401. 17s. 8d. The directors recommend that this amount be dealt with as follows: provision for reserves, depreciation, etc., as set forth in the profit and loss account, £10,111. 18s. 5d.; dividend at the rate of 6 per cent. on paid-up capital for the year, £6,007. 4s.; dividend at the rate of 1½ per cent. on vendors' shares, £282. 15s. 3d. The inauguration of the Musselburgh tramways and lighting undertaking took place on Dec. 12, 1904, and from that date to March 9 425,334 passengers have been carried by the tramways, receipts being £2,181. 8s. 3d. These returns have been obtained during the winter months, and should be considerably improved upon during the summer months. With regard to the lighting, applications for over 4,000 8-c.p. lamps have been received, the majority of which have been connected to the mains for some time past. These results are very satisfactory and the directors look upon the Company's holding in the Musselburgh Construction Syndicate as a valuable asset. The inauguration of the Bo'ness electric light undertaking took place on Feb. 6, and that of the Carnarvon undertaking on Feb. 23 of this year. The directors are satisfied with the applications for current received so far.

## ERNEST F. MOY, LIMITED.

The report of the directors for the 12 months ended Dec. 31, 1904, show that a profit of £831. 4s. 7d. has been earned during the year, which, together with the amount of £71. 8s. 7d. brought forward from last year, makes £902. 13s. 2d. available for disposal, and the directors recommend that this be dealt with as follows: 7½ per cent. dividend on ordinary shares, £588. 2s. 5d.; 6 per cent. dividend on preference shares, £80. 12s. 8d.; income tax on profit £831. 4s. 7d., £41. 11s. 3d.; general reserve account, £100; and that the balance of £92. 6s. 10d. be carried forward to next year's account.

## NEW COMPANIES REGISTERED.

**London Power Omnibus Company, Limited.**—Capital, £200,000. Object: to carry on the business of proprietors of motor omnibuses, other public or private conveyances of any description, whether driven or hauled by petrol, steam, electric, or other motive power. Registered office: 5, Copthall-buildings, E.C.

**Moter Omnibus and Wagon Company, Limited.**—Capital, £100,000. Objects: to acquire and carry out certain contracts relating to the construction, working, and dealing with motor omnibuses and other motor vehicles, whether worked by mechanical, animal, or other power. Registered office: 79, Salisbury House, E.C.

### Liens Registered.

**Llangollen and District Electric Light and Power Company, Limited.**—A debenture, dated Feb. 4, 1905, and a mortgage of even

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date (by way of collateral security), to secure £1,000, has been registered. Property charged: by debenture—the company's undertaking and property, present and future, including uncalled capital; by mortgage—certain leasehold premises. Holder: S. L. Jones, Glanrafon, Llangollen.

**Central Electric Supply Company, Limited, London, W.**—Acknowledgment of indebtedness registered March 7, creating £50,000 4 per cent. debenture stock, making, with £300,000 already created, a total of £350,000 debenture stock, supplemental to a trust deed dated July 2, 1901, for securing a sum not exceeding £500,000; also instrument of charge under the Land Transfer Acts registered March 7, for securing £55 000 with respect to the above £50,000 of stock. Trustees: Hon. A. Lyttelton, K.C., 3, Paper-buildings, Temple, E.C., and W. H. Fisher, M.P. Charged on the undertaking and all the property and assets, present and future.

**Direct Spanish Telegraph Company, Limited, London, E.C.** Lien registered March 8, for £20,000 4½ per cent. debentures. No trustees. Charged on the undertaking and all the property, present and future.

**Gloucestershire Electric Power Syndicate, Limited.**—Issue on Feb. 22 of £850 debentures, part of a series created same date, to secure £1,500, charged on the company's undertaking and property, present and future, including uncalled capital. Holders: H. C. Smith, 222, Ditchling-road, Brighton; N. P. W. Brady, 7, St. Helen's-place, E.C.; D. MacKinnon, 23, Great Winchester-street, E.C.; Sir James Mackay, G.C.M.G., K.C.I.E., 9, Throgmorton-avenue, E.C.; Sir George S. Mackenzie, K.C.M.G., C.B., and S. Hall, 25, Great Winchester-street, E.C.; Sir William H. Marling, Bart, and W. J. P. Marling, Stanley Park, Stroud, Glos.; G. L. Addenbrooke, 53, Victoria-street, S.W.; F. Winterbotham, 5, Rowcroft, Stroud; P. Still, 15, Cadogan-gardens, S.W. and C. Bathurst, jun., 3, Stone-buildings, Lincoln's-inn, W.C. No trustees.

**Malaga Electricity Company, Limited.**—Re-issue on Feb. 14 of £16,034 debentures, part of a series created by resolutions of March 29, 1897, Feb. 7 and 28, 1898, and Oct. 13 and 20, 1899, to secure £50,000, charged on the company's undertaking and property, present and future, including uncalled capital, and the electrical station at Malaga. No trustees. Total amount previously issued of same series, £44,738.

**Kent Electric Power Syndicate, Limited.**—A memorandum of satisfaction in full of a charge, dated April 9, 1904, securing £1,000 has been filed.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Manchester.**—The Corporation require tenders for switchboards. Tenders by April 4.

**Hoylake.**—The Council invite tenders for 250-kw. steam alternator, with piping, etc. Tenders by March 21.

**Hornsey.**—The Town Council require tenders for cables, meters, junction boxes, etc. Tenders by March 27.

**Cartagena.**—The Public Works Department, Madrid, require tenders for electrification of the local tramways.

**Sofia.**—The District Finance Commissioners require 15,000 insulators, elements for batteries, etc. Tenders by April 3.

**Christiania.**—The Post and Telegraph Department require tenders for 8,000 kilos. of ¼mm. bronze wire. Tenders by April 10.

**Salford.**—The Corporation invite tenders for the wiring of the new Council school, Liverpool-street, Seedley. Tenders by March 31. See advertisement.

**Bucharest.**—The Post and Telegraph Department require tenders for 13,000 kilos 3mm. bronze wire and 120 kilos 1½mm. copper wire. Tenders by March 29.

**Bradford.**—The Corporation invite tenders for 2,500 kw. of motor-generators or rotary transformers. Tenders by March 30. Full particulars in our advertisement columns.

**Liria.**—The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

**Norwich.**—The Corporation require tenders for rubber-covered wires and accessories, underground cables, and incandescent lamps. Tenders by March 20. See advertisement.

**Plymouth.**—The Corporation invite tenders for the supply of electricity meters, transformers, and cables (paper insulated). Tenders by March 18. See advertisement in last issue.

**Laventhem (Belgium).**—The Municipality require tenders for erection of central station, laying of mains, etc. Particulars (3s. 4d.) may be obtained from the Secretary of the Mayor of that place.

**Madrid.**—The Post and Telegraph Department (Direccion de Telegrafos y. Correos), Madrid, require tenders for 65,000 insulators. Tenders by March 28. A deposit of 5 per cent. of the tender value is required.

**Keighley.**—The Electricity Committee invite tenders for the following plant: (Contract No. 9) one Lancashire boiler; (10) one 300-kw. direct-current steam dynamo, high-speed enclosed engine. Tenders by 10 a.m. on March 27.

**Antwerp.**—Tenders will shortly be invited by the Belgian State Railways for the installation of electric light in their local railway station. Specification No. 619 may be obtained from the Government Railways Office, Brussels.

**Bucharest.**—The Post and Telegraph Department require tenders for 30,000 kilos iron plates, 30mm. by 8mm., 2,000 kilos ditto 30mm. by 9mm., 920 kilos 18mm. by 4mm., and 20,000 kilos 14mm. round iron staves. Tenders by March 21.

**Glasgow.**—The Trustees of the Clyde Navigation invite tenders for electric power generating and lighting plant for Clydebank Dock. Specifications, etc., may be obtained from Mr. T. R. Mackenzie, 16, Robertson-street, Glasgow. Tenders by April 10.

**Rathmines (Ireland).**—The Rathmines and Rathgar Urban District Council invite tenders for condensing plant. Specification, etc., may be obtained from Mr. George F. Pilditch, A.M.I.E.E., Electricity Works, Rathmines. Tenders by March 27.

**Swindon.**—The Corporation invite tenders for annual supply of incandescent and Nernst lamps; cables; fuse boxes, service boxes, and feeder pillars; lubricating oils and grease; and direct-current meters. Tenders by March 21. See advertisement in last issue.

**Birmingham.**—The Tramways Committee invite tenders for supply, delivery, and erection of 200 electric tramway cars. Conditions, specifications, etc., can be obtained from Mr. Alfred Baker, general manager, 254A, Corporation-street, Birmingham. Tenders by April 4.

**Madrid.**—Der Compania Electrica Madrilena de Traccion propose to extend their electric tramways from the Barquillo-street to Olivide-place. The concession for the works will be dealt with by the Public Works Department, Madrid, April 8. Tenderers for same must deposit a guarantee of £96.

**Switzerland.**—M. R. Vontobel, of Winterthour, and M. Charles Probst, of Lucerne, have obtained a concession for the construction of a narrow-gauge electric railway from Meiringen to Gletsch. The total cost of the enterprise is estimated at £241,600; £19,600 is to be expended on rolling-stock.

**Hammersmith.**—The Council invite tenders for the supply of boiler flues and economisers; high pressure steam-pipes; high-pressure feed-water pipes; exhaust steam, feed-water heater, and circulating-water pipes; steam-valves and feed-water heaters; and coal elevator. Tenders by April 5. See advertisement.

**Shanghai.**—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Pook and Co., 63, Leadenhall-street, E.C. Tenders by March 31, 1905.

## RESULTS OF TENDERS.

**Leicester.**—The Guardians have accepted the General Electric Company's tender for telephones.

**King's Lynn.**—The tender of the General Electric Company, at £1,998. 10s., has been accepted for a steam dynamo.

**Ilford.**—The Urban District Council have accepted the tender of the Western Electric Company, North Woolwich, at £1,750, for the supply of concentric armoured cable.

**Leith.**—Messrs. Bruce Peebles and Co., East Pilton, Edinburgh, have secured the order for a 600-kw. differentially-wound continuous-current dynamo and steam-engine.

**Ashton.**—The Town Council have accepted the tender of the Lancashire Electrical Engineering Company for the necessary steel-wire cable for the arc lamps in the market.

**Barnsley.**—Messrs. Monté-Callow and Co., 6, Ludgate-broadway, E.C., have obtained the contract for the supply of motor-starting switchgear to the Corporation for the ensuing year.

**Ilford.**—The Urban District Council have accepted the tender of Pullin and Shore, Boulton, at £1,100, for the installation of a telephone fire-alarm system on the double or metallic principle.

**Erith.**—The Urban District Council have accepted the estimate of Kelvin and James White, Limited, for the supply of the necessary electrical instruments for testing purposes at £124. 13s. 9d.

**Glasgow.**—The Corporation have accepted the tender of Grindley, Ross, and Co., 29, Commerce-street, Glasgow, at £487. 10s., for supplying and erecting electric light installation, etc., required in the new central police office.

**Leftwich.**—With reference to the recent contract for electric light at the Leftwich (Northwich) Isolation Hospital, we are informed that R. J. Nicholson and Co., of Manchester, have received an additional order for a complete system of telephones designed by them.

**City and South London Railway Co.**—The company have accepted the tender of Messrs. Walter Scott and Middleton for the construction of the extension of their line to Euston, *viâ* King's Cross, from their existing station at Islington, amounting to between £300,000 and £400,000.

**Lancashire Electric Power Co.**—Messrs. Bruce Peebles and Co., Limited, East Pilton, Edinburgh, have secured the contract for the supply of alternating-current motors of 15 h.p. and above to the Lancashire Electric Power Company for one year, for their hire-purchase and development department.

**West Ham.**—Messrs. Mountain and Gibson, Elton Fold Works, Bury, have obtained the contract for 55 improved double-deck trolley standards, with poles and heads complete, for the new cars of the West Ham Corporation tramways. The order has been placed through the Brush Electrical Engineering Company, who are building the car bodies.

**Leicester.**—The following tenders have been accepted: British Electrical Engineering Company, Limited, alternator £5,250, exciter £485, switchgear £350—£5,085; Hick, Hargreaves, and Co., Limited, set of engines for alternator, £4 855. In addition, the engineer estimates the cost of the foundations, etc., at £1,000, and a further £500 for steam and water connections, switches, cables, etc., making a total of £12,440.

**Manchester.**—Messrs. Bruce Peebles and Co., East Pilton, Edinburgh, have secured the order for three 590-kw. Peebles motor-converters, to be constructed on the Peebles-Bragstad-La Cour patent

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system. These are to be installed in the Dickinson-street station of the Manchester Corporation electric supply, and will convert 6,500-volt three-phase current to low-tension continuous current direct without interposition of transformers.

**West London Tramways.**—Messrs. W. T. Henley's Telegraph Works Company, Limited, Blomfield-street, London-wall, E.C., have obtained from the London United Tramways Company the contract for the cable work in connection with the extension of the West London Tramways to Wimbledon, Surbiton, Kingston, etc. This contract, which is one of the largest ever placed for cables in connection with tramway work, includes about 30 miles of three-phase, 11,000 volt, extra high-tension cable, and about 45 miles of low-tension feeder, distributor, and telephone cables, etc.

**Ghent.**—The Municipality of Ghent have awarded the contract for the supply of 15 electric cranes to a Belgo-German firm, established in Belgium, for the mechanical parts, in co-operation with a Belgian firm for the electric motors and equipment. The contract price for each of the cranes, which are to be of half-arch construction, is £440 for the mechanical parts, £214 for the electrical equipment, and £99 for the lower and elevated rails therefor. This tender, £753, the lowest made, was rendered still more advantageous, when quickness of delivery and economy of working were taken into account.

# BUSINESS NOTES.

## TRACTION.

**Whitfield.**—It is expected that the electric cars from Salford will run through to Whitfield before Easter.

**Rawmarsh.**—The deposit with regard to the Mexborough and Swinton Tramways Extension Bill has been paid.

**Dartford.**—The Urban District Council have completed their arrangements for a loan of £93,000 for the construction of tramways.

**Sheffield.**—The Corporation have decided to extend their tramway lines to Firth Park. The present lines stop 372 yards short of that point.

**Southport.**—The Town Council intend to oppose the application for a Board of Trade order by the Ormskirk and Southport Light Railway.

**Erith.**—The report of the consulting engineers is to the effect that good progress is being made with the permanent way for the tramways.

**Bradford.**—The relaying of the Wyke tramway, the estimated cost of which is £17,000, will now be proceeded with as quickly as practicable.

**Croydon.**—The Croydon Chamber of Commerce have discussed the tramway question, and passed a resolution against any extension of the tramways.

**Newcastle-on-Tyne.**—The Tramways Committee of Newcastle Corporation have decided to extend the tramlines from Scotswood-road to Scotswood Bridge.

**Wakefield.**—The Wakefield and District Light Railway Company propose to double their existing single line from Wakefield (through Lupset and Horbury) to Ossett.

**Swansea.**—A few trial runs have been made with the electric cars, but there are still a few lengths of route to be completed before the whole system is ready for inspection.

**Dundee.**—On the advice of Mr. Richardson, the electrical engineer, the span-wire construction is being used to replace a number of poles in Reform-street. The span wires are supported from buildings on either side.

**Tarporley.**—The scheme to connect Tarporley and Mouldsworth by means of a light railway to run through Duddon and Ashton has been approved by the Light Railway Commissioners. Mr. Fergusson is the engineer for the scheme.

**Kilmarnock.**—The Town Council have agreed, in view of the success which had attended the electric tramway cars, that the line on the main route from King-street Church to Riccarton should be doubled at an expenditure of £3,200. The committee are to arrange for the purchase of three additional cars.

**Leeds.**—A scheme for equalising the stages on the Leeds tramways has been approved by the traffic manager of the Tramway Committee. The object of the scheme is to give a two-mile ride for 1d. on every route throughout the city. The principle of the scheme has already been sanctioned by the Town Council.

**District Railway.**—The employés of this company have been granted an interview with the full board of directors at which all points in connection with the proposed new rates of pay were discussed. The statement submitted by the deputation of employés is to be carefully considered by the directors.

**Warrington.**—After hearing before the Light Railway Commissioners, the Cheshire Light Railways, Limited, have withdrawn their application for powers to construct a light railway between Knutsford and Warrington. The opposition brought against the scheme is responsible for the withdrawal of the application.

**Dalkeith.**—Notices have been posted throughout the district from Nether Liberton to Dalkeith, and in Bonnyrigg and Lasswade, to the effect that application would be made to the Secretary for Scotland in April, 1905, for a provisional order to incorporate a company and to lay down and maintain tramways in the district in question.

**Great Western Railway Bill.**—The District Railway Company, the Great Northern, Piccadilly, and Brompton Railway, and the London United Tramways Company have been granted *locus standi* to be heard in opposition to the above Bill, which provides for the construction of some short lines of railway in the Ealing, Acton, and Uxbridge areas.

**Perth.**—A deputation from the Perth Tramway Committee has visited Ayr, Paisley, Motherwell, Glasgow, Dundee, and Kirkcaldy in order to obtain information as to the management and working of an electric service of cars. As a result the burgh electrical engineer has been appointed tramway manager at an increased salary. A traffic superintendent will be appointed.

**Woolwich.**—The Works Committee of the Woolwich Borough Council have considered a plan submitted by the borough engineers showing the proposed widening of Plumstead-road, High-street, and Bostall-hill to Basildon-road. If the widening be carried out, it will admit of a double line of trams being laid down throughout the route. The estimated expense of the proposed widening is £50,000.

**Blackrock.**—At a special meeting of the Urban District Council in committee for the purpose of considering the Dublin Tramways Bill of 1905, a telegram was read from Mr. J. J. Mooney, M.P., stating that he would move that a clause to give permission to the company to supply electric light to the township should be inserted in the Bill when it came before the House of Commons.

**Aberavon.**—On Wednesday last an enquiry was held by Lieut.-Colonel E. Druitt, R.E., with respect to the Aberavon district electric provisional tramway order, in order to ascertain whether the consent of the Glamorganshire County Council ought to be dispensed with. The questions raised were: (1) Did the town require the tramway? and (2) Did they object to the pavement accommodation being curtailed by 6in.? We understand that the Corporation supported the amended scheme, under which a bridge has to be widened by the company.

**Dewsbury.**—The British Electric Traction Company have given notice of their intention to apply to the Board of Trade for approval to the transfer of the portion of the undertaking authorised by the Spen Valley light railway orders, situated in the borough of Dewsbury, to the Dewsbury Corporation, and the remainder of the undertaking to the Yorkshire (Woollen District) Electric Tramways, Limited. The system extends from Ravensthorpe (*via* Dewsbury) to Oleckheaton, from Thornhill to Dewsbury, and from Heckmondwike to Dewsbury, and is some 15 miles in length.

**London County Council.**—It is proposed that the undertaking of the Woolwich and South-East London Tramway Company be transferred to the Council at midnight on March 31. A credit of £50,000 has been passed towards the whole of the purchase. It may be remembered that the Finance Committee reported on July 23, 1901, when the Council decided to take steps to acquire these tramways, that from a purely financial point of view it was at least doubtful whether the undertaking, if purchased, would pay its way, and that the purchase must therefore be justified upon the ground that it is required by the general policy of the Council.

**Motor 'Buses for Railways.**—Councillor Boyle, of Manchester, presided on Wednesday at a conference of representatives of the North-Eastern, Midland, and Great Western Railway Companies and the executive committee of the Municipal Tramways Association for the purpose of considering the clauses in the three companies' Bills in Parliament this session, under which the companies seek powers to run motor omnibuses in connection with their respective railways. These Bills have been blocked on the second reading. Suggestions were made to the companies' representatives that the clauses should be amended so that they be limited in their operations to 'buses running to and from the companies' stations.

**Glasgow.**—Sir James Thompson, speaking at the annual meeting in Glasgow of the Caledonian Railway, denounced the Glasgow Corporation for extending electric cars to the suburbs and to country places outside the city. Such competition, he said, was hurting the railways, and was not a legitimate form of municipal enterprise. It was a grave danger, as it induced the population to reside outside the city boundary and increased the burden of taxation upon those who remained. The Caledonian Railway Company was Glasgow's biggest ratepayer. He urged the shareholders in all enterprises to oppose electric car extensions. It would be better for the Caledonian Railway to meet this competition by electrifying their suburban lines.

**Accrington.**—The committee of the House of Commons have passed the Bill of the Accrington Corporation empowering the conversion of the Accrington tramlines for electrical working. The committee also gave the Corporation authority to supply electricity in the Church, Clayton, Oswaldtwistle, and Altham areas, but refused power as regarded Haslingden, and they stipulated that the Lancashire Electric Power Company shall not be obliged to obtain the consent of Accrington to the company entering the four areas named, while if competition does take place, the Corporation are not to be at liberty to cut down the prices for outside consumers to less than those charged in the borough. Other provisions in the Bill, of a sanitary character, were passed without opposition.

**Gorleston.**—The Town Council held a special meeting at the town hall last week to expedite arrangements for taking over the Gorleston and Southtown Tramways. The town clerk presented a report from the General Purposes Committee, which stated that the total amount of the arbitration award was £15,000, including the incidental costs which have to be borne by the Corporation. They recommended that application be made for the borrowing of a loan of £15,000 on the security of the borough rate, and that the Tramways Committee be empowered to do all that is necessary for the carrying out of the undertaking immediately after the purchase from the company is completed, a cheque to be drawn for the amount of the award as soon as the town clerk had made arrangements for taking over the concern. This was agreed to, and the work of electrification has since been commenced.

**Yarmouth.**—Messrs. Preece and Cardew, the Corporation's consulting engineers, have undertaken the supervision of the tramways

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extensions. The tender of Mr. J. Tidman for the purchase of 360 tons of discarded rails at 40s. 7d. per ton has been accepted. No change is to be made at present in the hours and pay of the staff taken over from the company. The permanent staff are to receive half-pay during sickness for one month, their cases then to be reconsidered. On and after April 1 a charge of 1d. per package is to be made for passengers' luggage not taken inside the cars. A loan has been granted for £9,700 for the wood paving of Southtown-road, but the work is to be undertaken by the Tramways Committee at £8,700, the reduction of £1,000 being due to the lower of cost of jarrah blocks. It has also been agreed to pave with jarrah blocks High-street from the vicarage to the Memorial buildings, and to apply for a loan. The work will cost £1,360. The month's takings on the Yarmouth trams amounted to £254, an increase of £34.

**Railway Bills.**—The General Committee on Railway and Canal Bills met on Wednesday, and constituted the Railway and Tramway Bills which have been deposited for consideration during the present session into the following groups: Group 1.—Great Eastern, Great Northern and Great Western (New Railways) Railways. Group 2.—North-Eastern, North-Eastern (Steam Vessels), Midland and Rotherham, Maltby, and Laughton Railways. Group 3.—Aberdare Tramways, Great Western (Additional Powers), and London and North-Western Railways. Group 4.—Cork Junction Railway, Dublin United Tramways, Dublin, Wicklow, and Wexford, Great Northern (Ireland), and Midland and Mullingar, Kells, and Drogheda Railways. Group 5.—Charing Cross, Euston, and Hampstead, Edgware and Hampstead, Great Northern, Piccadilly, and Brompton (No. 1), and Baker-street and Waterloo Railways. Group 6.—London County Council (Tramways), London Southern Tramways, London United Tramways (Extension of Time), and Metropolitan Electric Tramways.

**London County Council.**—In connection with the sale of its undertaking to the London County Council, the Woolwich and South-East London Tramways Company claimed £57,206. The Council's valuation was £30 000. As a result of arbitration the purchase price has been fixed at £46,152. 3s. 1d., exclusive of harness materials, consumable stores, etc., which it has been arranged shall be taken over at a valuation at the date of the transfer of the undertaking on March 31. The Finance Committee point out that they reported in July, 1901, when the Council decided to take steps to acquire these tramways, that "from a purely financial point of view it was at least doubtful whether the undertaking, if purchased, would pay its way, and that the purchase must therefore be justified upon the ground that it is required by the general policy of the Council." After long delay and much debate the tramway scheme connecting Camberwell-green with Dulwich has at last been commenced. A large block of buildings at the end of Camberwell New-road has been demolished, and the lines are in progress which will enable the electric cars from the different bridges to pass up Denmark-hill and thence to Dulwich.

**Sunderland.**—The dispute between the Assessment Committee and the Corporation over the assessment of the electric tramway undertaking has been amicably settled at last. The following figures show that the Corporation have gained a decisive victory without taking legal action. The original valuation of the tramways for the year ending March, 1903, to which the Corporation objected, was based upon the receipts for that year, which were £59,284, and the amount of the assessment was £14,129. While the matter has been in dispute the figures for the year ending March, 1904, were obtained, and they gave the gross receipts as £62 597, and the assessment made on that return was £13,650. When the Corporation appealed to the Assessment Committee, that body offered to reduce the amount to £11,000, but the Corporation were far from satisfied with this offer, and hence the dispute. Now, however, the amount fixed, based upon the figures for the year ending March, 1904, is £7,653, and so the matter is settled without the Corporation having to take legal action. The Corporation also appealed to the Assessment Committee in respect of their electric lighting undertaking, and it is understood that negotiations are proceeding for a like settlement.

**London United Tramways.**—Messrs. J. G. White and Co., Limited, 22A, College-hill, Cannon-street, London, E.C., who have recently obtained the contract from the London United Tramways Co., amounting to about £165 000, supply the following particulars:—The contract with the London United Tramways comprises two distinct sections. The first is in Kingston, Surbiton, Malden, and Wimbledon districts. The following are the routes: Starting from a junction of London-road and Eden-street, the first route goes along Richmond-road as far as King's-road, and along King's-road to a terminus at the Kingston Gate of Richmond Park. The second route goes along London-road and Kingston-hill, terminating at George-road. The third route starts from a junction with the latter in London-road and goes along Cambridge-road, Kingston-road, Burlington-road, West Barnes-lane, and Coombe-lane, terminating near Raynes Park Station. The fourth route starts at Clarence-street, goes along Eden-street, St. James-road, Penrhyn-road, Kingston, Surbiton-crescent, Victoria-road, Portsmouth-road, and terminates at Winter's Bridge, Long Ditton. The fifth route starts with a junction with the latter in Victoria-road, Surbiton, goes along Victoria-road and Ewell-road, terminating at Red Lion-lane, Tolworth. The total route length of this line is about 10¼ miles, and the length of single track is about 18¾ miles. The second section is in Hanwell and Brentford, starting from a junction with existing tramways in High-street, Brentford, and then goes along Boston-road, Lower Boston-road, and joins existing tramway in High-street, Hanwell, with another branch going along Boston-road, and joining the same tramway in Broadway, Hanwell. The route length of these lines is about 2⅝ miles, and the length of single track 5½ miles. The type of construction of the track is particularly strong, and consists generally of No. 3 B.S. rails, with cross girders spaced 9ft. apart throughout, and the joints are supported by anchors of H section, secured to rails with bolts and clips. The concrete underbed is 6in. thick, finished off with a layer of 1in. fine concrete, and over this a floating coat of 1in. cement and sand to form bed for wood paving. The paving throughout is of jarrah wood, finished, in the Kingston section, with an edging of granite setts, while in the Hanwell and Brentford section the margins are entirely of granite setts. The overhead construction is span-wire throughout, the poles being 33ft. long, and the ornamental character of the remainder of the London United Tramways will be preserved on the new sections. The trolley wire will be 2/0 B. & S. gauge grooved copper wire, and will be supported by mechanical ears. The height of the trolley wire above rail level will be 23ft., which is greater than is usual, owing to special London conditions.

## LIGHTING AND GENERAL.

**Louth.**—The proposed electric lighting scheme has been rejected.

**New Address.**—Mr. J. R. Bell, M.I.C.E., has taken offices at 25, Victoria-street, Westminster.

**Glasgow.**—New wiring rules, to which we refer in another column, will come into force on May 1.

**Whitehaven.**—New instruments for testing consumers' wiring are to be purchased at a net cost of £18. 4s.

**Scalby.**—Arrangements have now been concluded for an extension of the National Telephone system to Scalby.

**Stafford.**—Permission has been granted to the National Telephone Company to lay an underground telephone pipe.

**Friern Barnet.**—The Council have granted an application from the Hornsey authorities to lay a short cable in their district.

**The Exchange Fire.**—Telephonic communication with the Bank Exchange, destroyed by fire on Feb. 28, has been restored.

**Gravesend.**—Application is to be made for sanction to borrow £4,814 for electricity works and £1,147 for a dust destructor.

**Bermondsey.**—The Council have agreed to an extension of the electric light mains and feeders at an estimated cost of £6,963.

**Kirkby-in-Ashfield.**—The question of a telephonic service for the district is being considered by a sub-committee and the postmaster.

**Barnsley.**—The Town Council have decided to extend their electricity works at a cost of £4,403, and will apply for the necessary loan.

**Arbroath.**—The negotiations with the Empire Company having failed, the whole matter of electric lighting has been referred to a committee.

**Loughborough.**—We understand that a report will be presented to the next monthly meeting of the Town Council recommending electric street-lighting.

**Barking.**—An enquiry has been held into an application of the Urban District Council for sanction to borrow £8,500 for purposes of electric lighting.

**Halifax.**—The electricity works are expected to show a surplus of about £3,000, a good proportion of which will be handed over for the relief of rates.

**Worksop.**—The Urban District Council have completed the loan for £1,000, the balance of the electric lighting loan sanctioned by the Local Government Board.

**Change of Address.**—The Electric Lighting and Traction Company of Australia, Limited, have removed their registered office to Finsbury Pavement House, London, E.C.

**Fulham.**—An expenditure of £245 is required for extension of electric lighting mains in Walham-grove, Elmstone-road, and Harbledown-road for public and private lighting.

**Gillingham.**—The engineer's last report shows that a total o 14,047 8-c.p. lamps, with 226 consumers, are now connected. A number of extensions are to be carried out.

**Bath.**—The Council have agreed to an application from the National Telephone Committee to erect 12 poles, subject to the exact position of each pole being approved by the surveyor.

**London Gazette.**—Frederick Stone, 47, Full-street, Derby, has been released from trusteeship in the estate of Harold Powell, electrical engineer, 47, Northumberland-street, Derby.

**Rosario Electric Co.**—The directors have declared an interim dividend of 3 per cent. for the half-year ended December 31, 1904, on the 6 per cent. cumulative preference shares of original issue (£5 each fully paid).

**Newport.**—The Electricity and Tramways Committee of the Corporation propose to apply for sanction to borrow a further sum of £12,500, repayable in 25 years, for electric lighting and power supply purposes.

**Yarmouth.**—A sum of £420 for lighting the Marine-parade North is to be provided out of the balance of the profits on the electricity undertaking, and £800 will be transferred to the credit of the general district rate.

**British Insulated and Helsby Cables.**—The directors recommend a dividend of 4 per cent. making 8 per cent. for 1904, placing £21,000 to depreciation, £5 000 to debenture redemption, £8,500 to special reserve, and carrying forward £7,100.

**Lichfield.**—The City Council have already consented to the provisional order which the Board of Trade propose to issue to Messrs. Foote and Milne, Limited, and have arranged for a protective clause to be inserted into the Shropshire and Worcestershire Electric Power Bill.

**Colne.**—The last report of the electricity works manager shows an increase of 970 in the units of electricity generated in February as compared with the corresponding month of last year. The consumers increased by 39. The promenade lighting scheme has been deferred.

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**Stamford and Rutland.**—An exhibition of electrical plant, appliances, etc., promoted by the Urban Electric Supply Company, Limited, was opened on Monday at the Assembly Rooms by Mr. F. P. Rawson, of Sheffield, the proceeds being in aid of the Stamford and Rutland Infirmary.

**Ferranti Limited.**—We are informed that under the scheme of reconstruction the new company was incorporated on the 27th ult., and will as and from March 1 proceed to carry on the business as hitherto carried on by Messrs. A. W. Tait and Arthur Whittaker as receivers and managers.

**South Metropolitan Electric Light and Power Co.**—The debenture stock transfer register of this company will be closed from the 20th to 31st inst. (both days inclusive) for the preparation of the warrants for half-year's interest payable April 1 next, which will be posted on the 31st inst.

**Shrewsbury.**—The Council have sanctioned an expenditure of £5 295 to carry out necessary extensions at the electrical works, and have authorised the Electric Light Committee to petition Parliament, if necessary, against a Bill to be introduced by a company affecting Shropshire and Worcestershire.

**Cheltenham.**—Mr. Ley Wood, at the last Town Council meeting, described experiments with various kinds of Nernst lamps, and declared that the committee had arrived at the conclusion that it would be inadvisable to substitute Nernst for arc lamps, as the cost of the alteration would be from £3,000 to £3,600.

**Maidstone.**—An enquiry has been held into the application of the Town Council for sanction to borrow the sum of £6,000 for the electrical undertaking, made up as follows: coal station, £330; extension of mains, £3 703; indicators, £150; public lamps, etc., £620; additions to the switchboard, £550; new feeder in High-street, £550; contingencies, £97.

**Northern Counties Electricity Supply Co.**—The directors recommend a further dividend of 1½ per cent., making a total of 3 per cent. for 1904, placing £1,500 to reserve account, leaving £256 to be carried forward. It is proposed to offer to the shareholders the balance of the last issue of shares not yet taken up, and to make an issue of debentures.

**Agency.**—The Rhodes Electrical Manufacturing Company, Limited, have appointed Mr. P. A. Paris as their sole representative for Manchester, including the counties of Cheshire and Lancashire, for the sale of their direct and alternating current motors. His temporary address is 42, Yarburgh-street, Alexandra Park, Manchester (telegraphic address, "Rhodique, Manchester").

**Brompton and Kensington Electricity Supply Co.**—The report for 1904 shows an available balance of £32,944. The directors recommend a final dividend on the ordinary shares at the rate of 11 per cent. per annum, making 10 per cent. for the year. The sum of £8,000 is placed to depreciation account, £676 to directors' additional remuneration, and £5,084 is carried forward.

**Camborne.**—A six days' electrical exhibition is being held opposite the works of the Urban Electric Supply Company, Limited, Tuckingmill, in charge of the resident managing engineer, Mr. F. S. Hanning. The gross proceeds of the exhibition will be handed to the West Cornwall Miners' Hospital, the committee of which have decided to give 5 per cent. of the amount to each of the local nursing associations.

**Dublin.**—In proposing the electric lighting estimates on Tuesday, Mr. Irvin said they had provided absolutely for the interest and sinking fund upon a sum of £20,000 that would be spent a couple of months hence on the extension of the electric lighting in the old city area. They were now in a satisfactory position. This year the rates would not have to provide one penny to carry on the electric lighting of the city.

**Wireless Telegraphy.**—A Reuter's Tripoli telegram says the Turkish Government has given a concession to a well-known German firm to establish wireless telegraphy stations at Derna (Tripoli) and Rhodes. An engineer has arrived here in order to make arrangements for the installation. Telegraph communication with Constantinople will be established in May. This is the Tripoli on the coast of Syria, near Alexandrette.

**Longton.**—The Corporation find the use of electricity for motive power purposes gradually extending and coming into favour with manufacturers and tradesmen, and have decided to adopt the following reduced scale of charges for power: for 500 units per quarter or less, 2½d. per unit; above 500 units and under 1,000 per quarter, 2¼d. per unit; above 1,000 units and under 1,500, 2d. per unit; above 1,500 units and under 2,000, 1¾d. per unit.

**Calcium Carbide.**—New regulations have been made by the Austrian Ministries of the Interior, Commerce, Railways, and Agriculture regarding the production and use of acetylene, as well as the storage and transit of calcium carbide. These regulations can be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C., any day between the hours of 10 a.m. and 5 p.m. (Saturdays, 10 a.m. to 1 p.m.).

**Private Bills.**—The following Bills have been read a second time in the (1) House of Lords: Metropolitan Railway Bill. (2) House of Commons: Wigan Corporation, Bristol Corporation, L.C.C. (Tramways), Baker-street and Waterloo Railway, Charing Cross, Euston, and Hampstead Railway, Edgware and Hampstead Railway, Great Northern, Piccadilly, and Brompton Railway (No. 1), Ealing Corporation, and the Chelsea Electricity Supply Bills.

**Preston Assessment.**—The premises and mains of the National Electric Supply Company, Limited, of Preston, were some time since assessed at a rateable value of £4,609. The company thereupon decided to appeal against this amount, and on Mr. Humphreys Davies appearing before the Assessment Committee upon their behalf, a reduction of the rateable value to £4,000 was obtained, with an undertaking that this amount should not be disturbed for two years.

**Heckmondwike.**—The Standing Orders Committee of the House of Lords have passed the Heckmondwike Improvement Bill, by which the authorities sought to confer further powers on the Heckmondwike Urban District Council with regard to supply of water and electricity, and the improvement, health, local government, and finance of the district, etc. Clauses 10 and 11 were struck out. They relate to the extension of the area of supply of electricity, and to an agreement with the British Electric Traction Company.

**Government Telegraph Revenue.**—The last Post Office telegraph return gives the gross amount received by the Post Office in 1904 in respect of telegrams, private-wire rentals, special-wire rentals, and other sources at £4,208,426. From this sum the amount paid to cable companies, £529,520, and telegram moneys refunded, £4,748, must be deducted, leaving £3 674,137. The amount expended by the telegraph section of the Post Office in salaries, rent, and other respects during the same period is £4,693,897, the balance of expenditure over receipts thus being £957,782.

**Bradford.**—For some little time past the electrical engineer has been carrying out tests with the mercury vapour lamp. At Tuesday's meeting Alderman G. H. Robinson (chairman of the Electricity Committee) moved, and Mr. H. Hibbert seconded, a motion for the adoption of the minutes which contained a recommendation that the Council should select from a list submitted an expert to advise the committee as to the best way of carrying out the work of the department. After discussion, an amendment that the services of an expert be dispensed with altogether was carried.

**Marconi Installations.**—It is reported that an agreement has been signed between the two Government departments concerned and the Marconi Wireless Telegraphy Company for the installation of instruments for transmission of messages to the mainland from six lightships in the neighbourhood of the Goodwin Sands. The lightships to be supplied are "East Goodwin," "South Goodwin," "Gull" "Tongue," "Sunk," and "Cross Sand." The messages will be received at the Dover receiving station and forwarded by ordinary telegraph to the nearest lifeboat station in case of need.

**French Cable Co.**—The French Cable Company, whose local lines the President of Venezuela contemplates seizing, is an undertaking subsidised by the French Government. The *Birmingham Post* says this suggests serious complications. Following the high-handed action of the Venezuelan Government towards the American Asphalte Company there seems to be trouble ahead for the South American Republic, which has already sustained an Anglo-German blockade of its coasts. The French Cable Company, which has an office in London, is registered in France as the Compagnie Française des Cables Télégraphiques. It came into existence just over 10 years ago in succession to the French Atlantic Cable Company, and the system has been extended. By a subvention dated July, 1895, the French Government has given a subsidy of 800,000fr.; in addition the French and Australian Governments guarantee in respect of the Australian-New Caledonian cable annual receipts of 300,000fr. for 30 years from the opening of the line, together with a contribution to working expenses.

**Stock Exchange.**—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Charing Cross, Euston, and Hampstead Railway Company's scrip (fully and partly paid) for £800,000 4 per cent. perpetual debenture stock, and Great Northern, Piccadilly, and Brompton Railway Company's scrip (fully and partly paid) for £1,200,000 4 per cent. perpetual debenture stock, and to allow the following securities to be quoted in the official list: Charing Cross, West-end, and City Electricity Supply Company's further issue of £50,000 4 per cent. debenture stock; Liston Electric Tramways, Limited, £500,000 ordinary shares of £1 each fully paid, Nos. 1 to 500,000, 500,000 6 per cent. cumulative preference shares of £1 each fully paid, Nos. 1 to 500 000, and £500,000 5 per cent. mortgage debentures of £100 each, Nos 1 to 5,000 (registered); Metropolitan District Railway Company's £537,351 assented extension preference (5 per cent.) stock, and £962,649 unassented extension preference (5 per cent.) stock, in lieu or the £1,500,000 extension preference (5 per cent.) stock now quoted; Potteries Electric Traction Company's further issue of £25,000 4½ per cent. debenture stock.

**Leeds.**—A scheme is about to be carried out for supplying the suburbs of West Leeds with electricity at practically the same cost as that paid in the centre of the city. It is proposed to utilise part of the land recently purchased in Stanningley-road, near Bramley Town End, for a tramway depôt, whilst the remainder is to be reserved as a sub-station for electric lighting purposes. Current generated at Crown Point will be transmitted to the new station at Bramley, and from there for private usage in the Bramley, Stanningley, Rodley, and Armley districts. Messrs. Matthews and Yates have recently equipped five boilers at the Crown Point electricity station with their Cyclone induced-draught system. This firm, which has its works at Swinton, early this month supplied one of their No. 11 Cyclone exhausters and a 26-h.p. motor, which is wound for 550 volts, and runs at over 400 revolutions per minute. On the 9th inst. a test was made with the apparatus, with the result that more water was evaporated and with less fuel than by the old method of using steam-jets under the fires, which the fan draught has superseded. As a less quantity of fuel was used for evaporating a larger quantity of water than by the old method, it will, of course, be understood that smoke was not seen during the test period. As the combustion of the fuel was more perfect smoke could not be formed. Under normal working conditions, previous to the fan being fixed great annoyance had been caused by the black smoke emitted from the chimney. The class of fuel used was ordinary slack, and the water evaporated was equal to about 9lb. of water per 1lb. of fuel. Messrs. Matthews and Yates, Limited, have quite recently erected two other installations in Leeds, which are working satisfactorily, and they are also erecting a number of installations in the city of Bradford.

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**Harrogate.**—At the last Council meeting it was proposed that the charges for lighting purposes be reduced as follows from July 1, 1905: flat rate from 5½d. to 5d. per unit; demand indicator, 6½. and 2½d. to 6d. and 2d. Councillor Sheffield, referring to this minute, asked how much surplus profit there would be for the relief of the rates after the reduction became operative. An amendment was carried requesting the Lighting Committee to consider the discontinuance of the demand indicator system, and to allow discounts.

**Sao Paulo Tramway Light and Power Co.**—This company was formed in 1899 to operate an electric railway, and also to carry on a lighting and power business in the city of Sao Paulo, Brazil. The capital is 7,000,000dol. in shares of 100dol. each, with 6,000,000dol. in 5 per cent. 30-year-old gold bonds of 500dol. each, redeemable in 1929. The common stock is in receipt of dividend at the rate of 8 per cent. The company owns and operates 60 miles of street track and 12 miles of steam railway. The shares are now quoted in London.

**Jarrow.**—Mr. Batey, the sanitary inspector, has made a detailed report to the Town Council in regard to the alleged smoke nuisance at the power station. He has made photographic observations and complained to the secretary of the power company. The company replied that they were fitting an apparatus on the boilers which they believed would remove any cause for complaint. While the fitting was proceeding further observations were taken on the centre chimney, to which the apparatus was fitted, and the inspector says that there is a slight improvement, but that it is not automatic.

**Burnley.**—It is proposed to reduce the charge for electric current to 3½d. per unit from 4d., and for motive power and heat from 3d. per unit for the first hour to 1¾d. for the first hour, and afterwards 1d. per unit. Public lighting will be reduced 50 per cent.—viz., from 3d. to 1½d.—and a further decrease is also announced in the charge for current for the tramways. This makes the fourth reduction since the trams began, which means a considerable help to the tramways department. The reductions have been from 2d. to 1⅞d., 1¾d., 1½d., and now it is proposed to charge 1·45d. The hire of motors is also to be lowered, the rentals being in ratio to capital cost. Further, arc lamps will be 15s. instead of £1.

**Aberdeen.**—The County Council have agreed to the granting of an electric lighting provisional order to Messrs. Lowdon Bros. and Co., Temple Electric Works, Dundee, for the Cults district, subject to the provisions contained in certain agreements entered into between the County Council of the county of Aberdeen, the Aberdeen District Committee, and Messrs. P. C. Middleton and Co., Limited, electric light and power engineers, and a further agreement entered into between the said County Council, the Aberdeen District Committee, and Messrs. Lowdon Bros. and Co., electrical engineers, Dundee, with the consent and concurrence of the liquidators of the said Messrs. P. C. Middleton and Co., Limited, in October, 1902.

**Dalkeith.**—The inauguration of the street-lighting by electricity took place on Saturday. Mr. K. Scott-Moncrieff, of the Electric Supply Corporation, Limited, London, who presided, presented to Provost Chisholm a silver electric switch, mounted on a marble slab, and which bore the following inscription: "Presented to John C. Chisholm, Esq., Provost of Dalkeith, by the Electric Supply Corporation, Limited, on first lighting up the streets of Dalkeith by electricity, 11th March, 1905." Provost Chisholm then switched on the current, a temporary wire having been laid into the meeting place from the street cables. The installation consists of 27 10-ampere arc lamps in three circuits of nine, and each of the lights is of 1,000 c.p.

**Luton.**—The electrical engineer's last report stated that since Jan. 27 45 698 units had been generated, and an equivalent of 72 8-c.p. lamps and four motors of 50 h.p. connected, making a total of 233 consumers with 14,182 lamps and 75 motors of 308 h.p. and that the units generated showed an increase of 79 per cent. over the number generated during the corresponding period of last year, and that at the present time applications were in for over 540 additional lamps and 248 h.p. in motors. The report was received. The electrical engineer has also presented a report as to the absolute necessity for an increase of plant to supply the present demand for power and light, and application is to be made for sanction to a loan of £5,000 for additional plant.

**St. Marylebone.**—The following estimate of expenditure has been prepared for the supply of distributor cables, house cables, and connections, as follows: nine miles of ·15 triple-concentric lead-covered distributor cable at £495 per mile, £4,455; seven miles of ·25 triple-concentric lead-covered distributor cable at £670 per mile, £4,690; house cables and connections, 500 at £2. 10s. per connection, £1,250—total, £10,395. The number of 500 connections is estimated by the resident engineer as the maximum number of new consumers likely to be connected during the year ending March 31, 1906. This expenditure is included in the original estimates of the consulting engineer, and is covered by the borrowing powers already sanctioned by the London County Council.

**New Company.**—The business of Messrs. Harris, Lee, and Co., 165, Queen Victoria-street, London, E.C., has been converted into a limited company, under the style of "Harris, Lee, and Co., Limited," and registered under the Companies Acts of the Transvaal. The management will be as heretofore, the partners having become directors of the new company, and holding the bulk of the interest. The company holds, among others, the sole agencies for South Africa for Messrs. Crompton and Co., Limited; the St. Helens Cable Company, Limited; Perfecta Seamless Steel Tube Company, Limited; Electric and Ordnance Accessories Company, Limited; Evershed and Vignoles, Limited; C. J. Thursfield and Co.; Zurich Incandescence Lamp Company; Gilbert Arc Lamp Company; Bastian Meter Company, Limited.

**Maidenhead.**—The electrical engineer in his last report states that the plant has run well generally since the last meeting, and that new consumers are coming in well again. Twelve services have been laid during the month, five of which are connected. There have been six further applications received since the last meeting, and the equivalent number of 8 c.p. lamps applied now exceeds 15,000. The following is a comparative statement of electricity generated, sold, etc., as furnished for the Board of Trade returns, and gives the increase in output of 1904 over 1903: quantity generated, 1903, 134,968 (1904, 218,497); sold to public lamps, 34 276 (51 236); sold to private consumers—by meter and contract, 66,827 (120,116); total sold, 101,103 (171,322); quantity used on works, 25,615 (46,316); total quantity accounted for, 126,718 (217 638); quantity not accounted for, 7,650 (859); maximum supply demanded, 156 kw. (212 kw.).

**King's Lynn.**—The last report of the borough electrical engineer states that during the month applications had been received for 76 additional lamps of 8 c.p. (or equivalent), making a total of 20,503 lamps and 508 consumers. The total number of Nernst lamps now in use for street-lighting was 32, and they give about 66 c.p. as compared with 32 c.p. in the ordinary street lamps, and consume about 15 per cent. less current. He estimates that if all the incandescent lamps were converted to Nernst lamps the extra cost per annum would be as follows: for renewals £190, for extra attendance £30—total, £220. Against this extra cost there would be an annual saving to the department in current of about £158. The first cost of converting the lamps would be 10s. to 12s. per lamp, or for the whole about £250. It has been decided to charge only 1½d. per unit for heating and cooking purposes, provided the current is registered on a separate meter, for which 1s. per quarter will be paid.

**Southampton.**—The electrical engineer, having suggested a reduction of the present charges, has been directed to prepare his estimate on the basis of a reduction of charge for the trams from 2⅛ d. to 2d., and to private consumers from 4½d. to 4d. and 4d. to 3d. for cellar and back lighting. A deputation from the Commerce of the Port Committee has waited upon the directors of the Telephone Company and their general manager (Mr. W. E. L. Gaine). The deputation having conferred with the company upon the subject of the suggested reduction of their telephone charges to subscribers in the county borough of Southampton, were informed that the Postmaster-General was negotiating for the purchase of the whole undertaking of the company, and that under the circumstances they could not consider any alteration in the charges at Southampton, although it was admitted that at Portsmouth and at two or three other places the charges were half of those existing at Southampton.

**Leicester.**—There is a profit of £3,947 resulting from the electric lighting undertaking for the half-year ending Dec. 31 last after paying interest on capital and £3 221 on account of sinking fund. The profit for the half-year ended June 30 last, as reported to the Council on Sept. 27 last, was £2,570, making the total profit for the year £6,518. The committee have reported on the question of providing additional plant at the electric lighting station. The present generating capacity of the station is equal to 3,400 kw. distributed between six alternators, two being equal to 1,000 kw. each and four to 350 kw. each. In December last the load reached 2,400 kw., necessitating the use of the two large machines and one small one. It is estimated that an additional 200 kw. will be called for next lighting season, requiring the use of a further small engine, leaving only two of the smaller type as spares. This the committee consider altogether inadequate should an accident occur to one of the large machines, and they have, therefore, accepted tenders for additional plant, particulars of which appear in another column.

**Dufftown.**—The Town Council have adopted a scheme for lighting the burgh with electricity. It is proposed to catch the water in the tail race as it leaves the Fife Mills at Orachie and use it to drive a turbine wheel. The flow of water there is taken to give, with a 7½'t. fall, a clear 13 h.p. to 13½ h.p. for the dynamo. The water would be taken in wooden troughs below Orachie Bridge, and then on the waste piece of ground near the railway bridge, where a hut would be constructed for the turbine and a small house for covering the machinery. The whole work is not to cost more than £700. This would give an installation of 120 to 130 16-c.p. lights, and as the present requirements of the burgh are 40 lights, 50 to 60 lights could be supplied to private customers at £1 per light of 16 c.p. per year. The annual expenditure is estimated as follows: interest on loan of £700 at 3½ per cent., £24. 10s.; sinking fund at 3½ per cent., £24. 10s.; water right, upkeep, and attention, £20—or a total expenditure of £69. An income of £60 would be got from private lighting, leaving a balance of £9 to be raised from the rates. This would be a saving of £30 to £40 yearly, as the present system costs the town from £40 to £50 per annum. The Council think that a provisional order would not be required, as there would be no danger of a rival company coming into the field.

**Swindon.**—The last monthly report of the electrical engineer shows that the number of consumers connected was 306, as against 163 in February of last year. The number of street lamps converted to date was 169, as against 126 at this time last year. The Electricity and Tramways Committee have recommended a reduction in the charges for electricity from March 31 as follows: Flat rate—to be reduced from 5d. per unit to 4d. per unit; maximum demand system—capital charge to be reduced from £7. 10s. to £6 per kilowatt; power charges—to be reduced from 2½d. per unit to 2d. per unit, with discounts as at present, and subject to the Corporation reserving the right to charge the 4d. per unit for all current taken between 5 p.m. and 10 p.m. in the winter months; street-lighting—25 per cent. larger lamps to be fixed as the old lamps give out, and the charges to remain the same as at present, excepting for arc lamps, the charge for which to be reduced from £17. 10s. per annum to £16. 10s. per annum; meter rents—consumers to be allowed one meter for the equivalent of every 180 lamps connected for lighting or power, without charge, and for each additional meter the rents to be as at present; discounts—that the discounts be discontinued; current for the tramways—to be reduced from 2½d. per unit to 2d. per cent. The report has been referred back.

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**London County Council.**—The Highway Committee reported on Tuesday that the Council on Oct. 13, 1903, sanctioned expenditure of £2,000 in connection with the making of surveys, the digging of trial holes, and the preparation of plans, specifications, estimates, etc., for the second portion of the Greenwich electricity generating station. Considerable progress had been made with this preliminary work, but alterations in the drawings of the buildings had had to be made in consequence of the Greenwich sub-station being erected independently of the main buildings, instead of as part of that work as was originally intended. This had necessitated some additional expenditure, and the sum of £2,000 above referred to was now practically expended. In view of the fact that the second portion of the Greenwich generating station would be required for the electrical working of the Council's (northern) tramways, and that its erection and equipment, if and when decided upon, would not occupy less than about 2½ years, they thought that the remainder of the preliminary work, as regards the preparation of drawings and the taking out of quantities, should be completed without delay. In this connection they pointed out that the Council had already determined to proceed, as soon as the necessary arrangements could be made, with the reconstruction of the first section of the Council's (northern) tramways. In the circumstances, therefore, they suggested that additional expenditure of £1,500 should be sanctioned for the purpose above indicated, and recommended accordingly. A conference will be held on March 20 between the City Corporation, the London County Council, and the metropolitan borough councils with reference to the promotion of the parliamentary Bills dealing with the supply of electricity in bulk in the County of London.

## PROVISIONAL PATENTS, 1905.

MARCH 6.

**4593. To use electric currents so as to electrolyse baths made of different acids for the purpose of destroying all vegetable matter in wool, rags, and other fibres.** Squire Rogers, The Observatory, Liversedge, Yorks.

**4595. Improvements in stopping and starting hydraulic pumps, electrically driven or otherwise.** Thomas Robson Charlton and George Herbert Traver, 11, Royal-arcade, Newcastle-on-Tyne.

**4625. Improvements in electric hoist controllers.** Joseph Gershom Childs, Hawthorn-road, Willesden Green, London.

**4643. An electrical grower.** Colin Graham, 1, Little Ealing-lane, South Ealing, London.

MARCH 7.

**4700. Improvements in electric light counterweight fittings.** James McFarlane and Harold Watson, 154, St. Vincent-street, Glasgow.

**4716. Telephone exchanges.** Frank Albert Lundquist, 65, Chancery-lane, London. (Complete specification.)

**4727. Improvements in and relating to ventilating fans.** Crompton and Co., Limited, and Claud Crompton, Arc Works, Chelmsford.

**4728. An improved instrument for displaying and recording the wave-form of alternating electric currents or voltages.** Crompton and Co., Limited, and Rudolf Goldschmidt, Arc Works, Chelmsford.

**4731. Improvements in electric pushes or switches for operating electric bells, telephones, signalling, and for other purposes.** Cecil Shartman Wansbrough, 33, Cannon-street, London.

**4740. Improvements in electric arc lamps.** Herbert Edward Angold, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**4741. Improvements relating to electrical apparatus for transmitting and receiving signals.** Arthur Trevor Dawson and George Thomas Buckham, 7, Southampton-buildings, Chancery-lane, London.

**4760. Improvements in dynamo-electric machines.** Friedrich Frohlich and Rudolf Farkac, 7, Southampton-buildings, Chancery-lane, London.

**4763. Improvements in electric circuit breakers.** William Harding Scott, 47, Lincoln's-inn-fields, London.

**4780. Improvements in and relating to appliances for testing electric batteries.** Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (Nicolay Jacobsen, Norway.)

**4783. Improvements in and relating to prepayment meters.** The British Thomson-Houston Company, Limited, 83 Cannon-street, London (The General Electric Company, United States.)

**4786. Arc lamp.** Thomas Alfred Hearson, 22, Southampton-buildings, Chancery-lane, London. (Phönix Elektrotechnische Ges. m. b. H, Germany.) (Complete specification.)

MARCH 8.

**4801. Improvement in obstruction removers or life-guards for electric tramcars and like vehicles.** Montague Brown Mountain, Godfrey Marsden Gibson, and Arthur Falkland Howard Head, 55, Market-street, Manchester.

**4816. An improved apparatus for detecting leaks in electric circuits.** William Alfred Buckland, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**4827. Improvements in trolley poles for electric tramway vehicles.** William James Bowden and James William Cronkshaw, 6, Bank street, Manchester.

**4832. Improvements in or relating to electrical fittings.** John Dugdill, 5, John Dalton-street, Manchester. (Complete specification.)

**4845. Improvements in and pertaining to alternating-current motors.** The Union Elektricitäts Gesellschaft, in liquidation, 27, Chancery-lane, London. (Date applied for under Patents Act, 1901, March 12, 1904, being date of application in Germany.) (Complete specification.)

**4848. Improvements in arc lamps.** Philip Middleton Justice, 55, Chancery-lane, London. (Phönix Elektrotechnische Ges. m. b. H., Germany.) (Complete specification.)

**4852. Improvements in or relating to signalling apparatus for use with electric railways or tramways.** Amos Edward Barber, 165, Queen Victoria-street, London.

**4858. Improvements in connection with the compensating poles of electrical machines.** Elektrizitäts Act.-Ges. vorm. W. Lahmeyer und Co., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, April 16, 1904, being date of application in Germany. (Complete specification.)

**4859. Improvements in the field-magnet arrangements of alternate-current electrical machines.** Elektrizitäts Act.-Ges. vorm. W. Lahmeyer und Co., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, April 30, 1904, being date of application in Germany.) (Complete specification.)

**4867. Improvements in or relating to electric vapour apparatus, and more particularly to lamps of the character known as electric vapour lamps, or mercury vapour arc lamps, or hermetically enclosed arc lamps, or the like.** Charles Orme Bastian and George Calvert, Birkbeck Bank-chambers, Chancery-lane, London.

**4878. Improvements in and relating to electric distribution systems and controlling apparatus therefor.** The British Thomson-Houston Company, Limited, and Edmund Basil Wedmore, 83, Cannon-street, London.

**4881. Improvements in and relating to electromagnetic brakes.** The British Thomson-Houston Company, Limited, and C. B. Larzelere, 83, Cannon-street, London.

**4883. Improvements in or relating to central-station telephone systems working with a common battery.** Isidore Bernard Birnbaum and Francis George Bell, 322, High Holborn, London.

MARCH 9.

**4957. Improvements in printing telegraph systems.** Sydney Elliott Page, 28, New Bridge-street, London. (Frederick Joseph Swift, United States.) (Complete specification.)

**4960. Improvements in electrical multiple influence or condenser machines.** Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Heinrich Wommelsdorf, Germany.) (Complete specification.)

**4967. Improvements in connection with the braking arrangement of electric motors.** William Harding Scott, 47, Lincoln's-inn-fields, London.

**4979. Improvements relating to resistance units for rheostats, electric heaters, and the like.** Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (The Wirt Electric Company, Incorporated, United States.) (Complete specification.)

**4982. Improvements connected with the control of electric circuits.** Michael Chapman and George Luther Stone, 18, Southampton-buildings, Chancery-lane, London.

**4984. An improved receiver for use in wireless telegraphy.** John Groome Balsillie, Clun House, Surrey-street, Strand, London.

MARCH 10.

**5010. Improvements in apparatus for controlling and operating the points of electric railways and tramways.** Edward Cross, "Dunedin," Oxford-street, Rotherham, Yorks.

**5013. Improvements in and relating to telpherage or overhead electric conveyor systems and the like.** Henry Schuster Cowx, 556, Chester-road, Old Trafford, Manchester.

**5042. Improvements in electrically-operated pianos.** Joseph Weber, 111, Hatton-garden, Holborn, London. (Complete specification.)

**5045. A low-voltage electric light for motor vehicles.** Orlebar David Bruce Payne, 1, Broad-street-buildings, Liverpool-street, London.

**5049. Improvements in insulators.** Arthur George Bloxam, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Joseph Goffin, Belgium.) (Complete specification.)

**5059. Improvements relating to the application and distribution of electric motive power, particularly for use in starting machinery and for similar purposes.** George William Mascord, 27, Chancery-lane, London.

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**5061. Improvements in elastic supports for cells and storage batteries.** Henri Tudor, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**5070. Improvements in cut-outs or safety devices for electric systems or apparatus.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**5073. Improvements in or connected with means for automatically breaking an electric circuit in the event of a leakage to earth.** Nalder Bros. and Thompson, Limited, and Arthur Frederick Harris, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

MARCH 11.

**5143. Improvements in electrically-driven steering gear.** William Horatio Harfield and William Routledge, 4, South-street, Finsbury, London.

**5149. Improvements in or relating to telephone and like transmitters.** Hahnemann Adolphus Cutmore, 315, High Holborn, London.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published March 30.*

1904.

**5634. Switch point and "frog" for the overhead equipment of electrical traction.** Bonthrone.

**6030. Telephone systems.** Parker and Adam.

**6104. Electric contact breakers or tremblers.** John Crisp Fuller, George Fuller, and Frederick Joseph Gordon.

**8398. Electrically energised pendulum clocks.** Granger.

**8575. Electrical device for shifting type carriers as well as paper carriers for typewriters, type telegraphs, and the like.** Benicke and Westerbeck.

**9103. Electric igniting devices for miners' safety lamps and the like.** Day. (Fabrik Elektrisher Zünder G. m. b. H.)

**9377. Electric treadles or contact makers for railway signalling and the like.** Wood and McKenzie and Holland, Limited.

**9744. Watertight covers for electric tumbler switches.** General Contracts Company, Limited, and Flood.

**10055. Supports for electric cables, hydraulic mains, and other conductors of power, especially suitable for use in mines.** Callender's Cable and Construction Company, Limited, and Ward.

**10248. Vapour electric apparatus.** Carolan. (General Electric Company.)

**10249. Vapour electric apparatus.** Carolan. (General Electric Company.)

**10456. Electric switches.** British Thomson-Houston Company, Limited. (General Electric Company.)

**10551. Arrangement of electric motors in or on electrically-driven vehicles.** Krizik.

**11041. Automatic electric circuit breakers.** Eckstein and Mellis.

**11470. Poles or electrodes of electrolytic apparatus and the like.** Atkins.

**11831. Gas or vapour electric apparatus for rectifying alternating electric currents and other purposes.** Von Recklinghausen.

**20627. Method for the electrolytic manufacture of water-jackets, casings, and the like.** Bosquet. (Date applied for under International Convention, Feb. 10, 1904.)

**21455. Electric time alarms.** Bromhead. (American Bank Protection Company.)

**25637. Space telegraphy.** Stone. (Date applied for under International Convention, Nov. 24, 1903.)

**25640. Space telegraphy.** Stone. (Date applied for under International Convention, Nov. 25, 1903.)

**26922. Arc light electrodes.** Weedon. (Date applied for under International Convention, Dec. 10, 1903.)

**27209. System of electrical distribution for railways and method of operating same.** Hallberg.

**29363. Electrical measuring instruments.** Lake. (Arcioni.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. £ | | Last price £ |
|---|---|---|---|
| **Commercial and Industrial.—** | | | |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ⅜-¼ xd |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 7/16-17/32 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | – | 5¼-6¼ |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | – | 5¼-5⅝ |
| —— 4½ per cent. Mortgage Debentures | 100 | – | 101-104 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 99-101 xd |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | – | 3¼-3⅜ |
| —— 4 per cent. Mortgage Debenture Stock | 100 | – | 91-93 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,751 | 2 | – | ½-⅝ |
| —— Non. Cum., 6 per cent. Pref. | 2 | – | 1½-1⅝ |
| —— 4½ per cent. 1st Debenture Stock | 100 | – | 92-95 xd |
| —— 4½ per cent. 2nd Debenture Stock | 100 | – | 79-82 |
| Callender's Cable, Debentures | 100 | – | 105-107 |
| —— Ordinary | 5 | – | 11-11½ |
| —— 5 per cent. Pref. | 5 | – | 5¼-5⅜ |
| Crompton and Co. | 3 | – | 2⅛-2⅜ |
| —— 5 per cent. Debentures | 100 | – | 96-98 |
| Edison and Swan United, "A" Shares, 1-99,261 | 3 | – | ⅝-1⅛ |
| —— "A" Shares, 01-017,139 | 5 | – | 1⅛-2 |
| —— 5 per cent. Debentures | 100 | – | 86 91 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 80 85 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | – | 1⅛-1⅛ |
| —— 7 per cent. Cumulative Pref. | 2 | – | 2⅛-2⅛ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | – | 97-99 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | – | 9¼-10 |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | – | 91-96 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | – | 13-13½ |
| —— 4½ per cent. Preference | 5 | – | ⅝-⅝ xd |
| —— 4½ per cent. Debentures | 100 | – | 109-111 xd |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | – | 16-17 |
| —— 4 per cent. Debentures | 100 | – | 100-103 |
| Parker, Thos., Limited, Ordinary | 10 | – | 10-10¼ |
| Telegraph Construction and Maintenance | 12 | – | 26 38 |
| —— 5 per cent. Bonds | 100 | – | 103 105 |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary | 10 | – | 12¼-12⅜ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | – | 9⅜-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | – | 11-12 |
| —— 4½ per cent. Debenture Stock, Red. | 100 | – | 105-107 |
| Bromley (Kent) Electric Light and Power Co. | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. 1st Debenture Stock, Red. | 100 | – | 101-104 |
| Brompton and Kensington, Ordinary | 5 | – | 10¼-10⅜ |
| —— 7 per cent. Preference | 5 | – | 10¼-10⅜ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 | 5 | – | 9 9⅛ |
| —— Nos. 60,001-80,000 | 5 | – | 6½-7 |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | – | 12½-13¼ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 105-108 |
| Charing Cross and Strand, Nos. 1-70,000 | 5 | – | 8-8¼ xd |
| —— 70,001-80,000 | 5 | .. | 7⅜-8¼ |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 4 15/16-5 1/16 |
| —— 40,001-80,000 | 5 | .. | 4 15 16-51 16 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | – | 103-105 |
| Chelsea Electricity Supply | 5 | – | 6⅜-7¼ xd |
| —— 4½ per cent. Debentures | 100 | – | 109-11 |
| City of London, Ordinary | 10 | – | 12½-13 |
| —— 6 per cent. Cumulative Pref. | 10 | – | 13⅜-14¼ |
| —— 5 per cent. Debenture Stock | 100 | – | 125-127 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | – | 103-105 |
| County of London Electric Supply, Ordinary | 10 | – | 9½-10 |
| —— 6 per cent. Cum. Pref. | 10 | – | 12¼-12⅜ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 103-105 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. | 100 | .. | 110-113 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | – | 6¼-6½ |
| —— 6 per cent. Cum. Pref. | 5 | – | 6¼-6⅜ |
| —— 4½ per cent. First Mort. Deb. | 100 | – | 106-108 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 2-2½ |
| —— 5 per cent. Debenture Stock, Red. | 100 | – | 86-91 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | – | 5¼-6 |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | – | 101-104 |
| Havana Electricity, Limited, 1-15,000 | 10 | – | 9¼-10⅛ |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | – | 7⅛ 8 |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 101-103 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 | 1 | – | 11/16-13/16 |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | – | 12⅜-13¼ |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red | 100 | – | 102-104 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅜-10¼ |
| London Electric, Ordinary | 5 | – | 2 9/16-2 13/16xd |
| —— 6 per cent. Pref. | 5 | – | 5⅜ 6 xd |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | – | 99-101 |
| Metropolitan Ordinary | 10 | – | 19¼-19⅜ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | – | 110-115 |
| —— 4½ per cent. Cum. Pref. | 5 | .. | 5⅜-5⅜ |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | – | 87-89 |
| Midland Electric Power Dis., Ld., 4½ p c. 1st Mort. Deb. | 100 | – | 99-101 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | – | 88-101 |
| —— Preference | 4 | – | 100-102 |
| Notting Hill Electric Lighting | 10 | – | 14¼-15¼ |
| —— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.) | 100 | | 102-104 |
| Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,510 | 5 | – | 6¼-6½ |
| —— 4 per cent. Debenture Stock | 100 | – | 98-100 |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures | 100 | – | 100-102 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 | – | ⅞-1 xd |
| —— 4 per cent. Debenture Stock | 100 | – | 79-85 |
| South London, Ordinary | – | – | 4¼-4⅜ |
| South Metropolitan Electric Light and Power Co., Ord. | 1 | .. | ⅝-1 |
| —— 7 per cent. Cum. Pref. | 1 | .. | 1 13/32-1 15/32 |
| —— 4½ per cent. 1st Mort. Deb. | 100 | .. | 107-110 |
| —— Ditto, June, 1904 | | .. | |
| St. James's and Pall Mall, Ordinary, 101-80,080 | 5 | – | 13⅜-14¼ xd |
| —— 7 per cent. Pref. | 5 | – | 8¼-8⅜ xd |
| —— 3½ per cent. Deb. | 100 | – | 98-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | – | 5 1/16-5 3/16 |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5⅛-5¼ |
| Westminster, Ordinary | 5 | – | 12⅜-13¼ xd |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | – | 6¼-6⅜ |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 | 5 | – | 5⅛-5⅜ |
| —— Ord. | 5 | .. | 8⅜-8⅝ |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | – | 140-143 |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 105-107 |
| Barcelona Tramways, Limited, Ord., 1-20,000 | 10 | .. | 12-12½ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 | 10 | .. | 9¼-10 |
| —— 5 per cent. Deb., Red., 1-600 | 100 | .. | 99-102 |
| —— 4½ per cent. Red. Deb. Stock | 100 | .. | 96-100 |
| Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606 | 1 | .. | ⅜-½ |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 | 1 | .. | 15/16-1 1/16 |
| Belfast Street Tramways, Ord., 1-26,600 | 10 | .. | 10½-11¼ |
| Blackpool and Fleetwood Tramroad | 10 | – | 13⅜-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | – | 1¼-1⅜ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | – | 3⅜-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 91-98 |
| British Columbia Electric Railway Co., Ord. Def. | 100 | – | 103-106 |
| —— Ord Pref. | 100 | – | 100-103 |
| —— Non. Cum. 5 per cent. Pref. | 10 | – | 10-10¼ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each | 40 | – | 105-107 p c |
| —— 4½ per cent. Vancouver Power Deb. | 100 | – | 99-102 |
| British Electric Traction Ord. 1-500,000 & 60,001-80,000 | 10 | – | 9¼-9⅜ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | – | 10¾-11¼ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | .. | 122-124 |
| —— 4½ per cent. 2nd Deb. Stock | 100 | | 97-99 |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Buenos Ayres and Belgrano Tram. Ord., 1-100,000 | 5 | 3¾-4 |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | 5⅞ 5⅞ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | 5⅞ 5⅞ |
| —— 5 per cent. Deb. Stock, Red. | 100 | 107-109 |
| —— Prov. Cert., all paid | 100 | 103-106 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | 97-99 |
| Calcutta Tramways, Limited, 1-102,268 | 5 | 8¾-9 |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | 106-108 |
| Cape Electric Tramways Nos. 1-480,000 | 1 | 1¼-1½ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | 4¾-5⅛ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | 101-104 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1s Mortgage Debenture Stock, Red. | 100 | 102-104 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | 9¼-10 |
| —— 5 per cent. Cum. Pref. | 10 | 11-12 |
| —— 4 per cent. Debentures | 100 | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | 13-14 |
| —— 5 per cent. Pref., Nos. within 1-60,000 | 10 | 15¼-16¼ |
| —— 5½ per cent. Mort. Debs., 1-3,000, Red. | 100 | 96-97 |
| Imperial Tramways Ordinary | all | 18-19 |
| —— 5 per cent. Cum. Pref. | all | 14-14¼ |
| —— 4½ per cent. Deb Stock | 100 | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 50,001-60,000 | 5 | 3-3½ xd |
| —— 4 per cent. Debenture Stock | 100 | 89-92 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | 8-8½ |
| London United Tys. (1901), 5 per cent. Cum. Pref. | 10 | 10 10½ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | 99-102 |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016. | 1 | 13/32 15/32 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | 31/32-1 1/32 |
| —— 4½ per cent. Deb. Stock, Red. | 100 | 105-107 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000 | $1,000 | 105-110 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 | 101-104 xd |
| —— Sterling 4½ per cent. Deb., 1922. 601-2,000 | 100 | 103-105 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000 | 5 | ¾-1½ |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | 12¼ |
| —— 5 per cent Cum. Pref. | 10 | 9¾-9¾ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Sk. | 100 | 104-107 |
| Potteries Electric Traction, Ordinary 20,001-40,00 | 10 | 9¼ 9⅝ |
| —— 4½ per cent. Debenture Stock | 100 | 9 9¼ |
| South Lancashire Electric Traction and Power Company | | 102 105 |
| —— £250,000 Ordinary | 1 | 1 |
| —— £101,152 5 per cent. Preference | 1 | 1 |
| —— £597,170 4½ per cent. Debenture Stock | 100 p.c. | 100 p.c. |

## Electric Railways.—

| | | |
|---|---|---|
| Central London, Ordinary | 100 | 93-95 |
| —— 4 per cent. Pref. | 100 | 101-103 |
| —— ,, ,, deferred | 100 | 83-86 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | 110-112 |
| City and South London, Consolidated Ordinary | 100 | 44¼-45¼ |
| —— 4 per cent. Debenture Stock | 100 | 108-110 |
| —— 5 per cent. Pref. Stock '91 | 100 | 120-123 |
| —— ,, ,, ,, '96 | 100 | 118-121 |
| —— ,, ,, ,, '01 | 100 | 114-117 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | 10-10¼ |
| —— Ordinary, 1-50,000 | 10 | 3¾-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — | 99-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | — | 98-99 |
| Waterloo and City, Ordinary | 100 | 82-84 |

## Telephones.—

| | | |
|---|---|---|
| National Telephone, Preferred | 100 | 112¼ 1 3½ |
| —— Deferred Stock | 100 | 106-108 |
| —— 6 per cent. Cum. First Pref. | 10 | 13-14 |
| —— 6 per cent. Cum. Second Pref. | 10 | 12-13 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | 5⅛-5⅜ |
| —— 5½ per cent. Deb. Stock, Red. | 100 | 100 102 |
| —— 4 per cent. Deb. Stock, Red. | 100 | 104 106 |
| —— 4 per cent. Prov. Cert. | — | 103-105 |
| [illegible] Telegraph and Electric Company | 1 | 1¼-1⅜ |
| —— 6 per cent. Cum. Pref. | 1 | 1 3/16-1 5/16 |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905 | 1904. | Week. | Current year. | 1904. | 1903 | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-senger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Mar. 11 | 1,052 | 1,035 | − 12 | + 5,734h | 19¼ | 19¼ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·14 |
| Ayr Corporation | ,, 11 | 175 | 158 | + 17 | + 616 | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 336,049 | 1·03 | 10·11 | 1,770 | 5 0 |
| Barking Corporation | ,, 11 | 57 | 39 | + 18 | + 270 | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 12 | 948 | 909 | − 11 | − 946 | 23·33 | 23½ | March 31 | 56,073 | 11,327,932 | 1,319,701 | 1·158 | 9·88 | 2,383b | 6·1 |
| Birmingham Corporation | ,, 11 | 355 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | — | — | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | — | — | — | — | — | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10·94 | — | 4·59 |
| Blackpool Corporation | ,, 9 | 316 | 2 0 | + 45 | + 6,178 | 17⅞ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 11 | 179 | 213 | − 34 | − 102 | 16½ | 16½ | Dec. 31 | 32,021 | 2,253,981 | 600,757 | 3·24 | 12·75 | 2,001 | 7 05 |
| Bolton Corporation | ,, 12 | 1,679 | 1,705 | − 26 | + 593 | 38 | 38 | March 31 | 94,151 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·89 |
| Bournemouth Corporation | ,, 8 | 940 | 905 | + 35 | + 2,295 | 10 15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | Feb. 25 | 3,554 | 3,360 | + 193 | +29,758 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | Mar. 12 | 727 | 762 | − 35 | + 3,081h | 9 | 7½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 10 | 4,4 6 | 4,344 | + 142 | — | 51¼ | 51¼ | Dec. 31g | 253,150 | 44,391,439 | 6,033,528 | — | — | — | — |
| Burnley Corporation | ,, 11 | 943 | 873 | + 75 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 12 | 336 | 231 | + 25 | — | 8¼ | — | March 31 | 11,574 | 2,556,134 | 282,378 | 1·08 | 9·81 | 1,570 | 7·57 |
| Cardiff Corporation | ,, 11 | 1,871 | 1,806 | + 65 | + 2,067 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 11 | 140 | 155 | − 15 | − 2·8 | — | — | Dec. 31g | 9,937 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 11 | 7,195 | 7,119 | + 76 | + 1,165h | 6 | 6 | ,, 31 | 362,471 | 44,953,938 | 1,292,674a | 1·87 | 64·87 | 58,229 | 35·70 |
| City & South London Railway | ,, 12 | 3,003 | 3, 01 | − 95 | − 2,031h | 6⅛ | 6⅜ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Colchester Corporation | ,, 8 | 154 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 9 | 414 | 347 | + 13 | + 135 | — | — | ,, 31g | 25,657 | 6,353,323 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | ,, 10 | 207 | 185 | + 22 | − 66 | 7·23 | 7·23 | March 31a | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 4 | 163 | 151 | + 12 | — | 4½ | 4½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0 91 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | ,, 10 | 92 | 95 | − 3 | — h | 7 | 6½ | Dec. 31g | 6,241 | 688,905 | 107,164 | 3·88 | 14·09 | 952 | 7·39 |
| Dublin U. T., electric cars | ,, 10 | 3,620 | 3,454 | + 166 | — | 47 | 46 | ,, 31g | 134,643 | — | 3,429,356 | — | — | — | — h |
| Dublin S. District, Electric | ,, 10 | 757 | 644 | + 113 | | | | | | | | | | | |
| Dundee City Tramways | ,, 8 | 790 | 751 | + 41 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 11 | 653 | 609 | + 44 | + 1,932 | 10·77 | 10·75 | March 31 | 34,312 | 12,950,259 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 11 | 13,907 | 12,938 | + 969 | +23,235h | 143 | 123 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Gloucester Corporation | ,, 8 | 231 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 8 | 2,389 | 2,096 | + 293 | + 5 335 | 33 | 30½ | March 31 | 68,283 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,069 | 8·77 |
| Huddersfield Corporation | ,, 11 | 1,200 | 1,051 | + 149 | + 4,283 | 35 | 35 | ,, 31 | 65,545 | 11,893,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | ,, 11 | 2,139 | 1,969 | + 170 | +11,380 | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | Feb. 25 | 346 | 337 | + 9 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | Mar. 9 | 105 | 117 | − 12 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 8 | 192 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 13 | 5,456 | 4,798 | + 657 | +17,141 | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | ,, 11 | 1,917 | — | — | — | 7¼ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | ,, 4 | 9 8 8 | 9,001 | + 834 | + 3,103 | 103 | 103 | Dec. 31g | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | ,, 12 | 1,469 | 1,535 | − 66 | − 697h | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — a |
| London County Council | ,, 4 | 11,767 | 9,139 | +2,628 | +118,838 | 46¼ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | Feb. 25 | 120 | 128 | − 8 | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | Mar. 9 | 95 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 11 | 11,652 | 10,6 4 | +1,023 | — | 131¼ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 11 | 105 | 97 | + 9 | — | 2¾ | — | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corptn. | ,, 11 | 3,548 | 3,529 | + 19 | — | 45 | 38½ | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newport (Mon.) Corporation | Feb 11 | 4 5 | 460 | + 25 | + 1,333 | 15 | — | ,, 25 | 185,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111b | — |
| Oldham Corporation | Mar. 12 | 1,378 | 1,063 | + 315 | + 5 369 | 34½ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 11 | 1,368 | 1,331 | + 34 | + 6,495 | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·15 | 12·39 | — | — |
| Reading Corporation | ,, 9 | 525 | 519 | + 6 | — | — | — | — | — | — | — | — | — | — | — |
| Rochdale Corporation | ,, 4 | 412 | 97 | + 315 | + 6,735 | 4½ | 4½ | 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 9 | 404 | 385 | + 19 | — | — | — | ,, 31 | 20,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·68 |
| Salford Corporation | ,, 13 | 3,871 | 3,610 | + 231 | + 9,823 | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 11 | 73 | — | — | — | 7⅞ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 12 | 4,536 | 4,447 | + 79 | + 6,595 | 34¼ | — | ,, 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 8 | 775 | 785 | − 10 | − 2,678 | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 8 | 228 | 204 | + 24 | + 1,609 | 6½ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 11 | 444 | 384 | + 60 | + 8,578 | 11¼ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 12 | 1,117 | 1,122 | − 5 | + 1 537 | 19 5⅛ | 18·48 | ,, 31 | 62,506 | 14,848,958 | 1,433,463 | 1 01 | 10·46 | — | 6·02 |
| Swindon Corporation | ,, 1 | 151 | — | — | — | 3¾ | — | — | — | — | — | — | — | — | — |
| Wallasey U.D.C. | ,, 11 | 635 | 571 | + 64 | + 2,555 | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·60 |
| Warrington Corporation | ,, 2 | 308 | 293 | + 15 | + 587 | 8¼ | — | — | — | — | — | — | — | — | — |
| West Ham Corporation | ,, 9 | 1,038 | — | — | — | 8 62 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 8 | 725 | 353 | + 372 | — | 7½ | — | ,, 31g | 20,878 | 4,263,066 | 417,335 | — | 12·006 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile. b Per mile of single track. c Include rail and tram. d Including depreciation. e Including one section of horse traction. g 1903. h Half-year's figures.
Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**Telephony in Canada.** — The special committee appointed to consider the nationalisation of the Canadian telephone system have elected as chairman Sir W. Mulock, the Postmaster-General, who is in favour of public ownership.

**Change of Title.**—It is probable that the title of the Mechanical Engineers' Association of the Witwatersrand will be altered to "The Transvaal Institute of Mechanical Engineers," the present designation being somewhat umbersome.

**Personal.**—The first recipient of the John Fritz gold medal to be awarded by the joint committee of the four national American engineering societies will be Lord Kelvin. This honour has to be bestowed on the man most representative of and eminent in scientific advance in the engineering field.

**McMillan Memorial Fund.**—We are requested to say that Mrs. W. G. McMillan desires to thank, in her own name and in the names of her children, the numerous friends who so kindly contributed to this fund. On account of their great number it is impossible for her to thank them individually, and she trusts, therefore, that they will accept this notice in acknowledgment of her gratitude for their generous kindness.

**Electro-Harmonic Society.** — The final smoking concert of the season is to be held to-night in the King's Hall of the Holborn Restaurant, Mr. James Swinburne taking the chair at eight o'clock. An admirable programme has been arranged to wind up the season. The vocalists will be Messrs. Charles Saunders and Alexander Tucker, and instrumental music will be provided by Messrs. Izard and Gatehouse and the orchestra. Recitations and sketches, humorous and musical, will be contributed by Messrs. W. G. Churcher, F. Chester, and B. Gammon. We note that Hon. Secretary W. E. Lane has changed his address to Finsbury-pavement House, E.C.

**Effect of Radium on Rubber.**—The *Journal* of the Chemical Society contains an abstract of an article by Mr. R. Ditmar on the action of radium rays on caoutchouc. The power of radium rays of penetrating caoutchouc has been examined by Madame Curie's radiographic method. A "concentrated" preparation of de Haen's radium barium bromide was used, but the action of this substance was not sufficiently powerful to induce radioactivity in the caoutchouc itself. The following conclusions have been derived from the results of the experiments of the author and the investigations of Madame Curie. The radium rays ($\gamma$-rays) penetrate both crude and vulcanised rubber, but the former more readily than the latter, probably owing to its porosity. Caoutchouc itself may be rendered radio-active (Madame Curie). The loss of activity of caoutchouc in air does not take place in accordance with the law which usually obtains for solids.

**Maintenance of Tramway Tracks.**—It seems likely that before long municipalities and companies owning electric trams will make a move in regard to the law concerning the maintenance of tramway tracks. Under the Tramways Act of 1870 the maintenance of the track devolves upon the tramway undertakers, which was equitable when animal haulage was the vogue; but with mechanical traction the wear from the trams is restricted to the rails. On the other hand, motor 'buses and heavy traffic in general cause great wear and tear to the track, which sometimes extends over three-fourths of the carriage-way. Thus electric trams are not merely subject to the competition of the motorcar, but have to provide a track for the latter to wear out, although they do not contribute a penny towards its upkeep. Our tramway legislation is of the antiquated order, and it is quite time that amendments were made to bring it into harmony with modern conditions.

**Manchester Section.**—Following close on the heels of their seniors, the students of this section held a dinner—which is to become an annual function—at the Grand Hotel, Manchester, on Saturday, Mr. C. D. Taite presiding. The chairman congratulated the hon. secretary, Mr. A. E. Jepson, on the 200 per cent. increase in the membership roll since last year. He referred to the advantages that electrical students now possess as compared with one-time students, not merely in educational facilities, but in physical comfort as represented by well heated and ventilated workshops. Mr. E. W. Cowan also spoke in reply to a toast, and, dealing with the financial position of the industry, described how his mouth watered when he heard textile manufacturers in the district discuss the likelihood of having to refuse orders for cotton goods requiring delivery before July. Mr. F. O. Mills hinted that an active rivalry with the London Students' Section might be of general benefit. The evening was enlivened by more or less extempore speeches and more or less good songs, and we understand that the youthful gathering was quiet and decorous—presumably for students.

**The Underground.**—In the small hours of Tuesday a trial trip was made on the Metropolitan Company's newly-electrified Inner Circle system. The little party of railway officials included Mr. Ellis, general manager, Mr. C. Jones, chief electrician, and Mr. A. Ingram, superintendent of carriages and rolling stock. The generating plant, train equipment, and carriages have already been described in these columns. The run was made without a hitch, the only stoppages occurring at South Kensington and Aldgate, to change on to the other line. Smoothness of running and good acceleration were attained. This satisfactory result encourages the hope that the electric trains will be able to perform the complete journey round the Inner Circle, which now occupies 70 minutes, in 50 minutes. The Metropolitan Company have now completed the electrification of their system from end to end. The District Railway are also understood to be ready, but have not yet run their trial trips. As soon as these have been satisfactorily accomplished the arrangements for joint working will come into operation, and thenceforward passengers will be conveyed round the Inner Circle by electricity alone. In fact, the Metropolitan are considering the running of some of the new electric trains on their section from South Kensington to Aldgate next week. Londoners are therefore likely to enjoy shortly the luxury of travelling on the Underground without the familiar smoke and fumes.

**Entering Moving Trains.**—The folly of entering a moving train has often been tragically exemplified on the steam lines, and the practice is certainly to be strongly deprecated in regard to the "tubes," especially remembering the limited space between the platform gate and the wall of the tunnel. On the Central London Railway the other day, a newly-arrived Russian made a rush for a moving train just as the gate was being closed. He reached the gate almost at the same moment as that section of the train entered the tunnel, with the result that he was jammed against the wall of the latter, and it appears that only the promptitude of the guard in applying the emergency brake saved the passenger's life. He was removed to the hospital, suffering from a wound on the back of his head and grazes on his legs. In consideration of the passenger's misfortune and ignorance of the English language,

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the company did not intend to prosecute, but owing to his and his friend's persistence in asserting that the accident was due to the company's carelessness, they felt compelled to do so. At Marlborough-street Police Court on Tuesday, the defendant told Mr. Denman, the magistrate, that he was pushed off the train, but after hearing the evidence, his Worship had no hesitation in rejecting the statement of the defendant, upon whom a fine of 40s. was inflicted. Incidentally Mr. Denman testified, from his own experience, to the great caution exercised by the company's servants. Happily these occurrences have been rare on the "tubes," due to the gate system operated by the guard on each platform.

**Technical Journalism.**—At a recent meeting of the American Trade Press Association, Mr. Arthur Warren, manager of publicity for the Allis-Chambers Company, delivered an interesting address entitled "A Plain Talk on Trade Journals." Mr. Warren, who has been a fertile contributor to the Press himself, discussed the various phases of technical and trade journals with great frankness. Dealing with advertising, he distinguished between exploiting a patent soap or medicine and pushing the sales of machinery. In the former case the advertiser appealed to an unsophisticated audience as represented by the world in general, but in the readers of the technical Press the industrial advertiser addresses a trained and experienced audience. Mr. Warren remarked that all manufacturers should realise the need of a publicity department, which was just as essential as a drafting-room or a factory. In a semi-humorous vein he deprecated the superabundance of the "Special" number, which is more in evidence on the other side of the Atlantic than here. Mr. Warren complimented the technical Press upon the high character and ability of its editors, and concluded with some suggestions for developing the news features of the journals. He recommended that members of the editorial staff should be allowed to circulate more freely through the shops and factories, making observations at first hand. Sometimes there were reasons for silence on the part of the manufacturer, as when he was developing a new invention, but, Mr. Warren observed, there should be a closer touch between the Press and the manufacturers.

**New Publications.**—The Harmsworth Encyclopædia promises to be a happy compromise between the very extensive works and the single-volume treatise. From the first three numbers which we have before us we notice that the work is printed in clear type, and is generously illustrated with maps, diagrams, and photos. A brief perusal suggests that the articles, of which there are to be 50,000, combine conciseness and completeness. The work appears to embrace the complete cycle of human knowledge, and great attention is given to science and technology. In this connection the following passage from the preface is worthy of mention: "An old encyclopædia is useless . . . . the discovery of radium and the investigation of its properties have profoundly modified our conception of the universe. The whole scientific world is eagerly awaiting developments, new and startling facts are bound to come to light before we publish the articles under letter R, and the latest views of science, up to the moment of going to press, will be found embodied in our pages." It will be noticed that the compilers speak confidently of the "new and startling facts" which are "bound to come to light" during the intervening months prior to the letter R being reached, but it is safe to say that if such events crystallise, the publishers will be as good as their word in including the latest information. We observe that the numbers before us include occurrences as recent as the assassination of the Grand Duke Sergius. Numerous experts are collaborating in the production of this work, which will comprise 40 fortnightly parts, published at the modest price of 7d.

**Milan Exhibition.**—We learn that the Association of Italian Manufacturers for the Prevention of Accidents in Factories will offer at the Milan Exhibition of next year several prizes for international competition, including the following: A gold medal and £330 for a new appliance for preventing accidents arising from contacts between primary and secondary windings in alternate-current transformers. No disturbance in the action of the transformer must arise in case of atmospheric discharges or abnormal increase of potential. A gold medal and £40 for a novel system of hand crane or winch fitted with a simple and practical contrivance to prevent the possibility of the handles revolving during the descent of the load. And a gold medal and £20 for a safety appliance, to be simple, strong, and reliable, to stop trucks automatically on an inclined plane on the hauling rope snapping. The appliance must be adaptable to existing plant. Applications to compete must be sent in not later than July 31, 1905, addressed to the Presidency of the Association of Italian Manufacturers for the Prevention of Accidents in Factories, Foro Bonaparte, 61, Milan. Appliances entered for the three prizes mentioned above must be exhibited at the competitor's expense, under such conditions as to allow of their being practically tested at the exhibition. No charge for space will be made to competitors who intend to exhibit their appliances, but applications must state the exact area needed. All inventions and appliances presented for competition remain the property of competitors, but the association will retain the drawings, models, and descriptions. Further information can be obtained from the director of the association, Foro Bonaparte, 61, Milan.

**Radioactivity.**—Prof. J. J. Thomson last Saturday delivered at the Royal Institution the second of his course of lectures upon "The Electrical Properties of Radioactive Substances." After discussing the three types of rays which have become familiar, he alluded to the more recently discovered class, which might be called $\delta$ rays. This newest kind was distinguished by want of penetrating power, for they could only get through a few millimetres of air at ordinary pressures, whereas the $\gamma$ rays, which were unaffected by the strongest magnetic and electric fields and were exactly analogous to the Röntgen rays, could pass through 6in. of solid lead. Reverting to the $\beta$ rays, Prof. Thomson gave an outline of the argument by which the volume of their particles was shown to be only one-thousandth of that of the hydrogen atom. These particles were sometimes designated negative electrons, to which the lecturer objected, on the ground that it at once suggested a positive electron, a thing of which not even the existence was known; he preferred the term "corpuscles." The mass of such corpuscles was invariable, wherein they differed from ions, which were charged atoms or molecules, and showed as many differences in mass as there were gases. It was while endeavouring to collect the electricity of the $\alpha$ rays, which were positively charged, and in mass were equal to nearly twice the hydrogen atom, that he discovered the new $\delta$ rays. He found that in an apparatus which should have indicated the presence of positive electricity, negative electricity was abundant, and he traced the cause of this down to the fact that the radioactive body employed in the experiment was pouring out an immense stream of particles which, like those of the $\beta$ rays, were negatively charged, but differed in that they were comparatively slow-moving.

**Board of Trade Reorganisation.** — The Commercial Committee of the House of Commons has submitted to the Premier a memorial on the subject of the Minister

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of Commerce. This approves generally the report presented by the Departmental Committee last year, and expresses a hope that the measure will be introduced at an early date. The committee advocates that means shall be placed at the disposal of the Minister of Commerce of readily obtaining information and assistance from practical and experienced representatives of various branches of industry, and it considers that the Commercial Intelligence Committee of the Board of Trade, with some enlargement of its membership and functions, would be well adapted for this purpose. Other suggestions are that while the nominees of the Government departments for the Commercial Intelligence Committee shall be maintained as at present, the number of commercial members shall be increased from 6 to 12 or 15; that the functions of the committee shall be enlarged by enabling it to suggest measures for the development and improvement of our commercial relations at home and abroad, instead of being, as now, merely an advisory committee on questions submitted for its consideration; and that the committee shall hold regular meetings, to be presided over as far as practicable by the Minister of Commerce, who would thus be brought into direct communication with the commercial representatives of the committee and with the representatives of other Government offices. It is proposed that the committee's extended scope shall embrace powers to consider commercial treaties and tariffs, to organise commercial missions, to appoint commercial agents abroad, either resident or temporary, for the purpose of obtaining information, and to form channels of communication between the office of the Ministry of Commerce at home and those engaged in trade in any foreign country, colony, or dependency. In addition, suggestions are made for inter-departmental co-operation.

**Cantor Lectures.**—The second of the series of these lectures was delivered by Mr. H. L. Webb at the Society of Arts on Monday last. It dealt with the subject—the line. It was pointed out that in the early days of telephony the object to be attained was the transmission of articulate speech over a comparatively short distance, whether that distance was calculated in yards or miles; but far more was rapidly required, and within a few years talking over a thousand miles or so was not considered extraordinary. The line over which such speech was transmitted was the most costly part of the installation, hence from the commercial as well as the scientific point of view deserved the closest attention to be best adapted to the work it had to perform. The troubles to be countered were three—attenuation, distortion, and induction. Each of these was discussed in turn, and starting from the old telegraphic lines and views, it was shown how improvements had been effected. Iron gave place—except in some out-of-the-way places—to copper and bronze. Hughes suggested the twisted wire and the necessity to get a perfectly balanced metallic circuit. Then Heaviside (Oliver of that ilk), with his deep mathematical and physical insight, suggested that inductance should be used to counter the evils of capacity. At first the experiments to practically carry out theory failed, but, nothing daunted, America, in the persons of Mr. C. J. Reed and especially in Dr. M. I. Pupin, proved the correctness of the theory, and the capacity trouble became a thing of the past by the proper use of balancing inductance coils. The latter part of the lecture dealt briefly with the advance in raising the capacity of a 2·5in. duct from 50 pairs to 500 pairs, or even in special cases to 1,000 pairs of wires, with the difficulties of laying ducts, etc., in big towns, and the various methods of distribution adopted. Quite a number of lantern slides were shown, which made a very effective method of driving home to the minds of the audience these difficulties and methods for overcoming the same.

**Students' Dinner.**—The success of the first dinner organised by the Students' Section of the Institution of Electrical Engineers, which was held at the Holborn Restaurant on Thursday last week, augurs well for its annual repetition. Mr. H. D. Symons, chairman of the section, presided, and several leading lights of the profession were among those who attended as guests. The latter included Mr. Alexander Siemens (president I.E.E), Mr. W. H. Patchell (vice-president I.E.E), Prof. J. Perry, F.R.S, Prof. E. Wilson, and Mr. W. M. Mordey (vice-president I.E.E.) In these circumstances it is not surprising that a considerable amount of advice was tendered gratuitously. Nor judging from some remarks made by the chairman was it altogether unnecessary, for it appears the muster of students on this occasion was far larger than is usual at their ordinary meetings. The advantage to be derived from regular attendance of these meetings and the free interchange of opinions generally was, of course, pointed out, while the excellence of papers recently contributed for discussion was aptly referred to as proof of the ability of those who presumably aspire to great things in later life. The gist of the speeches may be summed up in a single sentence: "There is plenty of room at the top of the ladder." Competition is only felt by those who crowd round its foot and fail to ascend when given an equal chance. Prof. Perry would have his pupils aim above the target, as the Japanese are doing. It fell to Mr. Mordey to respond to the last toast, "The Guests." He remembered a conversation which took place during the pioneering days of the electrical industry, when, referring to the output of a certain machine, he expressed the value in amperes and volts. A then prominent engineer, to whom his remarks had been addressed, interrupted with the request that he (Mr. Mordey) should state in intelligible language how much copper wire the machine in question was capable of heating. If they considered the crude units and limited knowledge of those days, they would wonder, not that so little, but so much had been practically accomplished by such men as Henry Wilde, and others. Some good songs added considerably to the enjoyment of the after-dinner proceedings.

**Electric Railway Operation.**—At a recent meeting of the New York Electrical Society, Mr. Herbert H. Vreeland, president of the New York City Railway Company, delivered an address entitled "Electric Railway Operation in a Great City," in which he took occasion to deprecate the tendency of electrical engineers to indulge in costly experiments upon systems in actual operation, as though they were laboratory apparatus. The lecturer emphasised the necessity of the electrical engineer learning the practical conditions which must govern the successful application of his knowledge. The distance between the engineer and the claim agent or the auditor seemed remote until it appeared that the engineer's device, by its great intricacy or delicacy of construction in the hands of a not over-intelligent motorman, had involved the company in a disastrous accident, or, on the other hand, until the device had been tested, and its economic results written down in the auditor's cold figures, to elicit from the general manager the verdict that it is too costly. Mr. Vreeland remarked that the electrical engineer generally learned his business in some great establishment largely devoted to experiment, where the gross earnings of an ordinary street railroad were written off the books in a single month for fruitless investigation, and where he was provided almost superfluously

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with the tools of his trade, with the result that when he came to handle street railway work it was sometimes difficult for him to realise that in the running of a car there is no time for repairs, and that no device, however generally useful, can be employed on a street car which, if it falls out of gear, requires the car to be stabled before it can be repaired. Another point to which he alluded was that no industry can afford to spend more than a certain fixed proportion of its earnings upon improvements. The expert, whether electrical engineer or other specialist, is rarely willing, the lecturer stated, to concede this condition of things, and was apt to become dismayed when he discovered that the funds available for improving appliances were strictly limited. In conclusion, the lecturer observed that if the electrical engineer expected to become successful commercially, he must adapt science to practical requirements instead of entering for constant innovations. We assume Mr. Vreeland's meaning to be that the engineer must contrive to strike the happy medium between a craze for novelty and the retention of the obselete.

**Royal Meteorological Society.**—An interesting exhibition of meteorological instruments arranged by this society was held last week in the library of the Institution of Civil Engineers. The development of recording instruments was well illustrated, as also the methods adopted for ascertaining the meteorological conditions in the upper air. The instruments used by Mr. J. Glaisher, F.R.S., in his famous balloon ascents for the British Association, 1862-66, Mr. W. H. Dines's kites and meteorograph used by him at Crinan, and Mr. W. S. Bruce's camera and meteorograph used with kites in the Scottish Antarctic expedition were to be seen. The thermometers, anemometers, and sunshine recorders used on board the "Discovery" in the recent national Antarctic expedition were also exhibited, as well as a number of beautiful water-colour drawings of sky and cloud effects in the Antarctic regions made by Dr. E A. Wilson. M. Richard, of Paris, showed a collection of most of his noted self-recording instruments, and Mr. Halliwell, of Southport, exhibited his new rain-gauges, anemometers, and evaporation tank. The Royal Meteorological Society arranged in a railed-off enclosure a typical climatological station. The Meteorological Council also showed in position the photographic barograph and the Beckley self-recording rain-gauge which were recently in use at the Fort William observatory. Many other instruments were shown, besides a large collection of photographs, records, drawings, maps, etc., illustrating meteorological phenomena. At a meeting of the society on the 15th inst., the president, Mr. Richard Bentley, delivered an address on "The Growth of Instrumental Meteorology." After briefly touching on the historic and non-instrumental era of meteorology, he spoke of the seven great weapons of meteorology—the thermometer, and of later years the heliograph, for temperature; the hygrometer and rain-gauge for moisture; the barometer for pressure; and the anemometer and kite for the study of the upper air; and of the great foundation of instrumental meteorology laid by Galileo, Torricelli, Wren, and Hooke. The president, in dwelling upon our indebtedness to Italy in science (as well as in art) from Galileo to Marconi, pointed out that the theory of rainfall was correctly enunciated as early as the beginning of the fourteenth century by Dante. He also dwelt on the great services rendered to the community by meteorologists, largely by volunteers at their own expense, and referred to the close observation kept by rain-gauges on the steadily diminishing water supply of the country, by anemometers protecting the traffic over some of our lofty and more exposed railway viaducts, by the use of the barometer for storm warnings and for the safety of miners in our pits, and by the heliograph with relation to the ripening of fruits and crops. The lecturer concluded by emphasising the importance of meteorology to the community in general, and appealed for greater assistance from the Government.

**Another Tesla Patent.**—We have received a copy of the judgment delivered in the United States Circuit Court in the case of the Westinghouse Company against the National Electrical Company, which had reference to the patents of May 1, 1888, for the Telsa polyphase system The plaintiffs contended that these patents were infringed by the defendants' synchronous motor and alternating-current polyphase generator. The defendants contended that Tesla's invention was the rotating field mode of operation, and that this was limited to a self-starting motor so operated; that their own synchronous motor with direct-current excitation was not covered by the Tesla patents, being simply a reversed two-phase alternating-current dynamo of a prior type used as a generator; and that the claims in the Tesla patents which introduced "direct-current excitation producing synchronous operation" must be limited to such use after the motor is started by the Tesla means and method and brought up to speed. The Court held that if the invention could be so limited the defendants escaped infringement; on the other hand, if it could not, the claims of the patents were broad enough to reach the defendant's method of operation. Reviewing the Tesla discovery, the Court defined it as a method to produce in the polyphase rotating field motor, the "whirling field of force,' and employment thereof was obtainable with or without direct-current excitation of the armature or secondary element. The fact that its use produced a self-starting motor without the aid of such excitation could not alone serve to limit the invention to that effect. The theory advanced of the obliteration of the alternating-current magnetisation by that of the direct current of the secondary element of the motor was not material, as the Tesla invention was unquestionably introduced in the operation of the defendants' motor, and the structure was within the patent description. The Court, therefore, held that "the defendants' synchronous motor structure and operation are within the generic invention covered by the claims of two of the fundamental Tesla patents; that the invention is utilised in the defendants' motor operation, notwithstanding the introduction of direct-current excitation to make it synchronous in lieu of the full realisation of the revolving field effect for self-starting; that such supplemental aid does not escape infringement with or without advantage in such association; and that in any view the combination patents referred to are not limited to after-effect of direct-current excitation, but apply to the defendants' combination." Judgment was therefore entered for the plaintiffs, the decree restraining the defendants from infringing the Tesla patents.

**Electricity Supply in London.**—The London County Council have just issued from their statistical department some analytical returns of the electric supply undertakings in London for the year 1903-4. The figures are rather late in publication, but the information given is of great interest to engineers. There were at the time of obtaining the returns 16 local authorities and 13 companies having powers under the Electric Lighting Acts, but of these the Council of Bethnal Green had not its scheme at work, and the St. Marylebone undertaking was still being supplied through the Metropolitan Electric Supply Company. Stoke Newington, another of the borough councils, obtained its supply in bulk from the Hackney Borough Council. The areas of the supply allotted to the com-

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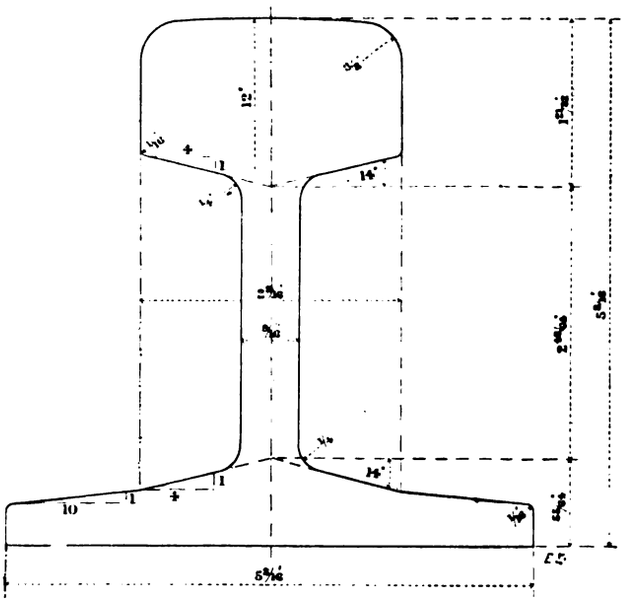
panies are described in the report, which clearly indicates the districts where there is competition. The table drawn up with this object shows that at Bermondsey, and also in Newington, a company is in competition with a local authority, and that in 11 other areas there are two companies in competition with each other. In comparing the returns made for companies and local authorities, it must be remembered that as a rule the local authorities make no charge for meters. The first table of prices shows the relative charges for private supply and for public lighting. Here at once there is evidence that when the local authority is the undertaker, the amount of street-lighting which is done electrically is much more than when the undertaker is a company. For instance, 25 per cent. of the total units sold by the local authorities and 18 per cent. of the net income are attributable to public lighting, while the average figures for the company are only 4 per cent. of the units sold and 2 per cent. of the net income. From other tables it is seen from the average returns that the local authorities supply at much nearer the cost of production than do the companies. This is, of course, what might be expected, as the companies are now, as a rule, paying good dividends, while the municipal undertakings have only to meet interest and sinking fund charges on their loans. These average ·8d. per unit, whereas the interest and dividends paid by the companies average 1·81d. It is interesting to note, however, that after these charges have been met the surplus available for the repayment of capital or for depreciation is ·78d. per unit for the local authorities and ·49d. for the companies. The return as to the allocation of charges when local authorities work dust destructors in conjunction with their generating station is interesting. The equivalent charge per unit generated for steam supplied from the refuse destructor is the factor which determines the advantage or otherwise of the combination. This charge is as low as ·2d. for Bermondsey and ·25d. for Woolwich. It increases to ·6d. for Hackney and ·5d. per Stepney, where an advantage may still be claimed. But at Shoreditch the charge now averages as high as 1·99d. per unit generated, whereas the total cost of the units produced from the steam station in the borough is only 1·819d. It would seem from this that the scale of charges between the two departments at Shoreditch needs to be revised. The following figures show how far ahead of the local authorities the London companies still are in respect of the amount of electricity supplied. In the year under review the companies sold 85,941,921 units, against 27,963,137 by the local authorities. The following additional particulars are also of interest: total capital raised by local authorities, £2,995,051; by companies, £11,815,101; revenue — local authorities, £400,668; companies, £1,498,717; expenditure — local authorities, £216,816; companies, £716,927; interest and dividends paid—local authorities, £93,019; companies, £646,834; average price obtained for private supply—local authorities, 3·59d. per unit; companies, 4·34d. The detailed figures of costs are exceedingly valuable for reference, but are too voluminous for individual comment.

**Engineering Standards Committee.**—We have received a copy of Report No. 11, which is devoted to flat-bottomed railway rails. It is provided that the rails shall be composed of from ·35 to ·5 per cent. of carbon, and from ·7 to 1 per cent. of manganese, while the proportions of silicon, phosphorus, and sulphur shall not exceed ·10, ·07, and ·07 respectively. The manufacturer shall furnish carbon and phosphorus determinations of each cast, and a complete chemical analysis, representing the average of the other elements contained in the steel, shall be given for each rolling. Such complete analysis shall be made from drillings taken from the rail or tensile test piece or pieces, and when the rolling exceeds 200 tons an additional complete analysis shall be made for each 200 tons. A margin of $\frac{1}{2}$ per cent. under to $\frac{1}{2}$ per cent. above the specified weight, and $\frac{3}{16}$in. above or below the stated length, is allowed. The general dimensions of standard rails range from Section No. 20, with height of rail 2$\frac{1}{2}$in., width of head 1$\frac{3}{8}$in., and the nominal weight in pounds per yard corresponding to the number of the section, to Section No. 100, with height of rail 5$\frac{3}{4}$in., width of head 2$\frac{3}{4}$in., and the nominal weight in pounds per yard corresponding to the number of the section. The accompanying diagram represents Section No. 85. The sections



of rail shall be accurately rolled to their respective templates, two sets of which, internal and external, shall, if required, be supplied to the purchaser. Rails are to be supplied for switches and crossings when so ordered, and such rails are to be of the required lengths, and cut from sound rails. For the impact test a piece of rail shall be selected from each cast. From this a piece 5ft. long, which may be taken from a crop end, shall be placed in a horizontal position, with the head uppermost, on two iron or steel supports resting on solid foundations, the upper surfaces of the supports being curved to a radius of 3in. The test shall comprise one blow, delivered midway between the bearings, from a falling weight or tup, the striking face of which shall be curved to a radius of not more than 5in. The weight of tup, span of test piece between centres of bearings, and height of drop for the various sections extend from 5cwt., 3ft. and 8ft. respectively for the 20lb. section to 20cwt., 3$\frac{1}{2}$ft. and 30ft. respectively for the 100lb. section. If any rail shows fracture under this test, the entire cast from which it was selected shall be rejected. The steel, placed in a testing machine of approved pattern, is to show an ultimate tensile strength equivalent to not less than 40 tons per square inch. Other matters dealt with include rails of special length for matching in curved line, branding, conditions of inspection, etc. A complete set of diagrams supplements the report, the price of which is 10s. 6d. Report No. 19 (price 5s.) deals with the temperature experiments on field coils of electrical machines carried out at the National Physical Laboratory. An abstract of the paper on this subject presented to the Institution of Electrical Engineers by Mr. E. H. Rayner, who conducted the experiments under Dr. Glazebrook's direction, appeared in our last week's issue.

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## ARMATURE WINDINGS OF THE CLOSED-CIRCUIT TYPE.

BY WM. CRAMP.

*(Continued from page 367.)*

### Two-Circuit Armatures with more than One Pair of Inductors per Commutator Section.

In all the examples of two-circuit windings so far discussed only two inductors per commutator section have been shown, but in many cases, especially for small machines, we may have many more.

This fact should, however, in no way lead to confusion, for the general laws of the winding are the same; only for each inductor we substitute a group, for each *pair* of inductors, a coil.

To show how this may be done, Fig. 20 has been modified from Fig. 14.

We assume that in place of 18 inductors there are 72, but still only nine commutator sections. In place of the simple connection 2 to 7 we get, as shown, a coil of four turns linking up *groups* 2 and 7, passing thence, on the one hand, *viâ* a commutator section to group 12, and, on the other, to group 15, exactly as in Fig. 14.

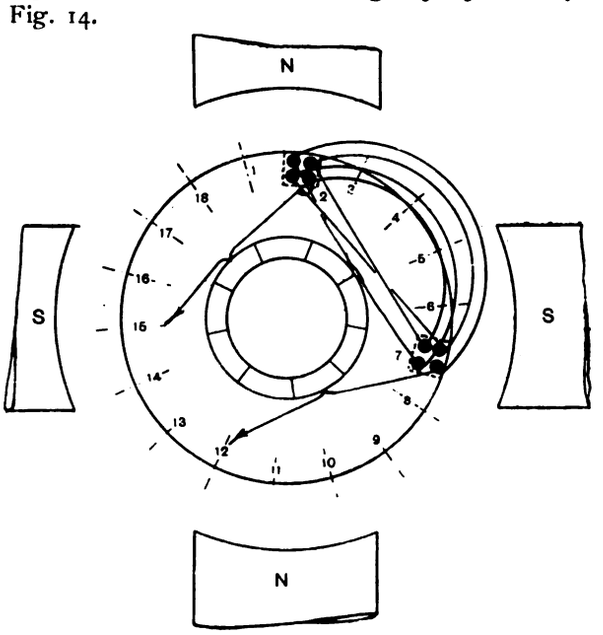


FIG. 20.

It follows, then, that in arranging any winding, the number of commutator sections is first determined and the winding arranged as if for a number of inductors equal to twice this number of sections: each of these inductors is then considered as split up to form a group until the total number given by the electromotive force formula is obtained.

It is obvious that the number of inductors must be both a multiple of the number of the commutator sections, and also, in the case of slotted armatures, a multiple of the number of slots.

### General Deductions.

1. Two-circuit simplex drum windings are those in which all the inductors are connected, so that they form between the brushes *two paths only* in parallel, no matter what be the number of poles.

2. This result is achieved by proceeding continually in one direction around the armature, with the end connections such that inductors lying in nearly similar positions under the various poles are connected immediately in series.

3. In order that the winding may close properly, it should obey the formula

$$w = p\,y \pm 2,$$

where $w$ is the total number of inductors on the armature;

$p$ the total number of poles; and

$y$ the mean number-pitch being a whole number.

If $y$ is an even number, the number-pitches must be taken alternately $y+1$ and $y-1$.

4. The total number of inductors must be a multiple of the number of commutator sections, and also, in the case of slotted armatures, of the number of slots.

5. However many poles the machine may have, two brushes only are essential; but, if desirable, there may be as many brushes as poles, without alteration of the winding.

6. On account of the shape of any section of such a development as Fig. 15, two-circuit windings are frequently called *wave windings* in contradistinction to those of the multiple-circuit type, which are called *lap windings*. This nomenclature, however, is again apt to be misleading, on account of the fact that some armatures may have more than one pair of inductors per section. Thus in Fig. 14 inductors 1 and 6 might form a complete coil of many turns whose end connections, however, would be arranged substantially according to the same system as explained on this page.

7. The same notation is used for these as for multiple-circuit armatures. Thus Fig. 19 will be described as a two-circuit four-pole drum, in which

$$w = 22$$
$$y_1 = 7$$
$$y_2 = 5.$$

The winding is simplex and re-entrant, and therefore denoted by the symbol o.

### Former-Winding of Two-Circuit Armatures.

Former-winding may be applied to drum armatures of this class, just as well as to multiple-circuit windings.

Thus in Fig. 20, if groups 2 and 7 lie in open slots, the coil shown would in all probability be wound apart from the armature, taped, and then slipped into position.

### The Same Armature as Multiple and as Two-Circuit.

It is clear that exactly the same coils might be used for a two-circuit as for a multiple-circuit armature, the end connections only being different.

Take, for instance, the armature of which Fig. 20 shows a portion.

There are nine coils, each of four turns, forming 18 groups of four inductors, each arranged in 18 slots with nine commutator sections.

If this armature is arranged as a two-circuit winding, the beginning of coil 2 to 7 is joined to group No. 15, and the end of this same coil to No. 12, and so on.

This armature will give, in a certain field, at a certain speed an electromotive force = V, and will carry without undue heating a current of C amperes.

If, on the other hand, we arrange it for a multiple-circuit winding, the coils will be the same, but the end of the coil just connected to group 12 will now be joined to the beginning of group 4, while that previously connected to group 15 will now be joined to the last inductor of group No. 5, and so on.

Under these conditions the armature will give $\frac{V}{2}$ volts, and at the same current density as before 2 C amperes, with the same field and at the same speed. This interchangeability is most useful to remember where many outputs are required from standard armatures;

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and in getting out new patterns of armature discs we should always bear in mind that, while any even number of inductors may be used for a simple multiple-circuit winding, the same is not true for two-circuit armatures.

It is well, therefore, in designing the disc to keep in view the possibility of having to use it for a two-circuit winding. This, in the case of four-pole machines, often resolves itself into having a commutator with an odd number of sections, and a number of slots to suit.

Similar peculiarities immediately apparent in practice are proper to every number of poles, as shown by the formula. A multiple-circuit winding is, except so far as the actual pitch is concerned, independent of the number of poles; but a two-circuit winding is dependent upon the number of poles, not only for its pitch, but for the number of inductors possible.

*(To be continued.)*

## NEW LOCOMOTIVES ON THE VALTELLINA RAILWAY.

*(Concluded from page 263.)*

### Electrical Equipment.

Each group of motors is provided with a primary switch. The two switches are mounted on a common frame in the centre of the driver's cabin. They are of the piston type (Fig. 12), and are actuated throughout by means of compressed air. In the act of switching in, the plate carrying the contact rods is raised by compressed air admitted through the starting valve of the pneumatic or master controller. The break occurs at two contacts per phase. The motors can be reversed only when the primary switch is open, by turning the plate carrying the contact rods through an arc of 60deg. Two pistons are provided for this purpose, being connected with the reversing valve of the

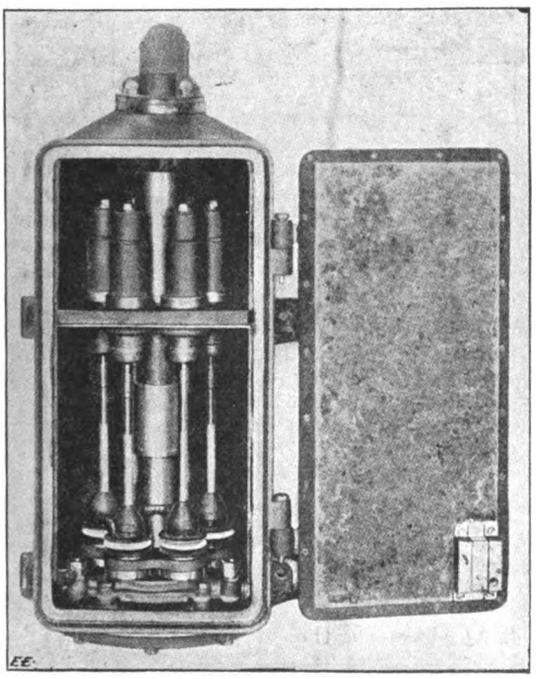

Fig. 12.—High-tension Switch.

master controller. According as the one or other piston is connected with the compressed-air reservoir or to atmosphere, the plate assumes one or other position.

The electrical controller serves to switch the two double motors in cascade or separate connection. Figs. 6-7 and 13 show the construction of this apparatus. It will be seen that the contact brushes through which the different connections are made, are carried by a shaft capable of movement in a vertical direction. Attached to the lower end of this shaft is a double-acting piston which works in an air-cylinder. The upper and smaller surface of this piston is open permanently to the compressed-air supply, so that the apparatus is usually held in the lower position, the motors being then in cascade. But when the corresponding lever of the pneumatic controller is set over to the full-speed position, compressed air is admitted through the

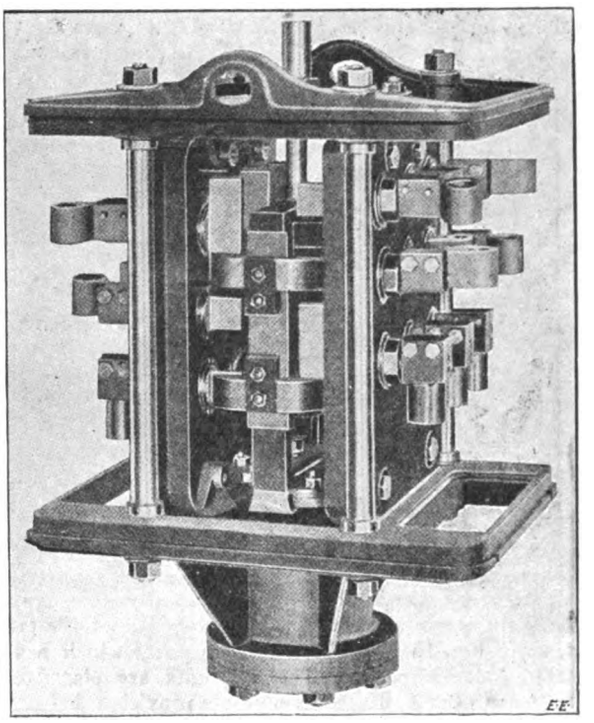

Fig. 13.—Electrical Controller.

speed regulating valve into the lower part of the cylinder, whereupon the shaft is forced upwards, due to the under surface of the piston being the larger. Thus the motors are put in separate connection. Since, however, the corresponding lever of the pneumatic controller can be moved only when the starting lever is in the off position, the motor controller cannot, of course, be operated except with the current off.

Each set of motors is further provided with a liquid starting rheostat. This consists essentially of a vessel having two compartments, the upper of which contains three groups of rheostat plates. These plates are clear

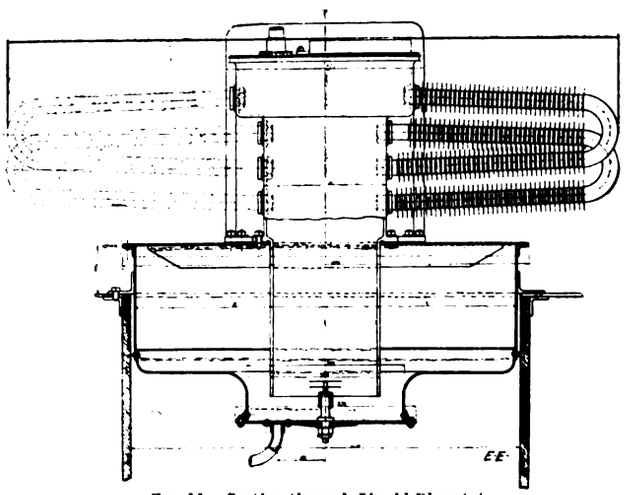

Fig. 14.—Section through Liquid Rheostat.

of the water when the motors are cut out. The resistance is inserted by admitting compressed air into the second chamber, so as to force the water up through the opening provided until it reaches the plates. The plate surface in contact with the water increases with the volume of air admitted until the resistance is reduced to its minimum, whereupon a short-circuiting device is operated automatically. Referring to Fig. 14, it will be seen that the chamber containing the rheostat plates is provided with an

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extension which dips into the water-tank. It is through the lower end of this extension that the water is forced up by the compressed air. The system of valves by means of which the supply of compressed air to the rheostat can be regulated is contained in a separate compartment, as also the ball-cock which acts upon the valves. The former will be described in detail later on. The chamber in which the rheostat plates are suspended is situated between the above-mentioned compartments, and the plates themselves differ in length and shape. The plates belonging to the three phases are arranged alternately and insulated from

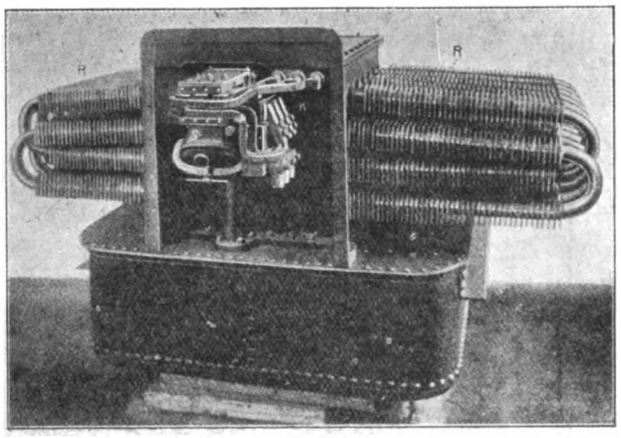

FIG 15.—View of Liquid Rheostat, showing Cooling Pipes and Short-Circuiting Device.

each other by means of porcelain insulators. A system of ribbed pipes which range out on either side of the tank, as shown in Fig. 15, serves to cool the water which has been heated in starting up. The rheostats are placed one at either end of the locomotive, ample provision being made for ventilating through the casing, as shown in Fig. 1, p. 155.

The arrangement of the regulating valves is shown in Fig. 16. The regulation is effected through the differential action of an electromagnet in the secondary circuit of the motors, as well as by the pressure due to the volume of compressed air admitted through the corresponding valve of the pneumatic controller. This pressure may, of course, be varied by admitting more or less compressed air, so that each position of the starting lever of the pneumatic controller corresponds to a certain starting current. The action of the system of valves may be explained with the aid of Fig. 16. The lever arm, M, attached to the shaft, *b*, is moved by the ball float in the water rheostat. If the level of the water in the plate chamber of the rheostat be low, the lever arm of the float will rest in the position indicated by the dotted lines and hold the valve T open, so that the water-tank of the rheostat is open to the space, W, below the smaller diaphragm. The valves P and N are closed by a spring; the two diaphragms are in their normal position; the armature of the electromagnet, *f*, does not exert any pressure through its support, *g*, since no current is flowing in the secondary circuit of the motor. When there is no air pressure in the chamber C, the valve H is opened by the spring $R_1$ and the piston D raised, so that the water-tank is connected with the atmosphere through the channel F, valve H, and channel E. The valves L, $N_1$, and R are held closed by the corresponding springs. The pipe A connects the system with the starting valve, while pipe B connects it with the regulating valve of the pneumatic

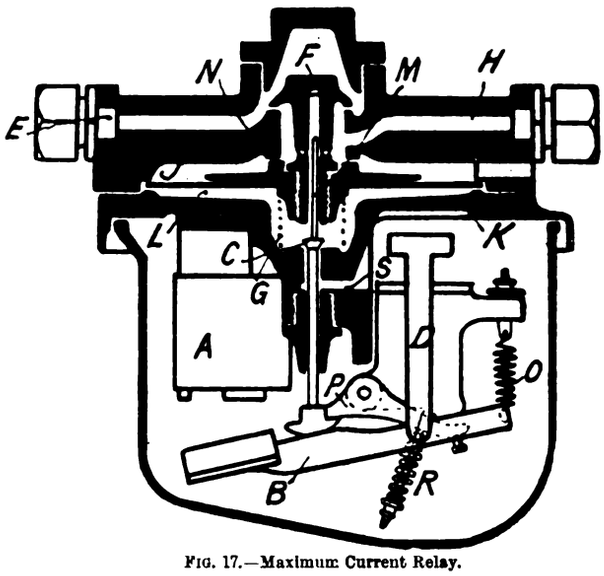


FIG. 17.—Maximum Current Relay.

controller. When the starting lever of the controller is put over to the first position, compressed air is admitted through the regulating valve into the pipe A and space C. The resultant pressure suffices to force down the piston D, and with it the valve H, thereby cutting off the water-tank from connection with the atmosphere. It is insufficient, however, to open the valve N against the counter-thrust of the spring S. Hence the rheostat is not yet switched in. By moving the starting lever further forward the regulating valve is also brought into action, thus admitting a certain volume of compressed air through the pipe B into the space, Q, between the two diaphragms. The upper diaphragm possessing the larger surface is consequently forced upwards, thus raising the valve N from its seat. Meanwhile, the valve P remains closed. The compressed air now passes through the valve N from the space C into the space W, and thence into the water-tank through the valve T, which has been opened by the lever connected with the float. Due to this action the water is raised into contact with the rheostat plates, and a current commences to flow in the secondary half of the motor, causing the armature of the electromagnet to be more and more attracted, until with the increasing current it exerts so

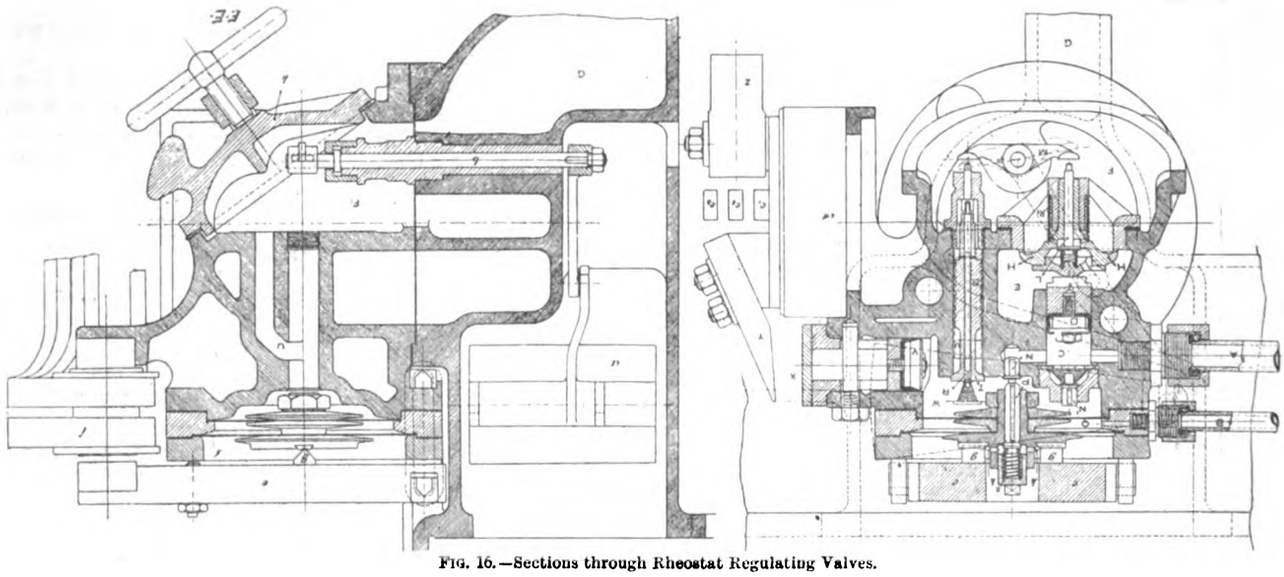

FIG. 16.—Sections through Rheostat Regulating Valves.

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much pressure on the upper diaphragm that the latter is forced back. This, of course, tends also to close the valve N, and the volume of air admitted is lessened, until finally the diaphragm is forced so far back as to open the valve P, whereupon the compressed air escapes from the space W into the atmosphere. The current now decreases, since the water rises at a slower rate or maintains the same level, and consequently the pull of the electromagnet is weakened, the diaphragm again bulging outwards. Valve P is closed, valve N opened wider and wider, thereby again admitting compressed air to the rheostat. In this manner the water ultimately attains a level at which the arm, M, of the float falls back and the valve T is closed. The compressed air in the space W then expands, driving the piston V forward against the counter pressure of two powerful springs, and so short-circuits the three brushes, Y, through the contact piece, X, of the short-circuiter. When the starting lever of the pneumatic controller is reversed to cut the motor out, the state of the rheostat is not altered so long as compressed air is only released from the space, Q, between the differential diaphragms through the regulating valve and pipe B. Not until the starting valve connects the pipe and space C with the atmosphere does its action begin. The compressed air remaining in the space W then closes the valve N, and opens simultaneously the valve $N_1$, through which the air has an outlet. A relatively slight decrease of the air pressure acting on the piston V causes the latter to be forced back by the springs, and thus open the short-circuiting device. The piston D and valve H are simultaneously acted upon by their springs and the compressed air, being forced upwards. This establishes a connection between the water-tank and space E, consequently also with the atmosphere and chamber containing the rheostat plates, thus causing the water to sink rapidly. Should air escape due to leakage when the rheostat is switched in, the lever arm of the float raises the small valve, R, in valve T, causing the latter to be raised in turn, so that compressed air is admitted to compensate for the loss.

Referring back to Fig. 7, p. 262, it will be seen that an automatic relay is connected in the air-pipe from the starting lever of the pneumatic controller to the rheostat governor. The function of the device is to cut the motors out of circuit in case of overload. It is designed to release the compressed air from the rheostat, and so cause this to be cut out. Its action may be explained with the aid of Fig. 17. The device consists essentially of an electromagnet, A, excited by the earthed phase of the main circuit. Should the current reach its maximum, the lever, B, attracted by this electromagnet, opens a valve, C, and thereby establishes connection between the rheostat chamber and atmosphere. A time limit is imposed on the action of switching out by the oil dash-pot, D, which retards the movement of the lever B in proportion as the overload current is smaller or greater. Under normal conditions the pipe, E, from the pneumatic controller is open to the pipe, H, leading to the rheostat, through the valve F, which is raised by the spring, G. The space, J, above the diaphragm, K, is open to the atmosphere, whereas the space, L, below the diaphragm receives compressed air through the small inlet, M. Hence the diaphragm is forced upwards, and closes the valve N. The spring, O, opposes the pull of the electromagnet. As this pull increases with the square of the distance of the armature, and consequently the electromagnet would draw the lever up too quickly, the arm, P, is introduced, due to which the electromagnet can only come into play when its pull is sufficient to contract the spring, R. Then the valve C is opened by the arm, P, and the space below the diaphragm is connected to atmosphere through the opening, S. This causes the diaphragm to bulge downwards, opening the valve N, while the pipe, H, leading to the rheostat is connected through to the space J, and therefore to atmosphere. The compressed air in the pipe E also closes the valve F, so that no more air is admitted. When the rheostat is switched out of circuit, the lever and dash-pot arrangement returns to its original position, due to the action of the springs, as the current drops. However, the compressed air must be released from the pipe E before the rheostat can be inserted again, as otherwise the valve F remains closed—that is to say, when the relay has operated, the driver must put the starting lever over to the off position before he can start up again. The relay can be set to operate with any overload by adjusting a spring at the end of the lever P.

Referring once more to Fig. 7, it will be seen that an operating valve is provided in each of the pipes from the starting valve of the pneumatic controller to the primary switches. This valve serves a double purpose. In the first place, it ensures a quick make and break of the switch, and, secondly, delays the break so as to allow time for the rheostat to be switched out first. In switching in, a certain pressure is necessary to raise the valve against the opposing thrust of a spring, and this pressure must first of all accumulate in the pipe. When the valve is ultimately raised, the compressed air is admitted suddenly under the piston of the primary switch, and the make is instantaneous. In switching out, the air is released simultaneously from the pipes of the rheostat and primary switch, but while the rheostat is at once cut out, the pipe leading to the primary switch must exhaust to a certain degree before the valve can return against the reduced pressure and so re-establish direct connection between the piston cylinder and atmosphere. When the return does take place, the sudden reduction of pressure causes an instantaneous break.

On referring to the diagram of electrical connections (Fig. 6), it will be seen that provision is made for two small transformers. Of these, however, one only has been installed at present, as it is desired to find out whether one transformer and one air-compressor will suffice for actual requirements in practice. The 5-kw. transformer is of the oil-cooled type and transforms current from 3,000 to 110 volts, at which latter pressure the driving motor of the air-compressor is supplied. This motor is coupled direct to the compressor, which runs at a speed of 430 revolutions per minute. The compressed air is conveyed to the air reservoirs through a non-return valve and an oil separator. Two such reservoirs are provided, both carried on the roof of the locomotive. One of these supplies compressed air for the electrical apparatus, while the other serves the Westinghouse brakes. The compressor motor is controlled by means of an automatic switch, which is operated by the pressure in the reservoirs, being closed or opened according as the pressure is reduced or increased above six atmospheres. This switch is fitted with carbon contacts, and the interruption of each phase occurs at two points. When the pressure in the air reservoirs exceeds a certain limit, a diaphragm admits compressed air to a piston working in a cylinder. The counter-thrust of a coiled spring is thereby overcome, and the carbon contacts are raised. On the other hand, when the pressure in the reservoirs is reduced the diaphragm releases the air from under the piston, which the spring then drives back, and the carbon contacts close the circuit. A three-pole hand switch is provided for emergency use. There is also a small hand pump installed, which enables the air reservoirs to be filled independently of the electrical equipment.

Each end of the driver's cabin is provided with a voltmeter, an ammeter, and a manometer. The signal whistle is operated by compressed air, as likewise the sand sprinklers. Hand brakes and automatic Westinghouse brakes are fitted to the locomotives. These act only on the six driving wheels, there being two brake blocks to each wheel, one at either side. Two of the new locomotives are equipped as described in the foregoing, but the third differs in that metal resistances have been fitted experimentally instead of liquid rheostats. This departure has necessitated, of course, the use of a modified form of pneumatic controller and different apparatus for regulating the resistance. In other respects the equipment of the third locomotive resembles that of the other two.

The modified form of pneumatic controller is shown in Fig. 18. As in the case of the type previously described, levers are provided to operate the valves connected with the reversing gear and motor controller respectively. Moreover, the action of these valves is the same for both types. But whereas in the former a starting lever was also pro-

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vided, this is substituted in the modified controller by a hand-wheel which operates a pneumatic starting valve, and at the same time regulates the resistance mechanically. This hand-wheel is mounted loosely on to the vertical shaft of the apparatus. It drives the outer cylinder, which is free to rotate within certain limits, through the medium of toothed gearing contained in the box, G, and it also drives the shaft. When the wheel is turned, the outer cylinder first revolves and operates in its turn

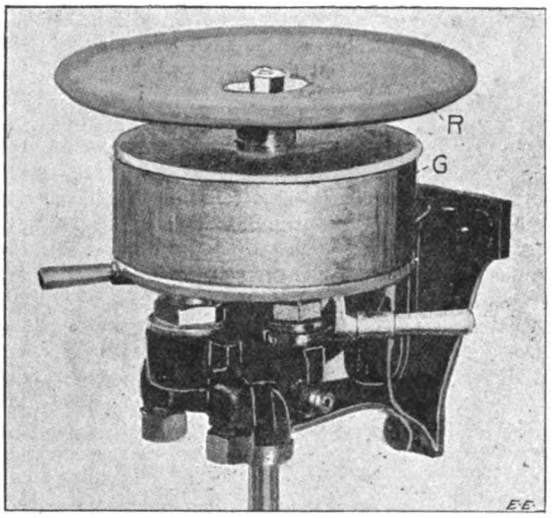


FIG. 18.—Pneumatic Controller on Locomotive fitted with Metal Rheostats, Valtellina Railway.

the starting valve, thus admitting compressed air to the primary switches. The outer cylinder is not capable of further movement in a forward direction, but now that the starting valve has been opened the shaft of the apparatus, which was previously stationary, is free to rotate, whereby the resistance switch is actuated through chain gearing and the individual units successively cut out until the whole resistance is short-circuited. The resistance regulators belonging to both sets of motors are moved

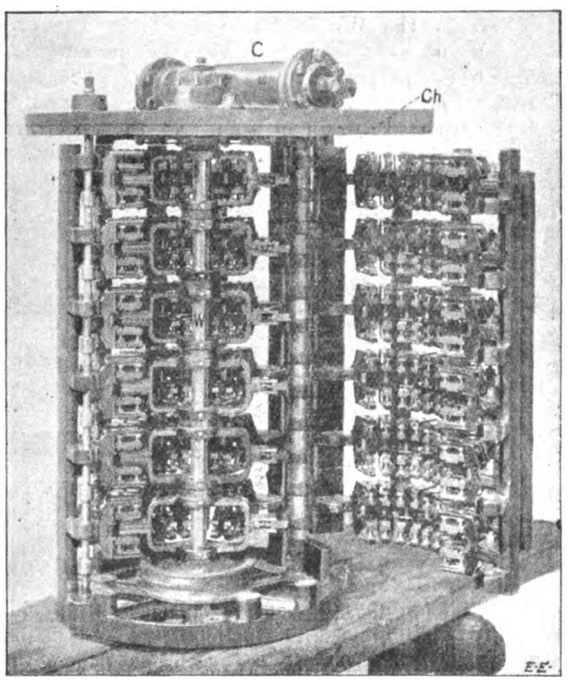


FIG. 19.—Regulator for Metal Rheostat.

simultaneously. For the rest the two controllers are interconnected in the same way as those of the type first described, while similar means are employed to minimise the possibility of mistakes by the driver.

The regulating apparatus (Fig. 19) for the starting rheostats consists of six rings of contacts insulated from each other, and connected to the secondary terminals of the motors on one side and with the individual sections of resistance on the other. The knives which engage with the contact jaws are carried by a vertical shaft actuated from the pneumatic controller through a chain and sprocket wheels. When this shaft is turned the resistance is cut out in sections until the last position is reached, at which the secondary terminals of the motors are short-circuited. There are two rheostats, one at either end of the locomotive. Each (Fig. 20) is built up of a number of units composed of German-silver strip. The regulation is effected in steps, and it is noteworthy that each position of the starting gear no longer corresponds to a constant current, as in the case of the locomotives previously described, but to a certain step, and the driver must keep an eye on the ammeter and regulate constantly, in order to keep the current within the desired limits.

An automatic relay similar to that in the other locomotives is provided to cut the resistances out in case of overload. For this purpose an air-cylinder, C (Fig. 19), in which a double-acting piston works, is mounted on the top cover of the regulating switch. The movement of the piston is transmitted through a worm shaft and toothed wheel to the vertical shaft of the switch. One end of the cylinder is connected with the starting valve of the pneumatic controller, and the other end with the automatic relay. Under normal conditions the pressure on the two sides of the piston is equal, and the shaft of the regulator can be moved freely. But when the relay operates it releases air from one side, and the excess pressure on the other side then

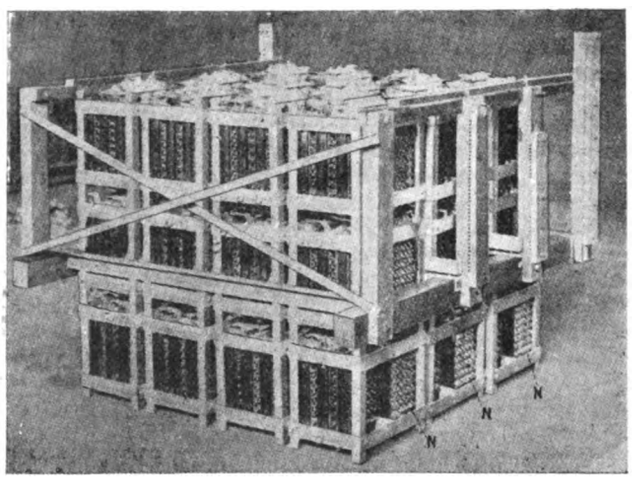


FIG. 20.—Metal Starting Rheostat.

causes the switch to be opened. At the same time the hand-wheel of the pneumatic controller is brought back to the off position, due to the connection through a chain and sprocket wheels. In order to prevent injury to the driver, the hand-wheel is of the smooth disc type.

It remains to add that the three locomotives were delivered in the spring of last year, and are used for hauling both passenger and goods trains. They have, so far, given complete satisfaction. It is noteworthy in this connection that the first of the trio continued in service for a month before it was withdrawn for a day's overhauling. All three locomotives are now in regular service, and haul passenger trains of 250 tons and freight trains of 400 tons total weight. They were thoroughly tested during their trial runs, and proved to meet all requirements.

[It will be admitted that these locomotives mark a great advance in railway work, and are a triumph of which Messrs. Ganz and Co. may be justly proud. We would remind our readers that Messrs. Bruce Peebles and Co., Limited, Edinburgh, are the firm's worthy representatives in this country, at all times prepared to undertake similar work.—ED. *E. E.*]

## THE MOTORCAR SHOWS.

Visitors to the automobile exhibitions held at Olympia and at the Agricultural Hall cannot fail to have been impressed not only by the growth in the size of the shows, but by the interest now taken in such exhibitions by the general public. Those interested in electrically-

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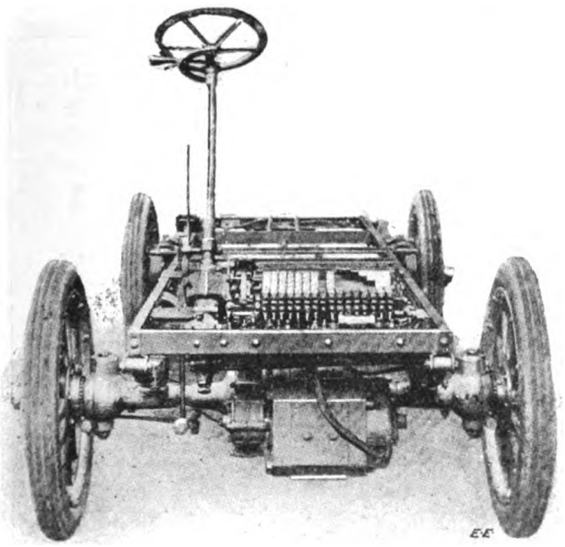
propelled vehicles will also have realised that although those cars exhibited were fairly representative of the types now in use, they were comparatively few in number, and that among those to be seen structural improvements were more numerous than electrical, and in some instances were the only changes found to be desirable. The use of electric cars is still limited, and must necessarily be so as long as the distance they are able to run and the speed at which they can travel is restricted by the limited capabilities of even the improved accumulators now obtainable. The weight of these cars and their operating cost is not less than double that of cars propelled by other means, but there is a sufficient demand for these vehicles by people who are indifferent to such considerations, and who attach more importance to quietness of running and freedom from vibration, together with other advantages inseparable from electric cars, to encourage their construction and gradual improvement by the few firms engaged in their manufacture.

The Silvertown Company's chassis, exhibited by Messrs. W. and F. Thorn, is an example of excellent work and is well arranged. It is equipped with two series-wound totally enclosed motors, one driving the rear wheels through a live axle and single-reduction gearing, and the other the front wheels through similar gearing. Universal joints inside spherical steering heads are required to enable the power to be transmitted to the front



The Silvertown Chassis.

wheels, when they take up angular positions for steering. The weight of the cells and motors is well distributed, and it is claimed that by driving all four wheels the tendency to skid on slippery road surfaces is very much reduced. The controller is arranged across the front of the frame, and is in a protected and yet very accessible position. There are eight forward running positions, five for braking and five for reversing. Recuperation is not attempted, and it is reasonably claimed that for town running such provision is of little use, gradients usually being few and slight. When changing from series to parallel positions, the circuit is opened on a carbon circuit breaker, and flashing at the controller contacts is prevented. There is also a connection between the foot-brake pedal and the circuit breaker, so arranged that when slightly depressed for a momentary check of the car it may be opened and closed again without returning the controller to the neutral position. If, however, the pedal is sufficiently depressed to apply the brakes then the circuit is broken, and remains open until the controller is returned to the neutral position for restarting. The arrangement provides some protection against unskilled driving, and should be useful for traffic running. The complete car exhibited is provided with a very handsome brougham body seating four persons, with a canopy top extending over a roomy front seat for an additional passenger besides the driver. Various types of cells are employed, and a running distance of 35 miles on level roads with a single charge is guaranteed.

The cars exhibited by the Kriéger Electric Carriage Syndicate, Limited, have undergone little change, and they are similar to those which may be frequently seen in use in London, and which may be recognised by their distinctive method of driving the front wheels. The front or steering wheels are each independently driven by a two-pole shunt-wound motor supported on a swinging arm, the point of attachment of which is coincident with that of the pivoted wheel axle. The motors are suspended from laminated springs fixed at their inner ends, and an easy drive is obtained with diminution of shocks at starting and stopping and of the stresses set up in the gearing. A pinion on each motor spindle gears into an internally toothed ring on the road wheel, and with this single-reduction gear there can be little loss in transmission. The motors are entirely enclosed, but provision is made for easy examination of the commutators and brushes. The arrangement of the controller provides for electric braking and for recuperation when descending gradients at high or low speeds, or when the cells are connected in two groups in parallel or all in series. Mechanical brakes are also provided, acting on drums on the rear road wheels. Fulmen cells are employed; they are 44 in number, and their capacity is 204 ampere-hours. The weight of the car with landaulet body to seat four persons is about 30cwt., and a distance of from 40 to 50 miles may be run on one charge.

The Ekstromer Accumulator Company exhibited a two-seated car provided with a battery of 48 cells having a capacity of 240 ampere-hours. The weight of the cells in their containing crates is 14cwt., and the weight of the car complete is 30cwt. The motor and gear shafts are hung below the centre of the car, and the pinion on the motor shaft gears into a spur wheel on the differential gear and side chain pinion spindles. The second stage of the gear reduction is through the side chains to the sprockets on the rear road wheels. Strong claims are made as to the capabilities of the cells, and tests by independent authorities have shown the watt-hours of discharge per pound of cell to be about 14. The car exhibited has run a distance of about 3,000 miles, and the cells have been in use nine months. It has been run from London to Bath, a distance of 108 miles, on one charge, the volts at the commencement and finish of the run being 108 and 92 respectively. The average speed was 13½ miles per hour. Observations taken during a run from Portsmouth to London, on unfavourable road surfaces and over a more hilly course, showed the watt-hours per pound of cell to be 13·9. The average speed during this run was slightly over 10 miles per hour. Information as to the longevity of the cells is not yet available.

The Mors Company, who are agents for the Compagnie Française de Voitures Electromobiles, exhibit an electric brougham propelled by a single motor hung from the forward end of the frame, driving the rear road wheels through a propeller shaft and bevel gearing. The motor is constructed with two fields and two armatures, which arrangement permits of four speeds without altering battery connections, the cells being always in series. The controller provides for the four forward running speeds, one reverse, and electric braking. Other electric vehicles were exhibited possessing features of interest, among which were those of the Electromobile Company, which we hope to refer to in another issue.

Considerable interest attaches to the exhibits of those firms engaged in the manufacture of the variety of auxiliary parts required for the different electrical ignition systems for petrol motorcar engines. The use of these parts in very large numbers has stimulated invention, and has resulted in considerable improvement in design and construction for particular requirements.

We are unable to now refer to more than a few of the numerous exhibitors of these very necessary accessories, but among those who are well known to manufacturers and owners of automobiles are Messrs. Peto and Radford, Van Raden and Co., United Motor Industries, Limited, J. Lacoste and Co., John C. Fuller and Son, etc. A great variety of accumulators, dry cells, and primary batteries for ignition purposes are shown, and among these attention may be directed to Messrs. Van Raden's woven glass accumulators. These have been manufactured for some years, and have acquired a high reputation for use with motorcars. They

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differ from other types of accumulators in that the carrier of the active material is not made entirely of lead, but is formed of a grid in which lead wires are interwoven as a warp thread, with extremely fine elastic glass wool as a weft. The material is pressed into these woven grids, and is very securely held. The plates, before being assembled, are enveloped in a sheet of spun glass. By this means good insulation is obtained, and the plates receive support over their whole area. The spun glass is extremely porous, and the plates may be arranged close together without liability of short-circuiting and the internal resistance of the cell is reduced.

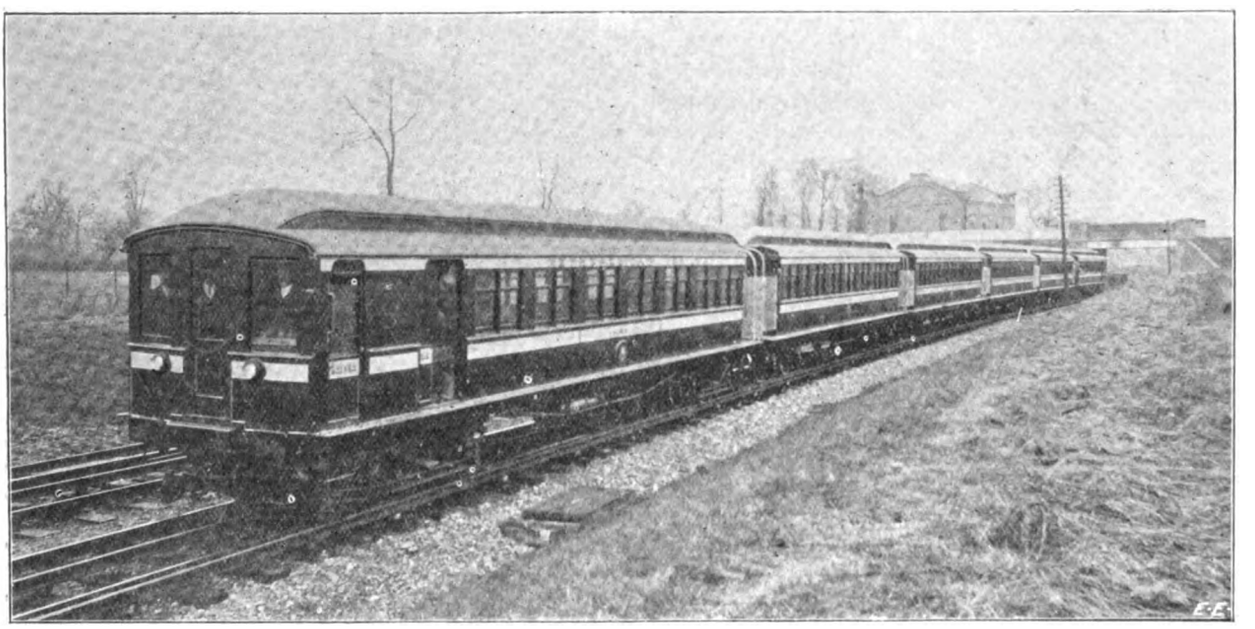
Induction coils of various sizes and of rectangular external form are shown, fitted with the well-known Carpentier trembler. Single coils, or groups of two, three, and four coils in single cases, are arranged for engines having from one to eight cylinders, and they are uniformly well finished. The Hospitalier-Carpentier manograph or indicator for high-speed engines, which is now receiving considerable attention, is exhibited.

There are a few exhibits of primary cells for ignition purposes, and the "Primol" Syndicate have produced a bichromate battery of simple construction which appears to possess advantages. The cells are arranged in boxes three in series, and the electrodes are carbon and zinc. The cells are hermetically sealed, and a neutralising agent is added to the electrolyte to prevent the evolution of gas. When the cells are not in use they must be inverted in order that the zincs shall not be immersed, but attention has been paid to easy withdrawal of the cell-box without disconnecting wires, sliding contacts being used. The cells are of small dimensions, are much lighter than accumulators, and renewal of the electrolyte after 1,000 miles running is easily done. The zincs may be used for the equivalent of a running distance of 6,000 miles, and are then simply replaced at very small cost. The weight of the three cells in their containing case for car purposes is 5lb., and for motor cycles 3lb.

Magneto-electric ignition is becoming much more commonly employed, and the arrangement of magnetos to work with induction coils, or with the induction coil or its equivalent included in the magneto, enables sparking plugs to be used at the motor cylinders instead of the more complicated mechanical contact gear hitherto required with the low-tension current from the magneto used without the induction coil. Space will not permit a description of these machines, but it may be stated that while they fulfil the electrical requirements satisfactorily, some of them are either of too delicate contruction to be durable, or have parts which require some attention, and which are not likely to receive it, since they are, in some instances, cased in and out of sight. The magnetos used on the Albion and on the Lanchester cars respectively of the high and low tension types are of simple and substantial design, and have proved themselves satisfactory. The Simms-Bosch and Eisemann magnetos are of more compact design, and are more commonly used at present.

The Kennedy Motor Company show their Simplex ignition plug, in which a magnetically-operated contact breaker is employed to cause a rapid make and break or trembler action at contact points in the combustion chamber of the engine cylinder. It is used with an accumulator and a contact breaker of the usual form in circuit, and subject to freedom of action when hot, and when some attention is given to lubrication should prove a satisfactory method of ignition. With multi-cylinder engines its application would be more costly than the usual high-tension coil and accumulator system of ignition.

An interesting application of Messrs. Crompton's electric pyrometers may have been observed by some of those who inspected the Clarkson steam omnibuses at the Olympia show. It is there applied to indicate the temperature of the steam as it leaves the generator on its way to the engine, and to enable the driver to keep the degree of superheat of the steam within predetermined limits. Such an instrument is of value to steam-car constructors, and Messrs. Crompton have supplied us with particulars of its construction and application to steam cars and of its use for various other purposes. They have paid particular attention to strength of construction and to so designing the indicating instrument that it shall be capable of withstanding the vibration it is subjected to on motor vehicles. The indicating instrument may be fixed in a suitable position for easy observation by the driver, and it has a clearly-divided scale 5¼in. long. For other applications a larger scale is used, and in the types more commonly used it is suitable for temperature ranges of 200deg. to 800deg. or 1,000deg. F., or for higher temperature ranges of from 400deg. to 1,100deg. C. We hope to more fully describe these instruments later, but it is interesting to record their application for steam-car purposes.



## THE METROPOLITAN RAILWAY COMPANY'S ELECTRIC TRAINS.

Above we reproduce a photograph of one of the electric trains delivered by the British Westinghouse Company to the Metropolitan Railway. The full details of the electric equipment appear in our description of the electrification of this line. The photograph shows more clearly than our previous illustration the general appearance of the electric trains which are now running regularly on the Baker-street to Uxbridge section of this line. We need only add that the comforts of the new rolling-stock propelled by electricity are much appreciated by the public living in the Uxbridge district.

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## TRAMWAYS PERMANENT-WAY CONSTRUCTION AND MAINTENANCE.*

BY JAMES LORD, A.M.I.C.E.

This subject is one which has been considerably debated in all its bearings during the last 15 years, and it may seem at first sight that nothing new can be advanced; such I venture to suggest is not the case, and the matter is still full of interest after 15 years' experience. I propose this evening not to take up time by enumerating and discussing the various systems of construction which have been practised in the past and many which are still being installed, but to give you the results of my own practice and experience extending over a period of 21 years, in the hope that the advocates for the various systems or methods opposed to those adopted by me will give their knowledge on this, in order to render my introduction of the subject of more value to the profession generally.

I have had an experience in the construction and repairing of municipal tramways for horse, steam, and electric cars at Bolton, Accrington, Blackburn, and Halifax. Since electric traction came to the front it has caused many alterations in the construction of the permanent way, owing to the cars being heavier and travelling at a greater speed. In the days of the horse cars the track was not of so great moment as at present. The concrete was generally laid first, the rails then laid with fishplates only at the joints and packed afterwards with a mixture of sand and cement, and these have been known to stand without any repairs for many years. Steam traction was next introduced, and this was much more destructive to the permanent way than horse cars, but not, in my opinion, to such a serious extent as the present electric cars, owing to the above reasons, and the weight being distributed over a longer area of track, as, in most cases, there were two bogies to each car and one to the engine.

During the time I was working as assistant under other engineers, four in number, each had a particular fancy for the lines being laid by one of the following methods—viz.: (1) that the concrete be laid first, the metals afterwards, and packed up; (2) that the concrete be laid first, the metals to be put on whilst the same was wet (this I consider a dirty and very unsatisfactory way); (3) that the rails be packed up on blocks, crowed, and the concrete be put in afterwards.

In Halifax, tramways were first laid in the year 1897 for the purpose of running electric cars, and up to the commencement of the year 1900 (the time I was appointed engineer) there had been some 12 miles laid. On these the concrete was laid first, then the metals afterwards, packed up with chippings and cement. The rails were of the girder pattern and weighed about 95lb. per running yard, with fishplates 24in. long, weighing 46lb. per pair, and soleplates 24in. by 8in. by ¾in., weighing 41lb., bolted to the bottom flange of the rail without being anchored down.

Since the year 1900 I have used girder rails weighing 96lb. per yard, with fishplates 25in. long, weighing 70lb. per pair, and anchored down at the joints with Howard Cooper's patent joint, 24in. long, with six rivets into the bottom flange of each rail. This joint block is simply a piece of rail turned the opposite way and the two flanges riveted together. I have also used an intermediate anchor (either one similar to those at the joints, or what is known as the Ames Crosta Bulldog anchor block). As to price of these anchors, there is very little difference. I am strongly of opinion that is better to lay the metals first and the concrete afterwards, and this practice I always carry out. I place the metals on wooden blocks packed up with wedges to the exact level, at intervals of about 9ft. apart, then the line is crowed, afterwards the concrete is packed under the metals and the remainder of the track to the level of the bottom flange of the rail; after this has stood for two days the wooden blocks are taken out and the holes filled in with concrete, and the following day the whole of the crevices under the metals are run in with a mixture of sand and cement (1 to 1). I have had several of the lines tested, but never found one rail in the least hollow. My objection to packing is that men do not pack equally, and this leaves the rail slack in places, which, with the vibration of the cars, causes the setts to lift; and, further, when the concrete is laid first it does not give such an even surface for the paving unless it is skimmed over afterwards, which adds to the expense, and, in my opinion, is not so satisfactory a job.

Since the year 1900 I have laid about 36 miles of track, and have used rails 60ft., 45ft., and a few 35ft. long, but much prefer the 45ft. lengths, for the following reasons—viz.: they are much more readily handled, especially in narrow and steep roads such as exist in Halifax; secondly, there is not the same danger that occurs with the longer rail, the latter very often acquiring a permanent set or hogback by sagging with its own weight, therefore the 45ft. rail is better to pave to and it is much easier to curve. It is true that in the 60ft. rails we have less joints to contend with, which also means less electrical resistance, but to counteract the cost of the joints the 45ft. rail only requires one intermediate anchor, whereas the 60ft. rail ought to have two to each rail, or we find the rail will not sit perfectly solid. The rail used in Halifax is 7in. deep, with a bottom flange 7in. wide and with a tread 2in. wide, groove 1⅛in. wide and 1in. deep, manufactured to the following specification:

*Weight.*—No extra weight over 1 per cent. per lineal yard above the specified weight will be paid for, or no rail weighing more than 1 per cent. per lineal yard less will be accepted; 85 per cent. at least of the rails shall be 45ft. long, the remaining 15 per cent. may be cut from longer lengths with defective ends, to lengths as follows: 5 per cent., 40ft.; 5 per cent., 35ft.; and 5 per cent., 30ft. No variation exceeding ¼in. will be allowed in the respective lengths of the rail. The ends of each rail to be perfectly square, smooth, free from all burrs and other defects, each rail to be coated with boiled oil whilst hot.

*Analysis.*—The chemical proportions in the bloom shall conform to the following: the quantity of carbon shall be 32 to 45 per cent.; silicon not to be more than ·06 per cent.; phosphorus not to be more than ·09 per cent.; sulphur not to be more than ·085 per cent. The blooms are to be free from defects of any kind and regular in quantity. The only metals of which they shall consist shall be iron and manganese, with a bare trace of copper. The engineer shall have power to have samples of the steel from time to time analysed by a chemist, and should these analyses not prove satisfactory, the expense must be borne by the contractor.

*Quantity and Test.*—The rails shall be perfectly straight, free from cracks, burrs, blisters, and other flaws, and of uniform section throughout. They shall show, when broken, a clear, close, and homogeneous fracture. Their ends shall be sawn off perfectly square and machined. The ingots shall be cast of such a size as to leave, when rolled into the finished rail or rails, a crop of at least 1ft. 6in. in length at each end, which shall be afterwards cut off. A piece of rail 5ft long will be taken from each blowing and placed on solid bearings, 3ft. 6in. apart, and the solid bearings shall be fixed on a solid cast-iron block weighing not less than five tons and be well bedded thereon. In order that the rails of that blowing may pass, the test piece shall stand the following test: (1) By a weight of 1,120lb. falling in proper guides upon the centre of each sample from a height of 10ft.

When at the first blow the set shall not exceed ¾in. ...
When at the second blow the set shall not exceed 1½in. } Sample not to be cracked or broken.
When at the third blow the set rail reversed.....

(2) By a weight of 1,120lb. falling in proper guides upon the centre of each sample four times from a height of 20ft., without sample breaking. Every rail shall be stamped with a mark which shall distinguish the blowing of which it formed part. All holes shall be drilled according to drawing, and shall be true and square through the rail.

*Fishplates.*—The fishplates shall be rolled from the same quality of steel in all respects as that specified for the rails. They shall be capable of being bent, when cold, round a bar 4in. in diameter without fracture. It will be noted in the above specification that the percentage of carbon is somewhat lower than in many engineers' specifications, my

* Paper read before the Leeds Local Section of the Institution of Electrical Engineers.

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reason being that having so many rails to bend on account of the number of curves, we have less breakages than we should have with a higher carbon. The writer has used rails 105lb. to the yard on sharp curves with 1¼in. groove. The engineer must be very careful in the gauging of the rails, or it is a great strain on the wheels of the cars. The gauge on curves should be slightly less, varied according to the sharpness of the curve. I have used both manganese and crucible cast-steel points and crossings, and think the former has a longer life. I have not had any experience in manganese steel-hardened renewable centre pieces, but I do not see any great advantage in them. I use 8ft. 6in. points with 5ft. tongues and 4ft. crossings, except on very sharp curves, then it is necessary to use shorter ones; but the writer would advise that the length of each tongue should be 6in. longer than the wheel base of the car, so that the trailing wheels would be on the tongue before the leaders leave, and then the strain is not so severe. I believe in a fair number of tierods, especially if wood pavement is to be used, or the expansion of the blocks is liable to put the track out of gauge.

*Concrete.*—The mixture I use is five parts of broken gritstone, one of clean sharp sand, and one of best Portland cement, turned over twice dry, then turned twice after water has been added. Formerly the whole of the tracks in Halifax were paved with local stone setts 6in. deep, but now I use nothing but granite or wood, except on the very steep gradients (those steeper than 1 in 10), and even then I use granite for the 18in. margins. The whole of the pavement is run in or grouted with pitch on the level roads to the top of the setts, but in gradients the top ¼in. is grouted in cement. If this is not done, the pitch runs in hot weather and is liable to run down the tread of the rail, which is dangerous for traffic. I laid in 1900 about half a mile of track on longitudinal sleepers, 10in. by 4in. creosoted redwood; it is less rigid, and therefore better for the rolling-stock. These sleepers were embedded in concrete, and the metals screwed down with coach screws at intervals of 4ft. 6in., but my difficulty has been to keep the setts level with the rails, owing to the slight vibration that takes place. If it were not necessary to keep the surface of the road in good condition for vehicular traffic, the writer would much prefer the lines to be laid on timber. The whole of our lines which were laid and were packed up from the concrete have gone badly at the joints and the setts are continually lifting and dropping, owing to the bumping of the cars on the joints, and these lines have constantly to be repacked and repaved. In fact, one line about one mile in length which was filled in with tar macadam I had taken up last year, and found some of the joints down quite 1½in. In relaying this track I welded the whole of the joints on the Thermit process (cutting off the bad ends of the rail and putting in short pieces), and anchored the rails at the joints and centres and paved the surface with granite. This work has proved very satisfactory up to the present. Of course, I may say it is not so perfect as would have been the case had new rails been used, owing, as above stated, to the joints being done and the rails hogbacked, but the road is not a very busy one and will last for years to come. The life of local setts on busy thoroughfares was certainly not more than three or four years, those next to the rail wearing down quite 3in. in that time. I have had little or no repairs as yet on tracks that have been anchored down. It is advisable to use anchors oftener on curves than on the straight, as the rail does not sit so well. The wear and tear on the metals in Halifax is very great owing to the steep gradients, which necessitate the constant use of the slipper brake.

I think it is essential that every engineer having under his control the construction and maintenance of permanent way should have possession of an emery rail grinder. The one in use at Halifax is, I think, up to the present unique, it being the only one of its kind so complete. It was built by Messrs. Ames Crosta and Co., sanitary engineers, Nottingham, specially for Halifax, and is fitted up with an electric motor so that it can travel and work from the overhead wire. It is also fitted with a 12-h.p. petrol motor and can travel and grind from this, if the overhead equipment is cut off, or in case of construction where the same has not been completed. The machine is fitted up with a complete set of drilling apparatus for drilling longitudinally and vertically, or, if required, at any angle, which is very useful and can be run from either motor (Fig. 1). I think it will be admitted that all tramways ought to have been laid to one standard gauge. The question arises, What should that standard have been? At present there is a large percentage of 4ft. 8½in., then comes 4ft., and lastly 3ft. 6in.

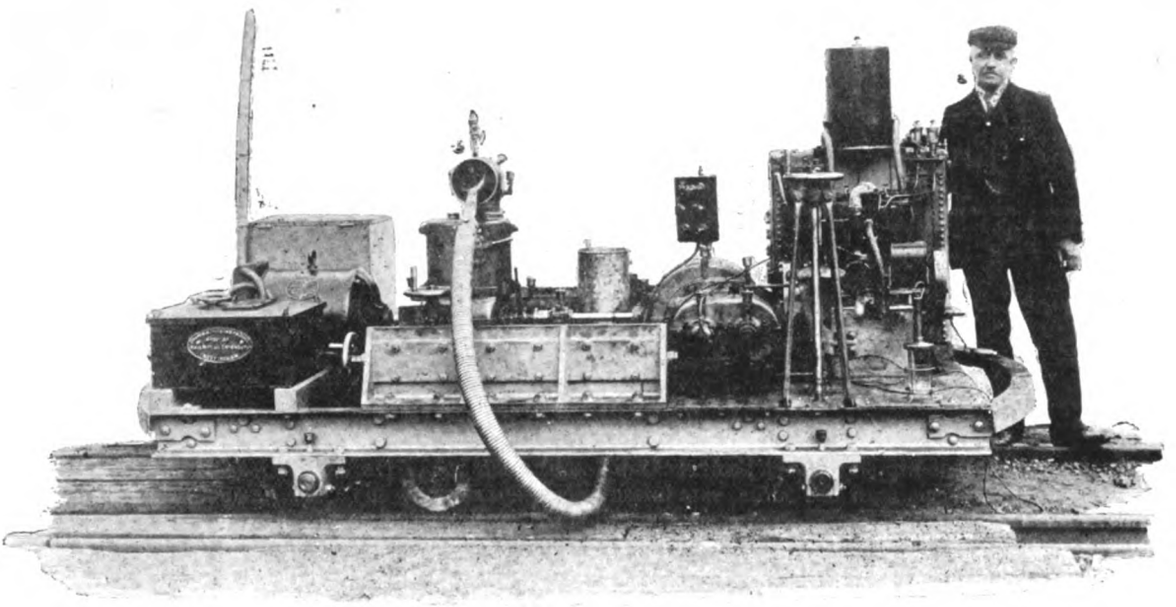

FIG. 1.

One of the points apart from the purely mechanical wear and tear of the tramways which requires the attention of the permanent-way constructor is that of the bonding of the rails, or other means adopted for reducing the electrical resistance of the rails as a return for the current, and it is self-evident that the nearer we get to a continuous rail, the better will be the conductivity and the less danger of electrolysis due to stray current to gas, water, and other metal pipes. It is clear that the welded joint approaches the nearest to the ideal solid way return. I have had some tests made of the electrical resistance of Thermit welding and otherwise, with the following results:

| | Ohms. |
|---|---|
| 1. Taking a solid rail 8ft. long as a standard resistance ..... | ·000067 |
| 2. With Thermit welded joint, without bonds, same length.. | ·000072 |
| 3. With Thermit welded joint, with one bond ..... | ·000067 |
| 4. Fishplates, sole-plate, and two bonds, newly constructed... | ·000078 |
| 5. Fishplate, sole-plate, and two bonds, after two years ..... | ·000095 |

The welded joint has a considerable value mechanically by giving increased strength to the track. In proof of this I may mention that I have made a number of tests and in all instances the rail has broken and not the joint.

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The lay-out of the curves is an important item in the maintenance account, as will be gathered from the following instance: I had a curve with a radius of 30ft., the wheel base of the car was 5ft. 6in.; this curve never lasted a longer period than six months, but some 2½ years ago this was altered to a 45ft. radius, and it is little worse to-day. On many of the curves which are 35ft. radius I have to put in a new check rail at intervals of about nine months.

It was my intention to have treated this subject with more detail, but remembering that the paper has been written mainly for discussion by the profession, who have a practical acquaintance with the various points of tramway construction, I have confined myself principally to my own experience and practice, in the hope that various other systems will be brought out and detailed in the discussion to follow.

## ADMINISTRATIVE COUNTY OF LONDON AND DISTRICT ELECTRIC POWER BILL.

The Select Committee of the House of Lords presided over by Lord Camperdown commenced on the 16th inst. to consider the above Bill. Eight other Bills have been also referred to this committee for consideration, and, in view of the fact that these are more or less in competition the one with the other, it has been decided that the evidence on all shall be heard before any decision is come to. These other Bills are as follows: (2) the East London and Lower Thames Electric Power Bill; (3) the Charing Cross and Strand Electricity Supply Corporation Bill; (4) the City of London Electric Lighting Companies' Bill; (5) the Metropolitan Electric Supply Company's Bill for Acton district; (6) the Metropolitan Electric Supply Company's Various Powers Bill; (7) the North Metropolitan Electric Power Bill; (8) the Central Electric Supply Bill; (9) the County of London Electric Supply Bill.

The first day was devoted to receiving the various petitions against the first-named Power Bill, and to the consideration by the committee of the procedure. After considerable discussion the Chairman announced that they would hear first the evidence on the Administrative County of London Bill by itself.

On Friday, March 17, the case for this Bill was opened by the Hon. J. D. FITZGERALD, who explained the scope of the proposed undertaking. He said that the company was seeking incorporation in order to supply electrical energy for power purposes in the county of London and in certain districts of the counties of Middlesex, Surrey, Essex, and Kent. [This area is shown on the map reproduced on next page.] It was proposed to establish three large generating stations at Greenwich, West Ham, and Fulham, on the banks of the Thames, in positions suitable for getting cheap supplies of coal and a practically unlimited supply of water for condensing purposes. It was intended to generate from these stations electricity at a very low cost, and to supply power to the companies and local authorities already existing, and to other persons if they wished to take it. The area of supply was to be divided into the industrial district and the western, or non-industrial, district. London was the only large industrial area in respect of which a Power Bill of this kind had not been passed. There were at the present time 30 local authorities and 21 companies supplying electricity in London, and they had between them 52 generating stations badly situated in cramped surroundings, incapable of expansion except at enormous cost, and most of them not fitted with machinery suitable for the economical generation of electricity on a large scale. Ninety per cent. of the business of the companies and local authorities was electric lighting. The industrial area embraced in the scheme of the promoters included a large stretch of rural district in view of the tendency on the part of manufacturers to remove their works into the country, where they could get land cheaper, where the rates and taxes were lower, and where they could house their workmen under better sanitary conditions. The only obstacle to this at present was the difficulty of getting an adequate supply of power on cheap terms. The capital asked for was £5,000,000 in shares, and £1,666,000 borrowing powers. Under the clauses of the Bill, the charges for supply by the company were fixed, subject to agreements, etc., that may be entered into, at 1½d. per unit, or, if required by the consumer, at a fixed sum quarterly, not exceeding £1 per kilowatt per quarter of the maximum power required to be supplied, and, in addition, a sum not exceeding ¾d. per unit. In the case of a consumer requiring a supply of electricity for power purposes during eight hours of the 24, this would work out at ·865d. per unit. The expectations of the promoters were based on the experience of the North-Eastern Company, which had now 37 miles of railway in the neighbourhood of Newcastle worked by electricity supplied by the Tyneside Power Company, who also provided the energy for the working of the Tyneside tramways, in both cases much more cheaply than the companies could supply themselves. That there was a magnificent field for electrical enterprise in London on the lines of the scheme before the committee was shown by the fact that a petition had been presented to Parliament in favour of the Bill signed by 350 manufacturers, employing between them 80,000 hands. On Tyneside steam power had been practically superseded by electrical power, 60,000 h.p. under steam having been displaced. There was no reason why similar results should not follow in London from the establishment of a big power scheme.

Mr. C. H. MERZ, examined by Mr. H. Lloyd, gave more particulars of the success of the Tyneside undertaking. He said that the adoption of electricity had resulted in an economy of 40 per cent. over the previous costs for power in shipyards. The manufacturer had also been able to increase his output, save labour, and to carry on his work more economically. As regards the supply of power in London he had prepared Table IV., which shows how far electricity supply had advanced in comparison with other cities at home and abroad. From this he found that London with 5 h.p. per 1,000 head of population had the lowest supply from public undertakers. Table V. was prepared to show what could be done in London, and how small a proportion of the total horse-power in factories is supplied from the public mains. These returns were based on Home Office figures. The industrial area referred to is the eastern portion of the area included in the scheme. These figures showed that the field of electric power distribution had been barely touched. He estimated that in 1911 there would be required some 1,243 million units within the proposed area of supply, of which 380 million units would be needed for power, 296 million units for lighting, and 567 million units for traction. He thought it would pay lighting undertakers to take supply in bulk from the company. To illustrate this he had prepared Table IX, from which it is seen that the average cost per unit generated was 1·92d. He estimated the average charge for supply in bulk from his company would be 1·048d., and for power ·86d. The present stations were much hampered by their positions, which rendered coal more expensive than it should be, and frequently the condensing arrangements were unsatisfactory. As regards the capital expenditure of the proposed undertaking, Mr. Merz gave the particulars given in Table XIII. The revenue account for the proposed undertaking for the year ending Dec. 31, 1910, would be as in Table No. XVI. The question of how the Bill would affect the various existing undertakers was then gone into. Mr. Merz showed that out of 21 companies, 15 lay outside the industrial area of supply. These companies could be supplied in bulk, and the Bill, if passed, would only give competition in the supply of railways, tramways, docks, canal undertakings, or any Government department. Within the industrial area the company could also supply direct to consumers requiring more than 500 h.p. The only competition, however, would be in the event of the present undertaker charging too high a price. From figures prepared for the 12 local authorities now supplying within the area, Mr. Merz found that the cost of production for the year ending March 31, 1904, had been £212,945. In this was included the works cost of generating and the capital charges on land, buildings, and machinery. He estimated that the cost of bulk supply at the maximum

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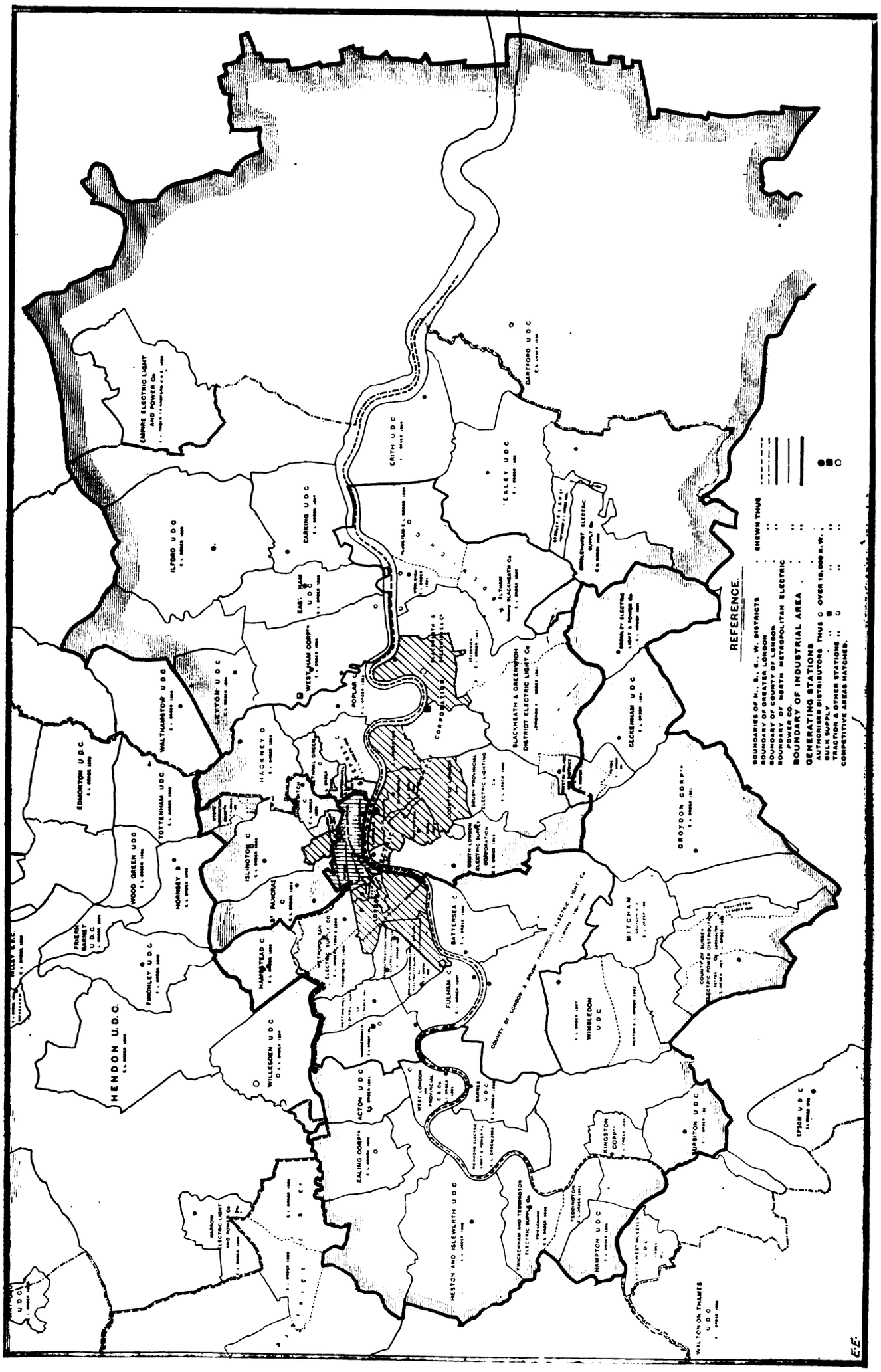


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prices fixed by the Bill would have been £142,137. He considers that these local authorities would be able to reduce their selling prices if they took supply in bulk from his company.

TABLE IV.—Electricity Supply in London. Comparison with Various Cities at Home and Abroad.

| Name of city. | Population. | Horse-power connected per 1,000 head of population. All purposes. | Power only. |
|---|---|---|---|
| Boston | 600,929 | 164·6 | 41·3 |
| Tyneside | 222,241 | 122·8 | 30·0 |
| Frankfurt | 306,000 | 80·1 | 28·7 |
| Berlin | 2,285 000 | 82·1 | 22·0 |
| New York | 3,732,903 | 52·6 | 13·9 |
| Hamburg | 700,000 | 76·7 | 12·7 |
| Glasgow | 785,897 | 43·9 | 8·26 |
| London | 6,565,390 | 48·0 | 5·4 |
| London (industrial area) | 3,812,283 | 25·8 | 4·8 |

TABLE V.—Power Requirements of London, compared with Amount supplied by present Lighting Authorities.

| | | Industrial area. | Proposed area of supply. |
|---|---|---|---|
| 1. Total number of hands employed | 1898 | 458,856 | 609,894 |
| | 1911 | 534,458 | 706,227 |
| 2. Total horse-power installed of all kinds in factories, etc. | 1904 | 456,415 | 592,992 |
| | 1911 | 484 148 | 636,695 |
| 3. Horse-power of motors supplied by present lighting authorities | 1904 | 18,316 | 34,236 |

TABLE IX.—Existing Electric Lighting Authorities. Statistics relating to proposed area of supply, year 1903-4, from Board of Trade returns.

| | |
|---|---|
| 1. Total capital expenditure | £16,598,715 |
| 2. Kilowatts of plant supplied in lighting stations | 181,034 |
| 3. Capital expended on stations | £9,243,982 |
| 4. Capital expended per kilowatt installed | £51 |
| 5. Board of Trade units generated | 159.154.144 |
| 6. Works' costs | £730,332 |
| 7. Works' costs per unit generated | 1·1d. |
| 8. Capital charges on stations | £545,667 |
| 9. Capital charges on stations per unit generated | ·82d. |
| 10. Total generating costs (6)+(8) | £1,275,999 |
| 11. Total generating per unit generated | 1·92d. |
| 12. Gross revenue | £2,345 029 |
| 13. Gross revenue per unit generated | 3·54d. |

TABLE XIII.—Capital Expenditure of Proposed Undertaking. Summarised from detailed table.

| | Works completed. 1910. | 1916. |
|---|---|---|
| Generating stations | £717.200 | £2,615 000 |
| Transmission system | 583.000 | 1,872,000 |
| Sub-stations and distribution system | 401,000 | 1 503,000 |
| Plant on loan | 200,000 | 400,000 |
| | 1,901,200 | 6,390,000 |
| Land and preliminary expenses | 180,000 | 350,000 |
| Total | 2,081,200 | 6,740,000 |
| Less reserve, etc. | — | 500,000 |
| Net capital required | £2,081,200 | £6,240,000 |
| Capital authorised by the Bill | | £5,000 000 |
| Borrowing powers | | 1,667,000 |
| | | £6,667 000 |

TABLE XVI.—Revenue Account for Proposed Undertaking for Year ending Dec. 31, 1910.

| Expenditure. | | Revenue. | |
|---|---|---|---|
| Generating costs: 183.300,000 units at ·154d. per unit generated | £117,617 | By sale of 137,500,000 units at ·7d. | £401,042 |
| Distribution | 23,680 | Sundry receipts | 20,000 |
| | | | 421,042 |
| General expenses, management, rents, rates, taxes, insurance, and sundries | 58,500 | Deduct expenses as stated | 290,337 |
| Selling department | 15,000 | Balance | £130,705 |
| | 214,797 | Which is sufficient to pay 6 per cent. on average capital for the year of £2,000,000 and carry forward £10,705. | |
| Reserve, depreciation, renewals, etc. | 75,540 | | |
| Total | £290,337 | | |

On Monday, March 20, Mr. C. H. Merz, cross-examined by Mr. Balfour Browne, said that while £51 per kilowatt installed was the average cost of the present London station, he admitted that some of these had cost a good deal less. He stood to his estimate of £8·4 per kilowatt for the stations he proposed to erect. He held that there was a large demand for power in London, which was not met because the price was high, and yet that London, owing to its size, could be supplied cheaper than any other place in the United Kingdom. He considered that it would be better to have two or three large stations to give this supply than the 60 to 80 stations now in use. He declined to give the exact figures at which they would supply a suburban railway, but said that the average charge to the North-Eastern Railway for the present half-year was about 63d., including the cost of transformation. The load factor of the supply to this railway was of the order of 35 per cent., and they guaranteed to take at least five million units per year. In the course of cross-examination as to the details of the proposed power stations, tables were handed in from which the following details are taken. Each generating station will contain six turbo-alternators, with a maximum output of 20,000 kw. The most economical load of these turbines will be 10,000 kw. The alternators will generate three-phase current at 12,000 volts and 25 frequency. The boiler-house will contain 48 boilers, in six banks of eight. Thus one bank will supply steam to each turbo-alternator. Heat storage will be provided to enable the output of each boiler to be doubled to meet the conditions of peak load. Seven boilers will under these conditions be able to supply steam for the maximum load on a turbine. The steaming capacity of each boiler will be 30,000lb. per hour at the most economical load. The normal capacity of the plant installed in each station will be 90,000 kw. with a maximum of 120,000 kw. for short periods. As regards the system of transmission and distribution, it is proposed to adopt the 'bus-bar ring system. Main supply cables would be carried through the northern and southern portions of the area to form a ring surrounding a portion of the river. The ring would be supplied from generating stations situated on the river at diametrically opposite points and a sufficient number of alternative routes (four from the east and two from the west) would be used to ensure the full maintenance of supply even in the event of the breakdown of one entire route. An inter-connector crossing the ring about midway between the generating stations would also be laid, thus combining the cables on the two sides of the river, and providing additional safety thereby. Main distributing centres would be spaced along the ring from which the tributary cables would radiate, and at which points the main cables would be sectionalised. In designing the tributary system, the chief aim would be to provide duplicate routes to every sub-station, with the ends of the loop fed from different main distributing centres on the 'bus-bar ring. In the low-tension network there would be no disconnecting boxes used in the streets. Other details of design were given to show the standard sizes of apparatus employed. For instance, the 12,000-volt cables would be three-core ·25 square inch, the transformer units would be either 500 kw., 1,000 kw., or 1,500 kw. capacity. The low-tension cables at 600 volts would be either ·25 or ·1 square inch section. He claimed increased economy in working due to the small number of large generating units which there would be in the station. It would not pay to put up large generating stations with 40 or 50 units of plant. He did not think there was any objection to scrapping existing generating stations if a gain was made in the yearly revenue account of the present undertaker. He supported his estimate of £8·4 per kilowatt of plant by the cost of the Carville power station on the Tyne. Here, with a peak capacity of 15,000 kw., the cost averaged £10 5. He also gave the cost per Board of Trade unit generated at this station for the last six months. Thus for February the low figure of ·120d. was obtained. With the increased cost of coal on the Thames he estimated the cost would rise to ·15d. per unit generated. He estimated that the cost of Tyne coal delivered at the London stations should average 8s. 6d. per ton.

## APPOINTMENTS VACANT.

**Chief Electrical Engineer,** Bermondsey Borough Council.

**Traffic Superintendent,** Rotherham Borough Council. £130 per annum.

**Greenock.**—The number of units generated for the five weeks ending Feb. 4 was 217,234 as compared with 169,725 for the corresponding period of last year, being an increase of 47,509 units.

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THE
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### TO CORRESPONDENTS.

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## THE SCRAP HEAP.

The question of scrapping has been discussed again and again, but it is continually cropping up, and plays a very important part in the controversies now raging. The question would not be so important if it did not involve that of municipal trading. The world is very hard—it praises success, but does not tolerate failure. Sympathy in commercial matters is a negligible quantity, and capital risked and lost has for practical purposes passed out of consideration. The private individual who loses his capital has no further place in commercial affairs, and the company which goes to smash is heard of no longer than it takes the courts to realise and distribute the assets. A municipality is hardly in the same category. It is just possible that it could become bankrupt, but it is very difficult to see how a final whitewashing to the absolute loss of creditors can take place while rates can be exacted that more than cover ordinary expenses. During the parliamentary enquiry relating to this year's Bills one of the prominent witnesses suggested that probably all the existing or, at any rate, most of the existing stations would be scrapped. Quite recently we pointed out, and it will not be out of place to recur to the subject again, that the question of scrap—or not to scrap—was in the abstract simple, but simplicity in the concrete is not so certain. Take any example, say, with a capital expenditure of half a million. This capital is used to provide something to sell, and out of the selling price (assuming success) all outgoing expenses have to be paid, including interest on capital, and if a municipality repayment of capital. We need not labour to mention every item, nor to discuss supply and demand—the latter is assumed. If a company or municipality deal in a monopoly, progress does not so much affect it. If, however, there is competition, then progress can ruin their concern by bringing into competition something that produces equally good results at a lower cost. This is all elementary knowledge, and if losses are merely losses, the world looks on and goes about its concern without recognising that anything out of the ordinary has happened. Another failure, that is all. Under the concrete conditions existing that is not all. A municipality that embarks half a million in business has to pay that half a million, and cannot lose it for the creditors in the ordinary acceptation of the term. When, then, can a municipality accept the inevitable and scrap its business premises? If progress provides a means so that it can purchase what it wants at a cost so much below its own cost of production that the difference will enable it to pay interest and annual instalments on capital, it might be said to be justified in buying in bulk and not generating. The concrete case, however, is far less simple. The purchasers want to participate in the reduction brought about by progress, and unless there exists a monopoly will insist upon such participation. If competition exists, the capital expenditure goes, and the ratepayers have to pay interest and annual instalments upon the capital lost. There seems to be no third way; either the purchasers have to pay a much higher price for what they buy than the conditions of progress warrant, or the ratepayers have to pay for having embarked in a business that has turned out to be a loss. All this assumes the reality of the progress, and there is no reason to doubt the correctness of the assumption up to a point. It has not been proved, however, that size of installation is effective in decreasing cost past a certain point. Hence progress does indicate scrapping except in certain cases, and each particular case has conditions which prevent generalisation. The fact remains, however, that it will not pay to buy in bulk when loss cannot be con-

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templated unless the users are satisfied not to participate in progress, or to participate to a smaller extent than the facts of the case really warrant. The arguments often put forward usually simply imply loss, which the ratepayer must be prepared to pay. The mere fact that it is cheaper to buy in bulk is no consolation to the ratepayer or the consumer. The liability incurred by law remains, and must be met. There has as yet been no method suggested whereby a municipal trading concern can play fast and loose with other people's money, and until such concerns are placed in a position similar to other trading concerns, the question arises which has never yet been met—that either the consumer or the ratepayer pays that which, under all other trading conditions, would be the loss of creditors. This is good for creditors.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### AUXILIARY RAILWAY SIGNALLING.

SIR,—Referring to letter from "Explosive" which appeared in your issue of March 10, we fully agree with him that all automatic signalling has the insuperable objection, that personal responsibility ceases by its use, and the failure of the electrical system was in a measure the cause of the recent French accident. The last paragraph of his letter suggests an emergency signal, to be under the direct control of the signalman in his box, one simple in both working and construction.

A client of ours has recently patented such an apparatus which would in every respect seem to comply with these requirements, and we shall be pleased to supply particulars of same to anyone interested therein.—Yours, etc.,

Cardiff, March 18, 1905. AITKEN AND Co.

### ELECTRIC TRAMCARS AND MOTOR 'BUSES.

SIR,—Your leader last week on the question of the electric tramcar *v.* the motor 'bus was most informative, and certainly Mr. Salter seems to have made out a very good case for our own side of the industry; but where I think the advocates of the motor 'bus make a great mistake is in basing their figures and arguments from the point of view of the *petrol* motor 'bus.

Now, I think it cannot be gainsaid that from a non-technical standpoint the petrol 'bus is not in it at all in comparison with the steam 'bus. In my opinion, the steam 'bus, from the point of view of the general public, is almost as far ahead of the petrol 'bus as the latter is of the old-fashioned horse vehicle. I have travelled in both types of vehicle since they have been put on the London streets, and whilst greatly impressed with the smooth and quiet running of the steam 'bus, I was much disappointed with the petrol type. The vibration and smell of the latter at stopping points was most unpleasant, and every start was a series of jerks.

Let us take a few points only in which the steam 'bus scores over its rival: (1) absence of smell; (2) absence of vibration; (3) smoothness in starting (its acceleration curve *is* a curve, not a zigzag); (4) greatly reduced noise.

There can be no doubt that, as far as the passenger and the man in the street is concerned, the steam 'bus is infinitely preferable. Granted this, the question before us is whether the steam 'bus can be worked more economically than the petrol 'bus.

I do not know whether any figures have been published as regards running costs of the steam 'bus. Possibly, as in the case of light cars, the steam 'bus takes more petrol to fire its boiler than the petrol engine itself uses. Against this can be put the lower grade of petrol used, and also there must be a considerable saving in lubricating oil. Where the steam car should score is in maintenance and depreciation charges. On the one hand, we have a simple smooth-acting steam-engine, driving direct, and throwing comparatively slight strains on its mechanism; and on the other hand a complicated explosion engine, which must be kept constantly running, start or stop, and with all the complications of gears and clutch. In every one of the hundreds of stops and starts these 'buses have to make the change through the two speeds must be made, and the wear and strain on the vehicle and tyres is in direct proportion to the skill, or want of skill, of the driver. It must always be a serious item.

It is for these reasons that I think the steam 'bus should prove far less costly to maintain than the petrol 'bus, and will accordingly prove a far more serious competitor to the electric tramcar than the petrol 'bus in its present development.—Yours, etc., M. F.

### MR. MARCONI'S LECTURE.

SIR,—It is interesting to note that Marconi is getting his speed up. We have been sending and receiving wireless messages at 25 to 45 words a minute for several years. The compliment to the expertness of our operators quite overcomes us.—Yours, etc., F. Z. MAGUIRE,

American De Forest Wireless Telegraph Company.

5, Warwick-court, High Holborn, March 16, 1905.

## NATIONAL PHYSICAL LABORATORY.

The annual inspection of the National Physical Laboratory took place on Friday last week, when a large number of gentlemen accepted the invitation of Sir William Huggins, president of the Royal Society, and Lord Rayleigh, president of the General Board, to be present. Dr. Glazebrook, the director, and his assistants explained the uses of the various appliances installed. The most interesting addition recently made to the equipment of the laboratory is, perhaps, a machine for measuring internal diameters by comparison with a known standard. It seems to be in a more or less experimental stage at present, but should be capable of extremely useful service.

Among the researches of more general interest concluded during the year are the following: An investigation for the Engineering Standards Committee into the properties of insulating materials at the temperatures ordinarily reached in generators and motors, and a study of the distribution of temperature in the coils of such machines. An examination of the allowances necessary to secure proper working between the running parts of machinery. An investigation into the properties of different qualities of guttapercha. Photometric and life tests of incandescent lamps under various conditions. An investigation into the methods of obtaining and measuring high temperatures of 1,800deg. C to 2,000deg. C. The erection and testing of a standard lathe for cutting leading screws for large lathes to a very high order of accuracy. An examination of the properties of nickel steels, prepared for the work by Mr. R. A. Hadfield. The construction of the electrical parts of a standard balance for the measurement of an electric current. The construction of a machine for examining the effect of rapid alternations of stress on materials used in engineering practice. In addition to these and other researches which have been successfully carried through, a number of enquiries have been declined for want of sufficient equipment. The committee hope that this may, however, be shortly remedied.

The programme for 1905 is equally varied as far as the character of the researches is concerned. Electrical engineers will be interested in the investigations on superheated steam to be carried out in the engineering department.

In the physics department, besides work on standards, a series of magnetic tests on iron are to be undertaken, with a view of obtaining, if possible, a non-ageing material with low hysteresis loss. For this purpose a firm of leading manufacturers is preparing a large number of samples in the form of rings and strips. One set of these samples are to be of uniform chemical composition, but submitted to various courses of heat treatment. Another set is to be of varying chemical composition, all annealed similarly, while a third batch is to include typically inferior material. A

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large electrically-heated oven is ready, and in this the various samples will be submittted to steady temperatures. At intervals hysteresis tests will be made. After examination of the first set of results it is probable that some, if not all, of the samples will be submitted to reannealling or other heat treatment, and after this the ageing tests repeated. It is hoped that in this way some clue will be obtained to the conditions which determine the magnetic quality of the material as regards ageing.

In response to a request from the Engineering Standards Committee, a series of tests on the distribution of temperature in transformers, similar to those already made on dynamos, is being undertaken with the co-operation of various prominent firms which have constructed special transformers for the work. Thermo-junctions of iron-eureka have been embedded in these, and will allow the temperature to be measured at various points. Determination of the efficiency of the transformers will also be made.

Other departments have an equally full programme. The representative gathering at the laboratory on Friday last showed great interest in the work in progress, which is of national importance.

## ELECTRICITY SUPPLY BILLS.

A conference, convened by the London County Council, was held on Monday at Spring-gardens, under the presidency of Mr. Cornwall, chairman of the Council, to consider what steps should be taken in reference to the Electricity Supply Bills now before Parliament. A large number of the metropolitan borough councils and the City Corporation were represented.

The CHAIRMAN, in opening the proceedings, alluded to the industrial progress of electricity, and to the necessity of safeguarding the interests of the public. He quite appreciated the advantage of securing the cheapest possible supply, but believed that, everything considered, this was most likely to be provided by the County Council and the borough councils. He reviewed the Bills introduced by the County Council in 1898 and 1901 to constitute it the supply authority for the Metropolis subject to certain conditions. The immediate object of the conference, however, was to arrange for united action in opposing the various companies' Bills so as to preclude monopoly.

A representative of the Council's parliamentary department having defined the position of matters before the Lords Committee, Mr. A. J. SHEPHEARD, vice-chairman of the Council's Parliamentary Committee, expressed the opinion that the effect of the Administrative County of London Company's Bill would undoubtedly be to create a monopoly. The company might say they had no such intention, but by increasing their capital their operations would become so extensive and their foothold so strong that they could defy competitors to oust them. Discussing the line of opposition that should be taken before the Lords Committee, he considered that, owing to the suddenness with which the matter had confronted the municipal authorities, the County Council could not at the present moment present an alternative scheme. He, therefore, advocated that application should be made for the postponement of the Bills until next session, in order to give the local authorities an opportunity of investigating the details and formulating their case against the Bills.

Mr. DEWEY (Islington) agreed with the previous speaker that the present moment was not opportune for the conference to discuss details, as the matter was urgent. He consequently moved the following resolution: "That this conference of the London County Council and metropolitan borough councils is of opinion that in the interests of the Metropolis the whole of the Electric Supply Bills now before Parliament should be strenuously opposed."

Mr. LYON (Hampstead) seconded.

The delegates from Finsbury and Wandsworth said they were substantially in accord with the resolution, but as their districts were dependent upon one of the companies for their electric light, they would be compelled to except that company from their opposition.

Mr. A. C. MORTON (City of London) strongly supported the resolution, declaring in emphatic terms that they had too many companies already.

Mr. ROBINSON (L.C.C.) observed that if reservations in favour of certain companies were to be made when resisting the Bills, there would be great danger of the opposition failing. He therefore appealed to the conference to give their whole-hearted support to the resolution.

After other speakers had briefly expressed their views, Mr. Dewey's motion was put to the vote and carried *nem. con.*

The conference then adjourned pending the decision of the Lords Committee.

## GLASGOW CORPORATION ELECTRICITY DEPARTMENT.

### Appointment of Chief Engineer.

At a meeting of the Glasgow Corporation held on Thursday, 16th inst., Mr. W. W. Lackie was unanimously appointed to succeed Mr. Chamen as chief engineer of the department. It will be remembered that Mr. Chamen has accepted an important appointment with the firm of Messrs. Bramwell and Harris, consulting engineers.

Mr. William W. Lackie was born 36 years ago, and is the son of Mr. David Lackie, iron merchant and iron-founder, Montrose, Forfarshire, who was provost of Montrose for three years. Mr. Lackie received his elementary education at Montrose Academy and the Aberdeen Grammar School. After leaving the grammar school Mr. Lackie went through the engineering course at University College, Dundee, under Prof. Ewing (afterwards of Cambridge), attending the classes for mechanical engineering and electrical engineering during the three sessions 1885 to 1887. The next year was spent in the laboratory of Lord Kelvin at the Glasgow University. Mr. Lackie then turned his attention seriously to practical work by entering the service of Messrs. Mavor and Coulson (then Messrs. Muir, Mavor, and Coulson), of Mile-end, Glasgow. That firm had then already come to the front in Scotland as electrical manufacturers, contractors, and supply undertakers, a position which in the two former respects at least they still continue to hold; and Mr. Lackie on entering their service was soon in the midst of some of their most important work, being employed at the wiring of the municipal buildings of Glasgow and several of the largest warehouses in the city. It was while with this firm, also, that Mr. Lackie had his first introduction to central-station work, being for four years frequently employed in the Miller-street generating station, which at that time supplied current to the General Post Office and several other large concerns. About that time also he had the good fortune to be connected with the erection of his firm's high-tension station in John-street. This station was the first real generating station for the supply of electricity to private consumers in the central area of Glasgow, and it is this station which was bought up by the Glasgow Corporation in 1892, and formed the foundation of the present electricity department. Mr. Lackie was appointed mains superintendent of the new venture, and has since remained in the service of the Glasgow Corporation. He superintended the laying of the whole of the underground mains under the scheme for which Prof. Kennedy was consulting engineer, and when Mr. Chamen came to Glasgow in 1898, he remarked at a public function organised by the officials of the electricity department on the occasion of Mr. Lackie's marriage, that he considered the Glasgow electricity mains as laid under Mr. Lackie's superintendence were in a state of excellence second to none in the United Kingdom. In 1897, the Electricity Committee recognised Mr. Lackie's abilities by promoting him to be chief assistant to Mr. Arnot, who

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was at that time chief engineer, and during Mr. Chamen's tenure of office as chief engineer (from 1898 up to the present time) Mr. Lackie has continued to hold that position. Mr. Lackie is the author of various papers on those branches of his subject which more immediately concern him, among these being a paper on "Underground Mains in Glasgow," communicated to the Physical Society of the Glasgow University in 1895, a paper on "Systems and Methods of Charging for Supplies of Electrical Energy," read before the Glasgow Local Section of the Institution of Electrical Engineers and a paper on "Earthing," also read before the same society—the two latter having been accepted for insertion in the *Proceedings* of the parent institution. During the past winter Mr. Lackie has delivered a special course of lectures on electric lighting and wiring in the Technical College, Glasgow. These lectures have been largely attended and well received.

Mr. Archibald Page, at present station superintendent, has been unanimously appointed to the post of chief assistant engineer, rendered vacant by Mr. Lackie's promotion. Mr. Page is 31 years of age, and is a native of Alloa, N.B. He received his elementary education at Dollar Academy, and his technical education at Heriot-Watt College, Edinburgh, and the Technical College, Glasgow. He served his time as a mechanical engineer in his native town. He entered the Corporation service about six years ago, and has in the interval gained rapid promotion through sheer force of ability.

Mr. R. B. Mitchell, resident engineer at the department's Port Dundas electricity works, has been appointed mains superintendent.

## THE HOLBORN AND FINSBURY ELECTRICAL EXHIBITION.

The Holborn and Finsbury Electrical Exhibition (118-122, Holborn), organised by the County of London Electric Supply Company, Limited, was opened at 11.30 on Monday, March 21, by Alderman Fitzroy Doll, the mayor of Holborn. A large and representative gathering of the aldermen and councillors of the various boroughs associated with the County of London Company (Holborn, Finsbury, Wandsworth, Camberwell, Bermondsey, and Southwark) were present, together with a very large number of the leading electrical engineers and representatives of the manufacturing and trading firms.

The MAYOR, in opening the exhibition, referred briefly to the big strides which the electrical industry has made during the last few years, and dwelt particularly on the recent developments of the use of electricity as applied to driving machinery. The latter, he insisted, were of such fundamental importance to manufacturers and users of powers that none could afford to do other than give the matter a serious consideration.

The MAYOR OF WANDSWORTH spoke in support, and mentioned that it was in his own borough that the most expensive operations so far as lighting is concerned of the company were carried on. He emphasised particularly the widespread benefit which resulted from the company's slot-meter scheme, by which houses were wired by the company free of initial cost, and cited the case of the London County Council cottages at Totterdown, Tooting, which were lighted under this arrangement.

Alderman E. C. TRIPP then spoke, followed by Mr. J. B. BRAITHWAITE, jun. (the chairman of the County of London Electric Supply Company, Limited), who referred to the remarks of the Mayor of Holborn as regards the uses of electric energy for driving machines, and pointed out that this side of the undertaking of the company was made an especial feature, and cited the fact that together with the City of London Company they supplied more than 20,000 h.p. for power purposes. He thought that this was a good answer to the ambitious scheme for the supply of power in London being considered by the House of Lords Committee. The engineer of this scheme proposed to show the London companies how to do their work. He thought they had nothing to learn from the proposed undertaking.

The exhibition itself is an exceedingly well-organised one, and most of the leading electrical firms are represented. There are no less than 55 stall-holders, and the range of exhibits is exceedingly wide. The promoters of the exhibition have organised two or three special exhibits to show the latest developments in domestic lighting and heating. A great feature is the large number of street-lighting appliances which are on view. These range from the ordinary incandescent lamp up to the latest form of mercury vapour lamps, exhibited respectively by the British Westinghouse Company and Mr. Bastian. Arc lamps are shown by a large number of firms, and the recent types of flame lamp show marked advances which have been made for securing higher efficiency with this type. The exhibits of motive power form, in our opinion, the backbone of the show. Motors are shown driving a great variety of mechanical tools and as applied to electric lifts, hoists, and other special work. Intending users of power will thus find in the exhibition useful hints on the latest methods of driving all classes of machinery.

So far we have only referred to the exhibition as one of interest to would-be consumers. There are, however, in many of the exhibits more features of interest to the electrical engineer himself; for instance, several of the large cable companies have well-organised exhibits to show their latest type of cables and accessories. The exhibition is one which is likely to remain open for some time and which will well repay one for a visit. We propose to refer to specialities to be seen on individual stands in our next issue.

## TEMPERATURE CURVES AND THE RATING OF ELECTRICAL MACHINERY.*

BY RUD. GOLDSCHMIDT, ASSOCIATE MEMBER.

*(Continued from page 377.)*

An enlarged temperature curve is given in Fig. 4, which can be used on any given scale by simply choosing the

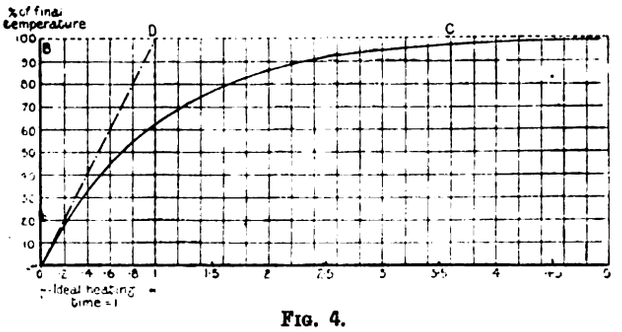


FIG. 4.

scale of temperatures so that O B is equal to the final temperature, and the scale of time so that $\frac{O\,B}{B\,D}$ is equal to the initial temperature increase. B D is the time in which the body would have reached the final temperature if no cooling had taken place during the period. In our example the initial rise per minute is $V = 0{\cdot}55$deg. C., and the final temperature is $tf = 50$deg. C. Therefore the "ideal heating time" B D is $\frac{50}{0\,55} = 90$ minutes $= 1\frac{1}{2}$ hours. To the ideal heating time we will give the symbol $T_i$.

$$T_i = \frac{tf}{V} = \frac{W_s}{C_h} \cdot \frac{C_v}{W_v} = \frac{\text{Watts}}{\text{Surface}} \times \frac{C_v}{\text{Watts}}.$$

$$T_i = \frac{\text{Volume}}{\text{Surface}} \times \frac{\text{Rise constant}}{\text{Heating constant}}.$$

$T_i$ is dependent only on the constant of the apparatus and on the ventilation, and is independent of the watts lost. This will be the basis for all our further calculations; for instance, in order to determine the very important practical question, after what length of time will a given machine approach its final temperature within a few per cent., we have only to examine the curve in Fig. 4, which

* Paper read before the Institution of Electrical Engineers.

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shows that the final temperature is attained within 5 per cent. at the end of three times $T_i$, the ideal heating time. For a commercial temperature test this time ought to be sufficient, as the temperature would be raised only 1½deg. more after another hour, assuming the final temperature to be 50deg. C. A table giving the constants of this curve is appended:

TABLE V.

| Time of heating. Unit: ideal heating time. | Per cent. of final temperature attained. | Time of heating. Unit: ideal heating time. | Per cent. of final temperature attained. |
|---|---|---|---|
| 0 | 0 | 1·25 | 71·5 |
| 0·1 | 9·5 | 1·5 | 77·8 |
| 0·2 | 18·1 | 1·75 | 82·8 |
| 0·3 | 26 | 2 | 86·6 |
| 0·4 | 33 | 2·5 | 92 |
| 0·5 | 39·5 | 3 | 95·5 |
| 0·6 | 45·2 | 3·5 | 97·3 |
| 0·7 | 50·5 | 4 | 98·4 |
| 0·8 | 55·1 | 4·5 | 99 |
| 0·9 | 59·5 | 5 | 99·5 |
| 1 | 63·3 | — | — |

On examining Fig. 3 we notice that the projection of the different tangents O D $e-10^1$, $f-20^1$, $g-30^1$, etc.—viz.,

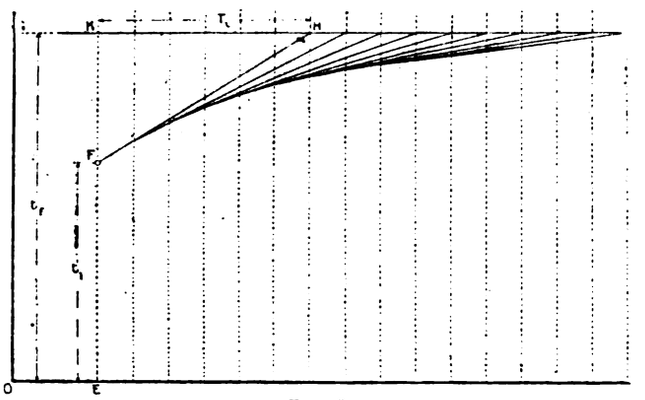


FIG. 5.

B D, $e^1-10^1$, $f^1-20^1$, $g^1-30^1$, etc.—are all equal to the ideal heating time, $T_i$. This fact enable us to construct the temperature curve starting at any point. Assuming the apparatus to be at an initial temperature, $t_1$, before starting the actual temperature test, and if the final temperature, $t f$, and the ideal heating time, $T_i$, are known, we can construct the temperature curve on the basis of the assumption that the air temperature is $t_1$ degrees higher. Make (Fig. 5) E F = $t_1$, O G = $t f$, K H = $T_i$, draw F H, and continue the construction as explained with reference to Fig. 3. In order to find the time when the final temperature will be reached within a certain percentage, Table V. can be used.

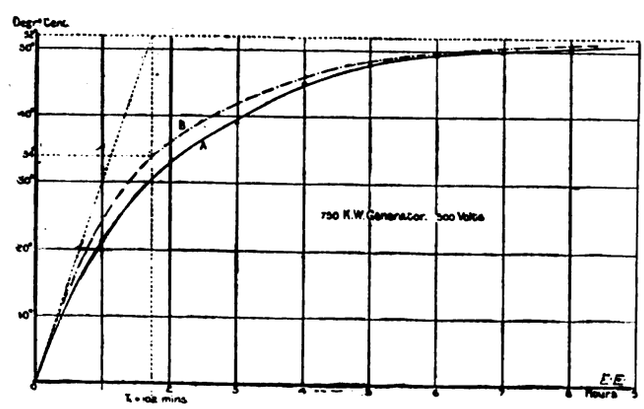


FIG. 6.

To find the time in which the field coil considered above will reach 47½deg., starting with a temperature of, say, 30deg. C., we need only consider the air temperature to be 20deg. higher, or the field temperature to be 20deg. less—that is, 50 − 20 = 30deg. C. = total range of rise = $t f^1$. The temperature under consideration—viz., 47½deg.—becomes 47½ − 20 = 27½deg. The latter as a percentage of the new $t f^1 = \frac{27\frac{1}{2}}{30} = 0{\cdot}92$. From Curve 3 or Table V. we observe at once that 0·92 of the final end temperature is reached in $2\frac{1}{2} \times T_i = 2\frac{1}{2} \times 1\frac{1}{2} = 3\frac{3}{4}$ hours.

A very useful rule for determining the length of time of the temperature test of a machine can be deduced as follows: It is only required to know (1) what the final temperature is likely to be and (2) the current density. The initial temperature rise is proportional to the square of the current density. In our example we had 1·7 amperes per mm.² (1,080 amperes per square inch) and an initial rise of 0·55deg. C. per minute. For 50deg. C. the ideal heating time, $T_i$, was 1½ hours. From this we can calculate tables of the ideal heating time, $T_i$, say for final tempera-

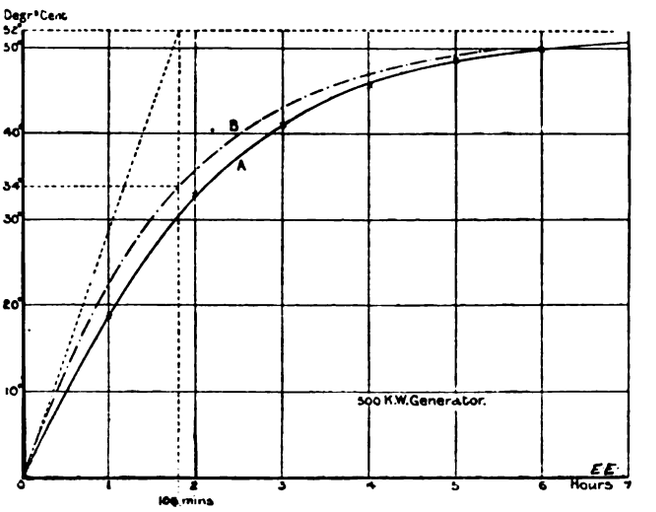


FIG. 7.

tures of 50deg. C. and 75deg. C. (measured by resistance rise).

TABLE VI.

| Current density: Amps. per square millimetre. | Current density: Amps. per square inch. | Ideal heating time in minutes for a final temperature of: 50° C. (90° F.) | 75° C. (135° F.) |
|---|---|---|---|
| ·25 | 160 | 4,200 | 6,300 |
| ·5 | 320 | 1,040 | 1,550 |
| ·75 | 480 | 460 | 690 |
| 1 | 640 | 260 | 370 |
| 1·5 | 960 | 115 | 173 |
| 1·56 | 1,000 | 107 | 160 |
| 2 | 1,280 | 65 | 97 |
| 3 | 1,923 | 29 | 43 |
| 5 | 3,200 | 10½ | 16 |

The application of Table VI. may be shown by some examples.

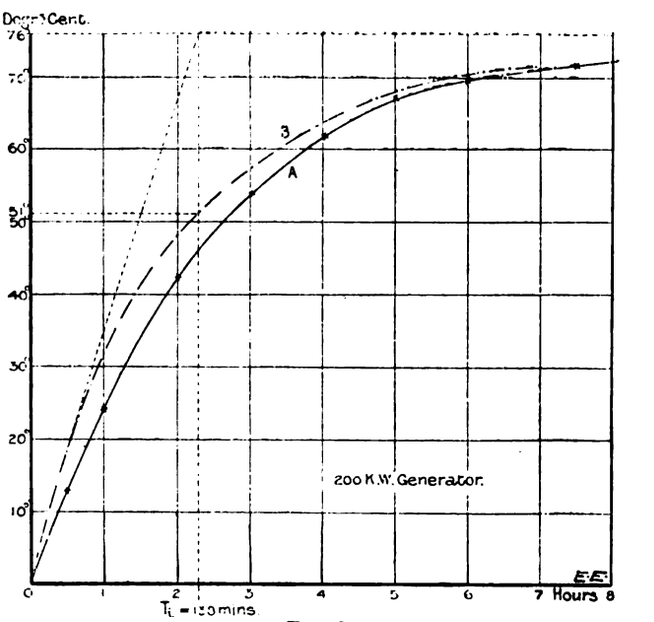


FIG. 8.

*Example* 1.—A continuous current machine is designed for 50deg. C. final temperature rise. The current density in the field coils is 1,000 amperes per square inch. How long is it to be tested in order to produce a rise of temperature equal to 95 per cent. of the final temperature?

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Due to its considerably smaller heating constant, the armature has, as a rule, reached the end of its ideal heating time, $T_i$ (see formula for $T_i$), and in consequence its final temperature, more quickly than the field coils have. Therefore the field coils determine the time of test for a continuous-current dynamo, and if their temperature is practically constant, one can be sure that of all other parts is also constant.

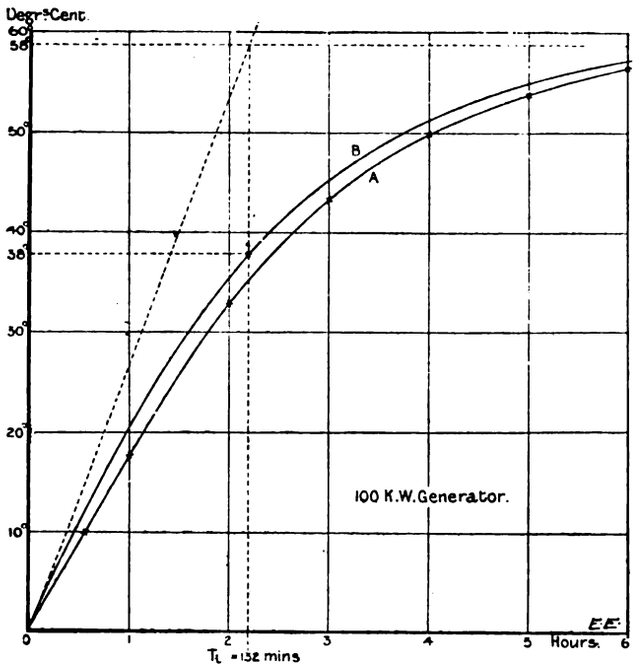


FIG. 9.

From Table VI. we take $T_i = 68$ minutes for 1,250 amperes per square inch, and from Table V. the time of test necessary to bring the parts within 5 per cent. or 2½deg. C. of their final temperature is $3 \times T_i = 3 \times 68 = 3\frac{1}{2}$ hours. If we were to test this machine for only a little over 2 hours $= 2 \times T_i$, only 86 6 per cent. of its final temperature would be reached. In further illustration of this example, which is of great practical importance, some temperature curves of "Crompton" continuous-current machines are added (Figs. 6 13).

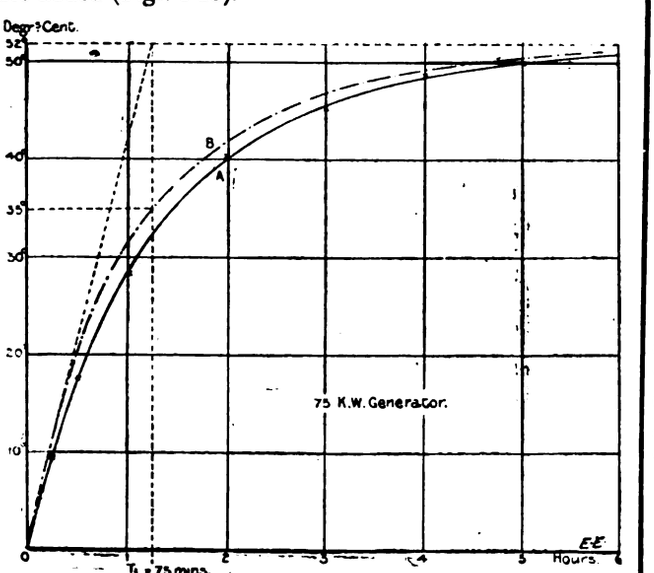


FIG. 10.

Fig. 8, for instance, refers to a 100-kw. open type 440-volt dynamo with a current density of 1·25 amperes per mm.² (830 amperes per square inch) in the field when hot. The Curve A is the curve actually observed, the Curve B for constant final loss being developed from A for the reason that during the test the exciting current was kept constant, and in consequence the loss in the field increased with the heating up of the copper. We see that the final temperature rise is 58deg. C. (measured by resistance increase).

Table V. shows that in the "ideal heating time" about two-thirds of the final temperature is reached. In our case $\frac{2}{3} \times 58 = 37$deg. C. Then from Curve B it will be seen

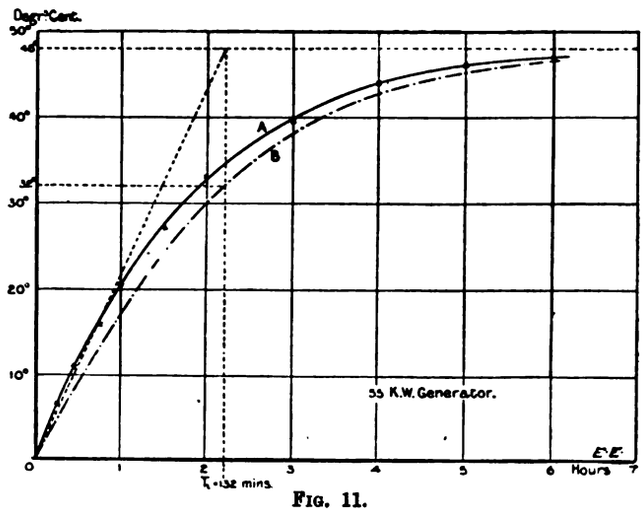


FIG. 11.

that this temperature is reached in 2 hours 12 minutes = 132 minutes—thus:

$$T_i = 132 \text{ minutes},$$

the initial rise is $\frac{58\text{deg. C.}}{132} = 0{\cdot}44\text{deg. C. per minute.}$

A current density of 1·25 amperes per mm.² corresponds to an initial rise of 0·50deg. C. per minute (Table I.), or making allowance for the heating of the copper,

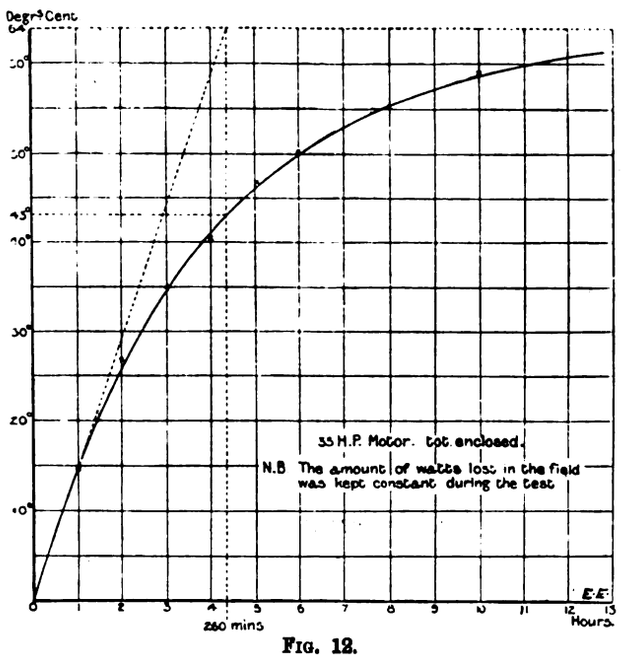


FIG. 12.

0·60deg. C. per minute. Therefore, the specific heat of the field coil owing to the influence of the insulation is $\frac{60}{44} = 1{\cdot}36$ times that of pure copper. The size of the wire was 0·088in.

*(To be continued.)*

## PERSONAL.

The Croydon Borough Council have appointed Mr. D. A. Mason to the position of electrical superintendent of the electricity works.

Mr. A. K. Taylor, well known in Hereford as an electrical expert, has been appointed electrical inspector at Bengal.

The Rotherham County Borough Council have appointed the borough electrical engineer, Mr. Edward Cross, to the position of borough electrical engineer and general manager of the tramways department with the combined salary of £350 per annum.

The Salford Tramways Committee have decided to recommend the Council to appoint Mr. George W. Holford, chief assistant in the new tramways department, as manager of the Salford system. The committee recommend that the commencing salary shall be £300 per annum, increasing annually by £50 to £500.

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## BALLADS OF BUSINESS.

### No. 6.—Deserters.

Here's to the men who started
In the electric line,
From which they now are parted
By chance or fell design.
We know just why they left it:
Their reasons all agree,
From Brainandthew to N.D.U.,
"To get more £ s. d."

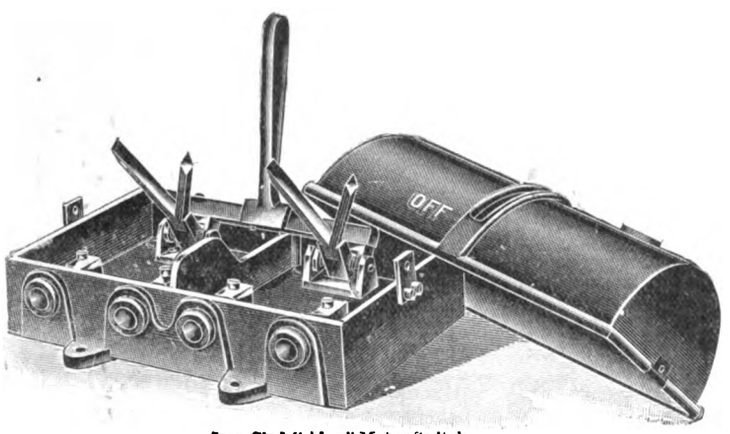
We'll drink success unto them
Whatever lines they're in—
Some are producing babies' foods,
And some dispensing gin;
Some upon 'Chance have started,
And some have gone o'ersea,
(While some bewail their lot in jail)
All for more £ s. d.

And shall we, proud survivors,
Scorn all who've left the race?
Ah! no; for some were strivers,
Discretion's no disgrace.
And—ask your conscience truly,
You of the I.E.E.—
If you'd their chance, would you not prance
To higher £ s. d.? B. C. H. J.

## TRADE NOTICES AND NOVELTIES.

### Ajax Motor Switches.

Messrs. Parmiter, Hope, and Co., Hulme Electrical Works, Manchester, have sent us one of their new iron-clad Ajax motor switches, which, we are told, have been designed to meet the demand for a thoroughly reliable motor switch at a low price. We have examined this switch as requested and find it combines several good features. For example, it has a very quick positive break, and it is quite impossible to leave it, even for a moment, in any position between full on and full off. The contact brush is made of phosphor bronze, and a thorough contact is ensured without "dragging." We understand the switch can be supplied with fuse in the same case, but this arrangement is not recommended for use on circuits above 250 volts. The accompanying illustration shows its general construction.




Iron-Clad "Ajax" Motor Switch.

### Large Alternators.

An illustration will be found among the advertisements in this issue of a very large armature, being part of one of the alternators which the Electric Construction Company, Limited, of London and Wolverhampton, have on order for the London County Council. For a long time past, when anything out of the ordinary run of electrical machinery has been required, we have been accustomed to see buyers placing their orders either in America or on the Continent, and the London County Council are to be congratulated on allowing a purely British firm to show how unnecessary, so far as large dynamos are concerned, it has been for public corporations and others to send their orders to foreign markets. The plant in question is amongst the largest, if not the largest, that has yet been called for. In all the E.C.C. are making four of these three-phase generators, each designed to give a continuous output of 3,200 kilovolt-amperes, at a speed of 94 revolutions per minute, and periodicity of 25 complete cycles per second per phase. The output of 3,200 kilovolt-amperes is to be rated with a power factor of 94 per cent. The working pressure is 6,600 volts, and the current per phase 280 amperes. The machines will be called upon to give an overload for two hours continuously of 20 per cent. additional current—that is, 350 amperes per phase. The field-magnet system is constructed directly upon the rim of the engine flywheel, in which the amount of stored energy, when revolving at normal speed, is 11,000 foot-tons. The E.C.C. are constructing the complete flywheel.

### "Pull" Type Button Switch.

We illustrate herewith a useful "Pull" type button switch which has been placed on the market by the Edison and Swan United Electric Light Company, Limited, Queen-street, London, E.C. This switch, it will be seen, is provided with an adaptor which presses the button when the cord is pulled, the on and off positions being actuated by one cord only. It is especially suitable for offices, warehouses, etc., and saves cost in the installation.

"Pull" Type Button Switch.

### Catalogues.

Insulating Materials, Driving Belts, etc.—Messrs. Arthur Cort and Co., 277, Camberwell New-road, London, S.E., have sent us a copy of their wholesale price-list of insulating hard or flexible vulcanised fibre, balata, guttapercha, and cotton belts, etc. A sample of red vulcanised fibre submitted to the Westminster Electrical Testing Laboratories was tested, with the results that a thickness of 0·625in. broke down with 16,100 volts alternating current, a thickness of 0·405in. broke down with 13,000 volts, and 0·220in. with 7,900 volts. The substance was tested between two plates, each of four square inches area, and the temperature of the surrounding air was 71deg. F. The material was not specially dried, but tested as received. The material is supplied in various colours and forms for different electrical and mechanical purposes. It is claimed that the balata, guttapercha, and cotton belts listed are conspicuous for their great strength, strong gripping and driving power, and almost entire absence of stretching.

Switchgears.—Messrs. Lionel Robinson and Co., Limited, Ferry Works, Thames Ditton, Surrey, makers of switches, fuses, cut-outs, regulators, and switchboards of standard patterns up to 11,000 volts, have issued a price list which includes illustrations and particulars of some useful specialities. Among them we note oil switches and fuses, automatic circuit breakers, and watertight motor-switchboards.

Automatic Fire Protection.—The descriptive booklet issued by the May-Oatway Fire Appliances, Limited, 92 and 94, Paul-street, Finsbury, London, E.C., for the current year partakes of the nature of an art production rather than of a catalogue, so excellent are the illustrations which it contains. In the front portion, Mr. G. H. Oatway, M.I.E.E., deals with fire-alarm practice, and describes the May-Oatway system of automatic alarms. Then follow illustrations of some notable factories, public buildings, etc., at home and abroad, in which the above system has been installed, and a long list of further installations. Although great progress has undoubtedly been made, it is complained that there is still no end of prejudice to overcome. The average insurance expert still advises for the protection of schools, dwellings, etc., the provision of so many buckets to a given floor space, and omits to make the slightest arrangement for calling sleepers in time to use them.

Moy Specialities.—A catalogue and three separate sheets recently issued by Messrs. Ernest F. Moy, Limited, Greenland-place, Camden Town, London, N.W., deal respectively with Mordey's patent fuses, ironclad motor-starters, double-pole knife switches in cast-iron cases, and distributing boards fitted with Acme switches.

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## LOW-TENSION THERMAL CUT-OUTS.

BY ALFRED SCHWARTZ AND W. H. N. JAMES.

This paper, read before the Manchester Section of the Institution of Electrical Engineers on the 14th inst., contains the results of long-extended experiments carried out by the authors. We regret that we can only give a brief *résumé* of the same, but their conclusions are so clearly drawn up that they will be of great service to electrical engineers.

In the first instance, the paper points out that the thermal cut-out or fuse is essentially a protective device, its function being to guard the circuits and apparatus connected therewith from injury due to abnormally large currents. An excess current in a circuit may occasion injury in two ways, by setting up (1) excessive heating; (2) mechanical or electrical strains and effects, either in the conductors themselves or in the apparatus connected to them. In the first case the time duration of the excessive current directly affects the resulting injury, whereas in the second case the damage done may be practically instantaneous. All electrical apparatus should be capable of carrying continuously its normal current without injury, and also of carrying currents very considerably in excess of this for short intervals of time. The requirements for an efficient protective device would therefore seem to be: (1) safe operation with a definite excess current within a given time, at the voltage of the circuit on which it is employed; (2) efficient operation with currents largely in excess of that required to bring it into action; (3) suppression of the arc consequent on rupture without explosion or damage to neighbouring parts or connections; (4) reliability of action; (5) ease of replacement and inspection; (6) non-interchangeability of devices of different ranges; (7) simplicity of construction; (8) low first cost, and cheap renewal of wire.

A brief *résumé* is then given of the developments of fuses, from the early days when they were a source of fire risk due to the fuse wire being embedded in wood. As regards fuse wire, it is shown that the current required to fuse a wire of circular cross-section of given material is dependent upon the following variables: (1) diameter; (2) time of current of flow; (3) length of fuse wire employed; (4) environment and position of fuse; (5) previous history of fuse wire. These individual points are then investigated by the authors, who give the results of a large series of experiments in curve form. They investigate the agreement between the results so obtained and the well-known formula of Sir W. H. Preece: $C = 2{,}887\ d^{1.5}$.

Other curves are then given for the variation of the fusing current, with the diameter of the wire for aluminium, silver, aluminium with spring attachment, and tin. The results are reduced to formulæ which fit the curves obtained. These formulæ are all of the form $C = A\ d^n$. The constants for these formulæ with various wires are given in the accompanying Table A. These cover not only the particulars already mentioned, but also the effect of position and of the size of the terminals to which the wire is joined. The fusing current for copper strip and lead strip was also investigated by the authors, as was also the differences produced by the enclosure of fuses within tubes. Another important investigation was the effect of mechanical injury on the behaviour of fuse wire and the deterioration with time. Investigations on this latter point show that when copper wire is used and allowed to get red hot, oxidation rapidly proceeds. The point corresponding to red heat is somewhere about 75 per cent. of the normal fusing current of the material. The behaviour of fuses on short-circuit is discussed, and experiments again explained by the aid of curves. The last part of this valuable paper deals with the construction of fuses, and here again the information given is most useful, as is that on the best way of testing fuses.

The conclusions at the end of the paper read as follows: It has been shown that a fuse wire may be subject to a number of influences which affect its fusing current to a greater or less extent. Most of these disturbing effects are small, ranging from about 3 to 12 per cent., and it may be urged that with a device which becomes operative with excess currents of 100 per cent., errors of the order named may be safely neglected. If these sources of error were present singly this might be so, but this is rarely the case, and it is to the accumulated effect of several of them operating together that the so-called unreliability of fuses is due. The maximum errors due to various causes in open and semi-enclosed types of fuses are scheduled below.

TABLE A.—Table of Constants for use with the Authors' Formula, $C = A\ d^n$, for determining the fusing current of wires under various conditions, and for diameters measured in inches, centimetres, or millimetres, together with the nearest sizes on the Standard Wire Gauge. Wire free in air from terminal to terminal in all cases.

| Particulars of fuse. | Range on S.W.G. | Range of fusing currents. | Index. | Constant. Cm. | Constant. In. | Constant. Mm. |
|---|---|---|---|---|---|---|
| Tinned copper—lengths of 2in. and upwards, horizontal | 47 to 33 | 1 to 10 | 1·195 | 821·3 | 2,501 | 52·4 |
| Lengths of 6in. and upwards, horizontal | 33 to 18 | 10 to 100 | 1·403 | 1,768 | 6,537 | 69·9 |
| Lengths of 2in. and upwards, vertical | 47 to 33 | 1 to 10 | 1·195 | 775 | 2,360 | 49·4 |
| Lengths of 6in. and upwards, vertical | 33 to 18 | 10 to 100 | 1·403 | 1,680 | 6,220 | 66 6 |
| Length of 4in., horizontal, with large terminals | 33 to 18 | 10 to 100 | 1·586 | 2,980 | 13,100 | 77 5 |
| Ditto, vertical | 33 to 18 | 10 to 100 | 1·586 | 2,844 | 12,470 | 73·8 |
| Length of 1½in., horizontal, with small terminals | 47 to 33 | 1 to 10 | 1·264 | 1,178 | 3,828 | 64·1 |
| Ditto, vertical | 47 to 33 | 1 to 10 | 1·264 | 1,112 | 3 611 | 60·5 |
| Ditto, large terminals | 47 to 33 | 1 to 10 | 1·34 | 1,690 | 5,890 | 77·3 |
| Length of 1in., horizontal, with small terminals | 47 to 33 | 1 to 10 | 1·32 | 1,567 | 5,360 | 75 |
| Ditto, vertical | 47 to 33 | 1 to 10 | 1·32 | 1,480 | 5,060 | 70·8 |
| Length of 4in., vertical, in Manchester Corporation house service box, with cover of mass of terminals, about 100 grm. | 33 to 18 | 10 to 100 | 1·614 | 3,228 | 14,530 | 78·5 |
| Tin—lengths of 3in and upwards, horizontal | 43 to 20 | 1 to 10 | 1·131 | 146·6 | 420 6 | 10 84 |
| Ditto, lengths of 6in. and upwards, horizontal | 20 to 7 | 10 to 80 | 1·32 | 239·3 | 819 | 11·46 |
| Silver—lengths of 5in. and upwards, horizontal | 35 to 18 | 7 to 70 | 1·287 | 967 | 3,210 | 50 |
| Aluminium—length of 4in. and upwards, horizontal | 42 to 22 | 3 to 45 | 1·461 | 2,188 | 8,539 | 75·7 |
| Ditto for critical currents, with spring attachment | 42 to 20 | 2 to 30 | 1·271 | 640 | 2,091 | 34·3 |

*Preece's Formula: Redetermined Values.*—Tinned copper wires at 100 amperes, 19 per cent. high; at 20 amperes, correct; at three amperes, 20 per cent. low. Vertical as against horizontal position: tinned copper, 5 per cent.

*Effect of Length and Cooling due to Large Terminals.*—Percentage increase over fusing current for a length which is independent of cooling of terminals.

| Tinned copper. | Lengths 6in. | 5in. | 4in. | 3in. | 2in. | 1in. |
|---|---|---|---|---|---|---|
| For 115 amperes | 2 5% | 6·5% | 15% | 31% | — | — |
| For 10 amperes | — | — | — | 2% | 5% | 30% |

*Effect of Terminals.*—Increase in fusing current for heavy terminals as against light ones for tinned copper: for 115 amperes length 4½in., 6 per cent.; for 10 amperes length 2½in., 3 per cent.; for 10 amperes length 1½in., 5 per cent. Vibration: tin and lead, decrease in fusing current, 3 per cent. Enclosure in tubes: decrease in fusing current, 12 per cent.

*Contact with Porcelain.*—Tinned copper in semi-enclosed porcelain fuse-holder: (1) Wire arranged so as not to touch the porcelain, increase above normal fusing current = 2 per cent. (2) When pulled tight and close to porcelain F C increased 10 per cent.; lead wire arranged as above in (1) increase in F C = 18 per cent.; arranged as in (2) above, increase = 52 per cent. Tinned copper in holder of damper type: wire out of contact with porcelain, F C increased 5 per cent.; wire in contact with porcelain, but without damper, F C increased 14 per cent.; wire in contact with porcelain and damper, F C increased 24 per cent.

The fuse is an extremely simple device, and it is perhaps

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due to this fact that it has not been treated with the necessary care. All experiments with fuses should be carried out with the greatest care if accurate results are to be obtained, and the same care should be exercised in their design and installation.

### Discussion.

Mr. C. D. Taite, from the chair, opened the discussion with deserving compliments to the authors, and mentioned that, among other things, the skin effect on lead and tin fuses was not generally known. The fact that Sir William Preece's well-known formula was proved to be in error by 10 per cent. evidenced the need for the paper. There were a great many forms of fuses on the British market, and in this our country differed from some foreign parts where there were fewer manufacturing firms, and consequently a fewer number of and more standardised patterns. He deprecated the idea of doing away with the old-fashioned fuse wire clamping screws, as upon emergency he believed that this design was very useful. He instanced a personal experience at an evening party, when, owing to the lights going out through the main fuse blowing, considerable inconvenience was caused, but the matter was readily rectified by himself with the aid of a mousetrap.

Mr. L. Andrews referred to the reputation for unreliability that fuses possessed, and instanced an occurrence at Hastings, when, with two fuses practically in series, one rated at 250 amperes and the other at 70 amperes, the *heavier* fuse blew upon a short occurring at a transformer on the far side of the lighter fuse. He could only account for this left-handed miracle on the assumption that the 250-ampere fuse had been heated up by an overload of long duration upon a branch circuit of 30 amperes, which was fed through this 250-ampere fuse, and that porcelain fittings had conducted the heat away from the 70-ampere fuse during the normal working of the transformer. He considered that it was practically impossible to fuse arc lamps, as a fuse that will not blow with the large excess currents due to starting up, etc., is too heavy when the normal current is increased in a less degree for long periods. He was greatly surprised at the result of the mechanical injury tests, which showed that a fuse cut in half almost was practically unaffected. The fact that there is more trouble with alternating-current than continuous-current fuses was, in his opinion, not due to a deterioration of the wire, but was the result of vibration at contacts, which were thereby loosened, and arcing was set up. It was very difficult to devise apparatus to overcome this—even locknuts were not wholly satisfactory in his own experience. He agreed with Mr. Taite as to the convenience of the old-fashioned fuse clamp arrangement, and instanced a case of lights jumping in church, which he found to be due to loose locknuts, and this matter was put right by him with the aid of the church door key as a main fuse. He advised reference to B. Hopkinson's paper to the Institution of Civil Engineers for some interesting details concerning carbon break, cut-outs, and magnetic blow-out apparatus.

Dr. C. C. Garrard thought that designers of low-tension fuses would find nearly all the data they require in the paper, which would have been additionally useful if the experiments had been extended to fuses of larger current-carrying capacity. With currents of 200 amperes and upwards the chief difficulty is the watt consumption and heating, as with a fuse of smaller size about 50 watts is the maximum allowable liberation of heat, and with a larger watt consumption the neighbourhood of the fuse gets excessively hot. With the object of standardising fuses he had been plotting curves of watt consumption and current during the last three years, and he thought that his method of testing corresponded more to working conditions than that advocated in the paper, as it was based upon the principle that any current below the melting-point value could be kept flowing through the fuse for an indefinite period without the fuse breaking circuit. He thought that it was useless to rate a fuse at 500 amperes if it would melt with 400 amperes passing for a couple of hours, and this result might be obtained by the methods mentioned in the paper. He instanced some remarkable results of increase of potential on breaking circuit upon fuses when a 10,000-volt increase was, in one instance, obtained on a very inductive circuit of 90 amperes at 220 volts continuous current. These rises were not only measured by a spark gap, but were confirmed as to their destructiveness by interposing pieces of paper between the electrodes, which paper was pierced by the spark made on breaking the fuse. Such a fuse would, therefore, cause damage to the apparatus that it was intended to protect, should it be needed to open the circuit.

Mr. E. W. Cowan commented on the singularity of a paper written by a professor being of such value to engineers! Terminal capacity he considered a great factor in determining the capacity of a fuse. From his experience, a fuse was useless in protecting an armature from a heavy reverse current from a battery. The principle of shunt fusing was insufficiently considered, as to the advantage of taking no current when working, but making the final break in a safe place. He hoped to have some details as to deterioration, as manufacturers were made, by consulting engineers, to run at 50 per cent. overloads. Circuit breakers for heavy currents were preferable to fuses, as the former opened at once on dead shorts, and used a time-element lag for less deadly effects. He also preferred long-drawn-out breaks to rapid snaps, which induced rise of pressure, among other things.

Mr. A. C. Cormack considered that atmospheric temperature would influence a fuse, and that a multiplicity of small fuses was better than a single large fuse. Terminal effects have got fuses their bad name for unreliability. Although automatic cut-outs were better for some purposes, like all automatic boxes of tricks, they were likely to go wrong, and where these existed a fuse should also be in series.

Mr. H. G. Baggs was grateful for the new formula evolved from the tests, although he thought Sir Wm. Preece's time-honoured $C = A\,d^{\frac{3}{2}}$ still good enough for workshop experimen's. He thought the time was coming when circuit breakers would take the place of fuses. He recommended that when the paper is published in the *Proceedings*, the paragraph as to RUNNING FUSES AT A MAXIMUM OF 50 PER CENT. OF THEIR NORMAL FUSING CURRENT should be printed in Roman capitals. The non-interchangeability of fuses was not desirable from a manufacturer's point of view, as circuits were sometimes used for different ratings as time went on.

Mr. C. C. Atchison appreciated the results of the experiments, as he had tried to make similar ones himself, but found that too much time was required. He considered that every type of house fuse box on the market had its defects, and corporations consequently had to make their own designs. The reference to changing fuses every three months was hardly based upon a consideration of work-a-day conditions, say, in an ordinary town with 2,000 fuses. As to the ousting of fuses by automatic contrivances: he believed that when fuses were standardised properly, the cut-outs would not be used at all. He preferred teak instead of porcelain for fuse boxes, and used this material charred on the inside to prevent combustion. Enclosed fuses were certainly very noiseless and sparkless in operation, and he instanced a case of one blowing in his station close to him, and only being found out by its effect on the machines.

Dr. Schwartz, in reply, referred to the mysterious efficiency of the damaged fuses, his only explanation being that the heat was conducted rapidly away by the remainder of the fuse wire. The alternating-current effect on fuse wire he considered was better explained by Mr. Andrews's theory of vibration than by Sir D. Salomons's idea as to molecular effects. He did not advocate putting fuses in oil, and preferred enclosing them in porcelain for special situations, as collieries, etc. He agreed that no fuse could be produced to save machines from sudden current rushes. The atmospheric temperature effect he considered to be inappreciable. He still preferred that fuses should be made non-interchangeable to any but authorised persons, and to these it would be simple to alter the standard fixed fittings in the fuse box by the substitution of other standard fittings of greater or less capacity. He disagreed with Mr. Atchison as to the perpetual unreliability of fuses. He thought that the Germans were steadily standardising fuses among other things. In that official-ridden country no ordinary man may replace a fuse, but he must employ the organised facilities to do such work. This was a nuisance to the householder, but it ensured reliability. A constant environment (such as with an enclosed dust fuse) adds to the constancy and reliability of the fuse, and he believed that this class would come more and more to the front. The only trouble was that they were not easy to refill, and the maker charges 8d. each, but his analyses of the filling materials used might help to save this.

## GLASGOW LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The monthly meeting of the above section of the Institution of Electrical Engineers was held on the 14th inst. at 207, Bath-street, Glasgow, Mr. Robert Robertson being in the chair. The evening was taken up with the discussion of the paper on "Earthing" by Mr. Lackie. A considerable number of lengthy written communications were received, and an exceptionally large number of those present took part. Many of the speakers, however, did not confine themselves to the subject matter of the paper.

Mr. James Johnstone (Glasgow), in a communication, said that while he agreed with the author's suggestion, that all metal sheathings of conductors should be kept clear of other metal work, the difficulty would be in getting this suggestion carried out. With regard to the author's suggestion of a resistance in the earth circuit, though it was decidedly novel, it still

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left the whole question open to debate, because they could have no guarantee that plumbers, gasfitters, or bellhangers might not come along and earth the whole system from the earth circuit with its resistance. Of course, it was possible to test each separate installation to see that this had not happened, but who was to be at the expense of making such periodic tests? In the case of motors the adoption of a resistance in the earth wire would obviate a considerable amount of damage, and the risk of damage from gas or other metal pipes would be minimised if the motor earth resistance were inserted between the motor and the piping. Care would be required, however, to see that in works the earth-wire was taken beyond any adjacent water-meter.

Mr. ALLAN ARTHUR (Glasgow), in a communication, said that one disadvantage of having only one earth in a large building was that in the event of the earth-wire being broken the whole system was insulated from earth, or only connected to earth by accident. Another disadvantage was that if the earthing were in the basement, and a fault occurred on the top flat, all the tubing to the earth was momentarily alive, whereas if there was an earth on every flat only a small portion of the current would travel along the tube, while most of it would go right to earth on the top flat. Mr. Arthur had noticed that in the samples of bad wiring shown by Mr. Lackie slip tubing had always been used, without the necessary precautions being taken to bond across the different lengths of tube. He thought that lead-covered wiring properly installed made a very satisfactory job. He could not agree that insulating the sheathing and earthing at one point through a resistance would in no way interfere with the precaution for the safety of the public from shock, as a partial fault would blow the fuse, which it might not do if the extra resistance were inserted.

Mr. D. M. WATERHOUSE (London) sent a communication, in the course of which he said that he was unable to agree that it was just as necessary that conduits should be earthed where the pressure of supply was only 100 volts, as in cases where it was 250. He believed that the sectional area of the earth conductor should be in proportion to the fuse protection of the largest conductor in the conduit which is earthed by it. He thought that Mr. Lackie's figures with regard to electric fires showed the fallacy of the prevailing idea that continuity and earthing of itself afforded security against fire risk. He contended that to increase the resistance of the intentional earth would result in sending a larger current through any existing unintentional earth. It was not possible to completely insulate the whole run of conduits throughout a building except at considerable expense, however admirable the idea in itself might be. Either two independent earths ought to be made, or the earth-wire itself must be protected from mechanical injury by enclosure in a metal tube. He was strongly in favour of earthing lampholders on installations where continuity and earthing were arranged for at all other parts.

Mr. J. W. BLACK (Glasgow), in a communication, said that he thought it would be found that earthed cast-iron boxes had been used in nearly every case where the main fuse had gone with an earth on a three-ampere circuit. If well-designed fuse boxes with insulated or non-metallic cases were used, he thought it would be practically impossible for an earth on a three-ampere branch to do more than blow the three-ampere fuse. He was of opinion that if the metallic sheathing were made electrically continuous throughout, and earthed at one or more points, and the fuse boxes properly designed, there would be no need to resort to Mr. Lackie's main suggestion, which would be bound to add greatly to the cost if it were to be properly carried out. The ideal system, he thought, was some well-designed concentric system with return. Lampholders he considered the weakest part of the insulation, owing to the fact that manufacturers had kept to the standard sizes of the 100-volt days, and with this size it was impossible to get in the proper amount of space for 250 volts.

Mr. GEORGE STEVENSON (Glasgow) said he had no objection to offer to Mr. Lackie's three suggestions as regards lighting if the wiring were carried out with steel-armoured cables, which if insulated with a thin layer of tarred jute made, in his opinion, a better job than any of the conduit systems at present so fashionable. With power circuits, however, over and above the resistance, it would be necessary where motors were mounted direct on a metal framework making a good earth, to insulate the motor frame from the base-plate. This meant insulating brushes and washers for the holding-down bolts, and fibre or wood strips, which increased the cost and made the job less satisfactory from an engineer's point of view.

Dr. BOTTOMLEY (Glasgow) sent a short communication in which he said he substantially agreed with the suggestions made in the paper.

Mr. J. M. MUNRO (Glasgow) said the whole paper showed that they had not arrived at an ideal system of wiring. With all its disadvantages, he was inclined to hark back to wood casing. With regard to the fires mentioned by Mr. Lackie, he thought that the number was very small, considering the number of installations and the variety of work represented. Mr. Lackie's first suggestion would be difficult to carry out, especially in old buildings. He believed that architects were very much to blame in the matter. They made no real provision for artificial lighting. Perhaps they (the contractors) ought to blame themselves to some extent. They ought to consider what recommendations they could make, and then try to come to some agreement with the Institute of Architects. He had always endeavoured to get all tubes insulated from other metallic work in buildings, and while this had often added a little to the cost, he did not see that it presented any real practical difficulty in most cases. A proper external insulating cover to the tube was of great assistance, but it was difficult to get a cover which possessed all the necessary qualifications. He would be glad if Mr. Lackie would say how often in an average week the earth-fuse blew in the station.

Mr. F. A. NEWINGTON (Edinburgh) said that the author's references to electric fires were particularly interesting. If the public got the idea that electricity was unsafe, it would greatly hamper the industry. They were all agreed that electric lighting was the safest form of illumination, and it rested with them to do what they could on the lines laid down in the paper to keep the industry from getting a bad name. Although there was a temptation for contractors to do cheap work, he thought that in the long run good work would pay best. He did not see any good in insulating the earth connection. He would like to have further particulars about the seven fires which had been mentioned by the author as having occurred in installations where the metal piping was earthed. He believed it was not possible to keep the tubing carrying electric conductors clear of all other metal work. Even if it was done at first, the first plumber that came along might run his pipes across the electric tubing, and then the condition of affairs would be as bad as ever. If the piping were clear of all other metal work, of course a resistance in the earth circuit would be very suitable in reducing the flow of electricity, but with other metal work in contact it would only make matters worse. He believed that with the present methods of working it would be better and safer to earth to all the other metal work in the building. He hoped that Mr. Lackie's paper would enable them to arrive at some better method of doing installation work than they had at present.

Mr. H. A. MAVOR (Glasgow) said he entirely disagreed with Mr. Lackie's three main conclusions. He would insist upon earthing at as many points as possible. With regard to the second suggestion in the paper, it would be magnificent if it were possible, but seeing that it depended on the possibility of the first suggestion, which had been shown to be practically impossible, it was not of much use.

Mr. WM. MCWHIRTER (Glasgow) said it was high time new rules were laid down by the master of works, whereby no soft metal tubing would be allowed inside of buildings under any conditions whatever. He was also of opinion that all tubing used in connection with electric wiring should be screwed. He did not believe in bonding, because by the time tubing was properly bonded it was dearer than screwed tubing. He was afraid that the use of a resistance in such a way as Mr. Lackie had suggested would give rise to fire risks in addition to those which already existed. He disagreed with Mr. Lackie's theory that faults in lead-covered cables were often due to a strand breaking, piercing the rubber and earthing in the lead. Most of such faults, he considered, were due to electrolysis.

Mr. W. A. CHAMEN (Glasgow) said he quite realised the danger and the objections that might arise against putting a resistance into the earth circuit, but after all they must be guided by their long years of experience, and they had come to find that the theories they had propounded and proved to their own and other people's satisfaction did not always work in practice. There was no doubt that their older theories about dead earths might still be right. They seldom got a dead earth, however, and that was how they found it necessary to insulate the earth-wire. They insulated the earth-wire because it sometimes did not make earth, and then it was a source of danger if it was near a gas-pipe. The real difficulty which they had with the earthing of the metal sheath was the momentary rush of current. That was the point that none of them realised sufficiently. Mr. Lackie had made a determined attempt at a compromise, and he thought it would be wise to give the arrangement he proposed a trial. Although it might seem impossible to keep tubing clear of all other metal work, he though it would be well that they should set that up as a rule to be adhered to as far as possible, and very probably they would be able to achieve it in a great many cases. If on testing they found that they had not managed to keep the tubing isolated throughout, then it would be wise to put in the necessary resistance. There was no reason why Mr. Lackie's suggestion should not be tried, and if they did not succeed in keeping the tubing clear they could give the resistance in the earth leads a trial.

A number of other speakers took part in the discussion, among them Mr. MORDEY (London), Mr. PILKINGTON (Glasgow), and Mr. MACKENZIE (Glasgow). Owing to the lateness of the hour it was agreed to postpone the hearing of Mr. Lackie's reply.

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## FORTHCOMING EVENTS

FRIDAY, MARCH 24.

**Physical Society.**—At 5 p.m., at University College "Note on the Voltage Ratios of an Inverted Rotary Converter," by Mr. W. C. Clinton; "On the Flux of Light from the Electric Arc with Varying Power Supply" by Mr. G. B. Dyke; "The Application of the Cymometer and the Determination of the Coefficient of Coupling of Oscillation Transformers," by Prof. J. A. Fleming, F.R.S.; exhibition of cymometers and other instruments.

**Institution of Civil Engineers.**—At 8 p.m., students' meeting. "The Wanki to Victoria Falls Section—Victoria Falls Railway," by Mr. C. T. Gardner; and "Design of a Double-Line Plate-Girder Railway Bridge," by Mr. H. S. Coppock.

**Royal Institution.**—At 9 p.m., "A Pertinacious Current," by Sir Oliver Lodge, F.R.S.

**Electro Harmonic Society.**—At 8 p.m., smoking concert in King's Hall.

SATURDAY, MARCH 25.

**Royal Institution.**—At 3 p.m., "Electrical Properties of Radioactive Substances," by Prof. J. J. Thomson, F.R.S. (Lecture III.).

**Institution of Electrical Engineers (Manchester Students' Section).**—Visit to Liverpool and Southport Electric Railway. Leave Victoria Station at 2.10 p.m.

**Paddington Electrical Exhibition.**—Opening.

MONDAY, MARCH 27.

**Society of Arts.**—At 8 p.m., "Telephony," by Mr. H. Laws Webb. (Lecture III.).

TUESDAY, MARCH 28.

**Royal Institution.**—At 5 p.m., "Vibration Problems in Engineering," by Prof. W. E. Dalby (Lecture II.).

**Institution of Electrical Engineers (Manchester Section).**—At 7.30 p.m., "Use of Electrical Energy in Mines and Collieries," by Mr. A. B. Mountain.

WEDNESDAY, MARCH 29.

**Institution of Electrical Engineers (Students' Section).**—At 7.30 p.m., "A Modern Generating Station, with special reference to the Lots-road, Chelsea, Station," by Mr. Chaffers.

FRIDAY, MARCH 31.

**Compatriots' Club.**—At 5.30 p.m., Westminster Palace Hotel, "The New German Commercial Treaties and their Probable Effect on British Industries," by Mr. W. A. S. Hewins.

**Institution of Mechanical Engineers.**—At 8 p.m., "First Report, Steam-Engine Research Committee," by Prof. D. S. Capper (further discussion).

SATURDAY, APRIL 1.

**Association of Municipal Corporations.**—Annual meeting at the Guildhall, when the agreement between the National Telephone Company and the Government and other subjects will be discussed.

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**Rontgen Society.**—April 6, exhibition evening.

**Institution of Civil Engineers.**—The thirteenth "James Forrest" lecture will be delivered by Colonel R. E. C. Crompton, R.E. C.B., on Monday, April 10, at 8 p.m., the subject being "Unsolved Problems in Electrical Engineering."

# LEGAL INTELLIGENCE.

## DEFECTS IN ELECTRIC MAINS.

In the King's Bench Division Messrs. A. H. Midwood and Co., Manchester, sued the Lord Mayor and Corporation of Manchester to recover the estimated loss of the plaintiffs' stock-in-trade, which was destroyed by fire caused by the fusing of one of the Corporation's electrical cables. The plaintiffs alleged that the Corporation had laid their mains in such a way as to constitute a nuisance, and that the fire was caused by their negligence. The Corporation denied the allegations.

Counsel having outlined the case, it was agreed that the following points should be left to the jury:

1. Was the fire caused by the fusing of the Corporation's cable?
2. Does the system adopted by the defendants constitute a danger to persons having property adjacent to the mains?
3. Is the method of localising faults by the burning out or smoke tests a reasonable and proper method, having regard to the risk of fire?
4. When the defendants became aware of the fault, did they deal with it for the purpose of preventing fire in a reasonable and proper manner?

**Mr. A. L. Taylor, M.I.E.E.**, on behalf of the plaintiffs, said that the system of "linking-up" was neither usual nor advisable in a city like Manchester. It was reasonably practicable to carry out a system of electric lighting without danger to property. Liverpool had been running a system 10 years longer than Manchester, and their mains had been on fire, but there had not been a single case of fire spreading inside premises.

Other evidence having been given on behalf of the plaintiffs, **Mr. Fletcher Moulton**, on behalf of the defendants, said that everything prudence dictated had been done by the defendants.

**Mr. Pearse**, the city electrical engineer, stated that on the day in question an abnormal current was observed to be passing to earth through the middle wire at one o'clock, and proper steps were taken.

**Mr. Patchell, M.I.E.E.**, and **Mr. C. L. Sparks** said that the Manchester system complied with the Board of Trade regulations.

The case was decided yesterday afternoon in favour of the plaintiffs. This important decision reaches us too late for comment this week.

## WILLESDEN ELECTRIC LIGHTING.

In the Court of Appeal on Wednesday the appeal of the Metropolitan Electric Supply Company, Limited, against the judgment of Mr. Justice Farwell, in an action instituted by the Attorney-General at the instance of the Willesden Urban District Council, came on for hearing. The proceedings before the Court below were reported in our issue of Nov. 4, 1904. On that occasion the Attorney-General obtained a verdict restraining the company from supplying current for lighting to the Great Western Railway from the company's generating station at Willesden, on the ground that the company's powers only entitled them to generate energy at Willesden, and not to give supply within that area.

Their Lordships, without calling upon counsel for the respondents, came to the conclusion that there was an express proviso in the defendants' Act of Parliament prohibiting the supply of electrical energy outside the specified area, and dismissed the appeal, with costs.

## MELBOURNE TRAMWAY AND OMNIBUS COMPANY, LIMITED v. KIDNEY.—MELBOURNE TRAMWAY AND OMNIBUS COMPANY, LIMITED v. THE CORPORATION OF THE CITY OF MELBOURNE.

The House of Lords last week heard consolidated appeals from judgments of the Supreme Court of the State of Victoria of March 13, 1902, and Dec. 7, 1903.

The appellants are a limited company authorised by an Act passed in Victoria in 1883 to construct tramways and work and run carriages thereon within the city of Melbourne and elsewhere. The Corporation of Melbourne claimed the power, as the licensing authority, to make by-laws relating to carriage licenses in their city. The first decision appealed against a conviction of the company by the court of petty sessions for employing for hire a tramcar without having had a license granted in respect of it. The second judgment supported a by-law made by the Corporation relating to the licensing of the company's tramcars and employés. Both cases raised substantially the same question as to whether the company were obliged to take out and pay for licenses in respect of the tramcars and their drivers and conductors, the decision in both cases being adverse to the company.

Judgment reserved.

## "LIVE" WIRE ACCIDENT.

### Brough v. the Potteries Electric Traction Company, Limited.

This was an action to recover damages for personal injuries sustained through the alleged negligence of the defendant company.

The plaintiff was employed as a loader at a colliery. It appeared that about an hour previously to the plaintiff starting work one morning there had been a breakage of the wires connected with the overhead electric tramway, and one of the wires hung down upon the roadway. The plaintiff apparently did not observe the wire as he crossed the road, and it curled itself round his body. The plaintiff was terribly injured, and had been unable to follow his employment having lost the use of his left arm. The alleged negligence on the part of the company consisted in the fact that the bridle wire leading from the side standard to the central wires was called upon to bear more strain than it should if the wires were properly constructed. It was contended that the bridle and the span wire should have separate and independent attachments to the iron standard. The fact that the bridle wire was alive, although it hung without touching the trolley wires, was alleged to indicate defective insulation. It was also urged on behalf of the plaintiff that the company were negligent in not immediately sending to the scene of the accident.

Medical and expert evidence was given on plaintiff's behalf, the witnesses including Mr. C. E. C. Shawfield and Mr. H. M. Sayers while Mr. G. J. Conaty tendered evidence for the defendants, on behalf of whom it was contended that they had taken all reasonable precautions.

His Lordship held that where a "live" wire was found hanging down into the roadway the onus was upon the defendant.

The jury found for the plaintiff, and assessed the damages at £300.

## FOOTBOARD RISKS.

Judge Greenwell gave judgment at the local county court for the Newcastle Corporation in a case in which they were sued by a passenger for injuries received through being jerked off a tramcar. At the time plaintiff was standing on the footboard after it had passed the stopping-place, where, he alleged, he had told the conductor he wanted to alight. The defence was that he gave no order, and tried to alight as the car was moving. The judge said that while he accepted the plaintiff's statement, he did not see how that gave him a claim. If he had given an order with which the conductor did not comply, that did not justify him in remaining on the footboard after the car had increased in speed on passing the stopping-place. The footboard was a place where a passenger had no right to travel. It was common for people to travel on it, but he thought they must occupy the same position as people who tried to get off while the car was moving—they were there at their own risk.

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# COMPANIES' MEETINGS AND REPORTS

## OLDHAM, ASHTON, AND HYDE ELECTRIC TRAMWAYS.

The ordinary general meeting of this Company was held last Friday, Mr. Emile Garcke presiding.

The **Chairman** have reviewed the report (a notice of which we gave last week), the same was adopted.

## CORK ELECTRIC TRAMS AND LIGHTING.

The annual meeting of this Company was held on Friday last, **Mr.** A. P. Monks presiding.

The **Chairman** stated that the receipts for the year were £45,148, and after the payment of expenses (£28,123) and the interest on debentures (£4,302), there remained £13,427. Of this sum £5,500 was paid in dividends on the preference shares, £1,000 carried to depreciation and insurance account, and it was proposed to pay 5 per cent. on the ordinary shares, carrying forward £885. The lighting and power business continued to show progress. The traffic receipts were also satisfactory.

The report was unanimously adopted.

## MERSEY RAILWAY.

The report of this Company for the half-year ended Dec. 31, 1904. states that the train mileage run during the half-year was 415,625 miles, as compared with 401,046 during the corresponding six months of 1903. The number of passengers conveyed during the half-year has been 4,657,876, as against 4,153,777 for the corresponding period of 1903, exclusive of season-ticket holders. The total receipts from all sources have been £41,789, as compared with £37,358 for the corresponding period of 1903. Working expenses, exclusive of the exceptional charges for pumping, ventilation, and lifts, have been £22,029, equal to 69·17 per cent., as against £28,203, equal to 75·50 for the corresponding six months. These exceptional charges for pumping, ventilation, and hydraulic lifts for the past half-year amounted to £3,854, equal to 9·22 per cent., as compared with £4,237, or at the rate of 11·34 per cent. for the corresponding period of 1903.

## SALISBURY ELECTRIC LIGHT AND SUPPLY.

The annual meeting of this Company was held last week, Mr. W. M. Hammick (chairman of the directors) presiding.

The report stated that the number of consumers had advanced from 662 with 23,833 lamps connected, to 820 with 26,674 lamps connected, thus showing a steady increase. The profit on the year's working, including £318. 0s. 4½d. brought forward from last account, amounted to £4,916. 3s. 7½d., and after paying an interim dividend at the rate of 4 per cent. for the half year, amounting to £600, and £1,452. 1s. 6d. interest on debentures and outstanding accounts, there remained a balance of £2,864. 2s. 1½d. to be dealt with. The directors recommend that a further dividend at the rate of 7 per cent. for the half-year be paid, making, with the interim dividend already paid, a total dividend at the rate of 5½ per cent. per annum for the whole year, and that £1,600 be placed to reserve, leaving £214. 2s. 1½d. to be carried forward to the next account.

The report was adopted.

## SLOUGH AND DATCHET ELECTRIC.

The report for the year ended Dec. 31 states that the capacity of the generating station is now 870 h.p., as compared with 510 h.p. last year, and the order has been given for an additional boiler of 500 h.p., which will be installed this year. The supply mains have been extended in many directions to connect up additional customers. The capital expended to the end of the year 1903 was £31,252. 9s. During last year a further sum of £7,729. 18s. 7d. was expended, bringing the total up to £38,982. 7s. 7d. The number of 8-c.p. lamps and motors connected up to Dec. 31, 1903, was 3,126. During the year 2,482 were added, bringing the total up to 5,608, of which 198 represent the motor power. The directors, after very careful consideration, decided early in the year to reduce the price of current to 6d. per unit for lighting and 3d. for motor power. The total revenue for the year was £3,011. 7s. 1d., including the sale of current in bulk to the Windsor Company, which amounted to £1,452. 5s. 2d. The total net profit available for distribution after adding the sum of £294. 17s. 9d. brought forward from the previous year is £1,628. 8s. 1d., and out of this the directors recommend the declaration of a dividend at the rate of 3 per cent. per annum (less income tax), which will absorb £1,050, leaving £578. 8s. 1d. to be carried forward.

## NEWMARKET ELECTRIC LIGHT.

The annual meeting of this Company was held at the offices, **Mr.** G. H. Verrall, J.P. (chairman of directors), presiding.

The directors' report stated that during the past year 1,737 8-c.p. lamps had been connected with the mains, making a total connected at the end of the year of 18,190 lamps. Applications for a further 728 lamps had been received this year. The profit on the year's working, added to £312. 18s. 10d., brought forward, amounted to £2,019. 5s. 8d., which, after providing for debenture interest, £707. 0s. 10d., left a balance of £1,312. 4s. 10d. The directors recommended that a dividend of 4½ per cent. be paid, that £250 be carried to reserve, and that £134. 10s. 6d. be carried forward.

The **Chairman**, in moving the adoption of the report and accounts, said that in addition to the applications mentioned in the report, nearly 300 more lights had been applied for, and 117 had been connected since the report was drawn up.

The report was adopted.

## BRITISH INSULATED AND HELSBY CABLES.

The report for the year ended Dec. 31, to be submitted at the meeting at Liverpool on the 27th inst., states that the profit for the year amounted to £129,817, to which has to be added the balance brought forward £6,165, making £135,982. The directors recommend a further dividend of 4 per cent. on the ordinary shares, making 8 per cent. for the year, carrying forward £7,114. The volume of trade has been large, but competition still continues very keen. A further sum of £8,500 has been added to the special reserve account. Additions to new plant and machinery, etc., during the year at the Prescot, Helsby, and Liverpool works have been necessitated in order to facilitate the Company's business, and widen the scope of its operations.

## HOVE ELECTRIC LIGHTING.

The annual meeting of this Company was held on the 16th inst., Colonel A. J. Filgate presiding. Particulars of the report appeared in our issue of the 10th inst.

The Chairman having revieved the position generally the report was adopted.

## COUNTY OF LONDON ELECTRIC SUPPLY.

The annual meeting was held at Winchester House on the 16th inst., Mr. J. P. Braithwaite presiding. In moving the adoption of the report (particulars of which appeared in our issue of the 10th inst.), the chairman alluded to the Company's Bill, now before Parliament, for extending their operations. The report was adopted.

## SOUTH WALES ELECTRICAL POWER.

The report of this Company shows that steady progress was made during the past year. Four stations—Bridgend, Cwmbran, Neath, and Pontypridd—have now been completed, and are supplying current receipts for the past year, amounting to £7,000, as compared with £1,900 for the previous 12 months. Arrangements have been made to supply a large number of collieries and works with current to the extent of 10,000 h.p., and the demand is stated by the directors to be continuously increasing. An important scheme of electrical development is foreshadowed in the county of Durham, the Newcastle Supply Company, which furnishes power to nearly all the Tyneside shipyards having agreed to purchase the shares in the County of Durham Electric Distribution undertaking, which holds provisional powers for Gateshead, Durham, Chester-le-Street, Jarrow, and South Shields.

## PERTH (AUSTRALIA) ELECTRIC TRAMWAYS.

The report for the year 1904 states that after paying the interest on the first and second debenture issues, the sinking fund for first debenture stock, and the trustees' fees, the balance standing to the credit of profit and loss account is £14,180, which is carried to profit allocation account. To this balance of profit of £14,180 is added the balance brought forward from last year—viz., £3 232 and £500 proportion of interest on guarantee deposit—making £17,912 from which has to be deducted £9,000 for preference dividends (paying all arrears to date) and £450 dividend tax in Western Australia. A balance is thus left of £8,462, of which £500 accrued interest as above is payable to the trustees for the debenture holders, leaving a balance of £7,952. Out of this sum the directors propose to add £5,000 to reserve account, leaving, with the £500 referred to above, a balance of £3,462 to be carried forward.

## BROMPTON AND KENSINGTON ELECTRICITY SUPPLY.

The annual meeting was held on the 16th inst., at Winchester House, London, Mr. H. R. Beeton presiding. Particulars of the report appeared in our last week's issue.

The **Chairman**, after remarking upon the need of legislation to relieve companies from burdensome and growing taxation, stated that the Board contemplated further reductions in price, believing that such a policy was best in the interests of the Company.

The report was adopted.

## OXFORD ELECTRIC.

The fourteenth annual meeting of this Company (particulars of whose report we gave last week) was held last Friday, under the presidency of the chairman, Sir Henry Mance.

The report was adopted.

# NEW COMPANIES REGISTERED.

**Simplex Motor Syndicate, Limited.**—Capital, £1,200. Object: to acquire from J. D. Roots certain patents and rights relating to improvements in internal-combustion engines, and to carry on the business of motor manufacturers, etc. Registered office: 83, Upper Thames-street, E.C.

**Hexham and District Electric Supply Company, Limited** — Capital, £30,000. Object: to supply electricity for light, heat, power, traction, and other purposes in the urban district of Hexham,

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and the parishes of Acomb, Sandhoe, Hexham, West Quarter, and Warden, all in Northumberland; to acquire a transfer of the rights and powers granted to E. P. Harvey, of Richmond, Surrey, by the Hexham Electric Lighting Order, 1904, etc. Registered office: Bank-chambers, Hexham.

### Liens Registered.

**Eastern Telegraph Company, Limited, London, E.C.**—Lien registered March 10, for £10,000 debenture stock, ranking *pari passu* with previous issues amounting to the total of £1,887,704; charged on the undertaking and revenue of the company.

**Edison-Bell Consolidated Phonograph Company, Limited.**—A trust deed, dated Feb. 20, 1905, to secure £15,000 prior lien bonds has been registered. Property charged, certain patent and trade marks, the leasehold lands and hereditaments known as Newbery House, 39, Charing Cross-road, W.C., and the company's other assets, present and future, including uncalled capital. Trustees: Sir William H. Quale-Jone, Kt., 14, Royal-avenue, Chelsea, and E. Dexter, 11, Ironmonger-lane, E.C.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Manchester.**—The Corporation require tenders for switchboards. Tenders by April 4.

**Salford.**—The Corporation invite tenders for wiring their Seidley School. Tenders by 31st inst.

**Hornsey.**—The Town Council require tenders for cables, meters, junction boxes, etc. Tenders by March 27.

**Cartagena.**—The Public Works Department, Madrid, require tenders for electrification of the local tramways.

**Colchester.**—The Corporation require tenders for electric pumping plant and surface condensers. Tenders by April 5.

**Sofia.**—The District Finance Commissioners require 15,000 insulators, elements for batteries, etc. Tenders by April 3.

**Christiania.**—The Post and Telegraph Department require tenders for 8,000 kilos. of ¼mm. bronze wire. Tenders by April 10.

**St. Marylebone.**—The Borough Council invite tenders for the supply of house meters, including maintenance for two years. Tenders by April 4.

**Salford.**—The Corporation invite tenders for the wiring of the new Council school, Liverpool-street, Seedley. Tenders by March 31. See advertisement.

**Bucharest.**—The Post and Telegraph Department require tenders for 13,000 kilos 3mm. bronze wire and 120 kilos 1½mm. copper wire. Tenders by March 29.

**Bradford.**—The Corporation invite tenders for 2,500 kw. of motor-generators or rotary transformers. Tenders by March 30. Full particulars in our advertisement columns.

**Liria.**—The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

**French West Africa.**—The Governor-General of French West Africa, at Dakar, requires tenders for the erection and equipment of a central station at that place. Tenders by May 15.

**Bilbao.**—The Public Works Department at Madrid require tenders for the concession of an electric tramway in Bilbao, from the Calle de Hurtado de Amézaga to Plaza Circular. Tenders by April 24.

**Laventhem (Belgium).**—The Municipality require tenders for erection of central station, laying of mains, etc. Particulars (3s. 4d.) may be obtained from the Secretary of the Mayor of that place.

**Utrecht.**—The Municipal Authorities require tenders for 20 electric motors for the tramways. Specifications may be obtained at 5s. from the Municipal Secretary, Town Hall, Utrecht. Tenders by 2 p.m. on April 8.

**Madrid.**—The Post and Telegraph Department (Direccion de Telegrafos y. Correos), Madrid, require tenders for 65,000 insulators. Tenders by March 28. A deposit of 5 per cent. of the tender value is required.

**Keighley.**—The Electricity Committee invite tenders for the following plant: (Contract No. 9) one Lancashire boiler; (10) one 300-kw. direct-current steam dynamo, high-speed enclosed engine. Tenders by 10 a.m. on March 27.

**Antwerp.**—Tenders will shortly be invited by the Belgian State Railways for the installation of electric light in their local railway station. Specification No. 619 may be obtained from the Government Railways Office, Brussels.

**Stockport.**—The Gas and Electricity Committee invite tenders for supply and laying of electrical feeder cables. Specifications, etc., may be obtained from Mr. A. J. H. Carter, borough electrical engineer, Millgate, Stockport. Tenders by March 30.

**Glasgow.**—The Trustees of the Clyde Navigation invite tenders for electric power generating and lighting plant for Clydebank Dock. Specifications, etc., may be obtained from Mr. T. R. Mackenzie, 16, Robertson-street, Glasgow. Tenders by April 10.

**Rathmines (Ireland).**—The Rathmines and Rathgar Urban District Council invite tenders for condensing plant. Specification, etc., may be obtained from Mr. George F. Pilditch, A.M.I.E.E., Electricity Works, Rathmines. Tenders by March 27.

**Birmingham.**—The Tramways Committee invite tenders for supply, delivery, and erection of 200 electric tramway cars. Conditions, specifications, etc., can be obtained from Mr. Alfred Baker, general manager, 254A, Corporation-street, Birmingham. Tenders by April 4.

**Switzerland.**—M. R. Vontobel, of Winterthour, and M. Charles Probst, of Lucerne, have obtained a concession for the construction of a narrow-gauge electric railway from Meiringen to Gletsch. The total cost of the enterprise is estimated at £241,600; £19,600 is to be expended on rolling-stock.

**Littleborough (Lancs.).**—The Gas and Electricity Committee invite tenders for erection and completion of proposed transformer station, Butterworth-street, Featherstall-road. Particulars, etc., can be obtained from Mr. S. S. Platt, borough surveyor, Rochdale. Tenders by 12 noon on March 29.

**Hammersmith.**—The Council invite tenders for the supply of boiler flues and economisers; high pressure steam-pipes; high-pressure feed-water pipes; exhaust steam, feed-water heater, and circulating-water pipes; steam-valves and feed-water heaters; and coal elevator. Tenders by April 5. See advertisement.

**London, S.W.**—The London County Council invite tenders (a) for the manufacture, delivery, and erection of eight 500 kw. induction motor-generators for certain sub-stations in connection with the Council's electric tramways, and for the supply and delivery at the Greenwich electricity generating station of (b) general wiring material and (c) low-tension cables, cable boxes, etc. Particulars may be obtained at the County Hall. Tenders by 10 a.m. on April 4.

**Shanghai.**—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Pook and Co., 63, Leadenhall-street, E.C. Tenders by March 31, 1905.

## RESULTS OF TENDERS.

**Hull.**—The Corporation have accepted the tender of Messrs. Siemens Bros., of London, for mains.

**Grimsby.**—The Corporation have accepted the tender of Messrs. Crompton and Co., Limited, Arc Works, Chelmsford, for the supply of motors for the next two years.

**Fulham.**—The tender of the Universal Engineering Company, Limited, for the construction of the brick chimney shaft at the electricity works, at £2,157. 10s., has been recommended for acceptance.

**Aberdeen.**—The Gas and Electric Lighting Committee of the Town Council recommend the acceptance of the tender of D. Bruce Peebles and Co., Edinburgh, for a 420-kw. generator for the electrical department.

**Ilford.**—The Urban District Council have accepted the tender of Messrs. Pullen and Shore, 97, Deansgate, Bolton, at £1,000, for the installation of a telephone fire-alarm system on the double or metallic principle.

**Stockport.**—The Tramways Committee have accepted the tender of Messrs. J. and W. S. Briscoe, Longshut-lane, Stockport, amounting to £10,326. 12s. 5d., for the construction of the roadway in connection with the Hazel Grove tramways.

**Deptford.**—The Borough Council have accepted the tender of Messrs. F. and C. Osler, of Oxford-street, W., at £532. 14s., for the supply of electric light brackets, electroliers, and fittings in connection with the new municipal buildings in New Cross-road.

**Mirfield.**—The District Council have accepted the following tenders: Callender's Cable and Construction Company, cables, troughs, packing, etc., £312 4s. 2d.; British Thomson-Houston Company, meters, £112. 6s. 8d.; Westinghouse Electrical Engineering Company, transformers, £204. 17s.

**Stoke Newington.**—The tender of Heenan and Froude, Limited, for the erection of destructor buildings and plant, at a cost of £8,345, has been accepted. Other tenders were Horsfall Destructor Company, Limited, £5,669 (single plant only); Meldrum Bros., Limited, £8,964 (duplicate plant).

**Erith (Kent).**—The Urban District Council have received the following tenders for the execution of all work required under the Council's assisted wiring scheme for period ending March 31, 1906: J. T. Jarvis and Sons, Pier-road, Erith, 10s. 6d per point (accepted); W. Dickinson, Bexleyheath, 10s. 9d.; G. A. Moore, Bexley-road, Belvedere, 12s. 6d.; Woodville Electric Company, Brook-street, Belvedere, 12s. 10d.; Hooper, Kearey, and Co., Greenwich, 14s.; Ward Bros., 28A, Basinghall-street, E.C., 14s.

**Battersea.**—The Borough Council have accepted the tender of Messrs. Babcock and Wilcox, Limited, in connection with the extension plant now being provided at the central electric generating station, at £1,810. The following tenders were also accepted for annual supplies: Messrs. Charrington, Sells, Dale, and Co., coal; Sloan Electrical Company, carbons for arc, etc., lamps; Willcox and Co., oils and engine-room stores; Electrical Company, electricity meters; Callender's Cable and Construction Company, service joint-boxes, etc., and cables.

**Lowestoft.**—The Corporation have received the following tenders for one water-tube boiler with superheater, brickwork settings, and accessories, together with the necessary pipework:

| | | | |
|---|---|---|---|
| Babcock and Willcox, 30, Farringdon-street, E.C. (accepted) | £1,337 | 0 | 0 |
| Sterling Boiler Company, 35, Victoria-street, S.W. | 1,391 | 0 | 0 |
| E. Le Bas and Co., Dock House, Billiter-street, E.C. | 1,391 | 0 | 0 |
| B. R. Rowlands and Co., Climax Works, Reddish, near Stockport | 1,415 | 0 | 0 |
| E. Danks and Co., Oldbury, near Birmingham | 1,423 | 10 | 0 |
| Clarke, Chapman, and Co., Victoria Works, Gateshead-on-Tyne | 1,464 | 0 | 0 |

**Geneva Tramways Co.**—The receipts for February amounted to £6,225, being an increase of £414 over last year.

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# BUSINESS NOTES.

## TRACTION.

**Newcastle.**—Two top-covered cars have made their appearance on the Corporation's system.

**Southport.**—The electrification of the pier tramway by the British Westinghouse Electric Manufacturing Company has been completed.

**Beckenham.**—The Urban District Council's proposal to introduce motor 'buses instead of electric trams has elicited a chorus of disapprobation in the local Press.

**Knutsford.**—The light railway scheme for Knutsford and Warrington came before the Light Railway Commissioners last week, when, owing to the quantity of opposition, it was withdrawn.

**District Railway.**—Mr. Yerkes on Monday received a deputation of the company's employés in reference to the scale of pay to come into force with the electric trains. No settlement was arrived at.

**Yarmouth.**—The work of electrifying the Gorleston section has been commenced. It is expected that this route, which is largely patronised by seaside visitors, will be ready by the early summer.

**Bradford.**—It is estimated by the local Press that the Corporation tramway receipts for the year ending 31st inst. will reach something like £230,000—roughly speaking, between £232,000 and £233,000 in excess of last year's takings.

**Dublin.**—It is reported that the tramway company had agreed to supply electric current for the public light of Blackrock, as a result of which that Council's opposition to the company's Bill now before Parliament may be withdrawn.

**Stockport.**—The contract for the electrification of the Hazel Grove line has been awarded, as will be seen in our "Results of Tenders" column. It is expected that the contractors will commence the work on March 27. A start will be made at both ends.

**Rochdale.**—The Corporation have some eight miles of new track to put down in the districts of Sudden, Marland, and Littleborough, which must be completed by August, as provided by the Corporation's Act. The work is being proceeded with vigorously.

**Ackworth.**—An enquiry has been held by the Light Railway Commissioners into the Ackworth and North Lindsey light railway scheme. The total mileage proposed is 53, and the cost is estimated at £580,000. Opposition was offered by the railway companies in the districts affected.

**London County Council.**—The receipts for the week ended the 11th inst. totalled £12,554 against £10,130 last year, and for the period from April 1 the aggregate was £625,232 against £485,490. The Council's Tramway Bill will come on for second reading in the House of Commons on April 6.

**Burton.**—The Town Council have instructed the electrical engineer to obtain tenders for a 100-kw. current dynamo, to be coupled to the shaft of No. 1 alternator, together with the switchboard and connections, at a cost of about £500, to meet the increased demand which the additional service of cars which the Burton and Ashby Light Railway will call for.

**Wellingborough Tramways Bill.**—At the quarterly meeting of the Northampton County Council it was stated that the Council's opposition to this Bill was simply intended to secure reasonable terms for the public, not to kill the measure. The Raunds Urban District Council have practically agreed terms with the company for the trams to be brought into that town, and have consented to petition in favour of the Bill.

**Edinburgh.**—The Corporation have published the statutory notice of their intention to apply for power to reconstruct existing lines, and to lay down new ones for working by some form of mechanical traction. Intimation has been given that it is intended to make application for a provisional order for the purpose of incorporating a company, to be known as the Edinburgh Suburban Electric Tramways, for the purpose of laying down tramways between Craigmillar Park and Eskbank.

**Broughty Ferry.**—A Dundee paper reports that all arrangements in connection with the formation and financing of a public company for the construction and working of the Dundee, Broughty Ferry, and District Tramways have now been definitely completed. Contracts amounting to close upon £90,000, and including the whole of the construction of the tramways and the building of the generating station and car sheds, are stated to have been entered into. Constructive work is to be begun in the early part of May.

**Coventry.**—On Tuesday Lieutenant-Colonel Yorke, C.B., on behalf of the Board of Trade, made an inspection of the extensions of the Coventry and District Electric Tramway Company. Commencing his tour of inspection at the railway station, the car proceeded to Broadgate, down Smithford-street, along Spon-street and Spon-end to the Chapel-street terminus. Lieutenant-Colonel Yorke also inspected the lifeguard and other appliances upon the tram. The Corporation have decided to institute proceedings against the company on account of dilatoriness with other lines.

**South Shields.**—At a special meeting of the Town Council on Wednesday there was a long discussion on the now familiar tram *v.* motorcar question. On behalf of the deputation who were sent to the principal towns to enquire as to the working of motor 'buses, it was reported they had come to the conclusion that that system was unsuitable for a town like South Shields. Councillor Barlow, the electric tram's champion, implied that the superiority of that vehicle was manifested by the deputation's report. It was decided to invite tenders for the laying of the electric tramways, the tenders to be considered at an early date.

**Motor 'Buses.**—At the resumed conference of municipal tramway authorities, Councillor Boyle, of Manchester, presiding, it was reported that the Midland Railway Company had agreed with the Liverpool and Bradford Corporations to insert clauses limiting the running of motor omnibuses to routes beginning or ending at one of the company's railway stations. The conference agreed that Mr. J. H. Whitley, M.P., should move an instruction to the committee dealing with the Bill to extend the clause to the railway's whole system, and also to secure the insertion of a similar clause in the North-Eastern Railway Bill and the Great Western Railway Bill.

**Cardiff.**—A recommendation was made to the Tramways Committee last week by the electrical engineer, Mr. Arthur Ellis, that a medical man should be appointed to examine the men in the employ of the tramways department. Mr. Ellis stated that they had to keep a reserve of 40 men to take the places of those who fell sick. He quoted an instance where a man who had only been in their employ six weeks fell sick, and became entitled to 50 per cent. allowance. Mr. Ellis was instructed to enquire as to the practice adopted by other departments of the Corporation, and to report.

**Kidderminster.**—A letter was read before the Rural District Council on Tuesday from the company which obtained an order to construct a light railway from Kidderminster to Bewdley, stating that they had written to the Kidderminster Town Council expressing disappointment that they had not received some proposals with regard to the operation of car traffic through the Bull Ring at Kidderminster. The cars could not be profitably worked unless there were facilities for passing through the Bull Ring to the railway station and to connect with the Stourport line. As the extended time for carrying out the order expired on the 2nd prox., the company had no alternative but to abandon their order.

**Walsall.**—At the meeting of the Town Council last week it was reported that the receipts for the month had been £1,793. 5s., against £1,801. 11s. 7d. in the corresponding month of last year, but that the receipts had averaged 9·36 per car mile, against 7·87. Wages paid had been £604. 1s. 1d., against £713. 19s. 8d. It was also reported that the old lines had been inspected by Lieut.-Colonel Yorke, R.E., for the Board of Trade, and the Tramway Committee had arranged to carry out his recommendations. The committee have arranged with the borough auditors to prepare quarterly reports as to the undertaking. At present the committee cannot see their way to adopt a system of ½d. fares as requested by the Walsall Trades' Council.

**Exeter.**—The completed sections from Heavitree to St. David's and Paris-street to Pinhoe-road were last week inspected by the Board of Trade. Two cars were run over the sections, and a careful examination made of the wire equipment, cars, and track, especially at the difficult junction of High-street with Queen-street, and the inspectors are reported to have expressed their satisfaction with the result. The Board of Trade certificate is expected in the course of a few days, but the line is not to be publicly opened before April 3. Twelve cars will be used. It is stated that the speed which the inspectors will sanction is nine miles per hour on ordinary track, six miles per hour on steep gradient, the curves to be taken at four miles per hour.

**West Fife.**—The position of matters in regard to the tramway scheme appears to have become somewhat involved. A new development has to be recorded in connection with the tramway scheme of West Fife. The Dunfermline and West of Fife Tramway Company have posted throughout the district the statutory notice of application for a provisional order in April, but they are at loggerheads with the district authorities upon the question of road works. A conference was held the other day, but no arrangement was come to, and the company are considering whether they shall abandon the scheme. Meantime it is reported that a number of Edinburgh gentlemen have come into the field, and it is understood to be their intention to form a company, and lodge application for a provisional order.

**Hastings.**—At last week's meeting of the Town Council the Railways and Tramways Committee reported upon the conference that had taken place with the company. On behalf of the Corporation, it was intimated that the proposed overhead system for the front line would have to be entirely abandoned, and, after discussion, the following form of undertaking, which the solicitors to the company intimated that their clients would be prepared to give on the subject, was proposed on behalf of the company: "During the extended period for completion of the works the company undertake not to apply for powers to use overhead traction on the front line except at the previous request of the Corporation." The committee recommended that, subject to the company also agreeing upon certain details and paying the Corporation's costs of opposing the Bill, the opposition be withdrawn and assent given to an extension until July, 1907, for the completion of the system. After a short discussion the report was adopted.

**The Paris Metropolitan.**—The success of this line appears to have exceeded expectation. The system in operation extends over some 20 miles, which is less than half the total concession. In 1900 the number of passengers (six months only) was 17,680 286; in 1901 the number was 55,282 027; and this has been increasing progressively, the number in 1904 being 140 247,228, making a total of 404 194 341. During the first two months of the present year over 30 867,700 passengers have been carried. When the line was mooted in 1891 the most optimistic estimates for the No. 1 section placed the annual traffic at from 25 000 000 to 30,000,000. In 1904 about 70,000,000 passengers travelled over this section of the line. M. Desplas, presiding at the Paris Municipal Council, pointed out at a recent meeting of that body, that the Paris "Métro," which came into being later than similar enterprises in London, Berlin, and New York, differs from them in that it confines itself rigorously to city traffic alone, not being in any way intended to act as a feeder to the main railway lines.

**Australia.**—The *New South Wales Railway Budget* states that electric traction has been substituted on the Ocean-street tramway, Sydney, for cable haulage, which has been in use for over 10 years. In consequence of the conversion of the King and Ocean streets cable

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tramway into an electric system, increased motive power has been provided at the Ultimo power-house. For some time past the increasing demands upon the supply of electric force have seriously taxed the resources of the Commissioners. At a cost of over £50,000 they have installed at Ultimo a Parsons turbine-engine of 3,000 h.p., with a speed of 1,500 revolutions per minute. The total power now available is approximately 17,800 h.p., a portion of which will always be kept in reserve for breakdowns. The latest installation has involved 16 additional boilers, bringing the total up to 48, rated at 250 h.p. each. The existing plant has a capacity of 9,775 kw., that of the turbine plant just installed being 1,875 kw. Complaints are made by the Railway Commissioners of the maner in which the poles carrying the electric traction wires in the city and suburbs are disfigured by the bill-posters. A considerable sum of money is annually expended in keeping the poles clean and painted, hence the Commissioners feel annoyed to find that their efforts to make everything connected with the electric system look neat and trim are nullified by the actions of billposters. The Commissioners are determined to prosecute persons detected in affixing advertisements to the electric poles. The City Council has also taken the matter in hand. Directions have been given by the Premier of Victoria that the proposed conversion of the St. Kilda railway line from steam to electric traction shall be referred to the Railways Standing Committee. The South Australian Government is still waiting for a reply to the communication sent to the Adelaide tramway companies regarding the purchase of tramways. The directors of the companies have met, but adjourned without arriving at a decision. A further conference is to be held, at which it is expected a joint reply to the Government will be drafted. Unless the companies are prepared to accept a price for their undertakings which in the opinion of the Government is reasonable, recourse will be had to arbitration.

**Swansea.**—The Corporation Bill to, *inter alia*, enable the Corporation to purchase the Swansea Tramway Company's lines came before a Committee of the House of Commons. Mr. Lloyd, K.C., explained that the company was granted powers in 1874, subject to a clause which gave the Corporation the right to purchase the tramways at the end of 21 years from the date of the authorisation of the tramways or the expiration of any subsequent period of seven years. The company sought further powers in late years, all of them being granted subject to this purchase clause; but in 1882 there was some variation of the terms, so that there were varying periods, at the end of which the Corporation could buy the trams, and the position became somewhat curious; he contended, however, that it was the intention of all parties and of Parliament that when the company came for fresh powers in 1882 they should be allowed 21 years of absolute ownership only in which to develop the undertaking; whilst probably at the end of that time the company might have, if they desired it, a lease for 21 years. The tramways were completed in 1885, and therefore the 21 years would expire in February next. The majority of the company's shares were purchased by the British Electric Traction Company in 1897, and the advisers of the company began to see if they could not put a different interpretation on the section, contending that the real meaning of the section was that in the first place the Corporation could buy nothing for 21 years, that at the end of 21 years they could purchase such portions as happened to fall in, and then grant a lease to the company for 21 years, and that during the lease they could purchase nothing more; and that at the end of 21 years they could purchase such other portions as might fall in at the expiration of seven years, and so on. The result of it all would be that the Corporation would not be able to acquire the trams until 1933. The Corporation went to the Court of Chancery. That tribunal could only say what was the meaning of the words in the company's Act as they stood; they could not enquire into the intention, and the Court decided in favour of the view of the tramway company. Therefore the company said that the clauses in question should be repealed, and the present Bill should be passed so as to give effect to what was the intention of Parliament. The Town Clerk of Swansea (Mr. Thomas) said that the Corporation did not oppose the company's Act of 1882 on the understanding that the whole system of tramways would remain in the hands of the company for 21 years from the date of the completion of the tramways authorised by the Act of 1882. At the end of the 21 years the Corporation were to have the right to purchase the whole undertaking. The object was to bring all the different lines of tramway into line, and to treat the whole thing as one concern. Mr. Balfour Browne, K.C., asked whether the clause, the words of which were said by the promoters not to carry out the intention of the parties, was not in the Bill precisely as submitted to Parliament. Witness replied that a misunderstanding had taken place. Mr. Balfour Browne, on behalf of the company, said that the Corporation did not attempt to appeal from the decision of the Court of Chancery, because they knew that the company were right. Now they said Parliament ought to set the bargain aside and take away the company's property. It was unquestionable that under the decision of the Court of Chancery the company were to be in possession of the tramway for 90 years. The effect of the Corporation's Bill was to take away the property in 1906. As a matter of fact, it was only the last section of the line that would be in the hands of the company in 1993, but whatever that might be, there was the bargain. The Corporation said that they understood something different by it. They should have understood that at the time the Bill was before Parliament. They had acted with their eyes open. After consulting in private for a few minutes the Committee decided that the preamble of the Bill was not proved so far as related to tramways.

## LIGHTING AND GENERAL.

**Maidenhead.**—The Council have sealed a loan of £6,500 for electric light extensions.

**Acton.**—Application is to be made for sanction to borrow £10,000 for hire-purchase and free wiring purposes.

**Baildon.**—The District Council have decided to apply for an electricity supply provisional order within their own district.

**Uxbridge.**—A small committee has been appointed to meet Mr. A. R. Bell, engineer of the electric light company, with regard to wiring the parish church.

**Truro.**—A committee has been appointed to consider and report to the Council on the advisability or otherwise of steps being taken for the provision of an electric lighting plant in the city.

**Hindley.**—The Hindley Electric Lighting Order, 1901, has been referred to a committee consisting of Messrs. H. J. Bouchier, E. Grime, J. Stott, J. A. Neville, H. V. Athron, and T. Southworth.

**Calcutta Electric Supply Corporation.**—The number of units delivered to consumers during the four weeks ending Feb. 24 were 187,706, compared with 123,838 in the corresponding four weeks of the preceding year.

**London Gazette.**—Llewelyn Hugh-Jones, Crypt-chambers, Chester, has been released from trusteeship in the estate of Frederick William Parkes and Edward Sadleir, electrical fitters and engineers, Dingle, Colwyn Bay, Denbigh.

**Telephone Trunk System.**—An additional trunk wire is in course of construction between Dundee and Kirkaldy, which will considerably relieve the pressure on the existing circuits, and result in considerable improvement in the service.

**Bishop Auckland.**—The West Auckland Parish Council have decided to open negotiations with the electric light company with the view to the lighting of the village by electricity. The sum of £120 is devoted to street-lighting at present.

**New Issue.**—American Telephone and Telegraph Company's 4 per cent. collateral trust bonds in this company are being offered through Messrs. Baring Bros. and Co., Limited, at the price of £199 per 1,000dol. bond (equivalent of 96½ per cent. Boston price).

**Flintshire.**—On Thursday Holywell was placed in the Chester area for telephonic purposes, and Holywell subscribers will now be enabled to have free communication with Chester, Buckley, Mold, Flint, and Connah's Quay, and *vice versâ*, instead of fees being paid for each call.

**Paddington Electricity Exhibition.**—An exhibition, which has been organised by the Metropolitan Electric Supply Company, Limited, to show the latest developments of electricity for lighting, power, and heating purposes will be opened at the Queen's-road Baths, Bayswater, W., on Saturday next, the 25th inst., at 12.30 p.m., by the Mayor o Paddington.

**Ealing.**—It has been decided to reply to the Hanwell District Council that the Ealing Town Council could probably supply them with current about six months after receipt of parliamentary power in bulk at 2¾d. per unit, with a rent for special main from their generating station, but that the Ealing Council would not take over the whole of the Hanwell Council's electric lighting responsibilities.

**Stock Exchange.**—Applications have been made to the Stock Exchange Committee to allow the following securities to be quoted in the official list: British Electric Traction Company's further issue of 5,000 6 per cent. cumulative preference shares of £10 each, fully paid, Nos. 356,438 to 361,437; Metropolitan District Railway Company's £537,351 assented extension preference (5 per cent.) stock, and £962,649 unassented extension preference (5 per cent.) stock, in lieu of the £1,500,000 extension preference (5 per cent.) stock now quoted; Oxford Electric Company's further issue of 2,000 ordinary shares of £5 each, fully paid.

**Blackpool.**—The borough electrical engineer (Mr. O. Furness), in his February report, shows a net increase in the works output over the corresponding month of last year of 22,306 units, made up as follows: Private lighting—February, 1905, 91,288; February, 1904, 93,265; decrease, 1,977 units. Public lighting—1905, 16,754; 1904, 17,531; decrease, 777 units. Corporation tramways—1905, 89,372; 1904, 62,122; increase, 27,250 units. Lytham and St. Annes tramways—1905, 4,280; 1904, 6,470; decrease, 2,190 units. Total for month—1905, 201,694; 1904, 179,388; net increase, 22,306 units. The Tramways and Electricity Committee have decided to recommend the Town Council to reduce the price of current to 6d. and 2d., with the alternative of a flat rate of 5d. All consumers whose consumption amounts to less than 5s. in value are to pay 2s. 6d. per annum for rent of meter.

**Mirfield.**—The erection of the sub-station at Eastthorpe, and the laying of mains, etc., have been finally settled. Several tenders (particulars of which appear in another column) were accepted. At the last Council meeting, Mr. A. B. Mountain, the Council's electrical engineer, explained that the Westinghouse tender for the supply of transformers was not the lowest, but the leakage in their transformers was not so great as in those of some of the other companies. Mr. Mountain was instructed to engage a jointer to superintend the laying of the mains, the fixing and reading of meters, and the connecting of consumers. Various cable routes were agreed upon. With regard to the work of excavation for the laying of the mains, Mr. Mountain said his experience had been that it was much cheaper to do the work themselves where it was to be done piecemeal. When several miles of mains had to be laid at a depth of several feet, as was the case in the power company's mains, there might be something in letting the work, but in the case of the Council, the raising and relaying of the pavement flags, which was a matter their surveyor would have to superintend, was the principal item, the laying of the mains in a trench perhaps 1ft. deep being a very small part of the work. The Council agreed that service mains be laid free of charge for a distance of 20 yards from the supply mains. The charges for the supply of energy were fixed as follows: for lighting purposes, 5d. per Board of Trade unit, and for motive power 2d. per Board of Trade unit for the first two hours and 1d. per unit afterwards, providing that the motor is run at three quarters of the full load. Rent will be charged for meters.

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**Carlisle.**—An agreement has been completed between the Corporation and the Tudor Accumulator Company, Limited, for the maintenance of the battery purchased from them. Since the last meeting eight applications for lights, equal to 490 8-c.p. lamps, have been received.

**Telephone Agreement.**—The telephone agreement with the Government, which is being discussed so much by the various local authorities who own or intend to own the municipal telephones, will be discussed at the annual meeting of the Association of Municipal Corporations at the Guildhall on April 1.

**Salford.**—The Town Council have decided to apply for sanction to borrow £600 to cover the cost of laying cable for lighting purposes. The estimate of £600 is made up as follows: cost of cable, £308; excavating, laying, filling-in, watching, and supervision, £109; carting, £49; reinstating, £62; joint-boxes and jointing, £15; contingencies, £57.

**Perth.**—Negotiations with the view of the introduction of the telephone system to North Perthshire are being revived on the understanding that the monetary guarantee be dispensed with, and that between Dunkeld and Pitlochry 80 "toll" subscribers or 42 "full-rate" subscribers be secured. The system may also be extended to Aberfeldy, provided the necessary support is secured.

**New Firm.**—Mr. W. Arthur Ker, late general manager for Messrs. Paterson, Cooper, and Co., Limited, manufacturers of electrical machinery, will shortly open offices at Edinburgh Life Buildings, 122-128, St. Vincent-street, Glasgow, as electrical and mechanical consulting engineer. Owing to the rebuilding of these premises, Mr. Ker's address, until May 28, will be Patella Works, Paisley.

**Metropolitan Asylums Board.**—The Board on Saturday agreed that application be made to the Local Government Board for their sanction to the Managers inviting tenders for the installation of telephones and fire-alarms at the Gore Farm (Upper) Hospital from six selected firms, and to their entering into a contract or contracts for the execution of the necessary works, without, in the first instance, advertising for sealed tenders.

**Bishop's Stortford.**—The Clerk reported at the last Urban District Council meeting that Messrs. Baker had communicated suggested alterations to the agreement for the transfer of the electric lighting order from the Council to a private company. The original draft had laid it down that the company was to pay the whole costs of the Council, not exceeding £250, and it was now suggested that £125 should be paid to cover the costs already incurred by the Council. It was decided to adhere to the amount of £250.

**Croydon.**—We understand that the Lighting and Electricity Committee have credited the Finance Committee in connection with the estimates for the ensuing year with £2,000 from the electric light undertaking account. The borough electrical engineer's last report upon the progress in the demand for electricity is as follows: current sold this year for public lighting, 47,095 units (corresponding period last year, 45,856 units); private lighting, 120,079 units (100,966 units); traction lighting, 81,675 units (79,006 units).

**Frome.**—A six days' electrical exhibition was opened in the market hall by the Frome Electricity Supply on Monday. The Frome Electricity Supply was represented by Mr. J. C. Wigham (chief engineer to Edmundson's Electricity Corporation) and Mr. F. M. Nicholl, A.I.E.E. (resident engineer and manager). Edmundson's Electricity Corporation commence to supply Frome last July with an equivalent of 3,050 8-c.p. lamps. At the present time the equivalent of 18,000 8-c.p. lamps has been connected to the supply mains, while applications equivalent to about 2,000 8-c.p. lamps await connection.

**Watford.**—The transformers for the arc lamps to be erected in Queen's-road and High-street have now come to hand, and the work of fixing the lamps will be proceeded with at once. With reference to a small arc lamp which has been erected experimentally, the engineer has found that the consumption does not exceed half a Board of Trade unit per hour, and he has arrived at the conclusion that a main road, such as the St. Albans-road, for instance, could be lighted in an efficient manner by means of these arc lamps at an annual cost not exceeding the present one for incandescent lighting other than the first cost of erecting the lamps.

**Exeter.**—The electrical engineer has reported that the cost of production for the past year represents a saving of £1,000 per annum, with an increased output of 10 per cent. The interest and sinking fund required will be met without the aid of the rates, and the extra supply for tramways, motors, and lighting already secured will enable the undertaking to meet all its liabilities in the coming year. The Electric Lighting Committee do not advise the Council to incur the expense of an independent test of the new machinery, but have resolved that the electrical engineer be required to report as to the efficiency of the whole equipment as soon as the work is completed.

**Wisbech.**—The Town Council have received the following letter from the Local Government Board: "Sir,—I am directed by the Local Government Board to advert to your letter of the 21st ult. with reference to the application of the Town Council of Wisbech for sanction to borrow £25,000 for electric lighting purposes, and I am to explain that the matter of the proposed contract between the Town Council and the National Electric Construction Company, Limited, is now under the consideration of the Board of Trade, and that pending the decision of that department, the Local Government Board are not in a position to deal further with the application for loan sanction. Any enquiries with regard to the contract, and matters arising in connection with it, should be addressed to the Board of Trade."

**Battersea.**—On Saturday the electric lighting failed in the principal districts of Battersea shortly before nine o'clock. The police in reserve at the Lavender-hill Police Station were at once sent into the principal streets to preserve order among the traffic and to protect shop and stallkeepers from the light fingered gentry. After ten o'clock the defect at the generating station was remedied and the supply restored. We have received the following details: The 750-kw. generator armature went to "earth" at 8.50 p.m., causing a total extinction of the supply. Unfortunately, on the Thursday night before, a 350-kw. machine broke down in the same way. It was therefore impossible to cope with the demand at that hour in the evening until the area had been split up into districts. By that time the demand was much lighter, and the whole supply was running again at 10.20 p.m.

**Burnley.**—The Electricity Committee of the Corporation have had before them the results of the present financial year, which comes to a close at the end of the month. On the prices obtained—viz., 1.75d. for traction, 4d. for lighting, 3d. and 1d. for motors, and 3d. for public lighting—the net profits will exceed £10,000. The recommendations of the committee are as follows: That the tramways be allowed a rebate for the present year, making the price 1½d. For the coming year the charges will be as follows: tramways, 1.45d.; private lighting, 3½d. flat rate; public lighting, 1½d.; motors, 1¾d. for the first hour and 1d. afterwards. This will bring the average price per unit sold to 1.7d., and the net profit at £4,000, after allowing £2,500 for depreciation. The committee has also decided to purchase more plant, which will comprise a 500-kw. generator, boiler, and condensing plant. A lively attack is expected from the members of the Tramways Committee when this recommendation comes before the Council, their contention being that the reductions should all have gone in their favour.

**Hanley.**—The Electric Lighting Committee reported at the last Council meeting as follows: "The assistant engineer reported a serious breakdown on the low pressure side of No. 6 engine on the afternoon of Feb. 1. The plant was about to be put on load, when the bolts securing the balance weight to the crank broke, the weight being flung against the column, smashing a large hole in each side. The engine was at once shut down, and instructions were given to disconnect the low-pressure side of the engine. The cylinder was firmly supported by timbers, and by the next afternoon the plant was again running on half-load. The cause of the breakage was found to be two defective bolts which had been used to secure the balance weight." The chairman, vice-chairman, and the engineer were empowered to consider tenders for the necessary repairs to No. 6 engine. The committee recommended that the sum of £1,150 be paid to the credit of the district fund account, and that the sum of £204. 2s. 2d., including £198. 18s. 11d. balance from the previous year, be carried forward to the current year's account. Discussion on the accounts was adjourned.

**Bath.**—The Corporation have issued a well-illustrated pamphlet entitled "A Few Facts concerning the Use of Electricity as a Motive Power," and "The Cost of same when taken from the Electricity Supply Mains of the Corporation of Bath." We note that a supply of continuous current at 220 and 440 volts is now available practically throughout the whole of the business area of the city of Bath, current for motive power purposes being sold at 1¾d. per Board of Trade unit. As illustrating the immense economy of small motors where the load is intermittent, two instances are quoted—viz., a small motor is utilised to work a hair-brushing machine at a cost of 2½d. per week, which displaced labour costing over 6s. per week, and the whole of the machinery of a dairy is driven by two electric motors of 5 h.p. and 2 h.p. respectively. The machinery is worked at a cost of 9s. 1½d. per week of seven days. Among Bath firms from whom letters have been received speaking highly of the use of electric motors in their business are Messrs. Mallett and Son, Messrs. Jacob Long and Sons, the Bath and Somersetshire Dairy Company, Mr. James Fortt, Mr. A. Ernest Meyer, Mr. George Bayntun, and Mr. John Collins.

**Arbroath.**—At a special meeting of the Arbroath Town Council on Saturday the following letter with reference to the electric lighting of the burgh was received from Messrs. D. and W. Chapel, agents for the Empire Electric Lighting and Power Company: "Dear Sir,—We observe from the report in the newspapers of the meeting held on the 30th curt. that the Town Council have failed to arrange for a transfer of the order to any other company, and we write to say that we are prepared to advise our clients to deposit the £750 in the hands of a neutral party to be held by him for behoof of both parties, and to be paid to the Town Council on delivery to our clients of a transfer of the provisional order approved and sanctioned by the Board of Trade, the £750 to be repaid to our clients should the transfer not be carried out from any cause whatsoever. We think these are terms which it is the interest of the Town Council to accept, and will be glad to hear from you as early as possible in order that we may communicate with our clients." The Town Council have replied that they adhered to their former decision, but that they would be prepared to continue negotiations with the Empire Company on the lines indicated in their last letter.

**Hastings.**—The borough accountant's abstract of the accounts of the electricity department for the year ended Dec. 31 last is very satisfactory, and shows a great improvement on the previous year. The deficiency on the year's working in 1903 of £951, has been turned into a surplus of £117. In addition to this, £4,980 has been paid off the sinking fund, instead of £4,311, an increase of £669, so that in comparison with last year the department shows an improvement of £1,737. The expenditure shows a slight decrease and the income an increase all round. The cost of generation last year was £6,990, 38·88 per cent. on income, and this year £6,495, or 33·37 per cent. Management expenses decreased slightly from £1,502 to £1,496, with a good decrease in percentage, 8·36 to 7·69. Other items were as follows: Distribution of electricity—1903, £360; 1904, £380 (an increase in total, but a decrease in percentage). Public lamps—1903, £826; 1,904, £893 (4·60 per cent. and 4·59 per cent.). Rents, rates, etc.—1903, £205; 1904, £316. Law charges—1903, £4; 1904, nil. Special charges—1903, £218; 1904, £260. Total expenditure—1903, £10,105 (56·21 per cent.); 1904, £9,870 (50·71 per cent.). On the

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income side everything had increased except miscellaneous receipts, £76 to £72. The items are: Sale of current—1903, £13,02); 1904, £14,231. Sales under contract—1903, £247; 1904, nil. Public lighting—1903, £4,029; 1904, £4,210. Rental of meters—1903, £653; 1904, £801. Rents receivable—1903, £152; 1904, £153. Total income—1903, £17,977; 1904, £19 467; or gross profits carried down of £7,872 in 1903, and £9 597 in 1904. Against these amounts were written off: Bad debts—1903, £11; 1904, £80. Interest on deposits—1903, £6; 1904, £8. Interest—1903 £4,495; 1904, £4,412. Sinking fund—1903, £4,311; 1904, £4,980; or an increase this year from £8,823 to £9,480. Nevertheless the result gives the deficit on last year of £951, and the surplus on this year of £117. Descending to some of the particular items we find that the £6,495 for generation of electricity is composed of £4,123 for coal and other fuel; £1,112 for repairs and maintenance; £932 for wages at generating stations; and £326 for oil, waste, water, and engine-room stores. Management expenses included £985 for salaries, £56 for stationery and printing, and £453 for general establishment charges. The £14,231 received for the sale of current per meter was composed of 361,811 units at 6d., 10,766 at 3d., 759 at 2½d., and 305,283 at 1½d., with a lamp charge of £3,135. That received by the public lighting includes 228,976 units at 1½d. (£1,431); lamp charge, £1,305; interest and sinking fund, £571; and repairs, etc., £891. The capital account gives the expenditure prior to Dec. 31, 1903, as £131,831. 19s. 3d.; expenditure on machinery, £3,785; on mains, £1,062; transformers, £99; meters, £1,025; electrical instruments, £13; a total of £136,819. The amount raised by loans is £140,494, and from revenue £30. There is a balance unexpended of £3,704. The borough electrical engineer's statement of electricity generated, sold, etc., during 1904 is as follows: Quantity generated in Board of Trade units, 1,044,405; quantity sold, public lamps, 228,976; private consumers by meter, 678,619; total sold, 907,595; quantity used on the works, 21,500; total accounted for, 929,095; not accounted for, 115,310; number of public lamps, 104; total maximum supply demanded, 667 kw. The Gwynne engine supplied with the Wheeler condensing plant is to be practically rebuilt out of revenue.

## PROVISIONAL PATENTS, 1905.

MARCH 13.

**5163. Improvements in electrical conduit fittings.** Samuel Withers, Jabez Griffin, and Arthur Duffield Robinson, 128, Colmore-row, Birmingham.

**5197. Improvements in electric switches.** Max Byng and Herbert John Coates, Peel Works, Adelphi, Salford, Manchester.

**5205. Improvements in and relating to trolleys for electric tramcars and the like.** John William Bradley and John Farrer Mason, 33, Chancery-lane, London.

**5206. Improvements in dynamo-electric machinery for continuous and alternating currents, also means of regulating same.** James Priestnall Naylor, 40, Cambridge-terrace, Robson-road, West Dulwich, London.

**5220. Improvements in cooling devices for vapour electric apparatus.** Percy Holbrook Thomas Westinghouse Patent Bureau, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, March 28, 1904, being date of application in United States.) (Complete specification.)

**5226. Improvements relating to electrically-fired internal-combustion engines.** Walter Park Little, 30, South-street, Exeter.

**5229. Improvements in or relating to the regenerative control of electrically-propelled vehicles.** John Smith Raworth, 46, Lincoln's-inn-fields, London.

**5230. Improvements in or relating to the regenerative control of electrically-propelled vehicles.** John Smith Raworth, 46, Lincoln's-inn-fields, London.

**5231. Improvements in or relating to the regenerative control of electrically-propelled vehicles.** John Smith Raworth, 46, Lincoln's-inn-fields, London.

**5232. Improvements in electric current circuit breakers.** Ernest Francis Moy and Percy Henry Bastie, Greenland-place, Camden Town, London. (Complete specification.)

**5259. Improvements in or relating to connectors for electrical conductors.** Arthur Basil Carey, 111, Hatton-garden, London.

MARCH 14.

**5270. Electric alarm, improved apparatus for use in railway signalling and also as a fire and burglar alarm.** James Jennett, 2, Castlereagh-road, Belfast, Ireland.

**5273. Novel or improved insulator for electric traction street poles.** Edwin Downward and James Peter Downward, Longport, Stoke-on-Trent, Staffs.

**5280. Improvements connected with electrical switches, circuit breakers, motor starters, and such like.** Verity's, Limited, and Arthur Edgar Gott, 11, Burlington-chambers, New-street, Birmingham.

**5295. Electromagnetic pump.** Robert Lyon Ibbetson, 1, Fishergate-hill, Preston, Lancs.

**5336. A device for automatically controlling air-compressors or other fluid-pressure generating apparatus driven by electric motors.** John Farrer Mason, 33, Chancery-lane, London.

**5357. Improvements in or relating to the forming of glass seals, especially applicable for hermetically sealing electrical conductors into glass.** Charles Orme Bastian, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**5370. Improvements in and relating to methods of insulating electric conductors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.) (Complete specification.)

**5371. Improvements in and relating to methods of and apparatus for insulating electrical conductors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.) (Complete specification.)

MARCH 15.

**5398. Improvements in the manufacture of pendants, brackets, and other fittings for gas and for electric light.** Harry Hateley, 122, Colmore-row, Birmingham.

**5409. Improvements in vapour electric apparatus.** Peter Cooper Hewitt, The Westinghouse Patent Bureau, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, April 9, 1904, being date of application in United States.) (Complete specification.)

**5419. Improvements in main switches or circuit breakers.** Thomas Reginald Herbert Tetley, Falcon Electrical Works, Poland-street, Manchester.

**5425. Improvements in or relating to electric furnaces.** Henry Livingstone Sulman and Hugh Fitzalis Kirkpatrick-Picard, 111, Hatton-garden, London.

**5447. Improvements in or connected with electrical measuring instruments of the wattmeter class.** Nalder Bros. and Thompson, Limited, and Richard Frank Curtis, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**5456. Improvements in detectors for electromagnetic waves or other weak electric impulses.** William Phillips Thompson, 6, Lord-street, Liverpool. (Gesellschaft für drahtlose Telegraphie m. b. H, Germany.) (Complete specification.)

MARCH 16.

**5489. Improvements in or relating to telegraphic apparatus.** Frederick George Creed and William Arthur Coulson, 46, Lincoln's-inn-fields, London.

**5491. Improvements in electric radiators or heaters.** Sherard Cowper-Coles, Grosvenor-mansions, Victoria-street, Westminster, London.

**5497. A system of signalling between guards of a train and the engine-driver of that train by means of an electric bell or light on the engine operated by a switch at the entrance to each carriage.** Harry Darley Osterfield, 6, Ranelagh-road, Westbourne-square, Paddington, London.

**5520. Improvements in or relating to electric circuit breakers.** Thomas Edgar Weaver, 134, Claremont-road, Manchester South.

**5553. Improvements in and connected with electric arc lamps.** Victor Watson Riley and Herbert William Rowing, Birkbeck Bank-chambers, Holborn, London. (Complete specification.)

**5554. Improvements in or connected with the insulators of the third rail of third-rail electric traction systems.** Franz Gustav Kleinsteuber, 52, Chancery-lane, London.

**5568. Improvements in balance weights for electric light pendants and the like.** Joseph Augustus Bauer, 4, South-street, Finsbury, London.

**5577. Improvements in telephone calls.** Peter Thomas Geyerman 40, Chancery-lane, London. (Comp'ete specification.)

**5582. Improvements in dynamo-electric machines.** Pierre Anton Joseph Lapeyrade, 18, Buckingham-street, Strand, London. (Date applied for under Patents Act, 1901, March 17, 1904, being date of application in France. (Complete specification.)

**5583. Improvements in and relating to measuring instruments.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**5584. Improvements in electric conveyor systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

**5585. Improvements in and relating to vapour electric apparatus.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

MARCH 17.

**5588. Apparatus for cleaning electric lamp globes.** George Hone, 9, Regent-street, Kettering, Northamptonshire.

**5590. Improvements in alternating and pulsating current electromagnets and solenoids.** William James Frederick Cooper, 55, Abbotsford-avenue, West Green, Tottenham, London.

**5643. Improvements in or relating to electrolytic cells.** Edgar Arthur Ashcroft, 111, Hatton-garden, London.

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**5660. Improvements in automatic electric make and break contacts.** Edward Bettridge Boucher, 21, Finsbury-pavement, London.

**5662. Improvements in and relating to track construction and electric signalling and controlling equipment therefor.** Guion Thompson and Huntington Wolcott Merchant, 1, Queen Victoria-street, London. (Complete specification.)

**5675. Improvements in dynamo-electric machinery.** Leonard Knight Clark, 4, South-street, Finsbury, London.

MARCH 18.

**5685. A new or improved method of electrically transmitting and indicating upon a screen the position of moving figures, moving objects, diagrams, writing, and the like.** John Alexander Kennedy-McGregor, 5, Corporation-street, Birmingham.

**5724. Improvements in dynamo-electric and electro-dynamic machinery.** James Grey Bell, 17, St. Ann's-square, Manchester.

**5755. Improvements in electric switches.** Kenneth Odell Searle, 35, Macauley-road, Clapham Common, London.

**5757. Improvements in and relating to alternating-current electric motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.) (Complete specification.)

**5758. Improvements in electric clocks.** George Bennett Bowell, 40, Chancery-lane, London.

**5769. Improved construction of accumulators or secondary batteries.** Alexander Elias Dakhyl and Antonio Galanti, 173, Fleet-street, London.

**5771. Improvements in or relating to printing telegraphs.** John Charles Barclay, 7, Southampton-buildings, Chancery-lane, London.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published April 6.*

1903.

**27265. Telegraph and like cables.** Lodge and Hardie.

1904.

**5892. Electric lamps of the character known as vapour lamps.** Bastian.

**6319. Electric conductors.** Heany.

**6811. Electrical signalling instruments.** Sullivan.

**6832. Electrolytical extraction of metals from solutions.** Webb.

**10242. High-tension electric current switches.** British Thomson-Houston Company, Limited. (General Electric Company.)

**10525. Driving gear for electrically-driven rotary brushes.** Maclean.

**10812. Overhead trolleys or collectors for electric tramway and railway vehicles.** Blaney.

**10873 Heating by electricity.** Voelker.

**10877. Fluid-pressure brake systems for railway vehicles, trains, and the like.** British Thomson-Houston Company, Limited. (General Electric Company.)

**11116. Electrical signalling.** Hards.

**13107. Switch mechanism for use in connection with inter-communication telephone instruments or telephone systems.** Electric and Ordnance Accessories Company, Limited, and Hall.

**25220. Protective systems for electric distribution lines.** Wilson. (Date applied for under International Convention, Nov. 20, 1903.)

**27904. Secondary batteries.** Gardiner.

**29408. Current distributors for the electric ignition devices of internal-combustion engines.** Renault. (Date applied for under International Convention, Sept. 23, 1904.)

1905.

**136. Electric transformers.** Conrad. (Date applied for under International Convention, Jan. 20, 1904.)

**1754. Electric ignition devices for explosion engines.** de la Valette. (Date applied for under International Convention, Jan. 28, 1904.)

**3433. Devices for exerting an electromagnetic influence on the arcs of electric arc lamps.** Carbone.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ⅝ ⅞ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 7/16-17/32 |
| British Insulated and Helsby Cables, Ord., 1-100,000 .... | 5 | – | 5¾-6¼ |
| —— 6 per cent. Cum. Pref., 1-100,000 ..... | 5 | – | 5¼-5⅝ |
| —— 4½ per cent. Mortgage Debentures ..... | 100 | – | 101-104 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. ..... | 100 | – | 99-101 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 ..... | 5 | – | 3⅛-3⅜ |
| —— 4 per cent. Mortgage Debenture Stock ..... | 100 | – | 91-93 |
| Brush Electrical Engineering, Ordinary, Nos. 1-106,751 .. | 2 | – | ½-¾ |
| —— Non. Cum., 6 per cent. Pref. ..... | 2 | – | 1⅛-1⅜ |
| —— 4½ per cent. 1st Debenture Stock..... | 100 | – | 92-95 |
| —— 4½ per cent. 2nd Debenture Stock ..... | 100 | – | 79-82 |
| Callender's Cable, Debentures ..... | 100 | – | 106-108 |
| —— Ordinary ..... | 5 | – | 11 11¼ |
| —— 5 per cent. Pref. ..... | 5 | – | 5¼-5⅜ |
| Crompton and Co. ..... | 5 | – | 2¼-2⅜ |
| —— 5 per cent. Debentures..... | 100 | – | 96-98 |
| Edison and Swan United, "A" Shares, 1-98,261 ..... | 5 | – | 1-1¼ |
| —— "A" Shares, 01-017,139 ..... | 5 | – | 1⅜-2¼ |
| —— 5 per cent. Debentures..... | 100 | – | 86 91 |
| —— 4 per cent. Deb. Stock, Red. ..... | 100 | – | 85 90 |
| Electric Construction, Limited, Nos. 1 to 112,100 ..... | 2 | – | 1¼-1½ |
| —— 7 per cent. Cumulative Pref. ..... | 2 | – | 2¼-2½ |
| —— 4 per cent. Perp. 1st Mort. Deb. ..... | 100 | – | 97-99 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 | – | 9¼-10 |
| —— 4 per cent. 1st Mort. Deb. Stock ..... | 100 | – | 91-96 |
| W. T. Henley's Telegraph Works, Ordinary ..... | 5 | – | 12¼-13 |
| —— 4½ per cent. Preference ..... | 5 | – | ⅝ ⅝ |
| —— 4½ per cent. Debentures ..... | 100 | – | 109 111 |
| India Rubber, Gutta Percha, and Telegraph Works ..... | 10 | – | 16 17 |
| —— 4 per cent. Debentures..... | 100 | – | 100 103 |
| Parker, Thos., Limited, Ordinary ..... | 10 | – | 10-10¼ |
| Telegraph Construction and Maintenance..... | 12 | – | 36 38 xd |
| —— 5 per cent. Bonds ..... | 100 | – | 103 105 |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary ..... | 10 | – | 12¼-13 |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 ..... | 10 | – | 9⅞-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 .... | 10 | – | 11-12 |
| —— 4½ per cent. Debenture Stock. Red. ..... | 100 | – | 105-107 |
| Bromley (Kent) Electric Light and Power Co. ..... | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. 1st Debenture Stock, Red. ..... | 100 | – | 102-105 |
| Brompton and Kensington, Ordinary..... | 5 | – | 10¼-10⅜ |
| —— 7 per cent. Preference ..... | 5 | – | 10-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 .. | 5 | – | 9 9½ |
| —— Nos. 60,001-80,000 ..... | 5 | – | 6⅞ 7¼ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. .... | 8 | – | 12¼-13¼ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 105-108 |
| Charing Cross and Strand, Nos. 1-70,000 ..... | 5 | – | 8-8⅛ |
| —— 70,001-80,000..... | 5 | .. | 7⅜-8⅛ |
| —— 4½ per cent. Cum. Pref. ..... | 5 | – | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 4 15/16 5 1/16 |
| —— 40,001-80,000..... | 5 | .. | 4 15 16-5 1/16 |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 | – | 103-105 |
| Chelsea Electricity Supply ..... | 5 | – | 6⅜-7⅛ |
| —— 4½ per cent. Debentures ..... | 100 | – | 109-111 |
| City of London, Ordinary..... | 10 | – | 11⅜-12¼ xd |
| —— 6 per cent. Cumulative Pref..... | 10 | – | 13¼-14 xd |
| —— 5 per cent. Debenture Stock ..... | 100 | – | 125-127 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) .. | 100 | – | 103-105 |
| County of London Electric Supply, Ordinary ..... | 10 | – | 9½-10 |
| —— 6 per cent. Cum. Pref. ..... | 10 | – | 12¼-12⅜ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 104-106 |
| —— 4½ per cent. 2nd Debentures Prov. Certs..... | 100 | .. | 110-113 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000.. | 5 | – | 6⅛ 6⅜ |
| —— 6 per cent. Cum. Pref. ..... | 5 | – | 6⅛-6⅜ |
| —— 4½ per cent. First Mort. Deb..... | 100 | – | 106-108 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 2¼-2⅜ |
| —— 5 per cent. Debenture Stock, Red. ..... | 100 | – | 86-91 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000..... | 5 | – | 5¼-6 |
| —— 4½ per cent. First Deb. Stock, Red..... | 100 | – | 101-104 |
| Havana Electricity, Limited, 1-15,000 ..... | 10 | – | 9¼-10⅛ |
| Hove Electric Lighting, Limited, Ord., 1-15,000 ..... | 5 | – | 7⅜-9¼ |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 101-103 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 ..... | 1 | – | 11/16-13/16 |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | | 12⅜-13¼ |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red ..... | 100 | – | 102-104 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅜-10¼ |
| London Electric, Ordinary ..... | 5 | – | 2 9/16-2 13/16 |
| —— 6 per cent. Pref..... | 5 | – | 5⅜ 6 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red... | 100 | – | 99-101 |
| Metropolitan Ordinary ..... | 10 | – | 18¼-18⅜ xd |
| —— 4½ per cent. First Mortgage Debenture Stock .... | 100 | – | 110-115 |
| —— 4½ per cent. Cum. Pref. ..... | 5 | .. | 5⅜-5⅝ |
| —— 3½ per cent. Mortgage Debenture, Red. ..... | 100 | – | 97-99 |
| Midland Electric Power Dis., Ld., 4½ p c. 1st Mort. Deb.. | 100 | – | 99-101 |
| Newcastle-upon-Tyne Electric Supply, Ordinary ..... | 5 | – | 98-101 |
| —— Preference ..... | 4 | – | 100-102 |
| Notting Hill Electric Lighting ..... | 10 | – | 14¼-15¼ xd |
| —— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.) .. | 100 | – | 102-104 |
| Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,510..... | 5 | – | 6¼-6⅝ xd |
| —— 4 per cent. Debenture Stock ..... | 100 | – | 98-100 |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures ..... | 100 | – | 100-102 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000.. | 5 | – | 2⅜-3¼ |
| —— 4 per cent. Debenture Stock ..... | 100 | – | 79-83 |
| South London, Ordinary ..... | | – | 4⅛-4¼ xd |
| South Metropolitan Electric Light and Power Co., Ord... | 1 | .. | ⅛-1 |
| —— 7 per cent. Cum. Pref. ..... | 1 | .. | 1⅛-1 7/16xd |
| —— 4½ per cent. 1st Mort. Deb. ..... | 100 | .. | 107 110 |
| —— Ditto, June, 1904 ..... | | .. | |
| St. James's and Pall Mall, Ordinary, 101-20,000 ..... | 5 | – | 13⅜-14¼ |
| —— 7 per cent. Pref. ..... | 5 | – | 8¼-8⅜ |
| —— 3½ per cent. Deb. ..... | 100 | – | 98-100 |
| Urban Electric Supply Co., Ordinary, 8-50,007 ..... | 5 | – | 5 1/16-5 3/16 |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5¼-5⅜ |
| Westminster, Ordinary ..... | 5 | – | 12⅜-13¼ |
| —— 5 per cent. Cum. Pref., 110,101-138,261..... | 5 | – | 6¼-6⅜ |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 ..... | 5 | – | 5⅜-5⅝ |
| —— Ord. ..... | 5 | .. | 8¼-8⅜ |
| —— Permanent 6 per cent. Debenture Stock, 1888 .. | 100 | – | 140-143 |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 105-107 |
| Barcelona Tramways, Limited, Ord., 1-20,000 ..... | 10 | .. | 12-12⅛ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 ..... | 10 | .. | 9¼-10 |
| —— 5 per cent. Deb., Red., 1-600 ..... | 100 | .. | 99-102 |
| —— 4½ per cent. Red. Deb. Stock ..... | 100 | .. | 96-100 |
| Bath Elec. Tramways., Ld., Pref. Ord. Shs., 75,001-150,606.. | 1 | .. | 13/16-15/16 |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 ..... | 1 | .. | 15/16-1 1/16 |
| Belfast Street Tramways, Ord., 1-26,600 ..... | 10 | .. | 10¼-11¼ |
| Blackpool and Fleetwood Tramroad ..... | 10 | – | 13⅜-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 ..... | 5 | – | 1-1⅛ |
| —— 5 per cent. Cum. Pref., Nos. 1 75,000..... | 5 | – | 3⅜-4⅛ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 94-96 |
| British Columbia Electric Railway Co., Ord. Def. ..... | 100 | – | 103-106 |
| —— Ord Pref. ..... | 100 | – | 100-103 |
| —— Non. Cum. 5 per cent. Pref. ..... | 10 | – | 10-10¼ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 | – | 105-107 p c |
| —— 4½ per cent. Vancouver Power Deb. ..... | 100 | – | 99-102 |
| British Electric Traction Ord. 1-500,000 & 60,001-80,000 | 10 | – | 9½-9⅝ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 ..... | 10 | – | 10⅞-11⅛ |
| —— 5 per cent. Perpetual Debenture Stock ..... | 100 | – | 122-124 |
| —— 4½ per cent. 2nd Deb. Stock ..... | 100 | | 97-99 |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Buenos Ayres and Belgrano Tram. Ord., 1-100,000 | 5 | 3¾ 4 |
| —— "A" 5 per cent. Cm. Pf., 1-40,000 | 5 | 5⅜ 5½ |
| —— "B" 5 per cent. Cm. Pf., 1-27,500 | 5 | 5⅜ 5⅝ |
| —— 5 per cent. Deb. Stock, Red. | 100 | 107-109 |
| —— Prov. Certs., all paid | 100 | 103-106 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | 97-99 |
| Calcutta Tramways, Limited, 1-102,268 | 5 | 8¼-8½ |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | 106-108 |
| Cape Electric Tramways Nos. 1-480,000 | 1 | 1⅜-1⅝ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | 4⅞-5¼ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | 101-104 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | 103-105 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | 9¼-10 |
| —— 5 per cent. Cum. Pref. | 10 | 11-12 |
| —— 4 per cent. Debentures | 100 | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | 12½ 14½ |
| —— 5 per cent. Pref., Nos. within 1-60,000 | 10 | 15¾ 16¼ |
| —— 5½ per cent. Mort. Debs., 1-3,000, Red. | 100 | 94-97 |
| Imperial Tramways Ordinary | all | 18-19 |
| —— 5 per cent. Cum. Pref. | all | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000 | 5 | 3-3½ |
| —— 4 per cent. Debenture Stock | 100 | 83-92 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | 8 8½ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | 10-10½ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | 99-102 |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb Stk., Red. | 100 | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016. | 1 | 13/32 15/32 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | 31/32-1 1/32 |
| —— 4½ per cent. Deb. Stock, Red. | 100 | 105-107 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000 | £1,000 | 105-110 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 | 101-104 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 | 103-105 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000 | 5 | ¼-1½ |

| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | 12½ |
| —— 5 per cent Cum. Pref. | 10 | 9⅜-9⅝ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Sk. | 100 | 104-107 |
| Potteries Electric Traction, Ordinary 20,001-40,000 | 10 | 9¼-10 |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | 9¼ 9⅝ |
| —— 4½ per cent. Debenture Stock | 100 | 102-105 |
| South Lancashire Electric Traction and Power Company | | |
| —— £250,000 Ordinary | 1 | 1 |
| —— £101,132 5 per cent. Preference | 1 | 1 |
| —— £597,170 4½ per cent. Debenture Stock | 100 p.c. | 100 p.c. |
| **Electric Railways.—** | | |
| Central London, Ordinary | 100 | 93-95 |
| —— 4 per cent. Pref. | 100 | 101-103 |
| —— ,, ,, deferred | 100 | 83-86 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | 110-112 |
| City and South London, Consolidated Ordinary | 100 | 44½-45½ |
| —— 4 per cent. Debenture Stock | 100 | 108-110 |
| —— 5 per cent. Pref. Stock '91 | 100 | 120-123 |
| —— ,, ,, ,, '96 | 100 | 118-121 |
| —— ,, ,, ,, '01 | 100 | 115-118 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | 10-10¼ |
| —— Ordinary, 1-50,000 | 10 | 3¾-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — | 99-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | — | 98¼-99½ |
| Waterloo and City, Ordinary | 100 | 92-94 |
| **Telephones.—** | | |
| National Telephone, Preferred | 100 | 110 111 xd |
| —— Deferred Stock | 100 | 104-106 xd |
| —— 6 per cent. Cum. First Pref. | 10 | 12¼-13¼ xd |
| —— 6 per cent. Cum. Second Pref. | 10 | 12-13 xd |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | 5⅜ 5¾ xd |
| —— 5½ per cent. Deb. Stock, Red. | 100 | 100-102 |
| —— 4 per cent. Deb. Stock, Red. | 100 | 104-106 |
| —— 4 per cent. Prov. Cert. | — | 103-105 |
| Oriental Telephone and Electric Company | 1 | 1¼-1⅜ |
| —— 6 per cent. Cum. Pref. | 1 | 1 3/16-1 5/16 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905 | 1904. | Week. | Current year. | 1904. | 1903 | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Car mile. | Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Mar. 18 | 1,075 | 1,031 | − 5 | + 5,718¼ | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·14 |
| Ayr Corporation | ,, 18 | 187 | 163 | + 24 | + 640 | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 316,049 | 1·03 | 10·11 | 1,770 | 5 0 |
| Barking Corporation | ,, 18 | 59 | 39 | + 19 | + 289 | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 19 | 982 | 931 | + 1 | — | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,319,701 | 1·158 | 9·98 | 2,383*b* | 6·1 |
| Birmingham Corporation | ,, 18 | 332 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | — | — | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | — | — | — | — | — | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10 94 | — | 4·59 |
| Blackpool Corporation | ,, 16 | 333 | 255 | + 47 | + 6,228 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 18 | 197 | 181 | + 16 | − 85 | 16½ | 16½ | Dec. 31 | 32,021 | 2,253,981 | 600,757 | 3·34 | 12·75 | 2,001 | 7 05 |
| Bolton Corporation | ,, 19 | 1,815 | 1,614 | + 201 | + 793 | 38 | 38 | March 31 | 94,161 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·89 |
| Bournemouth Corporation | ,, 15 | 964 | 8 4 | + 90 | + 2,385 | 10 15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | Feb. 25 | 3,553 | 3,360 | + 193 | +29,738 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | Mar. 19 | 814 | 722 | + 112 | + 3,733¼ | 9 | 7½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 17 | 4,427 | 4,603 | + 176 | — | 51½ | 51½ | Dec. 31*g* | 253,150 | 44,391,439 | 6,033,528 | — | — | — | — |
| Burnley Corporation | ,, 18 | 1,02? | 885 | + 138 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 19 | 312 | — | — | — | 8¼ | — | March 31*f* | 11,574 | 2,556,134 | 282,378 | 1·08 | 9·81 | 1,570 | 7·57 |
| Cardiff Corporation | ,, 18 | 1,838 | 1,735 | + 103 | + 2,170 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 18 | 135 | 161 | − 25 | − 263 | — | — | Dec. 31*g* | 9,987 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 18 | 7,070 | 7 062 | + 8 | + 1,175¼ | 6 | 6 | ,, 31 | 362,471 | 44,953,938 | 1,292,674*a* | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 19 | 2,884 | 2,973 | − 89 | − 2,180¼ | 6¼ | 6⅜ | ,, 31 | 165,003*a* | 19,069,319*a* | — | — | — | — | — |
| Colchester Corporation | ,, 15 | 157 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 14 | 406 | 413 | − 7 | — | — | — | ,, 31*g* | 26,657 | 6,353,823 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | ,, 17 | 209 | 202 | + 7 | − 50 | 7·23 | 7·23 | March 31*g* | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 13 | 170 | 165 | + 4 | — | 4½ | 4½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0 91 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | ,, 17 | 103 | 94 | + 14 | + 394 | 7 | 6⅜ | Dec. 31*g* | 6,231 | 588,905 | 107,164 | 3·88 | 14·09 | 932 | 7·39 |
| Dublin U. T., electric cars | ,, 17 | 3,905 | 3,701 | + 204 | — | 47 | 46 | ,, 31*g* | 134,643 | — | 3,429,356 | — | — | — | — A |
| Dublin S. District, Electric | ,, 17 | 833 | 729 | + 104 | | | | | | | | | | | |
| Dundee City Tramways | ,, 15 | 772 | 765 | + 7 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 18 | 731 | 624 | + 107 | + 2,033 | 10·77 | 10·75 | March 31 | 34,312 | 12,950,269 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 18 | 14,544 | 13,322 | +1,222 | +30,455A | 143 | 123 | May 31*g* | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 *b* | 7·40*d* |
| Gloucester Corporation | ,, 15 | 231 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 8 | 2,389 | 2,096 | + 293 | + 5,333 | 33 | 30½ | March 31 | 68,283 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,059 | 8·77 |
| Huddersfield Corporation | ,, 18 | 1,219 | 1,1 3 | + 116 | + 4,305 | 35 | 35 | ,, 31 | 65,545 | 11,893,287 | 1,652,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | ,, 18 | 2,213 | 2,020 | + 193 | +11,572 | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | Feb 25 | 346 | 337 | + 9 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | Mar. 15 | 109 | 127 | − 18 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 15 | 135 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 18 | 5,368 | 4,939 | + 359 | +17,535 | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | ,, 11 | 1,910 | — | — | — | 7¼ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | ,, 11 | 9 851 | 9,317 | + 534 | + 3,753 | 103 | 103 | Dec. 31*g* | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | ,, 19 | 1,497 | 1,512 | − 15 | − 622A | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185*a* | 1·82 | 19·30*a* | 5,110 | — e |
| London County Council | ,, 11 | 12,052 | 10,130 | +1,922 | +120,800 | 46¼ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | Feb. 25 | 120 | 128 | − 8 | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | Mar. 16 | 91 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 18 | 11,877 | 10,754 | +1,123 | — | 131¼ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 11 | 106 | 97 | + 9 | — | 2¾ | — | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newcastle-on-Tyne Corptn. | ,, 18 | 3,549 | 3,447 | + 102 | — | 45 | 38½ | ,, 25 | 185,027 | 39,715,120 | 4,059,807 | 1·1 | 10·94 | 4,111*b* | |
| Newport (Mon.) Corporation | Feb. 11 | 475 | 460 | + 25 | + 1,333 | 15 | — | — | — | — | — | — | — | — | — |
| Oldham Corporation | Mar. 19 | 1,513 | 1,012 | + 491 | + 5,861 | 34¾ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 18 | 1,490 | 1,442 | + 48 | + 6,544 | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·16 | 12·39 | — | — |
| Reading Corporation | ,, 16 | 581 | 529 | + 52 | — | — | — | — | — | — | — | — | — | — | — |
| Rochdale Corporation | ,, 18 | 441 | 102 | + 339 | + 7,170 | 4½ | 4½ | 31*g* | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·56 |
| Rotherham Corporation | ,, 16 | 332 | 409 | − 17 | — | — | — | ,, 31 | 20,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·68 |
| Salford Corporation | ,, 20 | 4,100 | 3,669 | + 431 | — | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 18 | 70 | — | — | — | 7¾ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 19 | 4,740 | 4,325 | + 415 | + 7,011 | 34¼ | — | ,, 25*g* | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 15 | 838 | 815 | + 13 | − 2,665 | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 15 | 224 | 214 | + 10 | + 1,616 | 6¼ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 17 | 427 | 402 | + 25 | + 8,601 | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 20 | 1,144 | 1,064 | + 80 | + 1 675 | 19 5½ | 18·48 | ,, 31 | 62,506 | 14,848,958 | 1,433,463 | 1·01 | 10·46 | — | 6·08 |
| Swindon Corporation | ,, 1 | 151 | — | — | — | 3¾ | — | — | — | — | — | — | — | — | — |
| Wallasey U.D.C. | ,, 20 | 659 | 575 | + 83 | + 2,683 | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·60 |
| Warrington Corporation | ,, 16 | 301 | 275 | + 26 | + 610 | 7¼ | — | — | — | — | — | — | — | — | — |
| West Ham Corporation | ,, 16 | 1,080 | — | — | — | 8·62 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 15 | 636 | 502 | + 134 | — | 7½ | — | ,, 31*g* | 20,878 | 4,263,066 | 417,335 | — | 12·005 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. A Half-year's figures. Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**The McMillan Fund.**—The President announced to the members of the Institution last week that this fund, amounting to £2,082, has now been invested in trustees' securities, in the names of Sir Wm. Preece, Mr. R. K. Gray, and Mr. Alexander Siemens, for the benefit of Mrs. McMillan and her children.

**Manchester Section.**—The annual general meeting of this section will be held at the University on April 11 at 7.30 p.m., when the chairman, vice-chairman, hon. secretary, and 12 members of committee will be appointed for next session. There will also be a paper on "Labour-Saving Formulæ in the Design of Direct-Current Dynamos," by Mr. J. Frith.

**North-East Coast Institution.**—The issue for March of the *Transactions* of the North-East Coast Institution of Engineers and Shipbuilders contains the adjourned discussion on "A Comparison of Vertical and Horizontal Tubes in Water-Tube Boilers," by Mr. W. R. Cummins, of which paper we gave an abstract in our issue of Dec. 2; and a paper on "The Launch of the U.S.A. Cruiser, 'South Dakota,'" by Mr. Jas. Dickie, with the discussion.

**Improving the Consular Service.**—It is a familiar cry that other countries take the lead over us in regard to consular affairs. An illustration of this is afforded by the action of the German Government in appointing a number of technical and commercial experts as attachés to their consulates in the chief towns of European countries, in order to assist industrial development. The list includes a specially-trained civil engineer for St. Petersburg. This method of fostering trade appears eminently suited to the end in view. It has been advocated for the United Kingdom before now, but the wheel of British consular progress revolves with marked deliberation. Unless our hopes are being flattered only to deceive, the proposed Ministry of Commerce may introduce much-to-be-desired reforms in the consular service.

**Tramway Management.** — The London County Council on Tuesday decided to sanction a vote of £150 for the chief tramway officer to visit the States and see how things are done in the large American cities. This is partly the outcome of the report presented by Mr. J. Allen Baker, the chairman of the Highways Committee, upon his tour in that country last year. The conduit electric tramways of New York having been at work for some time before the County Council's, the greater experience gained has enabled the undertakers to effect considerable economy in working, besides improvements in many details of organisation. Conduit cleaning, tramway stores depôts, and subway trams are other important matters for investigation. There is a tendency now to accept the achievements of our Transatlantic cousins with the proverbial pinch of salt, or even more, but it must be admitted that their enterprising methods seldom fail to provide useful hints.

**Association of Electrical Engineers, Italy.**—We have received part 1 of vol. ix. of the *Transactions* of the Associazone Elettrotecnica Italiana, which contains papers on "Stroboscopic Observations of the Alternate-Current Electric Arc," by Profs. L. Lombardi and G. Melazzo, of Naples; "Formulæ with regard to a Recently-Proposed Phase Meter," by Dr. P. Barreca, of Rome; an essay on "The Influence of Hertzian Waves on the Magnetisation of Steel," by C. Garibaldi, of Genoa; "Observations on the Working of the Magnetic Detector," by Prof. M. Ascoli, of Rome; and a paper, read at the Turin meeting by G. Gola, on "The Analogy existing between Hydraulics and Electricity." All these papers are profusely illustrated with cuts and diagrams. There are also two memoirs on late members—namely, N. Labroca and Prof. A. Cancani-Montani—by O. Lattes. The index gives a balance-sheet and other information in connection with the association, also the composition of the commission appointed to deal with the investigation of the standardisation of electrical measurements.

**Junior Institution of Engineers.**—Visits of this institution have recently taken place to the Brockie-Pell Arc Lamp Works and to the New Ritz Hotel, Piccadilly, where the skeleton-cage system of construction was seen. At the former establishment the members were received by Mr. James Brockie, the inventor of the Brockie-Pell lamp, who gave a very interesting account of its development and construction, and described generally the necessary characteristics of an efficient arc lamp. In the workshops a number of lamps of different types were shown in course of manufacture, and in the testing-room demonstrations were carried out to illustrate the effect on the arc of two methods of regulation — namely, differential and shunt coil only. This served to illustrate that with the shunt coil alone the current might be varied very considerably without affecting the length of the arc, whereas with the differential method the variation in length of the arc was very considerable with the same change in the current strength. The two lamps were run in series, so that each had the same current passing through it.

**Franklin Institute.**—We have received a copy of the March issue of the *Journal* of the Franklin Institute (Philadelphia), which contains papers on "Radium and Radioactivity in General," by Mr. R. H. Bradbury; "Telephone Line Engineering," by Mr. C. J. H. Woodbury; "An Ammeter for High-Potential Currents," by Mr. H. C. Snook; "Determination of Exponents in Adiabatics," by Mr. T. W. Gardner; and "A Simple Method of Calculating Water Analyses and amounts of Substances to be added for Preventing Scale and Corrosion in Boilers," by Mr. S. S. Sadtler. We notice that in the paper on "An Ammeter for High-Potential Currents," the instrument described is an ammeter for measuring currents flowing in the secondary circuits of induction coils. A D'Arsonval system is used, modified by placing a small condenser in parallel with the moving coils and its calibration shunt to compensate for the high-rate change of current, and by a ground on one side of the system to prevent sparking between the meter parts. The instrument is especially adapted for use in X-ray work, because it was found that the quantity of X-rays was directly proportional to the current flowing in the tube.

**Pneumatic Dispatch.**—The Electricity Committee reported to the St. Marylebone Borough Council yesterday that at an interview with the Metropolitan Pneumatic Dispatch Company, the representatives of the latter stated that their scheme would reduce street traffic by 30 per cent, which would be substantial compensation for the inconvenience resulting from the opening of the streets. Possibly there is an element of optimism about the estimate of 30 per cent., but if that figure be approached it will be a distinct factor in the solution of the London traffic problem. The company are willing that a clause shall be inserted in the Bill stipulating that their electric mains shall not be used for any purposes other than those of their scheme. It appears that, if the project is sanctioned, the municipalities are likely to gain a customer for power, as the company are desirous of taking this from the borough councils. The engineers of the company and the St. Marylebone Council are to discuss the question of terms, pending which the Council have deferred any action

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in the matter. A number of petitions have been lodged against the Bill, though many of them are of a formal character only. The advantages offered by the company's scheme at least merit a fair hearing.

**Canadian Mineral Production.**—The Geological Survey of the Dominion has issued a preliminary statement of the country's mineral production for 1904, which shows the value of the products to aggregate over £12,000,000. This is a slight decrease as compared with the previous year, but it appears to be attributable to a return to normal conditions, the values for recent years having been swollen by the rapid exploitation of the richer and easily accessible portions of the Yukon gold placers. Gold and coal now share first place among the Dominion's minerals, and as each represents 27 per cent. of the total production they constitute together more than half of the country's mineral values. Following these metals come copper, nickel, silver, lead, asbestos, petroleum, and pig iron, in the order named. An electrolytic lead refinery is in operation at the Canadian Smelting Works, Trail, B.C., producing pig lead, lead pipe, sheet lead, etc. Last year 19,000 tons of lead were produced, as against 9,070 tons in the previous year, but the output was a long way behind the maximum of 31,584 tons attained in 1900. Copper showed a moderate advance in production, the falling-off in Ontario being more than made up by the increased yield of the Boundary district and the Coast district of British Columbia. The exports of iron ore were 168,828 tons, valued at £80,000. In addition to the exports, about 180,932 tons were used in Canadian blast furnaces. About 530 tons of zinc ore were shipped during the year.

**Electrical Exhibition.**—The first meeting of the Executive Committee was held at the Hotel Cecil last week, when it was decided that the exhibition should be held at Olympia from Sept. 25 to Oct. 21. Instructions were given to issue the prospectus as soon as possible, many applications for space having been received. Finance and general purposes committees were appointed, and Sir William Preece was unanimously invited to accept the presidency of the exhibition. Messrs. Bridges and Smith, Balfour House, Finsbury-pavement (to whom all enquiries respecting space should be addressed), were appointed managers. The Executive Committee as appointed to date consists of Messrs. S. W. Baynes (St. Pancras electricity works), H. Bevis (General Electric Company), O. H. Bishop (Edison and Swan, Limited), H. W. Butler (Electrical Power Storage Company), E Cunliffe Owen (Metropolitan Electric Supply Company), S. T. Dobson (St. James's and Pall Mall Electric Light Company), T. C. Elder (Brush Electrical Engineering Company), C. S. Northcote (Verity's, Limited), H. Oppenheimer (International Electric Company), W. L. Packenham (Crompton and Co., Limited), W. H. Patchell (Charing Cross and Strand Electricity Supply Corporation), R. Portheim (Bruce Peebles and Co., Limited), and J. E. Kingsbury (Western Electric Company). The Municipal Electrical Association have still to elect their representative. We understand that the enterprise is meeting with cordial support from companies and municipalities all over the country, and this unanimity augurs well for its success.

**Turbines.**—On Monday evening Mr. J. D. Bailie, A.M.I.E.E., delivered a lecture before the Sheffield Society of Engineers and Metallurgists upon "The Parsons Steam-Turbine and its Applications." After tracing in detail the progress of the steam-turbine, Mr. Bailie described various turbine-driven steamers, and presented views and descriptions of the large new Cunarders built by Messrs. John Brown and Co. He showed curve diagrams exhibiting the results of exhaustive trials of the turbine-driven cruiser "Amethyst," as compared with the "Topaze" and other similar vessels driven by reciprocating engines, showing the enormous gain in efficiency due to the turbines and the consequent greater radius of action. With an allowance of 750 tons of coal, the "Amethyst" can travel 3,160 sea miles at 20 knots, as against the 2,140 sea miles of the boats with reciprocating engines speeded up to the same rate. In the course of the discussion Mr. S. E. Fedden (the city engineer) gave some interesting facts about the performance of a 500-kw. steam turbine-generator at the Corporation electric light station, which was bought from the Paris Exhibition, delivered at three weeks' notice, erected and set to work on full load within three days, and kept running for 19 or 20 hours a day for two years without stoppage or need for repair. When opened it was found that not only was there no wear on the vanes, but they had slightly thickened owing to a film deposited on them. The economy of the turbine-generator was fully maintained. He believed that the turbine-generator would take the place of the reciprocating engine for both continuous and alternating current generation.

**Deltabeston Wire.**—In our issue for Jan. 6 we gave a description of some field coils manufactured in the States with asbestos insulating wire to enable them to stand high temperatures. We now hear from the manufacturers of this wire giving us some more information respecting the same. The firm in question is the D. and W. Fuse Company, of Providence, R.I. The wire is insulated with practically pure asbestos, which makes it indestructible as far as temperature is concerned. The information given respecting this material as compared with cotton-covered wire is interesting at the present juncture, when the Engineering Standards Committee's report is under consideration. Thus the D. and W. Fuse Company state that investigations prove that at a temperature of about 147deg. C. cotton-covered wire will in time char to an extent that will break down its insulation. It was further ascertained that at 199deg. C. cotton-covered wire began to smoke in 20 seconds. At 239deg. C. it was distinctly discoloured in 50 seconds, and complete carbonisation had taken place at 245deg. C. in 2 minutes and 15 seconds. These temperatures are, of course, excessive, yet they go to show how short a space of time is necessary to ruin the field or armature windings on a railway motor where subjected as they are at times to enormous overloads. Deltabeston wire tested under identically the same conditions—in fact, subjected to identically the same volume of current—is absolutely unaffected. Reference to our note of Jan. 6 will show that after the coils have been wound with this asbestos insulation they are thoroughly dried, and then immersed in a paraffin insulating compound, which makes them waterproof.

**Cantor Lectures.**—The third of this series of lectures on telephony was delivered by Mr. H. L. Webb at the Society of Arts on Monday last. It dealt with the subject of switchboards. The lecture was largely illustrated with lantern slides, and concluded with what is an innovation—a welcome one—in scientific lectures, a series of biograph views illustrating the actual work in a telephone exchange. Early switchboards naturally partook of the character of telegraphic equipments. No one at first seemed to realise the possibilities of telephonic expansion. Mr. Webb in this lecture described the evolution of the modern switchboard. He commenced with the very earliest forms, illustrating them with models kindly prepared by the Western Electric Company, showing in the first instance the different methods adopted to get signals to and from subscribers. He compared the telephonic system to the nervous system in human beings. One set of nerves sent a call to the brain, another set carried the reply back from the

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brain. Then came the quick and necessary improvement in switchboard work, till with somewhat complex mechanism the result is simple and mostly automatic. The lecturer successfully combated the idea that a modern telephonic installation was a simple thing, requiring no engineering skill. On the contrary, it is a highly complex matter, requiring great technical skill to design and carry out, and is a power station as well. Another idea that the women employed are given to taking it easy was exploded, the biograph pictures being called in to help. And Mr. Webb was truly right. The modern telephone exchange is a wonderful institution, and allows no laxity either of brain work in the engineering staff or of active physical work in the operating staff.

**"Pertinacious" Currents**—At the Royal Institution last Friday, Sir Oliver Lodge enunciated the nature of the electrical current upon which he has conferred the designation "pertinacious." By this he simply meant a high-potential continuous current, which was obtainable from a voltaic battery with a quantity of cells in series, though that was an inconvenient and expensive method. An alternating-current dynamo could be reversed by means of the commutator, so that an approximately steady current was obtained, but with commutating devices it was not easy to employ high voltages. One way of obtaining high-potential continuous currents was by the use of a one-way rectifier. If a current were taken through the primary of a Ruhmkorff coil and a Caldwell break, and the secondary was connected to a number of Leyden jars, the provision of a rectifier which would allow the supply current to pass one way, but prevent all exit the other way, would enable the jars to be charged to bursting pressure, so that they could maintain a pertinacious current through a leak or other high resistance with which they might be provided. An arrangement of this type was of service for fog dissipation. He suggested that the action of the rectifier was due to the rapid clearing away from the anode of all the carriers of positive electricity, by means of the bombardment from the cathode, and to the fact that the current could only be conveyed by the agency of these positive carriers when they were allowed to come into actual contact with the positive terminal. The bombardment was found in time to create so high a vacuum in the vessel that no current at all could pass. It was therefore necessary to employ in the rectifier a vapour, such as that of mercury, the supply of which could easily be maintained from inside the vessel. Sir Oliver prefaced the lecture with some of his early reminiscences of the Royal Institution, which had acted as an inspiration to him.

**Patents.**—A memorial, with a large number of names eminent in engineering and science attached, has been presented to the President of the Board of Trade with special reference to No. 10 of the regulations which came into force on Jan. 1 last. In a covering letter the petitioners state that the Act of 1902 was designed, as shown by Section 1, to afford both to the inventor and the public the benefit of an official examination as to novelty, without incurring the serious risk of inflicting injury upon the inventor by refusing a patent for alleged want of novelty or by making public adverse official opinions. Rule 10, however, appears to be based upon the assumption that the Patent Office is charged with the function of publishing an official opinion to the world by placing an endorsement upon the specification whenever it appears to the examiner or comptroller that no patentable invention is disclosed, instead of merely requiring the applicant to mention any prior specification a knowledge of which might be deemed necessary to enable the public to form an accurate opinion. This latter seems to represent the intention of the Act of 1902, and the petitioners consider that Rule 10 is *ultra vires*, besides being unjust. The oppressiveness of the regulation is accentuated by the fact that an examiner, or even the comptroller, while acting with the best possible intentions, might well err in construing an invention as an anticipation when experts have disagreed upon similar points. We think that with the exception of this clause the new regulations mark an advance upon our previous legislation, but it is surely sufficient for an inventor to refer to any prior specification without handicapping him in the commercial world by denoting his patent with an official expression of opinion. We hope, therefore, the President of the Board of Trade will see his way to comply with the prayer of the memorial by amending Rule 10, even if a short enabling Act be necessary.

**Radioactivity.**—Concluding his course of lectures on the "Electrical Properties of Radioactive Substances" at the Royal Institution on Saturday, Prof. J. J. Thomson discussed in the first place the energy given off by radium. He pointed out that most of it was contained in the $\alpha$ particles, which contained such a quantity of energy that it could easily be detected by electrical methods, even when the rays were emitted at the rate of only one a minute, the test being infinitely more delicate than anything that could be accomplished chemically. Dealing with the recently-discovered $\delta$ rays, the lecturer explained that they were certainly given off by an alloy of sodium and potassium under the influence of light, and perhaps without light. Rubidium yielded them still more freely, and probably they were also emitted by substances not classed as radioactive. Prof. Thomson observed that in radium the particles as a whole were behaving in a commonplace manner, but here and there some of them were undergoing the change that was the source of radioactivity and were suffering a breaking-down process, which had already been traced through several stages It was only at the end of its career, after persisting unchanged for centuries, that the radium atom showed any peculiar properties. Incidentally, the lecturer deduced from this a warning against assuming too hastily that because a phenomenon, such as the rising of the sun, had happened an indefinite number of times in the past, it was therefore going to continue indefinitely in the future. Prof. Thomson concluded by considering whether radioactivity is a widely diffused property or is confined to a small number of substances. The question was complicated by the fact that naturally radioactive bodies imparted the property to other substances, but he thought the investigations carried on in the Cavendish Laboratory, Cambridge, demonstrated that many common-place substances were intrinsically radioactive, though in a very small degree.

**The Optical Convention**—The arrangements for this convention are now beginning to assume definite shape. The convention will be formally opened with an address from the president, Dr. R. T. Glazebrook, director of the National Physical Laboratory, on Tuesday evening, May 30, and the gathering will extend over the four following days, up to and including Saturday, June 3. The mornings will be devoted to papers and discussions, and in view of the interesting series of papers already announced, it is expected that this most important section of the proceedings will result in valuable contributions to optical science, and will fulfil the aims which those who have been active in promoting the convention have set before them. In addition to the papers, including one on "The Polarisation of Light," by Prof. S. P. Thompson, demonstrations of apparatus of special interest will be given in the afternoon in the laboratories

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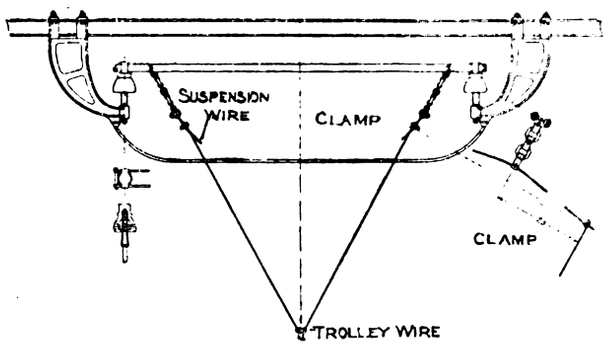
of the department of technical optics of the Northampton Institute. The exhibition of optical and scientific instruments will be held in the large hall of the Northampton Institute. To ensure adequate treatment, it has been arranged that each section shall be dealt with by an expert in the construction of the instruments represented in the section, together with an independent scientific member of the committee. The catalogue is now in active preparation, and the hon. secretary would be glad to hear from firms wishing to take a number of catalogues for private distribution. The social side is not being lost sight of, a hospitality and entertainments committee having been formed. Amongst other things, this committee is arranging for a conversazione and for the attendance at the convention of visitors from a distance. It is also proposed to pay a visit to the National Physical Laboratory at the invitation of Dr. Glazebrook. The hon. secretary is Mr. F. J. Selby, Elm Lodge, Teddington, and the secretary of the Local Societies' Committee is Mr. W. Rosenhain, 443, Gillott-road, Edgbaston, Birmingham, to whom all communications respecting the attendance of visitors from a distance should be addressed.

**Single-Phase Railway.** — Nieder-Schoneweide and Spindlersfield, Germany, have recently been connected by a single-phase railway, of which a description appears in our New York contemporary, *Electricity*. The line, which is about three miles in extent, was constructed by the Union Elektricitäts-Gesellschaft, of Berlin. Current is generated at a tension of 6,000 volts and a frequency of 25 cycles per second. Some features of interest are presented by the overhead equipment. On some portions of the line a method of single suspension is in use for the overhead conductors, the line being suspended from side bracket arms. In other places double bridle wires are employed. From the accompanying illustration it will be




seen that the wire is supported freely, and yet so as to provide against a failure of one of the suspension wires. Short lengths of wire connect the trolley wire to the bridle wires, which are in turn supported by rubber chains from a bar insulated from the bracket arm. The bar below the bridle wire is connected to the metal pole and thence to the rails. In case of the failure and breakage of one of the suspension wires it would touch this earthed bar, producing a short-circuit and throwing out the circuit breaker protecting the line. It can be seen from this that with the double-suspension system great safety is insured. Telegraph and telephone wires passing over the trolley wire are completely surrounded by a wire cage, which keeps them from coming into contact with the high-tension line. Where passing under steel girder road bridges, heavy insulators mounted on a wooden framework are used.

**Commutator Brush holder.**—A form of commutator brush-holder has been designed by Mr. Ernst Woehr, of Wilkinsburg, Pa., for obviating the disadvantage of the box-tight brush-holder. In the latter, unless a spring is used which takes up a great deal of space, the pressure of the brush against the commutator becomes rapidly lessened as the brush wears away. In Mr. Woehr's arrangement, which is described in the *American Electrician*, the brush is pressed towards the toggle links, 6 and 8, pivoted to the framework at 5, and having the knuckle at 7, as shown in Fig. 1. A spiral spring, 9, pulls on the link, 6, and forces

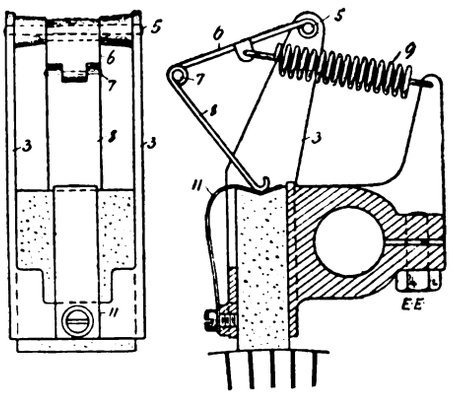



FIG. 1.

the brush downward. As it wears away, and the lower end of the link, 8, follows it down, the toggle angle becomes greater and greater, increasing the leverage of the spring, 9, over the toggle sufficiently to compensate for the decreased pull of the spring as the spirals contract. A thin conducting leaf, 11, is secured at one end to the brush box, and its other end is pressed against the upper end of the brush by the toggle link, 8. A modification in which two toggles are used, the two being drawn together by a spring attached to both, is illustrated in Fig. 2. The lower ends of the links, 8 8, are connected by a pivot, the pivot pin being

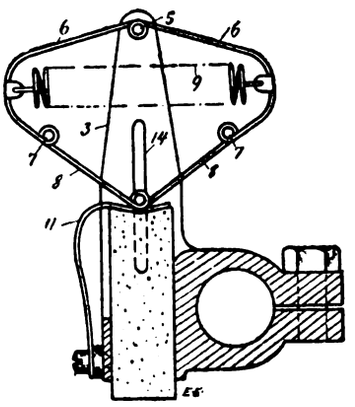



FIG. 2.

extended through a guide slot, 14, to keep the ends on the middle of the brush end, which is shaped to facilitate this in both forms of the device.

**The Institution.**—The joint discussion on Mr. E. H. Rayner's and Mr. R. Goldschmidt's papers, entitled respectively "Report on Temperature Experiments at the National Physical Laboratory" and "Temperature Curves and the Rating of Electrical Machinery," occupied the attention of members at last week's meeting. At the previous meeting Dr. Glazebrook, as director of the National Physical Laboratory, had briefly reviewed the experiments carried out there, and expressed a hope that they would prove of service to the industry. On the discussion being resumed, the ball was opened by Dr. S. P. Thompson, who, after congratulating Mr. Rayner upon producing an admirable paper, proceeded to attack Mr. Goldschmidt's formulæ, albeit in the most friendly spirit. The paper, said the professor, was a distinctly valuable one, and he only desired to ask the author to render it more so by elucidating a few matters of detail. In one respect he thought Mr. Goldschmidt's calculations could be mate-

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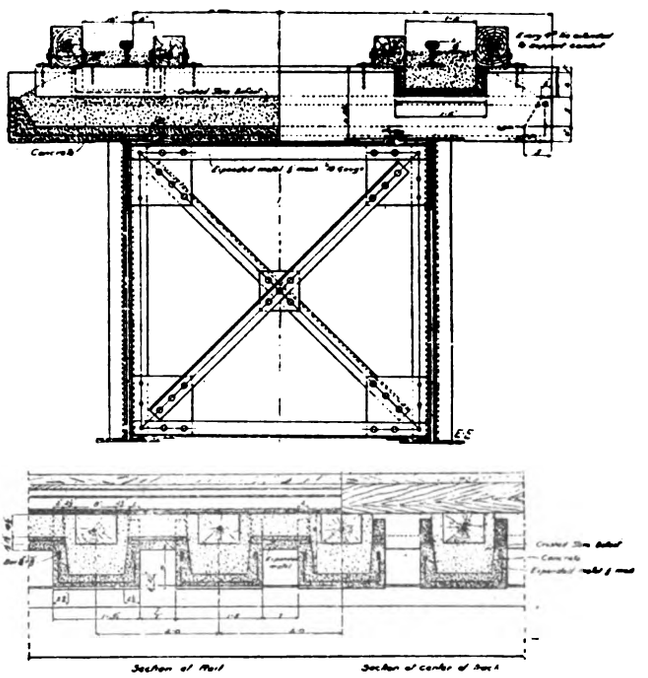
rially simplified, as the number of watts necessary to produce any temperature rise on the assumption that no heat is being given off by radiation can be ascertained by first principles from the specific gravity, specific heat, and calorific value. The next speaker was Mr. Hobart, who, getting off the mark at a quick pace, maintained express speed throughout. He complimented Mr. Rayner upon his investigations, which must have involved a great deal of work, but he suggested that more diversity might have been introduced into the methods employed. Then Mr. Miles Walker gained appreciation by enunciating a method of calculating the temperature of field coils by deduction from, say, the first two factors. The other speakers were Messrs. R. F. Berry, F. S. Russell, A. Russell, and J. S. Peck, the general tenour of the discussion being favourable to the authors, though a certain degree of misapprehension on various points appeared to exist. Replying, Mr Goldschmidt and Mr. Rayner in turn gave a concise review of the matters in question, the latter remarking that he had found Prof. Thompson's suggested method of ascertaining approximately the watts required to produce a certain temperature rise unsuitable. Preparatory to submitting a vote of thanks to the authors, which was carried unanimously, the President said that Mr. Rayner's paper was a highly valuable one, especially if taken in conjunction with the report of the Engineering Standards Committee. He had been much struck with the fact that the insulation resistances of the cotton-covered field coils remained constant for a certain time until the temperature of the wire began to rise, and then it went down in the most extraordinary way when the moisture was being driven out. This would account for a lot of failures in field coils in the earlier days. Mr. Goldschmidt's paper afforded confirmation that much greater work could be obtained from a dynamo for a short time than under the permanent conditions.

**Overhead Railway Vibration.**—Mr. Bion J. Arnold has recently made an extensive report to the Chicago City Council upon the best way of increasing the capacity and reducing the noise of the Union Elevated Railroad. The first part of the report deals with local conditions, which would not interest our readers so much as that which deals with a reduction of noise. It suffices to say, therefore, with respect to this first heading that Mr. Arnold advocates power mechanism for operating the switches and signals in the congested loop of the railway. He also advises an increase in the length of the stations, which will permit of longer trains being used, and the provision of more sidings at the points where certain branch lines approach the loop. With respect to the noise caused by the trains on this elevated structure, it is pointed out that a good deal of this comes from the trains, and hence cannot be entirely eliminated by any alterations in the track structure. The best, therefore, that can be done is to minimise the noise caused by the operation of the trains, and prevent it being intensified by supplementary vibrations set up in the structure and supports. Mr. Arnold reviews the various types of construction which have been used abroad, including that of the Liverpool Overhead Railway, and comes to the conclusion that a ballasted track is essential if noise is to be kept down. In the case of the Chicago Elevated Railway the rails rest immediately upon the ties, which in turn are rigidly secured to the upper chords of latticed steel trusses, thus giving the best condition that could have been devised for imparting the hammer blows, caused by the wheels upon the rails, directly to the structure, unless the rails had been placed immediately upon the upper chords or upon a metallic support between the rails and the chords. Mr. Arnold reports that if the structure had to be rebuilt, he would advocate the use of concrete throughout as a noise preventer. Under the existing conditions, however, he suggests that a ballasted floor should be provided on the present structure. The floor itself would be formed either of wood or reinforced concrete. The wooden type of floor has been tried experimentally on the Boston Elevated Railway with a marked effect towards deadening the sound. A steel floor could be used, but this is objectionable, not only because of the noise, but also because the steel is in a position where it is exposed to corrosion from water, oil, and greases, which find their way down through the ballast. The concrete floor is free from these objections, and when reinforced with expanded metal can be made in sections and afterwards placed in position. The principal objection to its use, apart from the cost, is that it would obstruct the light, and also give trouble from snow in the winter. In this respect the Liverpool Overhead line is an example of how the snow difficulty has been overcome, and Mr. Arnold thinks that snow-collecting devices could be used with success in Chicago. The increased weight of the



floor, as compared with the present means of supporting the rails, varies from 1,680lb. per lineal foot of track to 1,080lb. The increased weight would mean increased stresses in the structure, but it is pointed out that there would be at the same time a considerable reduction of impact, due to the blows being distributed over a wider area. The report advises that three forms of construction should be tried experimentally at Chicago. The first of these would have a wooden floor, and the other two would have floors made of concrete. Besides this, experiments would be made with three different forms of ballast, in order to see which was most effectual in reducing noise. After this has been done and the best construction determined, the whole of the lines in the centre of Chicago could be altered. Mr. Arnold claims that the experience gained in the application of ballasted floors to railroad bridges has shown that the track maintenance has been reduced to such an extent that the saving is more than sufficient to pay the interest on the increased investment made necessary by its adoption. The illustration herewith shows one form of floor which the report recommends should be tried. In this it will be seen that the sleepers carrying the rails rest on ballast, which in turn is carried by the reinforced concrete.

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## ARMATURE WINDINGS OF THE CLOSED-CIRCUIT TYPE.

BY WM. CRAMP.

(*Continued from page 403.*)

### Multiplex Two-Circuit Windings.

**Double Winding Doubly Re-entrant.**

Suppose we had a machine like Fig. 14, which, though it gave its right voltage and current, was not satisfactory as regards its commutation. We should think immediately that the commutation would be improved if we had more commutator sections. But we cannot get more, as we already have the maximum—*i.e.*, one section for every pair of inductors. The obvious thing to do, then, is to use in place of each inductor two inductors, each of half the section of the original. Or, in other words, place another winding upon the armature in system exactly similar to the present one, and thus double the number of sections. To show how this may be carried out, one or two inductors have been placed on the armature of Fig. 14 at G, H, K. And from this it is clear that the commutator to which this new winding is connected may either be entirely independent of the original commutator (say at the other end of the armature), or it may have its sections interleaved with those of the original winding. Thus the segment attached to H K would come next to that of 1—6, as shown dotted. Similarly that belonging to L and M would fall next to that attached to 2—15. If each brush be wide enough to touch at least two sections, the two windings so arranged will be constantly in parallel with respect to the brushes and the external circuit; and on account of the greater number of commutator sections the commutation is performed more gradually, and is likely to be more satisfactory.

Such an arrangement is called a two-circuit double winding, and since each winding is independent of the other, it is doubly re-entrant, and has the symbol o o. This and the single winding first described, are entirely analogous to the double winding of Fig. 10 and to its corresponding single winding respectively.

**Effect on the Previous Formula.**

It is interesting to note the effect of adding this other winding on the general formula.

Between every pair of the original inductors is one of the new ones, as H between 1 and 2. So that $w$ is twice what it was. Similarly, if the inductors be numbered consecutively, 6 becomes 11 and K becomes 12, etc.

The first winding goes:

$$1 \text{ ——} 11 \text{ ——} 21 \text{ ——} 31 \text{ ——} 5,$$

and the second winding goes:

$2$ —— $12$ —— $22$ —— $32$ —— $4$, where H = 2, K = 12, etc.

Each has a pitch of 10: an *even* pitch. And if the original single winding had $w$ inductors, it was according to the formula

$$w = p\,y \pm 2$$
$$18 = (4 \times 5) - 2,$$

and the new winding is

$$2w = p \cdot 2y \pm 4$$
$$36 = (4 \times 10) - 4.$$

We notice in this formula that not only are $w$ and $y$ doubled, but also the creep, so that the formula for such a case may be expressed by

$$w = p\,y \pm 2m,$$

where $m = 2$.

**Multiplex Windings of Multiple Re-entrancy.**

Similarly, had we wished to treble the number of commutator sections, we might have done it by splitting the winding of Fig. 14 into three parts: then between inductors Nos. 1 and 2 there would be two inductors, as H and another one. The formula becomes

$$3w = p \cdot 3y \pm 6,$$

or writing $w$ for the *total* number of inductors and $y$ for the new number-pitch,

$$w = p\,y \pm 2m,$$

where $2m$ is still the creep and $m$ is the number of independent windings.

For two-circuit armatures, then, where each winding is independently re-entrant, we have the general formula:

$$w = p\,y \pm 2m,$$

where $w$ is equal to the *total* number of inductors;

$p$ is the number of poles;

$y$ is the mean number-pitch; and

$m$ is the number of windings.

Again, since $w$ was before (and must always be) divisible by 2, now in the case of a double winding doubly re-entrant must it be divisible by 4, there being two similar windings on the armature; and this is independent of the number of poles. For a triple winding triply re-entrant $w$ must be divisible by 6, and so for $m$ independent windings $w$ must be divisible by $2m$.

**Question of Odd or Even Number-Pitches.**

We have just found that in the double winding with 36 inductors the number-pitch worked out at 10, an even number, yet it was not necessary to take two number-pitches alternately,

$$y + 1 \text{ and } y - 1,$$

as was done in the case of the single winding of Fig. 19.

The reason of this is that $10 = 2 \times 5$—*i.e.*, is twice an odd number so that it is simply a case of two simplex windings having $y$ = an odd number.

Now if we double the winding of Fig. 19, inductor No. 8 in that diagram becomes No. 15, and inductor No. 13 becomes No. 25.

This shows clearly that the armature of this diagram might be connected as a double winding doubly re-entrant, each winding having two even number-pitches—viz., 14 and 10; $w$ in this case becoming 44. Though this is quite correct, it is better to have resort to the formula, from which we find that a double winding may be arranged with the same number of inductors (44) and $y$ = 10, and for the reason just given 10 is suitable without taking different pitches at the two ends of the armature.

Thus it would be preferable to connect this double-wound armature according to the scheme:

$$1 \text{ ——} 11 \text{ ——} 21 \quad 31 \quad 41, \text{ and so on.}$$

In all cases, when changing over from a simplex winding to a duplex winding, such points as enable a cheaper armature to be manufactured should be constantly looked for. We shall collect these results when we have examined multiplex windings of other re-entrancies.

**Multiplex Two-Circuit Windings of Various Re-entrancy.**

It has been shown that a double winding which is doubly re-entrant is just like two simplex windings placed on the same armature. It follows, therefore, that when considered as one winding (not as two separate windings), the number of inductors being in

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each simplex armature divisible by 2, the total must be divisible by 4; from which we gather also that the number-pitch, whether odd or even in each simplex winding, must in the duplex be an even number. Now, it is also noticeable in Fig. 21, which represents such a duplex doubly-re-entrant winding, that if connection A were lengthened so that it joined on to inductor No. 2, while connection B is shortened, so that it takes the place of A on inductor No. 1, the winding is not in the least interfered with, since inductors 1 and 2 are at all times practically at the same potential and carrying the same current. Such a procedure, however, has two serious drawbacks; since, in the first place, it introduces two odd end connections, and, in the second, it destroys the independence of the windings. Arrangements of this exact type are not, indeed, found in practice; but it is clear that such an armature might exist, and that, though it would still be *duplex*, it could not be called *doubly re-entrant*. We should, in fact, class it as similar to the multiple-circuit winding of Figs. 12 or 13, being, like them, double, yet singly re-entrant.

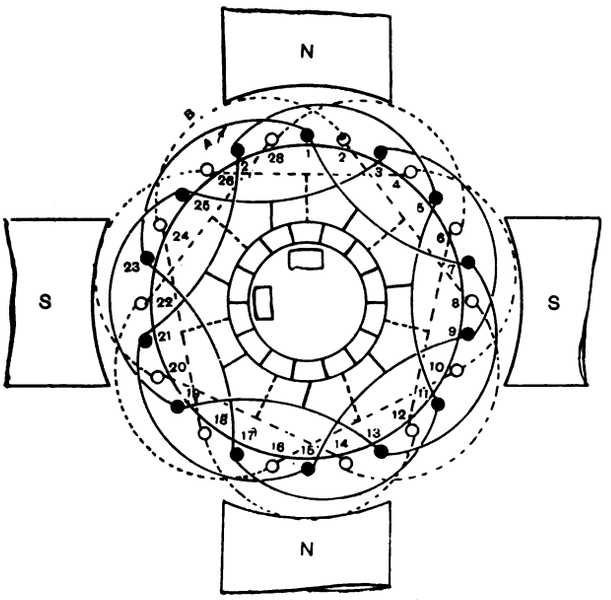


FIG. 21.

It is possible, then, to have a two-circuit double-wound singly re-entrant armature, and though, in the case above cited, there are of necessity two irregular connections, yet if we look at the reasons which cause an armature to be doubly re-entrant, we may be able to devise a method of arranging the end connections without this disadvantage.

**Reason of Independent Windings.**

Fig. 21 shows pretty clearly why the armature is doubly re-entrant.

*It is because any connection such as that from 25 to 3 is greater than the* creep *by an even number of inductors (in this case two).*

Or we may express it thus: In Fig. 21 the number-pitch is 6, and the total number of inductors 28.

Substituting in the formula these numbers,

$$w = p.y \pm 2m,$$

$$28 = 4 \times 6 + 4,$$

or $$2 \times 14 = (4 \times 3 + 2)\,2.$$

The formula thus shows that the number-pitch and $m$ have a common factor = 2, or, in other words, the armature may be resolved into two simplex singly re-entrant windings, each having 14 inductors and a number-pitch of 3.

Thus:

Either winding only picks out every other inductor, leaving the alternate inductors for the other winding. If, then, we could arrange the relationship between the pitch and the creep to be such that while the creep is still kept, that of a double winding—*i.e.*, 4—the difference between the pitch and the creep is such as shall take in, *not* every other inductor, but *all* of them, we should probably obtain the arrangement we seek. So long as the difference between the number-pitch and the creep is an even number, so long can only, at most, half of the inductors be included in any single winding. For the creep is of necessity an even number: therefore the number-pitch under these conditions must also be an even number, which means that either only the odd or only the even numbered inductors can be included in any single winding, as has already been frequently pointed out.

*(To be continued.)*

## ILFORD ELECTRICITY WORKS.

### Opening of Extensions

**On Thursday of last week there was a function at Ilford to celebrate the completion of large extensions in the electricity works there. In our issue for May 24, 1901, there will be found a full description of these works, which were opened in April of that year. Since then the history of the undertaking has been satisfactory, as the progress has been rapid both as regards lighting and traction. Thus, when the works were opened in 1901, the plant in the generating station consisted of two 200-kw. and one 100-kw. sets, each consisting of a high-speed Willans engine coupled to a multipolar generator by the General Electric Company, Limited; one booster balancer set by the General Electric Company, Limited; two batteries of 135 cells each by the Electrical Power Storage Company, Limited; three water-tube boilers by Messrs. Babcock and Wilcox, Limited. The number of consumers increased so rapidly from the commencement of the supply that it was soon found necessary to increase the capacity of the plant, and a fourth boiler was erected in March, 1902. Early in 1902 it was decided to instal two 550-kw. sets, and these were erected and completed by Messrs Dick, Kerr, and Co., Limited, in March, 1903, when the supply of current to the tramways was started. At the same time two additional boilers of the marine dryback type were installed by Messrs. J. Fraser and Sons, each of these boilers being equal in capacity to two of the boilers originally fixed. The first condensing plant and cooling tower were supplied and erected by Messrs. W. H. Allen, Son, and Co., Limited, in September, 1903. The original plant and these extensions were all carried out under the advice and superintendence of Messrs. Hawtayne and Zeden, consulting engineers to the Council.**

**Owing to the continued success of the undertaking and the rapid increase in the demand for current, the Council decided in December, 1903, to proceed with further extensions, and in July, 1904, obtained the sanction of the Local Government Board to a loan of £41,693 for this purpose. Specifications were prepared by Mr. Arthur H. Shaw, M.I.E.E, electrical engineer to the Council, and tenders were invited and contracts entered into in July, 1904, for the supply and erection of the various plant required. The extensions which have now been completed include the following plant: (1) 1,000-kw. multipolar generator by the British Westinghouse Electric and Manufacturing Company, Limited, direct coupled to a triple-expansion condensing engine of 1,600 h.p. by Messrs. Belliss and Morcom, Limited. This set is designed to run at a speed of 200 revolutions per minute, and to give an ordinary output of 2,000 amperes at 500 volts.**

**The condensing plant consists of a surface condenser capable of dealing with 27,000lb. of steam per hour, a**

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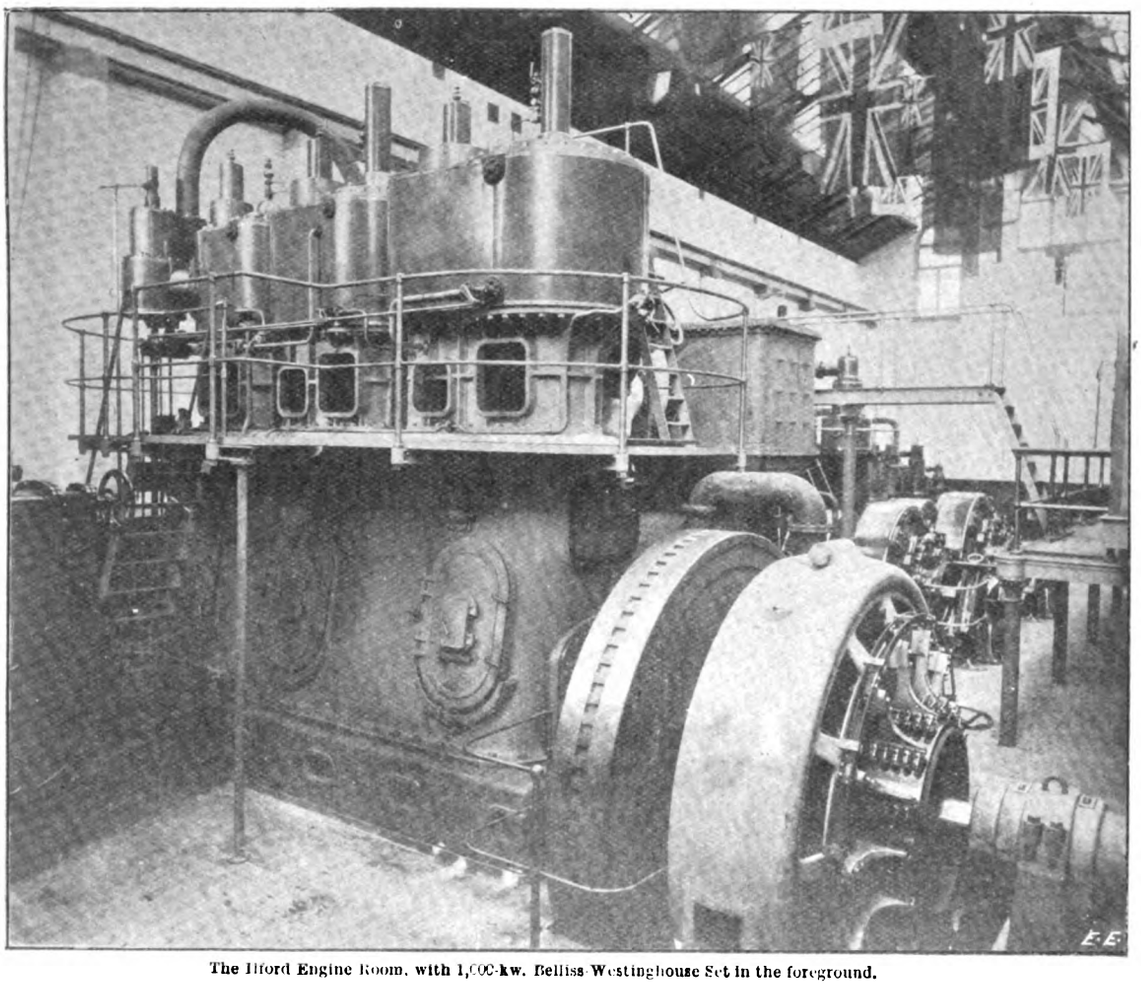
grease separator of Messrs. Holden and Brooke's make, motor-driven air and circulating pumps, Zschocke water-cooling tower, and pipework in connection therewith. The condenser, pumps, and motors are of Messrs. W. H. Allen, Son and Co.'s make, and the whole plant was supplied and erected by Messrs. W. H. Allen, Son, and Co., Limited, and is similar to that supplied by them in 1903. The pipework is so arranged that either condensing plant may be used in connection with either cooling tower, and also that either condenser may be used in connection with the new engines, or with the main exhaust of the smaller engines. Provision is also made for running any or all of the engines with exhaust to atmosphere.

The extension switchboard panels for use in connection with the new plant, together with all instruments and cables, were provided and erected by Messrs. Kelvin and James White, Limited, who have also provided the works distributing board, from which independent circuits are run to all the auxiliary station plant, such as boiler feed pumps, condensing plant, station lighting, etc., so that the current taken by each individual portion of the plant may be separately measured. The British Westinghouse Electric and Manufacturing Company, Limited, have also supplied the balancer set and switchboard in connection therewith, which is of sufficient capacity to deal with any development in the future. They have also supplied the reversible booster set and switchboard for use in connection with the battery on traction load, by which it is anticipated a considerable saving will be effected.

A water-purifying plant has been erected by Messrs. Lassen and Hjort in the yard, adjoining the engine-room, for dealing with the condensed water from the engines. By its use all trace of grease and other deleterious matter which may be contained in the water is eliminated, and a perfectly pure water obtained for the boilers, whereby the life of the boilers will be increased, and the labour on boiler cleaning much reduced.

The extensions to the engine-room and switchboard gallery have been carried out to the designs of and under the superintendence of Mr. H. Shaw, A.M.I.C.E., surveyor to the Council—the former by Messrs. F. and A. Wilmott, and the latter by Messrs. Norton Bros. A gangway has been erected connecting the switchboard gallery with the boiler-house, giving the engineer on duty direct access to the boiler-house. The steel tower and separating tank in the yard have also been supplied and erected by Messrs. Norton Bros. The water from the well will be raised by compressed air to this tank, where the air will be separated from the water, which will then flow by gravity to the tramway tank and to the large tank recently erected at the Council's new depôt. An Ados $CO_2$ recorder has been installed in the boiler-house, by means of which samples of the flue gases are taken at frequent intervals and analysed, the result being marked on a chart showing whether the coal is being fired to the best advantage or not. Coal-bunkers have also been provided, and a weigh-bridge installed at the entrance to the yard; the yard itself, opposite the boiler-house, being paved with scoriæ setts.



The Ilford Engine Room, with 1,000-kw. Belliss-Westinghouse Set in the foreground.

The following table will give some idea of the progress of the undertaking from its commencement:

TABLE SHOWING PROGRESS OF ILFORD UNDERTAKING.

| Years ending March 31. | Units sold. | | | No. of consumers | No. of equivalent 8-c.p. lamps connected. | Capacity of plant. | |
|---|---|---|---|---|---|---|---|
| | Lighting | Traction. | Total. | | | Kw. | H.P. |
| 1902 | 403,144 | — | 403,144 | 424 | 16,919 | 500 | 900 |
| 1903 | 749,576 | 22,613 | 772,189 | 1,070 | 36,230 | 1,600 | 2,500 |
| 1904 | 1,077,370 | 563,464 | 1,640,834 | 1,475 | 48,450 | 1,600 | 2,500 |
| 1905 (estimated) | 1,273,715 | 573,300 | 1,847,015 | 1,950 | 58,000 | 3,600 | 4,100 |

The inauguration of the new large generating unit was celebrated on Thursday. The chairman of the Lighting Committee, Councillor John Bodger, presided, and called upon Mr. A. H. Shaw to give a description of the new works. The chairman of the Ilford Council was then asked to declare the works open and to start the machinery. This Councillor R. Stroud, J.P., proceeded to do, after

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complimenting all concerned on the progress of the undertaking. The rest of the proceedings were devoted to votes of thanks, the contractors being included in this honour.

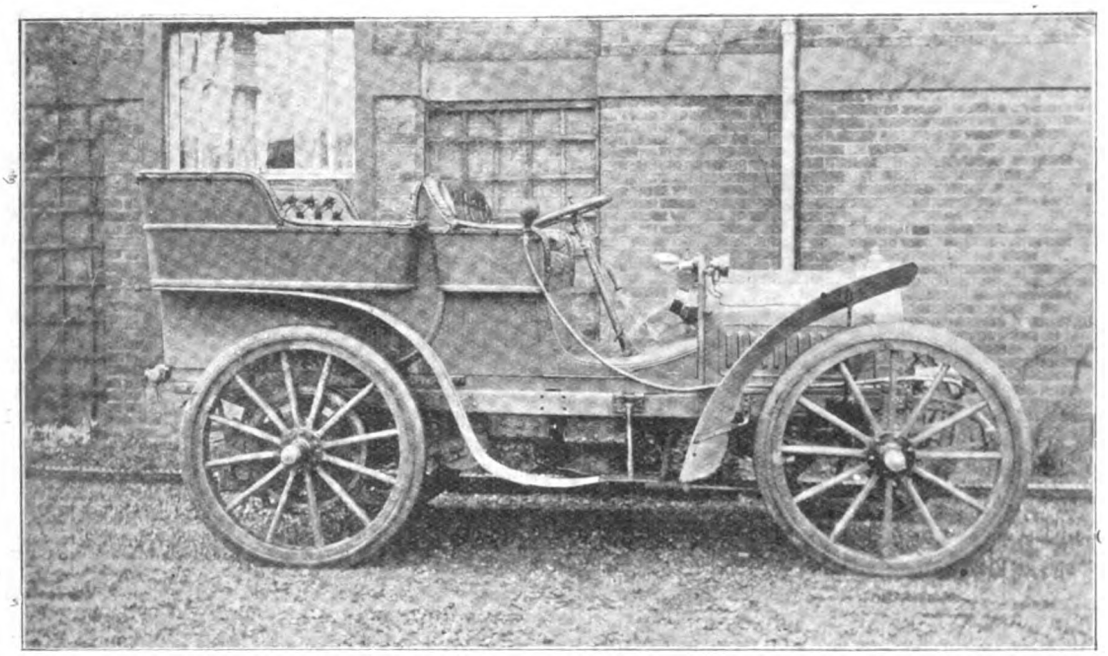
## ELECTRIC MOTORCARS.

Among those cars which were to be seen at the recent automobile exhibitions, and which we briefly described last week, were those of the Electromobile Company, and the Dynamobile exhibited by Messrs. Kuettner, MacDonnell, and Cookson, Limited. The electromobile cars are already very well known, but they have been further improved in detail and possess characteristic features. The frame of the chassis is of pressed steel with rolled-steel transverse members, it is straight in elevation and rectangular in plan, and the long semi-elliptic laminated springs upon which the vehicle is carried ensure easy travelling.

A single motor, rated at 8 b.h.p. at 1,500 revolutions per minute, is carried upon the fixed tubular housing of the rear live axle, and at the side remote from the axle is spring-suspended to relieve the transmission gear from shocks and to enable the car to be started smoothly. Double-reduction, double helical gearing is used between the motor and the differential gear, and by enclosing the whole of the gearing it can be effectively and copiously lubricated, resulting in silent running and pronounced freedom from wear. The motor is of MM. Contal and Gasnier's design, and is series-wound with two separate commutators connected to two separate armature windings. It is totally enclosed, and is provided with large inspection doors to give access to the commutators and carbon brushes. The latter are of the type successfully adopted by Messrs. Greenwood and Batley for their small motors. The controller is carried at the front of the car below the top line of the frame, and its aluminium framework is bolted to two longitudinal frame angles, which also provide a point of attachment for the steering gear. A sheet metal casing below the controller protects it from road dirt and wet, and it may be readily inspected through a trap-door in the floor boards immediately above it. It provides for a range of speed of from three to fifteen miles per hour for forward running, two electric brakes, and one reverse speed. The handle actuating the controller is conveniently placed immediately below the steering wheel, and operates through a tube concentric with the steering column and through bevel gearing, and an index plate below the handle indicates the controller positions for the different speeds.

The battery box is slung below the centre part of the frame, and this position has been adopted to render the changing of batteries easy and to obtain a low centre of gravity, together with other advantages. The battery consists of 44 Contal cells of the pasted type, weighing about 10cwt., and its capacity is 135 ampere-hours. Arranged as a victoria the capacity is sufficient to propel the car 40 miles, or as a double landaulet 30 miles. Experience has shown that with the particular form of plate used the positive plates have a life of from 12 months, and they are cheap and easily renewed. The cells give a one-hour discharge at 90 amperes, three hours at 45 amperes, five hours at 30 amperes, and 9½ hours at 20 amperes.

The Dynamobile touring car exhibited at the Agricultural Hall did not occupy a prominent position, and was probably missed by many who would have been interested in it. It is a modern example of the combination of petrol engine, dynamo, and motors, and in its design the undesirable features possessed by earlier vehicles of this type have been avoided. In appearance it is similar to the majority of petrol cars, and the two-cylinder Fafnir engine of 12 h.p. is carried on the frame beneath the front bonnet. It drives a four-pole compound-wound generator, and supplies current to two series-wound four-pole motors, spring suspended, and independently driving the rear road wheels through single-reduction gearing. The generator and motors are constructed by Messrs. E H. Geist, of Cologne, and it is claimed that their efficiency is such that 80 per cent. of the horse-power delivered to the generator is delivered to the road wheels. If this claim is not entirely realised, this efficiency of transmission still compares favourably with that obtained with many forms of transmission gear in common use with petrol-propelled cars.



The Dynamobile Light Car.

The engine is governed and the car may be entirely controlled through a single lever operating the controller. The driving of the car is thus rendered as simple as that of the ordinary battery-equipped electric car, for under the conditions of running the engine requires little attention other than occasional adjustment of the ignition lever and attention to lubrication. No cells are required other than those used for the electrical ignition system for the engine, and these are arranged to light the car lamps. They are kept charged by the dynamo, and the necessary periodical removal of the cells from the car necessitated with the petrol-propelled car is avoided. An objection to this type of car has hitherto been their weight, but we understand from Messrs. Kuettner, MacDonnell, and Cookson that the 12-h.p. car with tonneau body, arranged to seat six persons, only weighs one ton. With this satisfactory reduction of weight the great objection to these cars disappears, and the advantages they possess in simplicity of control ought to rapidly advance their use.

The Dynamobile system has been applied to heavy vehicles, and allows of front driving without in any way

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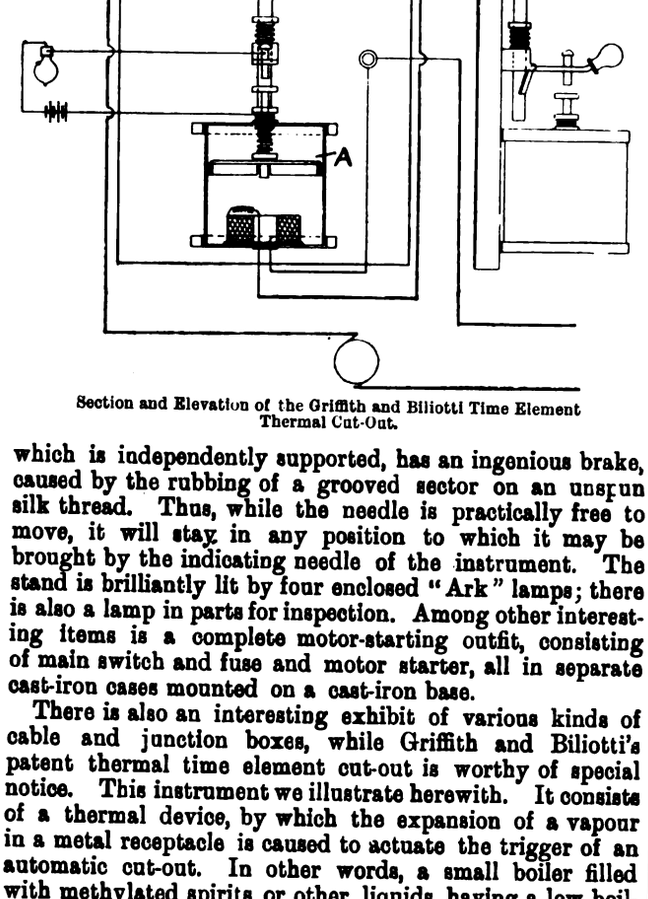
complicating the steering gear. We hope to have more particulars of their application for industrial purposes and some results of their performance later.

## HOLBORN AND FINSBURY ELECTRICAL EXHIBITION.

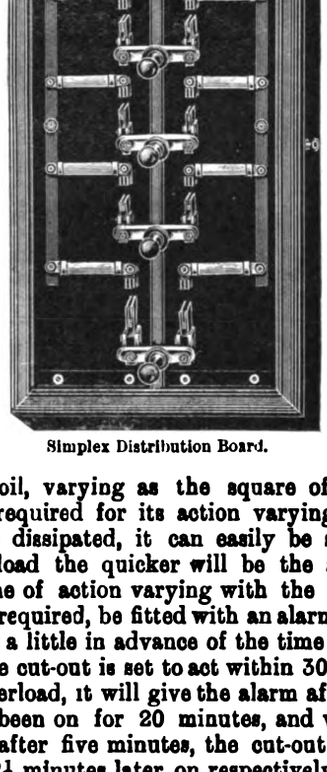
Amongst the stallholders at this exhibition are Messrs. Johnson and Phillips, who, on Stand No 36, have an attractive exhibit of switchboard and portable ammeters and voltmeters of various ranges and types, including hot-wire maximum demand, recording, illuminated dial station type of round and sector pattern, hot-wire and moving-coil instruments, vertical and horizontal edgwise moving-coil, electromagnetic air-damped instruments, portable moving-coil voltmeters of three and four ranges, portable electro-magnetic instruments, portable hot-wire ammeters and voltmeters, pocket instruments. The hot-wire maximum demand instruments are especially interesting, as they afford the means of recording the maximum reading either of the voltage or current, as the case may be. In order to do this a second needle is added, which is carried forward by the indicating needle of the instrument. This second needle,




Section and Elevation of the Griffith and Biliotti Time Element Thermal Cut-Out.

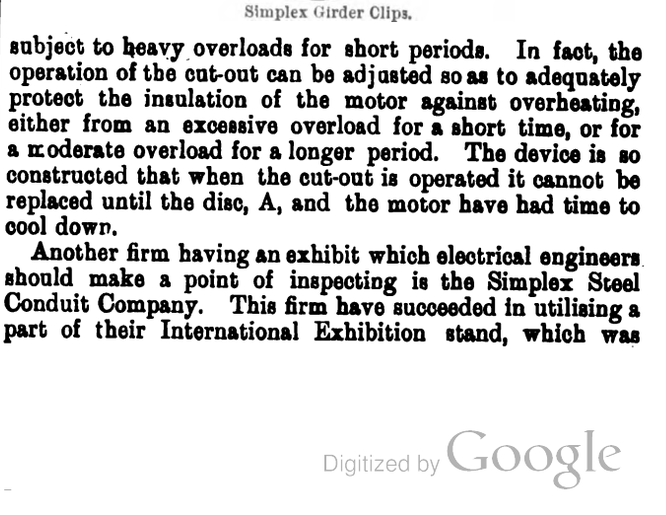
which is independently supported, has an ingenious brake, caused by the rubbing of a grooved sector on an unspun silk thread. Thus, while the needle is practically free to move, it will stay in any position to which it may be brought by the indicating needle of the instrument. The stand is brilliantly lit by four enclosed "Ark" lamps; there is also a lamp in parts for inspection. Among other interesting items is a complete motor-starting outfit, consisting of main switch and fuse and motor starter, all in separate cast-iron cases mounted on a cast-iron base.

There is also an interesting exhibit of various kinds of cable and junction boxes, while Griffith and Biliotti's patent thermal time element cut-out is worthy of special notice. This instrument we illustrate herewith. It consists of a thermal device, by which the expansion of a vapour in a metal receptacle is caused to actuate the trigger of an automatic cut-out. In other words, a small boiler filled with methylated spirits or other liquids having a low boiling point, is used to give a considerable mechanical motion when a definite temperature is exceeded. In the instruments we inspected this boiler is a hollow disc, marked A, made out of two very thin corrugated steel plates. The source of heat is a coil placed below the disc, and connected in series with the motor or circuit to be protected. With normal current the heat given out by this coil is not sufficient to vaporise the liquid within the disc above it. If, however, the current is increased this liquid begins to vaporise, but there is a definite amount of work to be done before the disc expands sufficiently to operate the cut-out. Thus with normal current the cut-out is not affected, but with, say, 25 per cent. overload, it could be so adjusted as to act within a range of 20 minutes to one hour; thus adjusted, an overload of 50 per cent. will bring it into action within 7 to 20 minutes. The watts



Simplex Distribution Board.

lost in the coil, varying as the square of the current and the time required for its action varying inversely as the watts thus dissipated, it can easily be seen that the larger the overload the quicker will be the action of the cut-out, the time of action varying with the overload. It can also, when required, be fitted with an alarm or indicator, which will ring a little in advance of the time of action; if, for instance, the cut-out is set to act within 30 minutes with 50 per cent. overload, it will give the alarm after the excess of current has been on for 20 minutes, and with 100 per cent. overload after five minutes, the cut-out coming into action 10 and 2½ minutes later on respectively, thus giving sufficient notice to the engineer-in-charge to prevent a failure in the supply. The apparatus is an exceeding simple one, and it serves to protect motor circuits which are



Simplex Girder Clips.

subject to heavy overloads for short periods. In fact, the operation of the cut-out can be adjusted so as to adequately protect the insulation of the motor against overheating, either from an excessive overload for a short time, or for a moderate overload for a longer period. The device is so constructed that when the cut-out is operated it cannot be replaced until the disc, A, and the motor have had time to cool down.

Another firm having an exhibit which electrical engineers should make a point of inspecting is the Simplex Steel Conduit Company. This firm have succeeded in utilising a part of their International Exhibition stand, which was

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used for the Paris Exhibition in 1900. It is built up of a rectangular framework of the company's tubes and conduits, with a liberal interspersion of standard fittings. Sample boards on the stand show the six grades of Simplex conduits in both the enamelled and galvanised types, and the more common types of fittings, such as bends, tees, junction boxes, etc., comprising the most up-to-date of wiring protection systems. Many new features and improvements which have been introduced into the system are shown on the table in front, such as multiple switch boxes, adaptable boxes, watertight fittings, main switches and cut-outs, and distribution boards for use on circuits up to 25 amperes capacity. The illustration herewith shows one of these boards as recently constructed for a special order. The firm have also on exhibit the Simplex girder clips, which have been designed in response to many enquiries for a ready means of carrying conduits on steel girders of standard dimensions. No drilling of the girder is necessary; they are fixed instantaneously by the most unskilled labour. They are supplied in three patterns for girders having up to 6in. flanges (1) for carrying conduits parallel to the girder, (2) for fixing the conduits across the girder, (3) or provided with a special wood base block for attaching ceiling rose, etc. Each of these three types may be obtained either with a hooked clip fitted with a movable nut or left straight for bending over the girder flange.

Messrs. B. Weaver and Co., of 22, Rosoman-street, Clerkenwell, E.C, are showing at stand No. 45 a large variety of moulded "ebonestos" insulators, bobbins, bushes, screwed nipples, hand-wheels, etc. This material has now been on the market for five years, and has proved beyond doubt that it is a reliable insulator of great mechanical strength and high resistance. We also notice that it takes a beautiful finish.

## IMPERIAL NOTES.

### CANADA.

There appears to be a growing tendency in some parts of our Empire to resent the term "Colonial." It is a feeling which it would not be well to ignore, especially as it is the natural outcome of an ambition deserving of our admiration and encouragement. We have Canada more particularly in mind—that country for which the mother land has done much in the past, but whose modern development is due almost entirely to enterprise and push from within. Shall we, then, ignore that pride to which such strength is entitled? No! It is far from our wish to offend the susceptibilities of our kindred across the seas by the use of a word which may be construed to mean something more than is intended. All who have given the matter thought must recognise that in the natural course of things Canada is destined to surpass this little island in those attributes which are the making of a great nation. The development of the country's vast resources of mineral and other wealth is bound to bring about this consummation sooner or later. Nor is it with jealous feelings that we regard the prospect. The old country is not quite played out yet, but its rate of progress, in a relative sense, must diminish as time advances. It requires but a superficial comparison of the potential wealth possessed by the two countries to settle any doubt on this score. But if, by mutual arrangement, we can strengthen the bonds which hold the separate parts of our glorious Empire together, then increased prosperity of any one part will add to the welfare of the whole, making it immaterial whether the condition of maximum prosperity be at one point or another. That, in brief, is our idea of Imperial policy—an empire to be upheld for mutual benefit within its area. Unity is strength, but it must be founded on something more than sentiment. Mr. Chamberlain has indicated a way, but the time when something tangible shall have been accomplished towards the practical realisation of his scheme is not yet, and while political parties are splitting hairs at home the leeway to be made up is increasing.

Apart, however, from politics we are not at all satisfied that manufacturers in this country are sufficiently alive to what might be accomplished by independent efforts in the way of promoting trade between this country and distant parts of the Empire. We hear the same complaint from several quarters—namely, that England fails to recognise the importance of her dependencies and their rising industries, while, at the same time, there is a gross lack of enterprise shown—even to the neglect of sending catalogues.

Thus a correspondent writes from Ontario: "We know very little about English electrical machinery or apparatus—seldom see a circular or catalogue—while our neighbours across the line are actually flooding our country with their literature. Fully 75 per cent. of the advertising matter that I get through the post is from the United States, and the remainder from home manufacturers, excepting occasionally something comes from the old country. This country offers a splendid field for electrical enterprises, being blessed with so much water power, especially in the provinces of Ontario, Quebec, and British Columbia. Millions of dollars are being spent at the present time in developing this power. We in Ontario are obliged to purchase all our coal from the United States, and pay 53 cents a ton (2,000lbs.) duty, having freight bills besides. This is forcing us to resort to the water power as a substitute. One of the largest enterprises of this character going on at present is at Niagara Falls, where over 350,000 h.p. is being developed. Our manufactured electrical goods cost more than they should, especially such lines as glassware shades, porcelain goods, fittings, and other small electric supplies. Electrical instruments and some lines of machinery are also sold at too high a profit. Copper, for instance, is mined on the north shore of Lake Superior and sold to United States manufacturers, who sell to their customers at three to four cents a pound less than our manufacturers will sell to us, just because there is not sufficient competition to hold down our home market to a reasonable profit. *If we had free trade with Great Britain, such things could not be.* I only hope that your people will soon begin to see the great advantage of having free trade within the 'British Empire,' and a tariff wall against all countries who raise a tariff wall against us. If your manufacturers pushed business a little harder here, it might have the desired effect."

Another correspondent writes from the same province as follows: "Canada is going ahead in leaps and bounds. There will be more acres ploughed in the next year, for the first time, in the North-West than are in Great Britain, counting farming land, mountains, lakes, game preserves, and all. England doesn't get the benefit. The smart Yankees, the Germans, and Italians are doing the business outside of cotton, woollen, and silk manufactures. Electricity is the great motive power on the increase. This country could nearly do without coal on account of the possibilities of the many great waterfalls. We can raise the wheat for the world. Our mines are proving to be as extensive as those of the U.S A. In fact, Uncle Sam has to get his nickel from us to even make his battleships. We have no mixed races to deal with. No false religion to stamp out. No sins to answer for unless it be for those of our parents. You Englishmen are too slow. It takes too long to get at the thing. You have done business in China, India, and Egypt too long to get the pace of Western life.

"How it shames one to see 'Henry Boker' or 'Made in Germany' on every piece of cutlery used! Americans are establishing branches in every line and spending millions while Englishmen sit idly by and see the country that has cost the old land so many years of care and treasure exploited by their more enterprising cousins. We put Italy into the rival class, because Italian machinery is being sold here by the ship load, simply because their engineers are making the best waterwheels in existence.

"All Canadians love the mother country and honour King Edward as much as any people could love a wise king, but Canada will have forgotten its relation to England in 25 years unless England gets better acquainted on this side of the Atlantic."

Strong aversion to the term "Colonial" is also expressed in this last letter, but we have already dealt with that matter, and it needs no further comment here. Our correspondent's observations are, no doubt, true enough in the

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main, but he does not always make those allowances which circumstances justify. For instance, Switzerland and Italy may be regarded as the homes of the water-turbine industry, due to the local demand which promoted its development long before Canada's need arose. In England, on the other hand, the abundance of cheap fuel caused neglect even of the little water power available; hence the particular industry in question received no great stimulating influence, and for a long time progressed only within narrow limits. That the growing demand outside these islands has not been quite lost sight of is evidenced, however, by some notable hydro-plant manufactured by Messrs. Gunther and Sons, of Oldham, for India. Let us hope this beginning is an indication of the rapid development of this branch of engineering.

For the rest we think it is due to Messrs. Dick, Kerr, and Co., Limited, Messrs. Bruce Peebles and Co., Limited, the Electric Construction Company, Limited, and a few other home firms in a minor degree, to say they, at least, have shown what can be done in Canada. But, then, one swallow does not make a summer—nor do a few. Hence it remains for others to follow good examples, instead of bewailing the effects of bad trade.

## ADMINISTRATIVE COUNTY OF LONDON AND DISTRICT ELECTRIC POWER BILL.

*(Continued from page 413.)*

On Wednesday, March 22, before the Select Committee of the House of Lords more evidence with respect to the above Bill was heard.

Mr. C. H. MERZ, under cross-examination, said that while they sought powers to manufacture gas, they had no intention or desire to distribute it in competition with the existing gas companies. He was quite prepared to stand by his figures, and to supply the Hackney Borough Council on terms which would be beneficial to the power consumer and possibly enable the price for light to be reduced. They had written to the Hackney Council on the subject, but had not received any reply.

Re-examined by Mr. Fitzgerald, Mr. Merz said that the average size of the user on the Tyne was about 60 h.p., as against 50 h.p. as assumed for London in the tables. The average was low because while a few large manufacturers took 2,000 h.p., they also supplied the small user. With respect to the figure of 1d. per unit charged by the St. Pancras undertaking, his calculation showed that the actual cost of production for power in this borough was 1·65d. with a load factor of 35 per cent. This being so, the consumers were supplied at a loss. The offer of the Metropolitan Company for the supply in bulk to the St. Marylebone Council was as follows: a sliding scale of 3d. for the first two hours of maximum demand and ¾d. per unit afterwards, with the maximum charge of 1·7d. per unit for the bulk supply. The result was that the St. Marylebone Council had to put up a generating station rather than pay these heavy rates. With the prices under the Bill they would have been supplied in bulk at about one-half of what the Metropolitan Company offered.

The Hon. C. A. PARSONS, under examination, said that with the increase in the size of a steam turbo-alternator the cost per kilowatt decreased. This held good for all sizes up to 10,000 kw. For instance, a 1,000-kw. would cost about twice as much per kilowatt as a turbine of 10,000 kw. capacity. Besides this the larger turbine would consume about 50 per cent. less coal per kilowatt. It would also economise in floor space and in first cost. Models were shown of three sizes of turbines to illustrate their relative dimensions, and to explain how the cost of buildings and foundations did not increase proportionately with the size of the unit. The present supply in the area in question was from 61 generating stations, and the average size of the engine was 500 h.p. This entailed a great waste of capital and in running expenses. The fuel alone would cost nearly three times more than with the unit he suggested. He estimated a 10,000-kw. turbine would have a steam consumption of 13lb. per kilowatt-hour working with 200deg. superheat. The consumption of the Newcastle turbines in the Tyneside Company's station was 15·4lb. per kilowatt-hour. The 18 per cent. difference between these figures would largely compensate for the increased cost of coal in London. He concluded that the average difference in coal consumption when using cooling towers for condensing and when a plentiful supply of circulating water was available, was about 20 per cent. With the cooling towers an enormous weight of vapour was discharged into the air. There had been a marked reduction of smoke on the Tyne since the introduction of the electric power company's system.

Under cross-examination, Mr. Parsons said that with the large unit he proposed there was not the same falling off of efficiency at light loads as with small units. He had built two turbines for overloads of from 6,000 kw. to 7,000 kw., and other makers of turbines had turned out 5,000-kw. sets. With these large units it was quite easy to arrange for 100 per cent. overload. He was not aware that the 1,000-kw. turbine supplied by his firm to the borough of St. Pancras had a steam consumption at full load of 18,000lb., as against 17,000 per hour guaranteed. The figures were new to him, and he stood by his estimated steam consumption for the 10,000-kw. sets. Under re-examination, Mr. Parsons said that the St. Pancras turbine had not yet been supplied with its proper condensing plant, and that no official trials on the set had been made.

Mr. C. E. L. BROWN, of Messrs. Brown-Boveri, of Baden, agreed with Mr. Parsons's evidence. He had had five years' experience in building turbines, and had supplied 10 sets of 7,000 kw. to Basle. His estimate of the cost of a station of the size proposed by Mr. Merz averaged between £7 and £7. 10s. per kilowatt. With turbines it was absolutely essential that there should be a high vacuum, which involved a plentiful supply of cooling water. If cooling towers were used, the vacuum was not so satisfactory, more boiler plant was needed, and the cooling towers required very large ground space. Under cross-examination, Mr. Brown said that the cost per kilowatt of a 3,000-kw. set was about 30 or 40 per cent. higher than with a 10,000-kw. set. In Switzerland the power from the station was frequently distributed by overhead mains.

Mr. S. Z. DE FERRANTI said he had gone carefully through Mr. Merz's estimates, and agreed thoroughly with them. He had looked particularly into the cost of laying the extra high-tension mains, and endorsed the evidence given by Mr. Merz on that subject. He had actually been over 100 miles of streets in London in connection with the scheme. The maintenance charges on these high-tension cables were now well known, as their life had been proved to be long. He had from the first advocated the concentration of large powers into a central station for distribution over a considerable area. He pointed out the disadvantages under which a large number of the existing supply stations suffered, either from difficulties of coal delivery or from want of sufficient condensing water. He considered that the present undertakings could not individually or collectively carry out such a supply as was proposed under the Bill. The stations did not work on the same systems, and hence could not be coupled together into one general scheme.

Under cross-examination Mr. Ferranti said that in the earlier Power Bills the large towns were not included. Last year, however, Bristol was included in the Somerset Power Bill. He did not consider that one could find a precedent for London's needs anywhere else. Also he did not consider that two large power undertakings could be work on similar lines in the same district, but two companies might supply individual consumers in the same district, as had been done in London. He thought the end of the matter would be that the present undertakers would find it advantageous to take bulk supply and become distributors only. An Ordnance map of London showed that the same had happened with the gas industry. There were on the map a large number of gasworks which had ceased to exist. In the same way with electricity, he thought that the present stations would be turned into distributing centres. If this were so, the monopoly which the power company would have would only be a monopoly

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of cheapness. Under re-examination, Mr. Ferranti said that the unsatisfactory state of some of the earlier power companies might be due to the exclusion from their areas of large towns.

On Thursday, March 23, Mr. VINCENT RAVEN, chief assistant mechanical engineer of the North-Eastern Railway Company, gave evidence in support of the Bill, as affording advantages to railway companies, and described the relations between his company and the Tyneside Power Company in connection with the supply of electricity. Before entering into the existing agreement his directors had considered the advisability of erecting their own generating station. The capital cost of such a station had decided them to take supply from the power company. The supply had been satisfactory. Power was now taken for driving the company's workshops, and arrangements were in progress for the supply of electric energy for plant in the railway company's docks.

Cross-examined, he said he knew of no other railway company other than the North-Eastern, either in England, on the Continent, or in America, which took electrical energy from a company or a local authority. He was aware that the electric railway companies in London supplied themselves already with electric power, but he was sure the North-Eastern Company could not have worked its electric trains so cheaply in that way.

Mr. J. F. S. GOODAY, general manager of the Great Eastern Railway Company, said that that company carried a larger suburban traffic than any other railway in the United Kingdom. His company had been considering the question of electrifying the suburban lines, and their electrical engineer estimated that if that were done they would require about 30,000 h.p. At present no company could give them that power, but they would like the option of taking the supply from a company. There was considerable interchange of traffic between London suburban lines, and if they were electrified it would be advantageous to have electricity supplied to them on a uniform system. He would rather have one substantial company to deal with than a number of undesirable companies.

Mr. BERRY, general manager of the Great Northern Railway, gave similar evidence.

Mr. CUNNINGHAM, general manager of the Central London Railway, said that if such a company as it was now proposed to form had been in existence when the twopenny tube was constructed, the company would have considered taking power from them instead of building their own generating stations.

Representatives of various manufacturing firms were afterwards called to give evidence in stpport of the Bill.

The Committee adjourned until Monday.

On Monday, March 27, Sir ALEXANDER BINNIE, formerly chief engineer to the London County Council, was called as a witness with reference to the proposal to lay a ring main around London. He said he regarded this suggestion as the best possible, and one which would minimise the breaking up of the streets. It was assumed that the tendency of manufacturers desiring to use electrical power would be to remove their works outwards to the "ring." His experience in reference to the electrification of the underground railways had shown the advantage of concentration in producing electrical power. In answering questions put in cross-examination, witness said it was true that the promoters could only supply electricity in the City through authorised distributors. He did not agree, however, that all their cables should be excluded from the City. It was only proposed to lay one main in the City, and that was a cross main from north to south, connecting the two sides of the ring main. Continuing, Sir Alexander Binnie said he knew that the generating station which the Underground Electric Railway, Limited, had erected at Chelsea cost over £1,000,000 sterling, and had a capacity of 67,000 kw., but he did not know that that worked out at a much higher figure per kilowatt than the estimate of Mr. Merz. Re-examined, he said the conduits for the ring main would be laid once for all, and any additional cable would be threaded through it without breaking up the streets.

Mr. A. STENNING, surveyor, said the estimates for land were ample for the requirements. By the clause for exemption from the London Building Acts the promoters desired to be placed in the same category with gas and railway companies. The buildings would be constructed of iron, would be incombustible, and fairly well isolated, and the ordinary rules for prevention of danger from fire would not be necessary.

Mr. C. H. MERZ, recalled, explained on the plans the proposed position of the ring main and the object with which the district had been divided into industrial and non-industrial areas. Westwards from the dividing line the promoters considered there would not be the demand for power for manufacturing purposes to justify them asking for the powers they wished to have in the eastern area, where factories were numerous, and the tendency was towards their increase. The line under the City was for the purpose of connecting the two sides of the ring, and the route might be varied to meet the wishes of the Corporation, but he was not prepared to avoid the City altogether. In the event of the Bills passing, the industrial area would be developed first.

This closed the case for the promoters.

Mr. NEVILLE, K.C., then addressed the Committee on behalf of the nine electrical companies petitioning against the Bill. These companies had embarked very large capital in undertakings carried on on the faith of provisional orders conferring power upon them. Capital to the amount of eight millions sterling had been expended, and a considerable amount of unissued capital would in the ordinary course be used for extensions of works. It was not his contention that no competition should be allowed, but the competition now threatened was not in any sense contemplated when the Act of 1888 was passed. With the provisional orders under which the existing companies exercised their powers were conditions as to purchase from which the promoters asked to be exempt, and without regard to the expenditure of capital in the past the present shareholders were to be deprived of the profits they might naturally expect after the use of electricity as a power had become established. There had been no lack of energy on the part of companies. Up to the present they had paid an average of 4 per cent. to their shareholders, and now, when the outlook was improving, the promoters wished to step in and reap the benefit of past efforts. The promoters anticipated that the existing companies would ultimately abandon their generating stations under the pressure of the cheap supply offered, but when that happened there would be in possession of the field a huge trust with a monopoly of the electrical supply for London in its hands, and then, he feared, no more would be heard of a supply at 0·75d. per unit.

Mr. CONACHER, general manager of the Metropolitan Electric Supply Company, considered that the existing companies had done their utmost to stimulate the use of electricity for power purposes, and their efforts represented in the aggregate a supply equal to 35,151 h.p. Their plant in existence was far beyond that required to meet present needs, and would supply all new requirements arising in the immediate future.

On Thursday, March 28, Mr. Conacher gave details as to the land owned by the companies available for extension to show that there was no need for a new company to supply electrical energy in London. The Metropolitan Company in 1897 purchased land at Willesden for the purpose of carrying out a policy of concentration, and they had in recent years been able to effect remarkable reductions in the cost of supply. The company were following the policy of abolishing their minor stations, and in a few years could give a still cheaper supply. He held that as the power demands increased they could still further reduce their charges. They could produce power then quite as cheaply as the proposed company. According to his reading of the clauses in the Bill, the new company would be enabled to pick up and choose their customers. The Bill would induce inequality of supply. As he read Clause 65, it would allow competition in the supply of electricity for lighting Government departments.

Under cross-examination, Mr. Conacher said his company charged slightly lower rates in those areas where

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there was competition than in other areas where there was none. With the exception of the London County Council tramways, he could point to no railways, docks, or waterworks supplied by the existing companies.

Mr. L. H. HORDERN, manager of the Westminster Electric Supply Company, said that 13 per cent. of their output was for power, and they had five consumers taking between 100,000 and 200,000 units per annum. Their charge for hotels was 2d. per unit, for tube station lighting 1d., and they were supplying local authorities at 1·1d. per unit for street-lighting. Under the Bill his company would lose consumers taking 2,000,000 units per annum. This would result in an increased cost in supply to small lighting consumers.

On Wednesday, March 28, Mr. L. H. Hordern maintained that his company could supply electricity for power purposes at as low a rate as that promised by the promoters. His company were in negotiation for the supply of 150 h.p. to the Army Clothing Department at Pimlico, and also with the London, Brighton, and South Coast Railway Company for a power supply for lifts at Victoria Station. By their arrangements with the Central Company they could meet all demands.

Mr. A. S. BAIN, managing director to the London Electric Supply Corporation, said under a three years' agreement with the London County Council, the company last year supplied 6,000,000 units for tramway traction. As the output doubled, the price went down by one-half. Negotiations were proceeding for supplying many large undertakings at $\frac{3}{4}$d. per unit for power purposes. They had now 12 active competitors within their area. If the promoters obtained their Bill they might, under Clause 69, exercise a power other companies had not, to enter into a combination with another company in the area, and, with the assistance of capitalists, sell below cost of production until they crushed out competition, and then they would have an absolute monopoly.

Prof. A. B. W. KENNEDY gave his opinion that the Westminster Company could meet all demands likely to arise, and that the capacity of their modern plant was sufficient.

Mr. H. W. SPRUNT, manager for the South London Electric Supply Company, said that, exclusive of a temporary supply to the London County Council tramways, they sold last year 274,000 units for power purposes.

Major CARDEW urged that, as the existing companies were able and willing to meet all prospective demands for electrical power, they should not be subjected to further competition during their tenure of their powers.

Mr. SEALE, manager to the Charing Cross Electric Supply Company, said they had offered to supply the local authorities at $\frac{15}{16}$d. per unit.

Colonel CROMPTON gave evidence in which he questioned the accuracy of the promoters' estimate.

## APPLICATION OF ELECTRICITY TO INDUSTRIAL PURPOSES.*

BY J. F. C. SNELL, M.I.C.E., MEMBER.

Many papers have been read during the last few years on this subject, and the author feels some diffidence in further discussing it. Yet, owing to the increasing use of electricity as an agent in the transmission of energy, and in its application to the driving of machines in shipyards, engine works, collieries, etc., he may be excused for still further discussing so important an agent, which is so extensively used by members of this institution. For there are at least two very important points which have to be dealt with constantly, in this district especially, and upon which there is still a great divergence of opinion. These are as follows: (1) The comparative economy between installations (for the driving of machine tools) laid down at the works themselves, and the purchase of electricity from an outside power station owned by either a separate company or by the municipality; (2) the comparative advantages of direct current and alternating polyphase currents. (As the subject will be treated with particular reference to the North-East Coast, only three-phase alternating currents will be considered.) Further, the author wishes to make clear two other matters which are of great importance to the management of these works: (3) their position electrically with respect to the Board of Trade and the Home Office; (4) the importance and economy of standardisation.

The author, as a member of the Engineering Standards Committee now deliberating in London, may be excused for driving home this necessity for standardisation, both in the interest of users and manufacturers and of the electrical and other industries adopting electricity for the transmission of power. Thus it is hoped that a clear understanding will be arrived at as to the relation of independent electrical generating plant *versus* the purchase from a public source of supply. The author, though himself the servant of a municipality engaged in the supply of electricity for general purposes, including most important industries, will endeavour in this paper to hold himself entirely free from bias, and to give a plain unvarnished account of both sides of this question, whichever view may be supported by the actual results about to be given, and he hopes that a clear conception of the obligation of users and suppliers to the Government departments for the protection of employés and property may be obtained; and also that useful and standard data may be recorded for future application by works now adopting electrical driving, and which will, undoubtedly, be driven by this method in the future.

### 1. RELATIVE ADVANTAGES AND COSTS OF INDEPENDENT AND CO-OPERATIVE GENERATION OF CURRENT.

Through the kindness of certain distinguished members of this institution, the author is able to record the actual results of electrical stations owned by two large shipyards, one of which is being partly driven by its own steam-driven plant and partly from a town supply, these two systems being entirely separate from one another. The other example is that of a shipyard supplied from its own gas-engine-driven generating plant. In the first case, the following particulars are necessary for a proper criticism to be given of the results—viz.: 4 boilers (marine type), 160lb. pressure; no superheat. 4 engines, each 250 h.p.; 1,000 total horse-power; 300 revolutions per minute, triple expansion, condensing. 4 dynamos, each 168 kw.; 672 total kilowatts, direct coupled to engine, compound wound, direct current, 220 to 240 volts. 104 motors supplied; 1,895 total horse-power; motors varying from 1 h.p. to 40 h.p. Class of work, combined shipyard and engine works. Maximum load observed, 504 kw. Total units generated per annum, 891,655. Load factor, 22 per cent. Class of coal used, smalls, 11s. per ton. Lbs. of coal per unit generated, 7·3.

*Note.*—It is only fair to add that owing to adverse local conditions the average vacuum is only 15in. The total capital outlay on this generating plant is £17,184, and the following were the working costs for 12 months—viz.:

| | | | |
|---|---|---|---|
| Labour (including 20 per cent. for working charges) | £832 | 14 | 1 |
| Coal, 2,924 tons at 11s. per ton | 1,608 | 11 | 11 |
| Feed water at 8d. per 1,000 gallons | 59 | 0 | 6 |
| Circulating water—make-up | 31 | 19 | 6 |
| Oil | 58 | 8 | 5 |
| Repairs and general stores | 141 | 2 | 10 |
| Works costs | £2,731 | 17 | 3 |
| Depreciation at 5 per cent. | 571 | 13 | 2 |
| Interest, 4 per cent. | 457 | 6 | 8 |
| Rent, rates and taxes, taken at 33 per cent. on the item for labour | 249 | 16 | 2 |
| Total costs | £4,010 | 12 | 9 |

thus making a total cost per unit of 1·08d. The second example is as follows: Number of gas-engines, 3. Total brake horse-power, 360. Dynamos, 3. Total kilowatts, 225. Belt-driven, shunt-wound, direct-current, 230 volts. Number of motors, 34. Total horse-power, 397 (motors vary from 3½ h.p. to 44 h.p. each). Class of work, shipyard. Maximum load observed, 207 kw. Total units generated during four months, 83,125. Load factor, 14 per cent. Cost of gas, 1s. 6d. per 1,000 cubic feet. During these four months the following were the ascertained

* Paper read before the North-East Coast Institute of Engineers and Shipbuilders on Feb. 24.

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costs: Number of units generated during the four months' test = 83,395.

| | | | |
|---|---|---|---|
| Town gas, 3,000,828 cubic feet at 1s. 6d. per 1,000 feet ... | £225 | 0 | 10 |
| Engine and dynamo oil ..... | 24 | 1 | 7 |
| Waste and stores..... | 5 | 9 | 10 |
| Repairs..... | 5 | 16 | 8 |
| Water ..... | 2 | 0 | 0 |
| Labour ..... | 84 | 12 | 1 |
| Interest and depreciation ..... | 60 | 0 | 0 |
| | £407 | 1 | 0 |

N.B.—No account allowed for supervision, or general establishment charges, or rating of machinery.

The cost representing 1·173d. per unit.

From these two examples it will be seen that there is a variation in cost per unit from separately driven plant of respectable dimensions from 1·08d. to 1·173d. It is only fair to point out that the average vacuum in the former case is only about 15in., and that the steam-pipe lead is of some length, both of which are factors which must operate against the costs; thus the results would have been better had there been ample circulating water, and a better steam-pipe range, or a moderate degree of superheat. Also, in the latter case, it will be observed that the dynamos are belt-driven, which must account for probably at least 5 per cent. loss of power, which would be saved by direct driving. On the other hand, the plant installed probably represents the cheapest capital expenditure on account of the higher speed of the belt-driven dynamos.

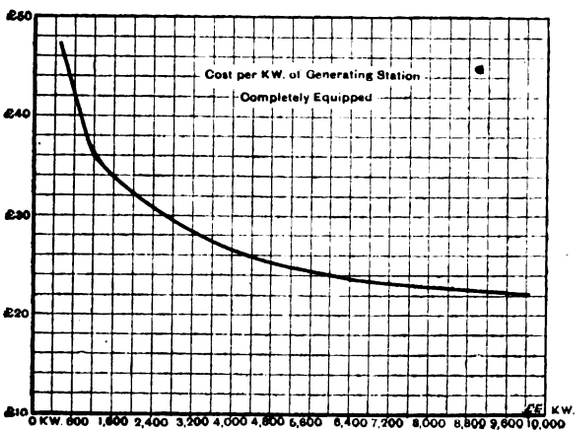


FIG. 1.

The author has always contended that in works requiring from 300,000 to, say, 1,000,000 units per annum, and with a load factor of 20 to 30 per cent., the cost will be found to vary from 1·25d. per unit to 1d., and he is of opinion that, looking at the question broadly, and taking into due account an adequate depreciation of plant and average cost of upkeep for, say, a period of 20 years, 1d. is about the lowest limit for installations of the size stated. He is aware, of course, that there are special cases in which, either through an abnormal and excellent load factor, or through the utilisation of blast-furnace gases, the cost is materially reduced below this figure. These, however, are quite the exceptions, and he affirms without fear of contradiction that the generality of installations will be found to have costs within the limits cited. As to the advantages of the works saving the capital expenditure; the responsibility involved in laying down their own plant, or the loss represented by the valuable space occupied; the incidental losses which result from having the machinery ready during many mornings in the year after holidays without the certainty of the men turning in, or during slack times; and the frequent special arrangements required to be made for working night shifts—all these items, which may be put to the credit of the outside power stations' point of view, will be dealt with later in the paper.

Now let us turn to the other side of the question—viz., supply to works from outside sources. Whether it be a power company like the Tyneside Power Company, or a municipal works such as Sunderland, what will be said will be true of most stations, and may be considered as generally applicable to all. The first and most obvious saving is in the capital outlay per kilowatt. The accompanying curve (Fig. 1) gives the relation of the cost per kilowatt (1 kw. = 1⅓ h.p.) between stations varying from 250 kw. up to 10,000 kw. Many independent plants do not exceed 200 kw. in extent, while the two power stations referred to have actually exceeded or are nearing the higher limit. Now, if, as the diagram shows, the smaller installation cost £45 per kilowatt installed (which figure includes buildings, boilers, engines, steam-pipes, condensers, dynamos, and switchboards completely equipped on the one hand; or buildings and gas-engines, water-tanks, dynamos, and switchboards completely equipped on the other hand; and also includes, for obvious purposes of safety, spare plant representing probably some 50 per cent. of the capacity of the running plant), it is obvious that the 10,000-kw. station, costing about £20 per kilowatt, can afford to spend money outside the station in laying adequate cables and fixing the necessary transforming machinery, and yet be able to effect a considerable saving on the capital sum.

Secondly, it must be equally obvious that, while a decent load factor of anything between 15 and 35 per cent. even may be obtained in an independent installation, yet the combination of a dozen and, *a fortiori*, several dozen such works in one station must result in a far better load factor, which is actually in practice found to be anything from 45 to 55 per cent. This improved load factor at the resultant station is owing to the non-synchronism of the various maximum demands on the several works, which among station engineers is known as the "diversity factor." This diversity factor really has a high value. The author knows examples where the resultant maximum load at a generating station is only some 60 per cent. of the integrated total of the maxima. This, obviously, means that a given amount of plant installed at the power station is able to deal with a much larger total of horse-power of motors installed in various works than the same plant could possibly deal with if it were split up into a number of small independent installations.

As one is speaking to so many engineers who may not be specifically electrical, it would be well to define the term "load factor," as so much depends upon this, the most important detail after capital cost in producing economical results. The load factor of any plant, then, is the ratio of the actual units generated in any given time to the units which would be generated were the plant working continuously at full load during that time. For example, the number of hours in a year is 8,760; an installation representing 100 kw., working continuously for 8,760 hours, would generate 876,000 units. If it is actually found that 219,000 units have been generated during the year, then the load factor of that plant has been $\frac{219{,}000 \times 100}{8{,}760} = 25$ per cent. It must be clear to anyone that a steam dynamo of 100 kw. working continuously will cost less per kilowatt per annum than if only working more or less intermittently, or at varying loads, during a quarter of that time. Now this is another of the advantages claimed for general sources of supply, and is not based on mere hypothesis, but is actually proved from the results obtained—viz, the thereby increased load factor due to the supply given to several works—together with the practical diversity of their maximum loads, as before stated, enables the kilowatt or the horse-power per hour (whichever basis be taken) to be more cheaply produced than if each works produced its own current.

The scale of prices upon which a power station may be reasonably expected to supply current is shown in the accompanying diagram (Fig. 2). This scale is based upon the practical capital cost of a large power station equipped with modern appliances, and the remaining figures of fuel, stores, wages, and other establishment charges are taken from actual practical results. Reference to Fig. 3, which deals with the cost of a small local station installed for the supply of large works, demonstrates at once the influence of the capital cost upon the units generated, and the economy which can be obtained from the concentration of many such small installations in one big power station, and even this does not account for the important detail already referred to—viz., the "diversity factor." From these two diagrams it will be possible for any director of works to see the relative costs for his particular factory

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which will result from either the town main or his own plant. There are other economic reasons why works should, in most cases, purchase their power rather than instal a separate generating plant—viz, overtime shifts can be arranged without any trouble in the way of keeping

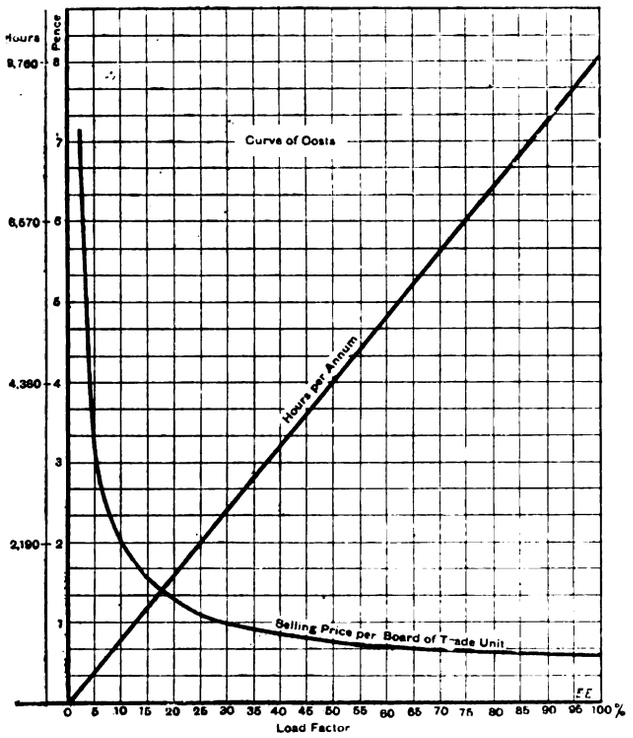


FIG. 2.

special men for working treble shifts in the local power station; on holidays there would be no worry from having to light up boilers or start gas-engines, and having the machinery ready to run and no men turning in; the manufacturer is saved the capital cost of the generating plant, and the space which the generating plant would

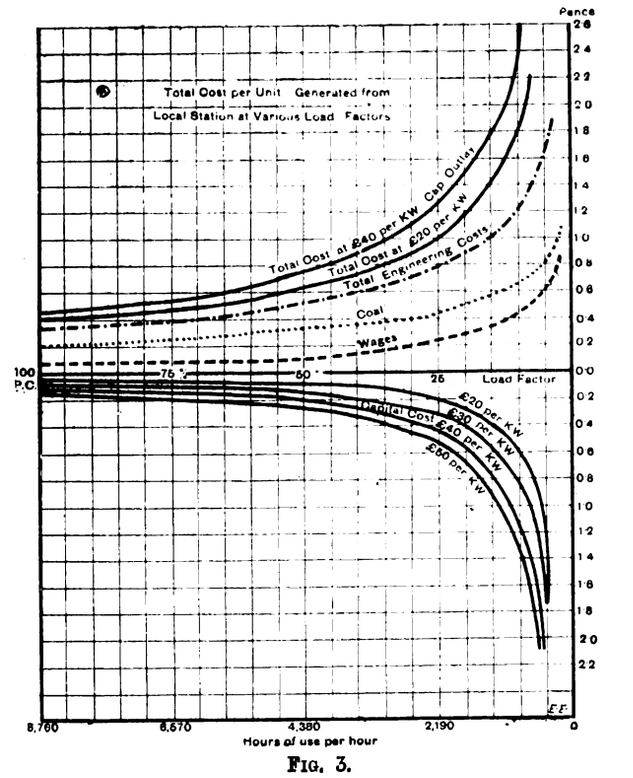


FIG. 3.

occupy has a great value for other purposes; and, further, he has not to trouble himself about antiquation of plant, or more efficient methods of generating electricity in the future. It will be granted that motors which are capable of working from 85 to 95 per cent. efficiency (according to the ratio of their load) will probably not be superseded by any more economical prime mover in the future. On the other hand, the manufacturer is entirely dependent on an outside source of supply—and the transmission cables and transforming machinery introduce a further element of breakdown, which, though amply guarded against as far as skill will allow, *is* a factor which cannot be negligible. It behoves a manufacturer, therefore, to see that in becoming dependent on an outside power or supply station the cables should be duplicated, and an adequate amount of reserve transformers should be insisted upon. From a comparison of the two diagrams (Figs. 2 and 3) one gets the following results for outputs of 100,000 or more units per annum.

| Load factor. Per cent. | Units per kw. demanded. | Price from power supply. Pence. | Price from own local station. Pence. |
|---|---|---|---|
| 15 | 1,314 | 1·5 | 1·75 |
| 20 | 1,752 | 1·25 | 1·45 |
| 25 | 2,190 | 1·125 | 1·25 |
| 30 | 2,628 | 1·00 | 1·10 |
| 35 | 3,066 | 0·875 | 0·95 |
| 40 | 3,504 | 0·800 | 0·90 |
| 50 | 4,380 | 0·75 | 0·75 |
| 60 | 5,256 | 0·68 | 0·65 |
| 70 | 6 132 | 0·65 | 0·58 |
| 80 | 7,008 | 0·62 | 0 60 |

The deductions to be made from the diagrams referred to show that the higher the load factor of a particular installation, the less reason is there for the purchase of power from an outside company, and the more excuse for installing one's own plant; and that at a load factor of 50 per cent. the costs are identical, and that for load factors above 50 per cent. the power can be more economically generated on the spot. But as this only applies to exceptional plants, such as pumping or paper mills working continuously, and does not apply to engine works and shipyards having a load factor of under 40 per cent., the inference is that the greater number of works in this district will benefit from co-operation by becoming consumers of one general power supply.

*(To be continued.)*

## FRICTION LOSSES IN SHAFTING.

The efforts that are being made by the engineers in charge of the large power stations, supplemented by the fact that one modern textile factory—viz, the Heasandord Mill, near Burnley—has been installed with electric motors for driving not only the preparation machinery, but also the actual looms, have caused many millowners in Lancashire to consider the advisability or otherwise of adopting this system for the transmission of power both in spinning mills and weaving sheds.

As might be naturally anticipated, the first question asked by these millowners is, What will the generation of electricity cost us if we instal our own dynamos? and, secondly, What will the current cost us per brake horse-power if we take a supply from the public mains? When this question has been answered to their satisfaction, there arises the equally important question, What shall we save, and if there be an increased economy, will it be of sufficient magnitude to allow ample margin not only for depreciation and interest, but also to justify us in the spending of a large additional capital?

The usual answer that appears to be given by the electrical engineers who are trying to make a speciality of textile work is to refer the millowners to American practice, and to state in glowing terms the great advantages that have been reaped there by enterprising millowners. Unfortunately, this does not appeal to the hard-headed men owning our cotton mills. They attach a certain amount of importance to results obtained in America or on the Continent, but argue that the conditions that obtain here are probably different to those that obtain abroad, and, furthermore, that if this advantage has been obtained in one mill, it should be easy to demonstrate how it has been obtained, and to locate exactly where the saving has been effected. In his paper before the Managers of Textile Mills, Mr. Payne stated that while he knew from his experience that economical results were obtained by adopting electrical driving in all classes of textile mills, he could

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not definitely locate the exact places where this greater economy was effected; and until this more exact economy information is obtained or until several English mills have been electrically equipped and the economical effects noted in this country, it is doubtful if any great number of mill-owners will be persuaded to make the innovation.

The usual method of procedure in making a survey for the preparation of a scheme for electrical transmission is first of all to find the total power developed, and then to find the amount of power lost in friction, and by deducting this latter from the total power it is assumed that the total useful power is arrived at. This method would be quite satisfactory if only the amount of power lost in friction were obtained, but unfortunately this is not the case, and the figures which are arrived at are at the best only an approximation, and unfortunately there is no reliable data available respecting the losses due to friction in shafting and belting transmission.

To a very great extent the whole of the information respecting friction losses is confined to the results deduced from Prof. Benjamin's experiments, and published by him in the paper read before the American Society of Mechanical Engineers in December, 1896, supplemented by the article in the New York *Machinery* in the following year. While admitting the great value of these papers, and the careful research work conducted by Prof. Benjamin, the writer is not satisfied that the results obtained are correct, though he is thoroughly satisfied that the usual practice of obtaining the frictional losses, which is indicated above, gives results that are only approximations, and at the best not close approximations.

In the first place, the manner of taking steam indicator diagrams is far from satisfactory. The first requirement is that the indicator shall register correctly, while following this it is necessary to take readings of the speed and pressure at the exact instant the cards are taken; after this a calculation has to be made of the area of the piston rod and so forth, so that while the actual cards are not absolutely correct, as is shown by the difference that always exists when repeated or duplicated cards are taken, the amount of the error will probably be exaggerated by the calculations that are afterwards made, and some slight divergence from the true speed or the correct steam pressure.

Granting, however, that the cards obtained are correct, and that the calculations contain no error, the true frictional loss has not been obtained. What is obtained from the first set of cards is the power required to turn the engine and the shafting round *unloaded*. If now a second set of cards are taken with the shafting fully loaded, it is manifestly incorrect to assume that the difference in the power indicated by these cards and the first set is the power usefully employed. This assumes that the frictional loss is a constant for all loads, which it cannot be. The power required to turn a shaft at a certain speed when the load is light is entirely different to the power that is required to turn the same shaft at the same speed, neglecting entirely the power required for the load when the shaft is loaded. So that if by the customary method it is found that the frictional loss amounts to, say, 34 per cent., it is quite reasonable to assume that the true full-load loss is 40 per cent. or perhaps more.

A case under the writer's personal knowledge proves this. A motor was temporarily put down to drive a certain machine, when it was found that the current required was 40 amperes at 200 volts; afterwards the machine was moved so that the motor drove it off a line shaft—that is, instead of the motor driving the machine through a direct belt, two belts were used, and a long length of shafting had to be turned. To drive the belts and the shafting it was found that five amperes at 200 volts were necessary, but to drive the machine under these conditions required not 45 amperes, but 50 amperes. This showed that there was an additional frictional loss of equivalent to 200 volts 5 amperes; but the experiment did not indicate where this loss could be located. It is evident that if the major portion of this loss is in the shafting and belt transmission, there can be no difficulty in showing why a greater saving is the result of the electrification of various factories, because there is a far greater frictional loss in the old system than is generally allowed for.

In the case just mentioned the shafting was a simple long length. Now, every mechanical engineer knows that one of the chief places for loss of power is in bevel gear, and it would be interesting to repeat the experiment driving through a pair of bevel wheels. This would be the more interesting with respect to the installation of electrical driving in spinning mills and weaving sheds, owing to the large number of bevels that are always found in these factories.

There is a large unexplored field for research in connection with frictional losses under different conditions, and the data that would be gleaned would be of the most useful character. It would appear as though the only satisfactory method of carrying out such research is an electrical method. It is generally stated that the greatest difficulty is experienced in obtaining figures relating to frictional losses owing to the fact that tests are made under special and not under normal conditions; the lubrication, for instance, is either better attended to, or other special conditions obtain that affect the result. There is no real reason why this should be the case. All that is required is a dynamo and motor whose efficiencies are known exactly for all loads. If then, long lengths of shafting are driven light off the motor, the input being noted, it is easy to find the actual power required to turn these shafts round light. The dynamos should be then belted to the farthest shaft, and the electrical power generated either used for some useful purpose or dissipated in a water bath. By this means the shaft could be loaded to any desired extent, and tests could be made not only at full load, but also at any intermediate loads. All that is necessary is to note the input of the motor and the output of the dynamo at the same moments, and, in order to prevent error, the measuring instruments could be duplicated, and use also could be made of recording instruments. The efficiencies of the dynamo and motor being known, reliable figures could be obtained. Such a test could be carried out for all forms of shafting transmission, and would have the further advantage that it could be made under normal conditions, and not under special conditions. To be of any commercial value, the tests should be carried out on shafting already erected in different classes of factories, and not on new shafting specially put up for the purpose.

There is no doubt that such a series of tests would be costly, and would occupy a considerable amount of time, but the results would amply repay the capital cost and the labour. Probably there is no individual firm who are in a position to conduct such a series of tests, and even if they did they would probably retain the data for their own use; but considering the large amount of money which is spent annually by different societies and colleges upon research work, much of which is more of a theoretical than a practical value, there should be no difficulty experienced in inducing one of these bodies to make a series of practical tests upon frictional losses.

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*Associate Members.*—R. G. Cooper, 6, Dogo-street, Canton, Cardiff; E. A. Davies, 124, Croydon-road, Anerley, S.E.; A. Davis, 121-125, Charing Cross-road, W.C.; B. Glenny, 14, Harrington-street, Dublin; R. D. B. Glenny, 14, Harrington-street, Dublin; L. O. Heyes, Lynwood, Park-crescent, Wigan; W. A. Heyes, 5, Sefton-street, Southport; E. O. Hopkins, 32, Kestrel-avenue, Herne Hill, S.E.; E. W. King, Corporation Electricity Works, Bootle; E. H. Rayner, M.A., Elm Lodge, Queen's-road, Teddington; J. W. Wyatt, 31, Benton-road, Sparkbrook, Birmingham.

*Students.*—J. A. Allan, Seafield, Longman-road, Inverness; E. L. Pretrand, 499, King's-road, Chelsea, S.W.; C. F. D. Suggate, 28, Slatelands-road, Glossop.

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## ACQUIRING FREEHOLD RIGHTS.

The *Times* in its engineering supplement this week furnishes another proof, if one were needed, as to the rapid development of telephonic work during the last quarter of a century. Its figures relate to America, and are taken from the census reports. They give details for the years 1880 and 1902. In the former year there were 48,414 subscribers, in the latter 2,178,366. At the earlier date the number of employés was 3,338, at the latter 78,752, while the capital authorised was respectively £3,477,340 and £76,906,813, the latter bringing in a revenue of £17,365,107, permitting dividends to the amount of £2,996,543, while a surplus remained of £1,335,609. Roughly speaking, these figures show interest of about 4 per cent. paid, which could have been increased if no other consideration intervened to over 5 per cent. Of course, without far more details than these no valid deductions of any kind can be made. We have given them for only one purpose, to show the increasing importance of the industry. In our own country the importance is as great, but the troubles in the way of telephony are greater, because imperial, municipal, and private enterprises are all mixed up, and will have, within the next few months or years, to be straightened out. A committee will, we presume, be appointed one of these days, and among other problems will have to consider the position arising from the existence of overhead wires over a variety of properties without demur for a period of twenty years. An owner is approached for permission — possibly an agreement is made to pay a nominal yearly rent of a shilling—to erect poles and run wires for telephonic purposes. Very often the owners are not fully alive to the consequences of a more or less informal acquiescence in the procedure. We believe, however, that if the owner is not far-seeing enough to make special terms, get a proper legal agreement, which has to be duly stamped with annuity duty, and be careful to exact the rent annually, he may at the end of a tolerating period of twenty years find that he is no longer master of what may be or what may not be done. The amount being small is probably frequently uncollected, because it seems more trouble than it is worth to collect; but unless the party pays this annual consideration no acknowledgment of the owner's rights is given. Assume that the dealing is with a telephone company. If this shilling remains uncollected year by year till twenty years have passed, and there is no written document on the part of the company, the company will obtain a freehold easement; and then, if the owner requested the removal of posts or wires, he would find that he had legally no power to compel the removal, the answer, legal and effective, being that the company had acquired an easement, and could not be compelled to remove poles or wires. Of course, we have to make a good many assumptions. The Post Office, if it ever takes over the companies' and municipalities' systems, will take what exists at the time of taking over, and will not object to freeholds. So that it behoves owners to look after themselves, as it will not be in the Government's interest to look after them. Undoubtedly a Government office desires in the abstract to deal fairly all round, yet it may object to retrospective action. We wonder how many so to say freeholds have already been created because the trouble to prevent has not seemed at the moment worth the candle. Perhaps it will be argued that overhead wires in this country are doomed, and that in the future everything will be underground. That view may be correct; it is, however, very doubtful. The necessities of town thickly populated, and thinly populated districts, are quite distinct, while the law holds

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good for both. We are sorry to say that the *Times* of late, instead of discussing certain questions in a spirit of fairness, seems to look upon them with a bias. It is—so are we—anti-municipal, but it always seems to discuss as if the pro-municipalists had not an exceedingly strong case. Above we have pointed out the necessity of care in owners that they lose not their rights. The *Times* in the same issue as it gives the telephonic figures shows the difficulties not only in free competition in matters such as tramways, lighting, and telephony, but even when there is no competition, when it refers to one class of street work interfering adversely with some other street work. All these questions more or less hinge for success upon a common use of the streets. If telephone wires are by-and-by to be wholly underground, more fuel will be added to the fire. If they are to be underground in the hands of monopolists, then the general public have great cause to grumble, for their free use of the streets is continually interfered with, to their loss both in time and money. The forthcoming committee will have its work cut out to do justice between companies, municipalities, the general public, telephone users, and the Government departments.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### COPIES OF CORRESPONDENCE, ETC., *RE* SALE OF SPECIFICATION BY MR. BUCKLEY FOR WORK AT BATLEY CO-OPERATIVE SOCIETY.

*Letter from J H. Taylor and Co, Huddersfield, to H. B. Buckley, architect, Batley, 11-2'05.*

"We enclose herewith cheque value 10s. deposit for specification for above. Please forward this to ——."

*(2) Postcard Mr. Buckley to Messrs. J. H. Taylor and Co., 13 2'05.*

"The 10s. is a charge (not returnable) see advt., and not deposit, so please let me know by return if you require a copy or not. Will reserve you one until hearing from you."

*(3) J. H. Taylor and Co. to Mr. H. B. Buckley, 15-2'05.*

"Your postcard to hand. The advertisement in the *Yorkshire Daily Observer* did not state that the amount paid was not returnable. We have never previously been asked to make a payment of this description, in an experience extending over forty years. We are willing to give you a tender free of charge, which will cost us not less than £2, but we certainly are not prepared to pay for the specification. We shall be pleased to give you a tender on the above conditions. If, however, you do not agree to this, please return our deposit."

*(4) H. B. Buckley to J. H. Taylor and Co., 16-2-'05.*

"Thank you for your letter of the 15th inst. *re* charge of 10s. This has had to be made owing to the great number of applications previously made for the specifications in order to keep out the inferior small firms, and so give the better a fair chance of giving a proper tender for the work."

*(5) H. B. Buckley to Lancashire Electrical Engineering Company, Ashton, 10-2-'05.*

"*Re* wiring for electric lighting for Batley Co-operative Society. Please note the 10s. is a charge, and not a deposit (see advertisement). The specifications are ready. Do you wish to have them? If so, I will forward them on hearing from you."

*(6) H. B. Buckley to Lancashire E.E. Co., 13-2'05.*

"Herewith is returned your cheque as desired. Surely, if you did not desire to conform to the conditions, you might have said so without imposing your opinions on others. Instead of being to the disadvantage of the Co-operative Society, it is intended as the reverse, as probably only the best class of firm will compete for the work, thus eliminating smaller and inferior firms and giving a better chance to the firms who do tender. Evidently you have not considered the matter, otherwise you would have seen this. There have been shoals of persons desirous of tendering for the work which would have been useless, and taken both their's and the committee's time."

*(7) Batley Co-operative Society to Lancashire E.E. Co., 17-2'05.*

"We have your letter *re* charge for specification. We regret if there is any irregularity in this matter. Of course, Mr. Buckley is our architect, and he was asked to prepare specifications and get in tenders for the work, and we were not aware that this course would be adopted. His explanation is that a great many firms apply for specifications, and then he hears no more of it. It has gone too far now for our interference on the present occasion."

*(8) Lancashire E.E. Co. to Batley Co-operative Society, 18-2'05.*

"We thank you for your courteous letter of the 17th inst., and are pleased to know that you were not aware of the course adopted in reference to the specification for lighting. We note that it is now too late for your interference, but we shall be quite satisfied if our action will prevent a similar condition in future tenders. Your architect ought not to send the specification without a deposit, and then he would safeguard himself against bogus people applying. We send herewith for your perusal an original letter showing how the best firms deal with such matters. Kindly return the letter after perusal. Again thanking you for your attention to the matter."

*(9) Leeds E.C.A. to Mr. Buckley, 18-2'05.*

"The members of the Leeds Branch of the Electrical Contractors' Association (Incorporated) desire to express their disapproval of the charge of ten shillings (not returnable) made in connection with the supply of specifications of the electric light installation for the new central stores of the Batley Co-operative Society in Commercial-street, Batley. They wish to point out that this charge is a new departure, quite different to a returnable deposit, and that it does not commend itself to their sense of the fitness of things, and is likely to lead to abuse. They do not, of course, wish to dictate to anyone, but merely to respectfully urge their objection."

*(10) Mr. Buckley to Leeds E.C.A., 21-2-'05.*

"In reply to yours of the 18th inst., I am well aware about the 'new departure' you name, which was done with a purpose, and of a necessity, and the same has answered its intentions."

*(11) Minute of Resolution passed at Meeting of Northern Section E.C.A., 25-2-'05.*

"That this meeting strongly condemns the action of the architect to the Batley Co-perative Society in asking for a money payment (not returnable) for copies of specification for electrical work to be done, and that copies of the correspondence and of this resolution be sent to the Batley Co-operative Society, the Leeds and Yorkshire Architectural Society, and the electrical and architectural Press."

## INSTITUTION OF MECHANICAL ENGINEERS.

The first report of the Steam-Engine Research Committee was presented by Prof. David S. Capper, member, at the meeting of the institution on the 17th inst. The above-mentioned committee was constituted at the instance of the late Mr. Bryan Donkin to investigate and carry out research upon the initial condensation in steam-engine cylinders. Through the kindness of Messrs. Marshall, Sons, and Co., of Gainsborough, a special engine was obtained at cost price for the purposes of the investigation, and erected in the engineering laboratory at King's College. The report deals at considerable length with the results of experiments, extending over several years, on jacketed and unjacketed cylinders. But important as the subject undoubtedly is, we are unable, owing to the great pressure on our space, to give

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more than the general deductions. In the reporter's own words, it is dangerous to draw conclusions of too general and sweeping a character from experiments upon one type of engine under one set of conditions, but it may fairly be claimed that the ground covered by this report has never previously been surveyed with an engine showing more consistent and definite results, nor under conditions which enabled so detailed an analysis of the results to be made. It may, therefore, be anticipated with some confidence that the definite indications shown by the results form a real contribution to the present knowledge of the phenomena accompanying condensation and re evaporation in an engine cylinder under given conditions of jacketing. The points which have been elucidated may be summarised as follows:

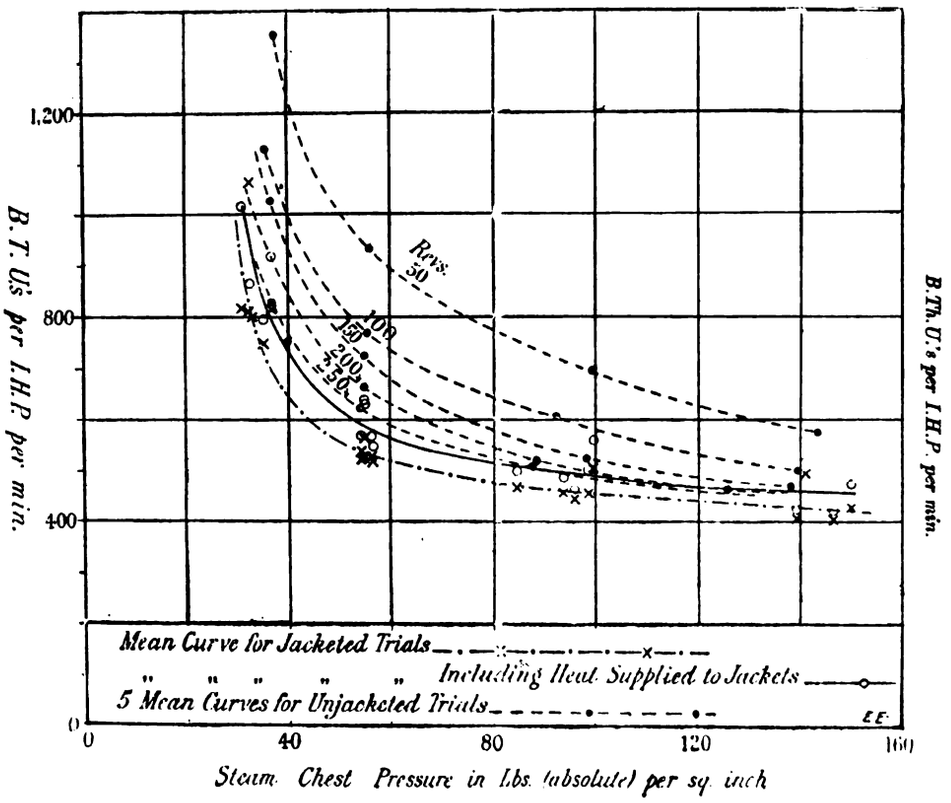


FIG. 1.

Firstly, leakage through the slide valve, to the importance of which Messrs. Callendar and Nicolson have drawn attention, has been quantitatively determined under defined conditions, and has been shown to be nearly independent of speed of sliding surface and proportional to difference of pressure between the two sides of the valve. Further, it has been shown that the assumption that the leakage is inversely as the overlap of the valve is at least in the main well founded. And, further, that with well-fitted valves

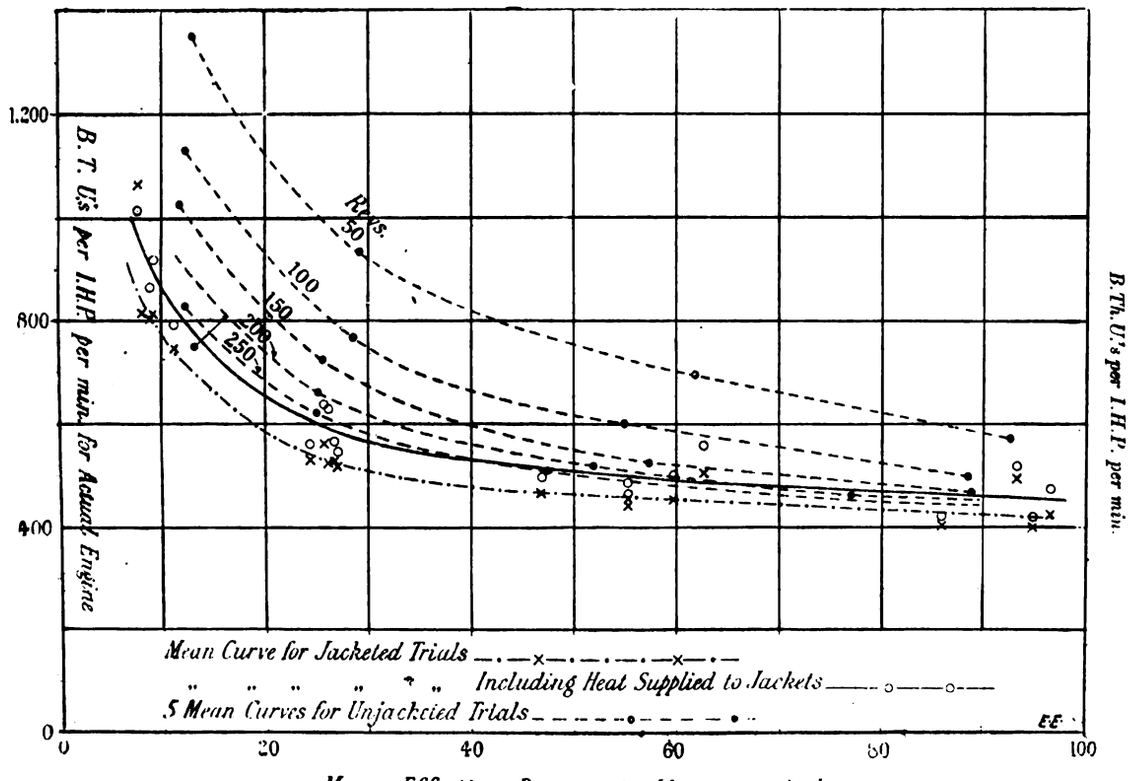


FIG. 2.

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the leakage may amount to over 20 per cent. of the steam entering the cylinder, and is rarely less than 4 per cent.

Secondly, it has been shown that for an unjacketed engine with a given ratio of expansion initial condensation, expressed as a percentage of the steam in the cylinder, *diminishes* with increase of initial temperature, while the total condensation per stroke *increases* with such temperature increase. This, though suggested by Messrs. Callendar and Nicolson's researches, has never previously been demonstrated with clearness, as if leakage is not allowed for, the results are obscured and even reversed, and the conclusions arrived at without leakage allowance are therefore unreliable.

Thirdly, it appears from the results here obtained that the re-evaporation for a given ratio of expansion is as great and sometimes greater without jackets than with them. This shows very clearly that the regenerative action of the cylinder walls with a given ratio of expansion is largely independent of their mean temperature. No quantitative analysis of re-evaporation is possible where leakage is not taken into account, as without the necessary allowance results would be largely illusory.

Fourthly, it is possible from the results obtained to show the temperature when for any speed of revolution with a given rate of expansion the jackets will become unnecessary or wasteful. If the heat units per indicated horse-power per minute required by the unjacketed engine for each speed of the series be plotted either on an initial pressure or a mean effective pressure base the points for each speed will be found to lie on four curves, which become closer and closer to one another as the speed increases, and all converge to a point as pressure or temperature increases. If the heat consumption for the jacketed series be likewise plotted, it will be found that the points for the different speeds at each pressure lie irregularly round a point, their exact position being determined by the accidentally slight variations of the conditions of each trial. A fair curve through the means of these points will lie below the corresponding curves for the unjacketed trials, but if the heat absorbed in the jackets be included the resultant curve cuts the unjacketed curves at points which for each speed indicate the temperature and pressure at which the jackets cease to be economical. Such curves are shown on Figs. 1 and 2. It will be seen that the full black line, which is the resultant mean for the jacketed trials, cuts both the 250 and the 200 revolution unjacketed curves within the temperatures and pressures included within the scope of the present experiments, and the temperatures and pressures where the 150, 100, and even the 50 revolution curves would cut, can very closely be predicted. As far as the reporter is aware, this is the first time when an exact determination for a given engine and ratio of expansion of this point has been diagrammatically shown.

## TEMPERATURE CURVES AND THE RATING OF ELECTRICAL MACHINERY.*

BY RUD. GOLDSCHMIDT, ASSOCIATE MEMBER.

*(Continued from page 419.)*

### III.—Heating and Cooling.

Temperature curve (Fig. 13) refers to a 440-volt, 4-h.p., semi-enclosed motor. Curve A is actually observed. Curve B gives the temperature curve reduced to constant loss. We gather from the curve that the final temperature, $t_f$, = 64deg. C., and that two-thirds of this final temperature, or 42deg. C., is reached in 72 minutes. The ideal heating time, $T_i$, is therefore 72 minutes. Initial temperature rise $\frac{64}{72}$ = 0·89deg. C. per minute. The current density when the copper was hot was 1·8 amperes per mm.², which, according to Table I., corresponds to 1·05deg C. per minute for cold copper or 1·26deg. C. per minute for hot copper. Through the influence of the cotton insulation the specific heat of the field coil has been increased $\frac{1·26}{0·89}$ = 1·42 times.

* Paper read before the Institution of Electrical Engineers.

The size of wire was 0·028in. With very small high-volt motors it was observed that the specific heat of the thickly-insulated thin wire of the field coils (say 0·012 size) was

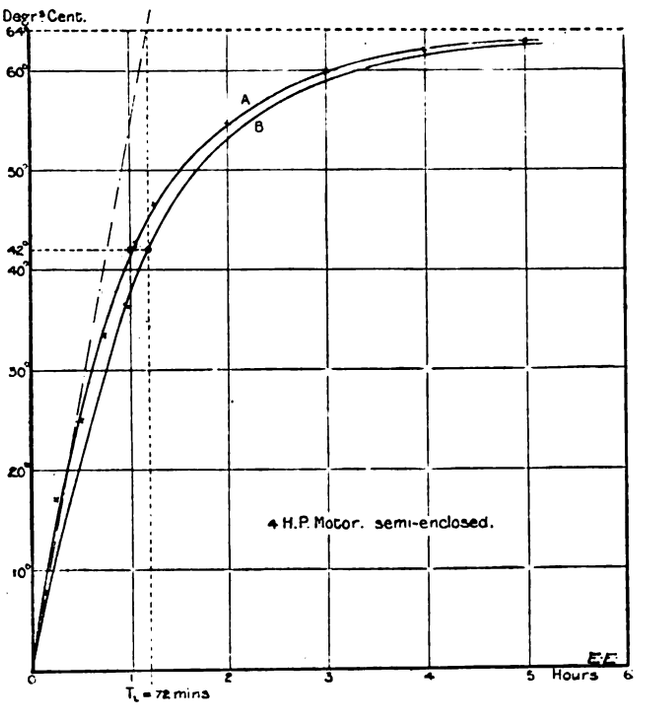


Fig. 13.

nearly double that of pure copper. The following table refers to the curves given in Figs. 6-14:

| Curve Fig. | Output of machine. H.P. | Kw. | Volts. | Type. | Size of wire in inches. | Ideal heating time in minutes. | Current density. Amps. per mm². | Increase of the specific heat through the cotton insulation. |
|---|---|---|---|---|---|---|---|---|
| 6 | — | 750 | 500 | Open | ⅛ sq.in. | 105 | 1·28 | 1·22 |
| 7 | — | 500 | 500 | ,, | ·109 | 108 | 1·25 | 1·25 |
| 8 | — | 200 | 440 | ,, | ·102 | 138 | 1·25 | 1·25 |
| 9 | — | 100 | 440 | ,, | ·088 | 132 | 1 25 | 1 36 |
| 10 | — | 75 | 500 | ,, | ·048 | 75 | 1·58 | 1·42 |
| 11 | — | 55 | 55 | ,, | ·088 | 132 | 1 05 | 1·22 |
| 12 | 35 | — | 110 | Totally enclosed | ·065 | 260 | 1·00 | 1·35 |
| 13 | 4 | — | 440 | Semi-enclosed | ·028 | 72 | 1·8 | 1·42 |
| 14 | 1½ | — | 110 | Totally enclosed | ·028 | 85 | 1 65 | 1·60 |

It is well known that large machines require a very much longer test than small ones. This is very clearly

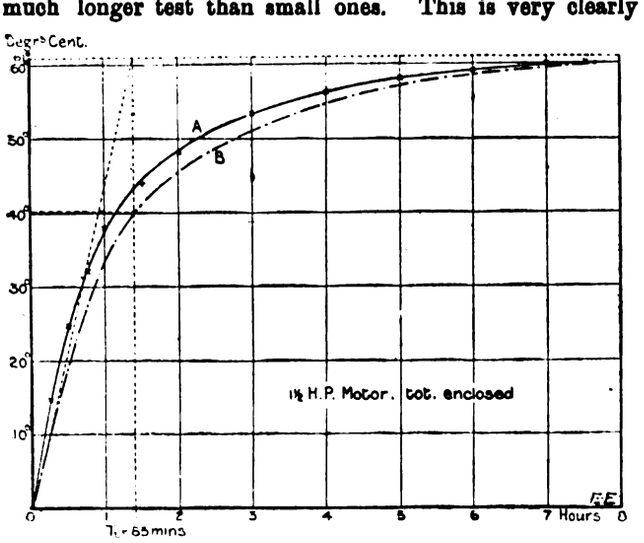


Fig. 14.

shown by the formula for $T_i$. Whilst heating and rise constants do not vary very much with the size, the ratio $\frac{\text{volume}}{\text{surface}}$ increases with an increase of the size.

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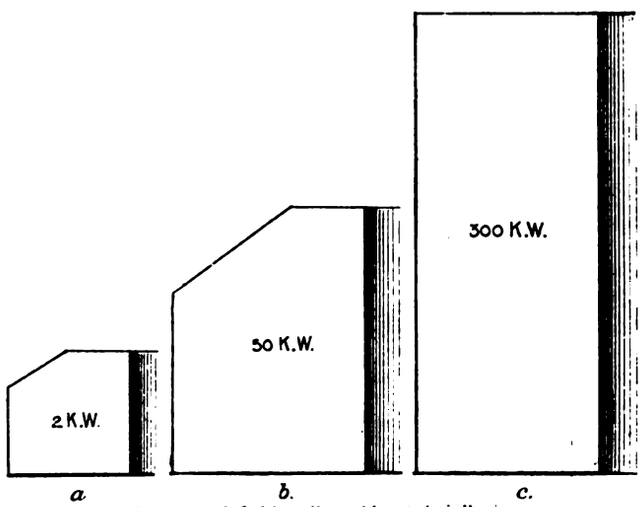
Fig. 15, *a*, *b*, *c*, shows sections of field coils of 2-kw., 50-kw., and 300-kw. Crompton dynamos. In the case of the 2-kw. machine, the section of the coil is 25cm.$^2$, and the circumference of the section 19·5cm. For the purpose of comparison $\frac{\text{section}}{\text{circumference}}$ may stand for $\frac{\text{volume}}{\text{surface}}$. As an average it may be assumed that 50 per cent. of the total section of the field coils is copper; thus we find

For 2-kw. machine $\frac{\text{section}}{\text{circumference}} = 1{\cdot}3$; $\frac{\text{volume}}{\text{surface}} = 0{\cdot}65$.
For 50-kw. „ „ $= 2{\cdot}0$; „ $= 1{\cdot}0$.
For 300-kw. „ „ $= 2{\cdot}7$; „ $= 1{\cdot}35$.



Section of field coils. About ¼ full size.
Fig. 15.

If for the 2-kw. machine a four hours' temperature test is considered sufficient, the 50-kw. machine must be tested 6¼ hours, and the 300-kw. machine must be tested 8¼ hours. For practical use, the current density will be more convenient for determining the test time than the dimensions. We may, therefore, conclude our investigations on this point by stating that dynamos with stationary field coils, which are designed for about 50deg. C. measured by resistance rise, reach their final temperature within two or three degrees.

| | | | | | | |
|---|---|---|---|---|---|---|
| At the end of 1 hr. with field current density of | 3,000 | amps. | per sq. | in. | | |
| „ | 3 | „ | „ | „ 1,500 | „ | „ |
| „ | 6 | „ | „ | „ 1,000 | „ | „ |
| „ | 9 | „ | „ | „ 800 | „ | „ |

*Example* 2.—A motor has a temperature rise of 50deg. F. with a current density in the field of 1·7 amperes per mm.$^2$

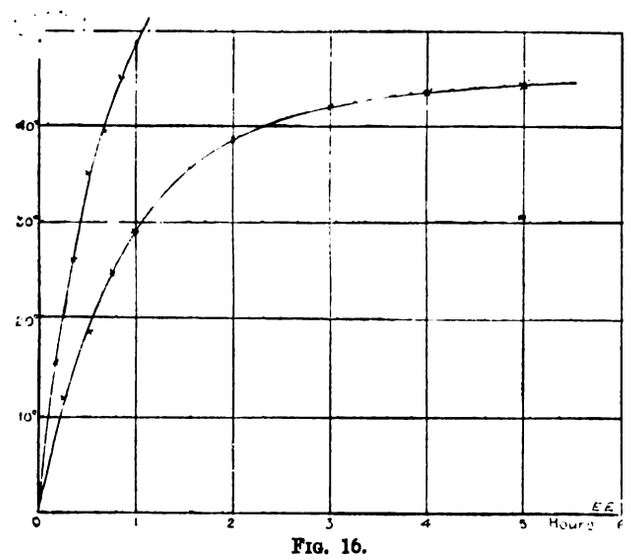


Fig. 16.

What current density should be used if we apply the same machine as a crane motor with 75deg. F. after one hour?

From our original example we know that the ideal heating time is $T_i = 1\frac{1}{2}$ hours. One hour is, therefore, equal to $0{\cdot}67 \times T_i$. At $0{\cdot}67 \times T_i$ (see Table V.) 50 per cent. of the final temperature, $tf$, is reached; therefore, for the crane motor $tf = 2 \times 75 = 150$deg. F. The watts lost can be increased in the ratio $150/50 = 3$ times, and thus the current density may be increased $\sqrt{3} = 1{\cdot}73$ times. As a crane motor with 75deg. F. temperature rise after one hour (measured by resistance), the current density must be $1{\cdot}73 \times 1{\cdot}7 = 2{\cdot}9$ amperes per mm.$^2$—that is, 1,850 amperes per square inch.

A test of a 10-h.p. Crompton motor is also given. Curve A (Fig. 16) is the field temperature rise for continuous running (current density 1·7 amperes per mm.$^2$), while Curve B is a one-hour test with 42 per cent. higher current density—that is, 2·4 amperes per mm.$^2$ We see that the final temperatures of the Curves A and B are the same (46deg. or 48deg. C.). As regards the temperature of the armature, it attained 42deg. C. during the continuous run. The flux went up about 20 per cent. during the one-hour test, in consequence

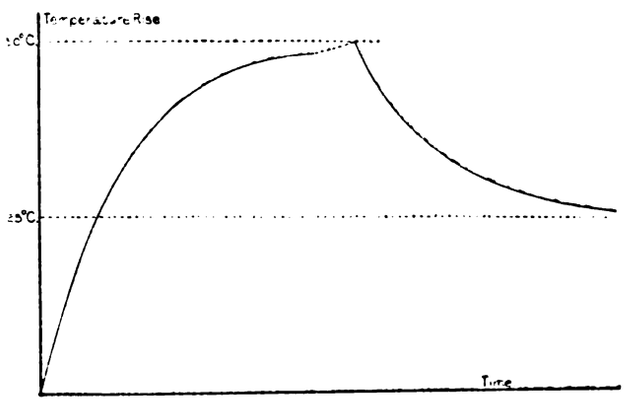


Fig. 17.

of 42 per cent. higher excitation, and the armature current was kept 42 per cent. higher than for the continuous run. The temperature rise after one hour was 38deg. C. This temperature is lower than the continuous running temperature, due to the core loss not having increased in the same ratio as the copper loss.

If a heated body has attained the temperature which we have called the "final temperature," all heat subsequently produced is given out to the surrounding atmosphere.

Referring to our previous example again, we stated that if the body has a temperature of 50deg. C. above that of the atmosphere it gives out by radiation and convection as much heat as would increase the temperature of the body at the rate of 0·55deg. C. per minute. With a temperature of only 35deg. C. we found the state to be inconstant, the temperature increasing at the rate of

$$\frac{0{\cdot}055}{50}(50-35) = \frac{1}{90} \times 0{\cdot}15 = 0{\cdot}165\text{deg. C. per min.}$$

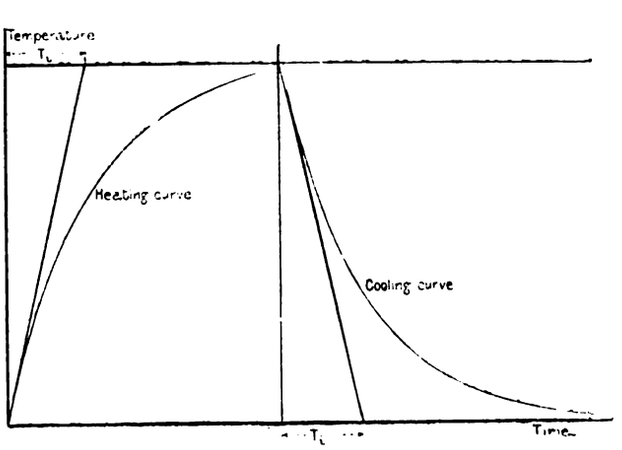


Fig. 18.

Now we know that the ideal heating time

$$T_i \frac{50}{0{\cdot}55} = \frac{\text{Final temp.}}{\text{Initial rise}} = 90\text{min.}$$

and is a constant of the apparatus, so that we may say

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$$\text{Temp. increase per min.} = \frac{\text{Final temp.} - \text{momentary temp.}}{\text{Ideal heating time.}}$$

$$E = \frac{tf - t}{T_i} = \left(\frac{50 - 35}{90}\right).$$

We will suppose that the temperature was more than the temperature of equilibrium, 50deg. C.—say 70deg. C. We may assume that this temperature was obtained by overloading the apparatus at some time. Then the cooling action is 70/50 = 1·4 times greater than that which just balances the temperature increase of 0·55deg. C. per minute. Thus at the instant when the temperature of the body cools down at the rate of $E = \frac{50 - 70}{90} = 0$ 22deg. C. per minute, we see that there the calculation of the cooling is the same as that of the heating, and if E is positive it indicates temperature increase, while if negative it indicates a cooling action.

It is important to consider the cooling curve in cases where the development of heat suddenly becomes less. Supposing the lost watts were suddenly reduced by half (Fig. 17), then the new final temperature would be $\frac{1}{2} \times 50 = 25$deg. C., and the initial rise $\frac{1}{2} \times 0{\cdot}55 = 0{\cdot}275$deg. per minute. If the body had already attained its end temperature of 50deg. C. during the first instant after the change, the temperature would drop at the rate of $\frac{25 - 50}{90} = -0$ 275deg. per min. At any other temperature the calculation of the temperature drop is equally easy; at 35deg. C., for instance, we find $E = \frac{25 - 35}{90} = -0{\cdot}11$deg. per minute. Proceeding by intervals of 10 or 20 minutes, we can trace the whole cooling curve, which tends to reach the new final temperature of 25deg. C.

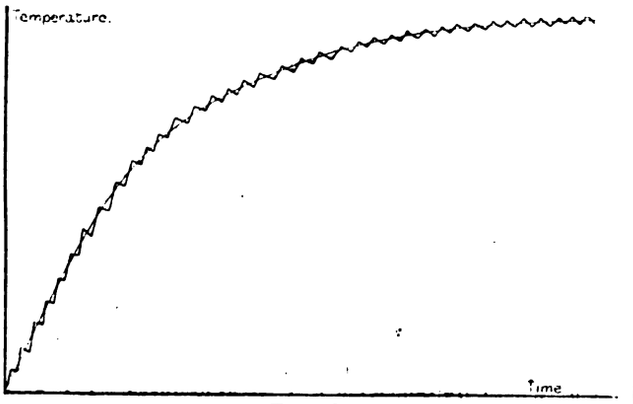


FIG. 19.

By a complete heating and cooling curve we understand the heating curve rising up to the final temperature, and the drop curve from this temperature down to 0 = air temperature. The rate of the drop in the first moment is $\frac{50 - 0}{90} = 0{\cdot}55$deg. C. per minute, being the same as the initial rise. Therefore, we see that the initial rise and the initial drop are identical. The "total rise" was 0 to 50deg. C.; the "total drop is naturally the same amount—*i.e.*, 50deg. C to 0. This is sufficient to show us that the falling curve and the rising curve are identical in form, only reversed. The consequence is that we are able to apply the same graphic method as that described in connection with Fig. 3, and that after finding the correct scale in the manner previously described, we can use Fig. 4 upside down as a standard cooling curve for every possible case.

The tables can also be easily adapted to the cooling curve. Table V. shows, for instance, that the machine is heated up from 0 to 75 per cent. of the final temperature (in our example $0{\cdot}75 \times 50 = 37\frac{1}{2}$deg. C.) in $1\frac{1}{2} \times$ the ideal heating time, $T_i$ ($1\frac{1}{2} \times 90 = 135$ minutes). Bearing in mind that the cooling curve is a heating curve (only reversed), we may say that in $1\frac{1}{2}$ times $T_i$ the body is cooled down from 50deg. C. to 100 per cent. − 75 per cent. = 25 per cent. of the final temperature—that is, in the example, to $0{\cdot}28 \times 50 = 12\frac{1}{2}$deg. C. If the load is only reduced in such a degree that the losses are halved, the new final temperature to which the body would tend to cool down is $\frac{1}{2} \times 50 = 25$deg. C.

With reference to the above, we found that the initial rise in this case is 0·275deg. C. per minute. The total amount to be cooled down is 50 − 25 = 25deg. C., thus the "ideal cooling time" is $T_i = \frac{25}{0{\cdot}275} = 90$ minutes, just as for the heating time, and consequently in, say, $1\frac{1}{2} \times T_i = 135$ minutes, the body has cooled down $0{\cdot}75 \times 25 = 19$ deg., and so reached a temperature of 50 − 19 = 31deg. C.

Before concluding our investigations on cooling, it may be pointed out that with rotating machines during the cooling period, when the machine is shut down, the cooling conditions generally are worse than those existing when the machine is working. This is due to there being no ventilation when the machine is at rest. When the machine stands still, the heating constant (equivalent to cooling constant) of the field coils is about two-thirds of that with the machine revolving at normal speed. This ratio naturally depends on the sort of machine, and on the influence of the armature losses on the field temperature, etc. It would, however, be beyond the scope of our real subject to consider this question fully in the present paper. We will, therefore, only study in principle how a change in the degree of ventilation influences the temperature curve.

*(To be continued.)*

## FORTHCOMING EVENTS.

FRIDAY, MARCH 31.

**Compatriots' Club.**—At 5 30 p.m., Westminster Palace Hotel, "The New German Commercial Treaties and their Probable Effect on British Industries," by Mr. W. A. S. Hewins.

**Institution of Mechanical Engineers.**—At 8 p.m., "First Report, Steam-Engine Research Committee," by Prof. D. S. Capper (further discussion).

SATURDAY, APRIL 1.

**Association of Municipal Corporations.**—Annual meeting at the Guildhall, when the agreement between the National Telephone Company and the Government and other subjects will be discussed.

**Royal Institution.**—At 3 p.m., "Some Controverted Questions of Optics," by Lord Rayleigh.

MONDAY, APRIL 3.

**Society of Arts.**—At 8 p.m., Cantor Lecture IV., "Telephony," by Mr. H. L. Webb.

TUESDAY, APRIL 4.

**Institution of Civil Engineers.**—At 8 p.m., further discussion on Mr. C. S. R. Palmer's paper, "Coolgardie Water Supply."

THURSDAY, APRIL 6.

**Institution of Electrical Engineers.**—At 8 p.m., discussion on the report to Council on the International Electrical Congress, St. Louis, by Mr. W. Duddell, hon. secretary to the delegation, and on the papers on "Systems of Electric Units," by Profs. Ascoli, G. Giorgi, H. S. Carhart, and G. W. Patterson, and Dr. F. A. Wolff.

**Chemical Society.**—At 8 p.m., general meeting.

**Royal Institution.**—At 5 p.m., "Synthetic Chemistry," by Prof. R. Meldola.

**Rontgen Society.**—Exhibition evening.

FRIDAY, APRIL 7.

**Compatriots' Club.**—At 5.30 p.m., Caxton Hall, "The Economics of Preference," by the Hon. B. R. Wise, K.C.

**Royal Institution.**—At 9 p.m., "American Industry," by Mr. A Mosely.

**Institution of Electrical Engineers (Manchester Students' Section).**—At 7.30 p.m., "Electric Cranes," by Mr. Jennison.

SATURDAY, APRIL 8.

**Birmingham Electric Club.**—At 7.30 p.m., "Lightning Conductors," by Mr. W. H. Whitehouse.

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**Institution of Civil Engineers.**—The thirteenth "James Forrest" lecture will be delivered by Colonel R. E. C. Crompton, R.E. C.B., on Monday, April 10, at 8 p.m., the subject being "Unsolved Problems in Electrical Engineering."

**Physical Society.**—April 14, "Ellipsoidal Lenses," by Mr. R. J. Sowter; "The Determination of the Moment of Inertia of the Magnets used in the Measurement of the Horizontal Component of the Earth's Field," by Dr. W. Watson; and a series of lecture experiments illustrating the properties of the gaseous ions produced by radium and other sources, by Dr. W. Watson.

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## TRADE NOTICES AND NOVELTIES.

### Catalogues.

EDISWAN LEAFLETS.—Two leaflets illustrating new designs of fancy glass shades and globes have been sent to us by the Edison and Swan United Electric Light Company, Limited, 36-37, Queen-street, Cheapside, E.C.; also one dealing with fuseboards of the "terminal" type, specially suitable for motors or for controlling large lighting circuits.

ELECTRICAL COMPANY'S LITERATURE.—A mass of literature has been issued recently by the Electrical Company, Limited, 121-125, Charing Cross-road, London, W.C. This includes a comprehensive price-list of rubber wires and cables, a descriptive list of E.C. ampere-hour motor meters of the firm's R.A. type, and leaflets illustrating respectively their double-tariff meter combination, automatic cut-off switch for shop windows, lamp signs, etc., weatherproof motor switchboard, motor switch and starting box, electric capstan and 50-ton crane at Southampton Docks with E.C. electrical equipment.

STANDARD SCREW THREADS, Hampshire Works, Station-road, Walthamstow, N.E.—New lists have been issued of the British Association standard screw threads, of which the firm are the original makers, and we are informed that they will supply these free of charge and post free to any of our readers who use or are interested in taps, screw plates, dies, etc., not only of the B.A. type, but any other.

### G.E.C. Progress Sheet.

The Progress sheet issued by the General Electric Company, Limited, 71, Queen Victoria-street, E.C., for February last includes particulars of several novelties, some of which we illustrate herewith. Fig. 1 shows a new heavy pattern of sealing-wax heater for workshop use. It is wired for two circuits, one for heating the wax up quickly, and the other for maintaining it at the right consistency. Fig. 2 shows a new design of battery fan. The fan motor in this combination is constructed with a permanent magnet field, which enables a much higher efficiency to be obtained than is usual. Our last illustration (Fig. 3) represents a handy form of inspection lamp fitting for motorists. The lamp itself is of the "Osmi" type, and is claimed to give a good light when connected to an ordinary ignition battery. A very compact form of tail fitting, with "Osmi" lamp for motor cycles and cars, is described, and particulars are also given of a lampholder designed to prevent the withdrawal of lamps by unauthorised persons. When the lamp is inserted in the holder, a special stud at the top is turned by means of the key provided, and this effectually locks the spring contacts, thus preventing the removal of the lamp.

FIG. 1.—Sealing-Wax Heater

FIG. 3.—Inspection Lamp Fitting for Motorists.

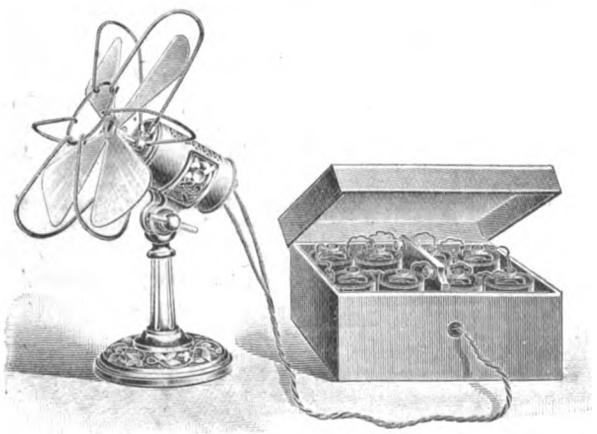

FIG. 2.—The Magnet Battery Fan.

### Electrically-Driven Pumps.

In our issue of Feb. 10 last we referred at some length on p. 202 to a standard line of electrically-driven variable-stroke boiled feed pumps of very excellent design, which Messrs. Hayward-Tyler and Co., of 99, Queen Victoria-street, London, E.C., are manufacturing at their Luton Works under the Sinclair patent. Since then we have received from the above firm a copy of their new catalogue, Section M, dealing with electrically-driven and other three-throw pumps. Incidentally, this catalogue serves to show the very rapid strides that electricity is making as a flexible and convenient means of applying power to pumps. The adaptability of the pumps is practically unlimited, ranging from domestic water supply, boiler feeding, etc., to fire protection and mines drainage. It is also noteworthy that the illustrations are from actual photographs, and represent a selection of the many patterns supplied by Messrs. Hayward-Tyler and Co. For special reference we have selected the two combinations illustrated repectively on pp. 22 and 23 of the catalogue. The first of these (Fig. 1 herewith) is a 3in. by 6in. vertical treble-barrel pump, coupled through gearing to an electric motor. This pump was designed for delivering 1,500 gallons per hour against a head of 300ft. The whole is enclosed in a strong wrought-iron case with chains for suspending, and was built for use in mines. It will be noticed that the motor is provided with hinged covers to allow for easy access. Fig. 2 shows a 3½in. by 6in. horizontal three-throw plunger pump geared by machine-moulded cast-iron gearing to a

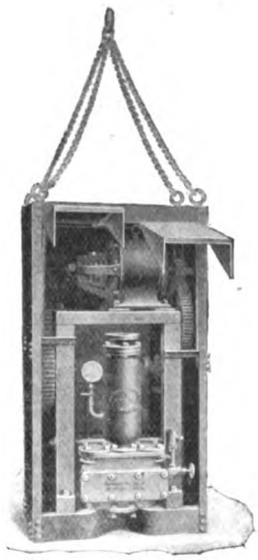

FIG. 1.

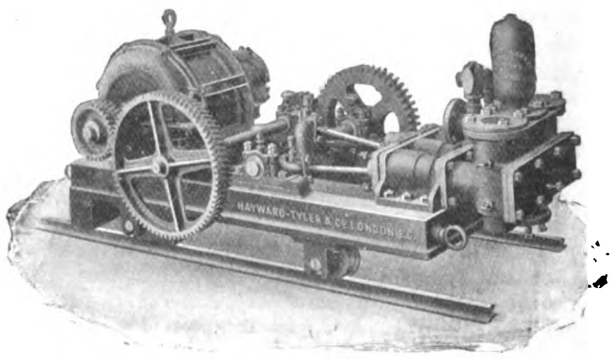


FIG. 2.

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continuous-current electric motor, and mounted on a travelling truck. This combination was supplied to a large ironworks, and is capable of delivering 3,000 gallons per hour against a head of 80ft. We need not dwell here upon the great advantage of electrically-driven over steam-driven pumps for portable purposes in mines, etc., but in this connection we are glad to have Messrs. Hayward-Tyler and Co.'s assurance that for most purposes the flexibility and convenience of electricity as a motive power for pumps is being fast recognised, as proved by numerous orders and enquiries for all ranges of their machines, including mining pumps of the largest sizes.

## "Pluto" Electric Heaters.

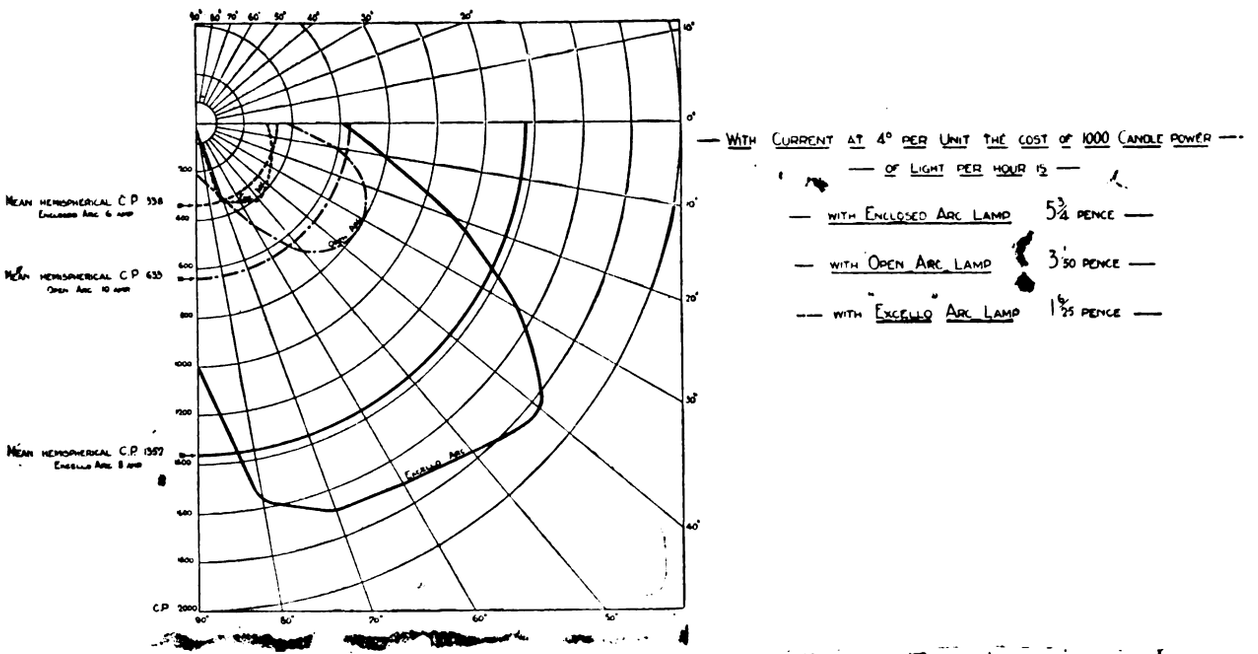
We were invited last week by the Electric Corporation, Limited, to inspect a selection of their "Pluto" electric heaters at 69-70, Aldersgate-street, E.C. These heaters mark an entirely new departure, and for æsthetic reasons alone will scarcely fail to secure a very large demand. Great care has, in fact, been taken to obtain artistic designs, the possibility of art metal work being fully developed, while some of the styles shown will appeal very strongly to lovers of the antique. It may be truly said that each "Pluto" heater is not only an article of utility but a piece of furniture deserving of admiration. Apart from artistic merit, the great feature of these heaters is the principle which they combine. The heating medium consists of resistance wire of special non-oxidising alloy wound spirally on porcelain cores having concave sides to admit of the free circulation of air immediately round the wire. Each core so wound constitutes a section, and can be easily replaced in case of breakage, which is, however, extremely unlikely. A number of these sections are combined in one heater, and regulation is obtained by switching in the whole or part of them as required by means of two switches which govern three temperatures. The sections are enclosed in a metal chamber provided with a thick covering of asbestos material. Open-ended tubes or ducts pass vertically through this chamber, which quickly becomes a reservoir of heat when the electric current is switched on, with the result that the tubes are raised to a high temperature, air being drawn through them, heated, and freely circulated. The asbestos covering of the heating chamber, of course, tends to conserve the heat, so that when the circulation is once started, less current is required to maintain it, and some of the sections can, therefore, be switched out. Practically all the heat generated is usefully employed, hence economy. The latter is claimed to be high, and we have no reason to doubt but that it is so, but as exhaustive tests are not yet completed we must, perforce, reserve full information for a later date. It is estimated, roughly, that 500 watts will suffice to heat 1,000 cubic feet of air-space, but the figures vary with the conditions obtaining. One heater, which we were informed was taking 2½ amperes at 200 volts, recorded a temperature of 300deg. F. of the heated air. In some of the heaters a fan is fixed above the tubes, being rotated by the ascending air, which it forces through pierced side panels, thus circulating a layer of hot air at a low level. Such heaters can be placed anywhere for effect. We hope to deal with "Pluto" heaters more fully in a subsequent issue.

## Excello Arc Lamps.

Below we give the results of some comparative tests for candle-power and efficiency made by the Westminster Electrical Testing Laboratory with the Union Electric Company's Excello flame arc lamp and two other types. It will be seen that the figures are very favourable to the Excello type, and amply substantiate the claims which the makers have made from time to time, while they explain the great success with which these lamps are meeting. The types compared were respectively as follows: ordinary open-type arc lamp, rated at 10 amperes, and fitted with cored carbon in top and solid carbon in lower carbon-holders; enclosed arc lamp, rated at six amperes, and fitted with solid carbon top and bottom; the Excello flame arc lamp, rated at 8 amperes, with arc burning horizontally, burning Noris-Excello carbons Nos. 104 105. All three lamps were provided with alabastrine globes. The amount of light obscured by the globes appeared to be the same for all three lamps. The same photometer, light standard, and instruments were used throughout. Following are the details of the tests:

*Electrical Details.*

| | Open arc. | Enclosed arc. | Excello arc. |
|---|---|---|---|
| Positive carbon ..... | 18mm. cored | 13mm. solid | 9mm. flame |
| Negative ,, ..... | 12mm. solid | 13mm. ,, | 8mm. ,, |
| Mean current in amperes ... | 10·8 | 6·25 | 8·7 |
| Mean pressure in arc volts | 44·0 | 77·6 | 44·0 |
| Mean consumption in watts (Shunt included) | 476 | 485 | 382 |




CANDLE POWER CURVES OF THREE TYPES OF ARC LAMPS TESTED AT WESTMINSTER ELECTRICAL TESTING LABORATORIES.

EXCELLO, OPEN ARC, ENCLOSED ARC. 11TH MARCH 1905.

*Candle-Power Details*

| Angle below horizontal. | Candle-power. Open arc. | Enclosed arc. | Excello arc. |
|---|---|---|---|
| 0 degrees ..... | 353 ..... | 290 ..... | 600 |
| 10 ,, ..... | 390 ..... | 308 ..... | 760 |
| 20 ,, ..... | 735 ..... | 330 ..... | 1,120 |
| 30 ,, ..... | 800 ..... | 350 ..... | 1,520 |
| 40 ,, ..... | 790 ..... | 382 ..... | 1,830 |
| 50 ,, ..... | 690 ..... | 410 ..... | 1,750 |
| 60 ,, ..... | 490 ..... | 360 ..... | 1,700 |
| 70 ,, ..... | 330 ..... | 345 ..... | 1,680 |
| 80 ,, ..... | 250 ..... | 75 ..... | 1,560 |
| 90 ,, ..... | 210 ..... | 30 ..... | 1,000 |
| *Results.*—Mean hemispherical candle-power. | 633 ..... | 338 ..... | 1,352 |
| Watts ..... | ·753 ..... | 1·435 ..... | ·282 |

From the above it appears that the watts per mean hemispherical candle-power is in the case of the Excello arc lamp but 37·5 per cent. of that obtained with the open arc and 19·65 per cent. of that obtained with the enclosed arc. It is added that it was impossible to test the Excello lamp without globes, as its candle-power was then higher than could be measured in the photometer room, but assuming that the globe absorbed the same amount of light as that fitted to the open arc, the mean hemispherical candle-power without globe should work out at about 2,300 c.p. The accompanying illustration shows the polar curve plotted from the measured figures of candle-power. It remains for us to congratulate the Union Electric Company, Limited, of 151, Queen Victoria-street, E.C., on the above results.

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## MANCHESTER MAINS.

### An Appreciation of a Slandered System.

It would appear to the casual reader of the recent legal proceedings against the Corporation of Manchester (on account of premises damaged by fire caused by a fault on the electric mains) that there was something particularly rotten about the system of electrical distribution adopted by that Corporation, if the verdict of the jury is to be considered of value. Briefly, the verdict stated (1) that the system constituted a *nuisance*, by causing danger to persons having premises adjacent to the mains; (2) that the electrical authorities were guilty of *negligence* in their methods of localising the fault in question; and (3) that when this fault developed it was *improperly* dealt with as regards fire risks. Electrical men will be considerably interested in the verdict all over the country, and especially those connected with systems of distribution which may be likened to the Damoclean sword, as regards their factor of safety from destructive breakdown. These latter will probably liken the system that has been so severely questioned to their own happy-go-lucky arrangements, numbers of which, alas! still exist all over the kingdom; and it is likely that those in charge of such hair-bleaching networks will take a none-too-soon warning from the incident.

There are other systems existing, however, with but one quarter of the precautions taken by the Manchester authorities, which are enjoying an immunity from serious accident due to their more favourable present circumstances, and whose superintendents will possibly look upon the Manchester affair as a providential retribution for inefficiency and shortsightedness. And it is these superior persons that require to be assured of the absolutely unique position of the Manchester Corporation electricity concern, both as to efficiency and longheaded precautions for the future. It should here be said that this article is not written for the sole purpose of justifying the Corporation staff against the legalised slanders of last week, but to point out that though a certain system of distribution may come an occasional and perfunctory cropper, it is no proof that other systems are, therefore, of more all-round value.

As regards the design of the network, it must not be imagined that the accidents that have happened were due to ignorance of the conditions. The system was originally laid down by Mr. C. H. Wordingham, and, right or wrong, he evidently fully appreciated the risks that were to be run, as per the following extract from his book on central stations, published in 1901. This extract shows that the system is based upon "the best means of maintaining continuity of supply," damage to property being apparently a secondary consideration.

Now, in all except the smallest towns, it is desirable to connect up the distributing mains to form what is known as a network—*i.e.*, wherever distributing mains meet conductors of the same polarity are connected together. There may be either one large network, or a number of isolated ones.

The argument in favour of one network is very strong. By interconnecting all points as far as possible, and by joining up every street at both ends, there is established, as it were, a conducting sheet on each pole from which current can be drawn, and if the demand is excessive at any one point the supply can flow to that point from all directions. The importance of this is great, for, in spite of great experience, it is impossible, in laying distributing mains, to avoid occasionally under-estimating the demand in a given street. If these distributors are connected at several points to the rest of the network, this is of little moment. Moreover, the area of maximum demand is constantly shifting from hour to hour, and with one large network less copper is required to deal with this than with a number of isolated networks, each of which must be large enough for its own maximum. Again, if the position of the demand has not been accurately foreseen, and the feeding point has not been placed in exactly the right spot, the error is practically eliminated by the network. With such a system, also, there is much less chance of being unable to reach a consumer in case of a fault.

Against these advantages there would be nothing to urge, if one could be certain that the insulation of the mains would always continue intact; but the best of mains will fail sometimes, and the consequences are then much more far-reaching than if there are a number of small independent networks. *In point of fact, it is a question of the best means of maintaining continuity of supply.* If it were feasible to arrange an automatic cut-off, whether in the form of a fuse or a mechanical circuit breaker, so as to isolate any section of mains which become faulty, there would be no question that one network is preferable; but, unfortunately, such a system of cut-outs is practically impossible at the present time. For, imagine a complicated network arranged with a cut-out on every section of main, and suppose a short-circuit on a given section, this short-circuit would allow a large quantity of current to flow for a short time. If all was in order, the circuit breakers on that section of main would be thrown; but, in order to throw these circuit breakers, large currents must have flowed through other portions of the network in order to reach this section, with the inevitable result that the circuit breakers on these portions, which are also set to cut off with extra current, are thrown as well, a dozen cut-outs, perhaps, going out of several hundred, and there may be but a slight clue as to where these cut-outs are, as the course taken by the current will vary according to the conditions of the load at the time.

Another great difficulty in using cut-outs arises from the fact that if the outer conductors of a distributing main be interrupted between two feeding points, and there are no balancers on the section, the lamps on the circuit or circuits which have the smallest load will be subjected to an undue pressure - this alone is almost fatal to the use of cut-outs.

If the question once be faced that a short-circuit cannot be efficiently provided against by means of cut-outs, but has to be burnt out, then the advantages of a large network become manifest, for the relative importance of a short-circuit diminishes as the extent of the scale of operations increases. Consider the case of a station supplying half a million lamps, and distributing at 400 volts. When all lamps are alight, their combined resistance between the outer conductors is only about one four-hundredth part of an ohm, and it must be an extremely bad short-circuit which has, and can maintain, as low a resistance as this. There is a good chance of burning out a fault quickly if the network will admit of heavy currents being delivered at any point.

From this it will be seen that the conditions under which the Corporation network exists are somewhat severe, and it is clear that this has been fully recognised by the Corporation electrical staff, and that the risks have been provided for to the best of their ability.

One item in the evidence may be taken as an example of what is meant. Mr. James Swinburne stated that with the exception of the five-wire arrangement, everything in the system was standard. This is only partly correct. As mentioned by Mr. L R. Lee (the Manchester mains engineer) in a letter to this paper of Oct. 30, 1903, he is no believer in standard practice, except, perhaps, as a minimum basis upon which to build his own more solid designs, and this is well known by those who have dealings with the Manchester Corporation. Take the insulation of the Manchester cables, for example. In them the Cablemakers' Association thicknesses of dielectric (which are the recognised standards) are exceeded up to double their values. The lead sheathing is also increased from the Cablemakers' Association's well-used standards in like proportion. Take the method of laying cables. Where other corporations almost universally use ½in. clearance between cables on the solid system, the Manchester standard is ¾in. Where others use wood and pot troughs, Manchester has cast iron, which are socketed and bolted together; and, further, her extra high-tension cables laid therein are earthed to every yard of trough by malleable iron clips. As to facilities for disconnecting, the arrangements are also unique in the provision of specially constructed pillars in roomy boxes, built like strong rooms, well ventilated, drained, and generally kept in drawing-room order. Every cable entering these chambers is distinctively and vividly coloured, and is clearly labelled as to size and route. If there were prizes offered for the condition of underground arrangements (similar to railway station competitions in floriculture), the Manchester system would romp home, judging from what the writer sees upon networks all over the country.

In conclusion, while justice appears to have been done in making the cause pay for the effect, there was surely no need to add insult to damages by using the three epithets mentioned in the opening paragraph to a system whose strong points (apart from the question of original design) are its thorough efficiency and provision for the future.

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# LEGAL INTELLIGENCE.

## MIDWOOD v. CORPORATION OF MANCHESTER.

Our last week's issue contained a report of this case, in which judgment was delivered as we were going to press.

**Mr. Moulton, K.C.**, in concluding his speech for the defence, submitted that the defendants had acted perfectly correctly in difficult circumstances.

**Sir E. Clarke, K.C.**, replying on the whole case, said Mr. Moulton had spoken as if the defendants were not liable because they had complied with all the Board of Trade regulations. That was not the law, and the jury had nothing to do with the statutory rights and obligations of the Corporation or the regulations of the Board of Trade. The Legislature had known perfectly well how to deal with the danger which must inevitably occur to persons in the neighbourhood of electric works, because there was a special clause in the provisional order under which the defendants were empowered to carry out these works, saying, "Nothing in this order shall exonerate the undertakers from any indictment, action, or other proceeding for nuisance in the event of a nuisance being caused by them." That special provision got rid of all the regulations and rules of the Board of Trade. The evidence for the defendants was that the risk of burning up houses was a necessary incident of their system. If that was so, then it was clearly a nuisance which had been brought to the doors of the inhabitants by the Corporation, and they were undoubtedly liable for any damage which was caused by such a nuisance. They admitted that it was impossible to foresee these occurrences, and, therefore, any private person was at the mercy of this system. Fortunately, in this case, the premises damaged were a warehouse, but the consequences might be serious if a similar accident happened to a house where there were a number of people asleep. The reports put in showed that there had been 20 accidents in three years, and his learned friend was mistaken in saying that no compensation had been paid, because in one case the Corporation paid £100. Of course, the other persons who were injured did not care to run the risk of bringing actions against the Corporation, which would be conducted in the way this case had been, at enormous expense to all parties. This case, however, involved a substantial amount as well as an important principle, and he hoped the result of it would be to secure that in future, when accidents took place by which private persons were damaged, they would be properly compensated.

**His Lordship**, in summing up, pointed out that the allegations of nuisance and negligence stood on entirely different grounds. If a person created a nuisance, it was no answer for him to say that he had not acted negligently. On the allegation of negligence the question was, did the defendants' servants take all reasonable steps to localise the fault, and if they had done so, could they have prevented the fire? The evidence on which the plaintiffs relied to support the charge of negligence was that earlier in the evening the defendants' servants had information of the irregularity in the light of the public-house in Fountain-street, but, notwithstanding that information, they did nothing to disconnect the supply in Fountain-street until it was too late. The two questions he left to the jury were, did the system adopted by the defendants constitute a nuisance by causing danger to persons having premises adjacent to the mains; and when the defendants became aware of the fault did they deal with it for the purpose of preventing fire in a reasonable and proper manner? At the request of Mr. Gordon he included a third question—Were the defendants guilty of negligence in their method of localising and dealing with faults?

The jury, after a short deliberation, returned answers to all the questions in favour of the plaintiffs.

**Sir E. Clarke**, in asking for judgment for the plaintiffs, asked his Lordship to rule in his favour that on Section 67 of the provisional order authorising these works the plaintiffs were entitled to judgment, whatever the jury's verdict might have been. He only wanted to protect himself on the point of law in case the matter had to be argued in the Court of Appeal.

**His Lordship** said he would not rule on the point, but he had made a note that Sir E. Clarke had taken the point, so that he could argue it hereafter if necessary.

Judgment was then entered for the plaintiffs for the amount agreed as damages, £677, with costs.

## BATH ELECTRIC TRAMWAYS.

An appeal by the plaintiffs from the judgment of Mr. Justice Farwell in the case of Longman *v.* the Bath Electric Tramways, Limited, was concluded on Tuesday.

Plaintiffs purchased 1,500 preferred ordinary shares of £1 each in the Bath Electric Tramways, Limited, registered in the name of Mr. Peter Bennett. The transfers were left at the company's office for registration, and a few days later the company's solicitors wrote to the plaintiffs stating that the shares had been previously transferred by Mr. Bennett, and that, therefore, the company could not part with the certificates. It seemed that when the shares were previously dealt with, the company by mistake sent the transfer for 1,500 shares to Mr. Bennett, and he failed to comply with a request to return it. The plaintiffs then sued the company to have the shares registered in their names and to recover damages. Mr. Justice Farwell held that there was no cause of action against the company, and dismissed the action, with costs.

**Lord Justice Vaughan-Williams**, in giving judgment, said he thought the judgment of Mr. Justice Farwell ought to be affirmed, because plaintiffs had not been misled by the statements or conduct of the company, and that the company had not been shown to have been negligent of any duty which was owed to the plaintiffs individually or as members of a section of the public, and the negligence which had been shown in the certificates in question was not the immediate or real cause which led to the loss of the plaintiffs.

Appeal dismissed.

## MOTOR LAW PROBLEM.

At the North London Police Court, Claud Clench, electrical engineer, was summoned on Monday for neglecting to have a distinguishing number affixed to the general identification mark.

**Mr. Staplee Firth** raised the novel point that it was the London County Council who were responsible for the absence of a number on the identification plate. Under the Act each manufacturer was assigned an identification mark, and the assigned mark in this case was "A L R." Nothing was said by the Council's officials about a number. Mr. Firth went on to contend that the section of the Act, though badly drafted, implied that a number was necessary in addition to the identification mark only where the manufacturer had more than one car in use.

The **Magistrate**: That is quite a new point.

**Mr. Firth**: I have never heard it raised before.

The **Magistrate**: It looks, on the face of it, as if the Council's mark assigned to your client is null and void, but whether that relieves him from the consequences of an infraction of the Act was another matter. His Worship deferred his decision.

## FIRE AT OLYMPIA.

It will be remembered that during the recent great automobile show at Olympia, it was reported that a fire had broken out on one of the stands, owing to an electric cable fusing in a showcase of the United Motor Industries. Arising from this an action was brought by the United Motor Industries, claiming £61 damages from the contractor for the lighting, Charles Oliver Clark, trading as Oliver Clark and Co.

The Judge, in summing up in defendant's favour, said: "The case has been most interesting. The issues of the case were of considerable importance to the defendant, he being an electrical engineer in a very large way of business, and his reputation was now at stake. It must be remembered that he laid on the electric light to 34 other stands at the motor exhibition without any fault being found in respect of any one of them." The expert evidence produced by the defendant left no doubt as to the cause of the supposed fire, and although the trial had occupied the attention of the Court for two whole days, the judge did not think five minutes had been wasted. The result of numerous experiments were fully appreciated by the jury, who, after retiring for a quarter of an hour, returned and said they were of opinion that the fire was not caused through defective work on the part of the defendant, but through celluloid being placed in too close proximity to the electric lamps. His Honour accordingly gave judgment for the defendant on claim and counterclaim, with costs.

## CLEARING SNOW FROM TRAMWAY LINES.

An action was heard by Sheriff Mackenzie at Airdrie last week, in which the Town Council sought recovery of £7. 0s. 8d. from the Airdrie and Coatbridge Tramways Company.

The plaintiffs had to clear away accumulations of snow left on the street through the defendants using a snow-plough. The defendants contended that the Town Council as local authority were bound to keep the streets clear of snow, and they lodged a counterclaim of £10 for having cleared part of the street for them. The Sheriff, after hearing evidence and argument on the point, held that the Aberdeen case ruled in this matter, and gave judgment for the plaintiffs.

# COMPANIES' MEETINGS AND REPORTS

## BRITISH INSULATED AND HELSBY CABLES.

The annual meeting was held at Liverpool on Monday, Mr. E. K. Muspratt (chairman) presiding.

The **Chairman**, in moving the adoption of the report (of which we gave particulars last week), said that having regard to the continued keen competition in the trade, the report would probably be regarded as satisfactory, especially in view of the fact that the increased price of rubber referred to at the previous annual meeting had been further augmented during the year under notice, whilst the selling price of this class of goods had remained unaltered. He referred to the investment of a very large share of the Company's funds in other undertakings, principally an electric supply company in Victoria and in the Midland Electric Corporation. In regard to the operations of the Midland Electric Corporation, he regretted that manufacturers and others in the Midlands appeared to be not quite so up to date as their competitors elsewhere in their appreciation of the advantages to be derived from the use of electricity. Nevertheless, there was a growing demand, and he hoped that with improved trade there would be a great improvement in the future.

The report was adopted.

## NATIONAL ELECTRIC CONSTRUCTION.

The eighth ordinary general meeting of this Company was held at Winchester House on Monday, Mr. R. Stewart Bain, chairman of the Company, presiding.

In moving the adoption of the report and accounts (of which we gave particulars in our issue of the 17th inst.), the **Chairman**

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commented upon the great progress as compared with last year, a £4,000 loss having been converted into a £20,000 profit. As regards the future, their prospects were distinctly favourable. They had just concluded two agreements, one for laying down an electric tramway in a town on the south coast, and the other for taking an electric lighting and tramway order in the Midlands, both of which they had every reason to believe would be very profitable, and which would occupy them for at least the next 18 months. In addition, they proposed to apply for powers for the extension of the Musselburgh tramways along the coast, and they had already applied for powers for making a new tramway between Edinburgh and Queensferry.

The report was unanimously adopted.

## MERSEY RAILWAY.

The half-yearly meeting of this Company was held last week at Worcester House, Walbrook, Mr. James Falconer presiding.

In moving the adoption of the report (of which we gave particulars last week), the **Chairman** said that substantial progress had been made during the half-year, both as regarded the number of passengers carried and the total receipts, and this was the more satisfactory seeing that the comparisons were now being made against receipts from electric traction, whereas former comparisons made at previous meetings were with receipts from steam traction. It was gratifying to find that the increases continued, and were due not to the novelty of the new method, but to the appreciation on the part of the public of the conveniences given by the Company. There was an elasticity about their system which rendered it capable of dealing with any traffic that might be looked for, and the chief thing necessary now was to popularise the line in the eyes of the public.

The report was adopted.

## PERTH (WESTERN AUSTRALIA) ELECTRIC TRAMWAYS.

The sixth annual meeting of this Company was held last week, Mr. Robert O. Ogilvie presiding.

The **Chairman**, reviewing the report (of which we gave some particulars last week), stated that, as compared with the previous year, the receipts showed an increase of about £7,000, of which nearly £6,000 was clear profit. The directors had every reason to anticipate that at the end of the present financial year they would be able to declare a dividend on the ordinary shares.

The report was adopted.

## BRUCE PEEBLES AND CO.

The report for the year ended Dec. 31 states that the net profit after making all necessary charges for the management of the business, including directors' and managing director's remuneration and auditors' fees, interest on debentures and income tax, amounted to £28,792. 7s. 6d., which, after adding the balance of £354. 5s. 1d. brought forward at Dec. 31, 1903, makes the available balance at the credit of profit and loss account, £29,146, 12s. 7d. The dividend on the preference shares, less income tax, for the half-year to June 30, 1904, was paid on Sept. 30, 1904, absorbing £2 856. 16s. 10d.; and the amount required for payment of the dividend on the preference shares, less income tax, for the half-year to Dec. 31, 1904, is £2,850. The directors recommend the payment of a dividend at the rate of 6 per cent. per annum on the ordinary shares in respect of the year to Dec. 31, 1904, less income tax, requiring £5,706. 5s.; placing to the preference shareholders' special reserve fund £2,870. 4s. 9d.; writing off preliminary expenses, £4,000; transferring to general reserve fund £7,000; and carrying forward £3,854. 6s.; together representing £29,146. 12s. 7d. The new works at East Pilton were completed in February, 1904, and the change has been very beneficial. The cost of the works stated in the original prospectus was estimated at £53,000, but owing to the expansion of the business the total expenditure under this head has been £93 000. The turnover for the past year has been more than double that of the previous year, and the orders on the books of the Company at the close of the year considerably exceed in amount those of the previous year. The Company have also several large profitable contracts on hand for power and traction companies. Owing to the considerable increase in the business of the Company, it is necessary that further capital should be raised. The shareholders will therefore be asked to sanction the creation of 10,000 additional preference shares of £5 each, and 10,000 additional ordinary shares of £5 each, and to increase the borrowing powers to the extent of £50,000. The further share capital will be issued as soon as possible, but it is not intended to exercise the new borrowing powers meantime.

## WILLANS AND ROBINSON.

The twenty-second half-yearly report to be submitted at the ordinary general meeting on April 5 states that the operations of the Company during the half-year have resulted in a loss, as regards the Rugby business, of £19,895. 1s. 4d., and as regards Queen's Ferry of £22,876 14s. 10d., or £12,771. 16s. 2d. in all. It is pointed out, however, that £18,954 1s. represents depreciation, and that £5,127. 2s. 9d. represents the valuing down of sundry stocks, etc., not arising directly out of the half-year's work. The total of these sums, £24,081. 3s. 9d., is in the nature of a "book" loss, and does not represent actual diminution of the liquid assets of the Company. As the debit balance brought forward amounted to £37,180. 6s. 11d., there is now a debit balance on the profit and loss account of £79,952. 3s. 1d. An endeavour has been made, in accordance with a wish expressed by shareholders at the last meeting, to apportion certain expenses between Rugby and Queen's Ferry. In some respects it has only been possible to do this by estimation. The directors have thought it right to exercise fully as great prudence in the matter of depreciation as in the times when the affairs of the Company were most prosperous. The extremely unfavourable trade conditions of the past year, leading to a reduction in prices unprecedented in the history of the Company, have resulted in a heavy loss even in the engine building section of the business. The directors are, however, glad to say that the steam-turbine business is developing rapidly, and promises to become a valuable speciality. A friendly arrangement has been entered into with Messrs. C. A. Parsons and Co., and the Company has taken a license enabling it to work under the patents of the Hon. C. A. Parsons. The Company has also valuable patents of its own under which it will continue to work. As regards Queen's Ferry, the attempt to find a purchaser for the business, or even for the works, has had no success, owing to the state of the trade. Work was necessarily carried on during the half-year, though under very great disadvantages, in order to complete existing contracts for boilers. Repeat orders, upon satisfactory terms, having resulted, the directors propose to continue the manufacture of tubes and boilers upon the present modest scale, in the hope that the business will grow to be self-supporting. This result may be contributed to by the steel manufacture, which, after being abandoned in May, 1904, was restarted at the beginning of the now current half-year, with every prospect, so far as can be judged at present, of proving profitable. The directors are satisfied that it is better under present circumstances to run the Queen's Ferry Works than to close them. Mr. T. O. Lazenby retired from the Board last autumn on account of ill-health. The vacancy has not been filled, and the Board propose that the number of directors, raised last year to seven, be reduced to five as before.

## FOLKESTONE ELECTRICITY SUPPLY.

The report for 1904 states that up to Dec. 31, 1903, the equivalent of 54,805 8-c.p. lamps was being supplied, but during the past year the equivalent of 64,915 8 c.p. lamps has been supplied. The revenue account shows a profit of £9,051, which, with the profits on installation work, etc., and £303 brought forward, and after allowing for interest on debenture stock, dividend on preference shares and bank charges, etc., and carrying £1,700 to depreciation fund, makes a net balance for distribution, after allowing for the interim dividend at the rate of 4 per cent. per annum already paid, of £2,058. The directors recommend a dividend at the rate of 7 per cent. for the half-year (making 5½ per cent. for the year), which will require £1,750, thus leaving a balance of £309, which it is proposed to carry forward. The profit in respect of the Hythe revenue account has been credited to the Hythe temporary lighting suspense account, reducing the balance on that account to £111. The sum of £1,557 has been written off in respect of depreciation of accumulators. It is proposed shortly to make a further issue of 4½ per cent. debenture stock, ranking with the £50,000 first debenture stock already issued. The stock will be offered in the first place to the shareholders and stockholders of the Company.

## W. T. GLOVER AND CO.

The report for 1904 states that the amount standing to credit of profit and loss account is £7,976, after adding £3,649 to reserve fund. The demand for goods of the classes manufactured by the Company (especially those for home consumption) has not shown any improvement during the period under review. The general financial position of the Company has improved, but the comparatively small demand above mentioned, and the severe competition existing, render it necessary for the directors to pursue a cautious policy. Accordingly they regret they do not yet feel justified in recommending the payment of a dividend. There is an increase in the item under the heading of investments due to payments made during the year, to which the Company was previously committed, and not to any extension of investments. The Company's rights and easements which were affected by the Bills promoted during the past year by the Trafford Park Estates, Limited, and the Stretford Urban District Council, have been satisfactorily protected, and the various points of contention amicably settled. A fund, as authorised at the last general meeting, has been created to indemnify the directors standing from time to time as guarantors for the fulfilment of the Company's contracts.

## BROMLEY ELECTRIC LIGHT AND POWER.

The report for 1904, to be submitted at the meeting on 3rd prox., states that the lamp connections have increased from 47,030 to 56,199. The sale of current has increased from £9,843 to £11,366. The result of the year's trading, including the balance of £35 brought forward from last year and after allowing for bad and doubtful debts, shows a profit of £8 286, and after payment of debenture and loan interest, etc., amounting to £2,527, the amount available for dividend is £5,759. An interim dividend at the rate of 4 per cent. per annum was paid for the half-year in October, and the directors now recommend a further dividend at the rate of 7 per cent. per annum, making a total dividend of 5½ per cent. for the year, that £1,800 be placed to the renewal reserve fund account, and that the expenses in connection with the new issue of capital, amounting to £24, be written off, leaving a balance of £85 to be carried forward.

## GREAT NORTHERN TELEGRAPH OF COPENHAGEN.

An approximate computation of the receipts and expenditure for 1904 gives net receipts of £480,000, which the directors will probably propose to distribute as follows: reserve and renewal fund, £56,000;

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pension fund of staff, £8,000; remuneration to board of directors, £2,500; dividend equalisation fund, £53,500; dividend and bonus of 24 per cent. (5 per cent. of which has already been paid), £360,000; whilst the amount carried forward to 1905 will be about the same as was carried forward from 1903 to 1904.

## LIVERPOOL DISTRICT LIGHTING.

The report for the year ended Dec. 31 last states that the demand for electricity continues to increase satisfactorily, the number of units sold during 1904 being 246,943, as against 187,197 in 1903, and the amount received £5,384, as against £4,213 for 1903. The number of lamps supplied on Jan. 1, 1905, was 16,517, as against 14,000 in 1903. The directors announce that through a piece of great misfortune in the shape of bad debts, principally on the contracting business, it is impossible to declare any addition to the 2 per cent. dividend paid in August. They have thought it well to carry forward the small balance of £262, which remains to credit of profit and loss, and to write off the whole of the debt referred to, amounting to £1,879. The gross profit for the year amounted to £2,906, and with the balance brought forward from 1903 of £786 gives an available profit of £3,693. But for the misfortune referred to £2,142 would have been available for distribution.

## BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS.

There is a balance on the year's working of £77,913. 13s. 10d., which, with the amount brought forward from last year (£2,479. 17s. 1d.), has been carried to net revenue account. After providing for the charges against revenue account and for the premium on £2,300 5 per cent. debenture stock purchased and cancelled, there remains a balance of £42,336. 0s. 11d. The 6 per cent. dividend on the "A" and "B" preference shares absorbs £20,250. An interim dividend of 1½ per cent. on the ordinary shares was paid in October last, and the directors now recommend a balance dividend of 2s. 6d. per share, free of income tax, or a total of 4s. per share, or 4 per cent. per annum, absorbing £20,000, and leaving a balance of £2,086. 0s. 11d. to be carried forward to next account.

## GUILDFORD ELECTRICITY SUPPLY.

The report for the year ending Dec. 31 states that the gross receipts were £4,859. 15s. 11d., as against £3,897. 7s. 7½d. for 1903. There is a balance on the revenue account of £1,848. 8s. 3d., after allowing £300 for depreciation, £200 for preliminary expenses written off, £150 for payment of a further instalment on the suspense account for law costs, and £119. 6s. in respect of depreciation on free wiring plant. After making provision for dividend on preference shares, interest on debentures, etc., the net revenue account shows a balance of £438. 14s. 2½d. for distribution. Out of this the directors recommend a dividend at the rate of 3 per cent. for the past year on the ordinary shares, which will require £403. 16s., leaving a balance of £34. 18s. 2½d. to be carried forward to next year's accounts.

## NEW COMPANIES REGISTERED.

**Mitcham Motor Company, Limited.**—Capital, £8,000. Objects: to carry on the business of vendors and factors of motorcars and other vehicles, whether propelled by electricity or other power, and to adopt an agreement between E. N. Læwer and A. W. Aitken of the one part and J. W. Collings on the other.

**Electric Ignition Company, Limited.**—Capital, £10,000. Objects: to acquire the business carried on by Constance Hall as the Electric Ignition Company, and to carry on the business of manufacturers of appliances of all kinds for electric ignition of internal combustion engines, manufacturers of electrical and mechanical appliances, electricians, workers of and dealers in electricity engineers, founders, etc. Registered office: Royal Wellington Works, Sampson-road North, Birmingham.

**Electro-Medical Supply Company, Limited.**—Capital, £6,000. Objects: to acquire the business of manufacturers of electrical medical battery apparatus and accessories, etc., carried on by J. Richert, E. I. Pronk, and A. E. Davies, at 22, Harp-lane, Great Tower-street, E.C., as J. Richert and Co., etc. Registered office: 61, New Cavendish street, London.

### Liens Registered.

**Llandudno and Colwyn Bay Electric Traction Company, Limited.**—Particulars of £60,000 debentures, created by resolution of Feb. 24, 1905, have been filed pursuant to Section 14 (4) of the Companies Act, 1900. Property charged: the whole of the company's undertaking and property (as a floating security). No trustees.

**Stanley Electric Carriage Company, Limited, Chelsea, S.W.**—Lien registered March 21, for £6,000 6 per cent. debentures. Holder: Major-General Sir E. H. Sartorius, K.C.B., Old Swan House, Chelsea-embankment. Charged on all the property, present and future, the undertaking, goodwill, business, and the uncalled capital for the time being.

**Light Cure and Electro-Therapeutic Institute, Limited, London, W.**—Lien registered March 20 for £540 8 per cent. debentures, part of £1,500 authorised. No trustees. Charged on all the effects and property, present and future, including the uncalled capital for the time being.

**Electrical Bleaching Company (1904), Limited, Manchester.**—Lien registered March 22 for £2,000 6 per cent. debentures, part of £14,000; amount previously issued, £12,000. No trustees. Charged on the undertaking and all the property and assets, present and future, except the uncalled capital.

## PERSONAL.

Mr. J. Mortimer, of Messrs. J. G. White and Co., tramway contractors, having received an appointment on the tramways at Cape Town, South Africa, was presented by the office staff with a shaving outfit, and by the workmen with a smoking cabinet and silver watch guard.

The Bermondsey Borough Council have appointed Mr. George Ingram, of Norwich, switchboard attendant, and Mr. A. B. Gundry, of New Cross, who has been engineer in-charge at St. Pancras Borough Council for three years, third engineer in charge at the electricity works.

The officials and employés of the Rotherham Corporation electricity works last week presented Mr. R. Jones, station superintendent, who has left to take up a position under the Southend-on-Sea Corporation, with a handsome case of drawing instruments and a large framed photograph of the electricity works staff. The case bears an appropriate inscription. There was also a silver matchbox, a present from Alderman D. L. Winter, J.P., the chairman of the Electric Light and Tramways Committee. Mr. E. Cross, the borough electrical engineer, made the presentation.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Manchester.**—The Corporation require tenders for switchboards. Tenders by April 4.

**Salford.**—The Corporation invite tenders for wiring their Seidley School. Tenders by 31st inst.

**Cartagena.**—The Public Works Department, Madrid, require tenders for electrification of the local tramways.

**Colchester.**—The Corporation require tenders for electric pumping plant and surface condensers. Tenders by April 5.

**Sofia.**—The District Finance Commissioners require 15,000 insulators, elements for batteries, etc. Tenders by April 3.

**Christiania.**—The Post and Telegraph Department require tenders for 8,000 kilos. of ¼mm. bronze wire. Tenders by April 10.

**St. Marylebone.**—The Borough Council invite tenders for the supply of house meters, including maintenance for two years. Tenders by April 4.

**Salford.**—The Corporation invite tenders for the wiring of the new Council school, Liverpool-street, Seedley. Tenders by March 31. See advertisement in last issue.

**Liria.**—The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

**French West Africa.**—The Governor-General of French West Africa, at Dakar, requires tenders for the erection and equipment of a central station at that place. Tenders by May 15.

**Brussels.**—The Government Railways require tenders for electric lamps and accessories in 21 lots. Specification No. 620 may be obtained from their Brussels office. Tenders by April 12.

**Bilbao.**—The Public Works Department at Madrid require tenders for the concession of an electric tramway in Bilbao, from the Calle de Hurtado de Amézaga to Plaza Circular. Tenders by April 24.

**Laventhem (Belgium).**—The Municipality require tenders for erection of central station, laying of mains, etc. Particulars (3s. 4d.) may be obtained from the Secretary of the Mayor of that place.

**Utrecht.**—The Municipal Authorities require tenders for 20 electric motors for the tramways. Specifications may be obtained at 5s. from the Municipal Secretary, Town Hall, Utrecht. Tenders by 2 p.m. on April 8.

**Nuneaton.**—The Electricity Committee of the Nuneaton and Chilvers Coton Urban District Council invite tenders for the supply and delivery of cables and joint-boxes. Tenders by April 10. See advertisement.

**Antwerp.**—Tenders will shortly be invited by the Belgian State Railways for the installation of electric light in their local railway station. Specification No. 619 may be obtained from the Government Railways Office, Brussels.

**Glasgow.**—The Trustees of the Clyde Navigation invite tenders for electric power generating and lighting plant for Clydebank Dock. Specifications, etc., may be obtained from Mr. T. R. Mackenzie, 16, Robertson-street, Glasgow. Tenders by April 17.

**Batley.**—The Corporation invite tenders for tramway extensions—viz.: (Contract No. 14) permanent-way construction and paving; (15) overhead equipment, steel poles, etc.; (16) feeder cables, conduits, and accessories. Tenders to the Town Clerk by April 17.

**Birmingham.**—The Tramways Committee invite tenders for supply, delivery, and erection of 200 electric tramway cars. Conditions, specifications, etc., can be obtained from Mr. Alfred Baker, general manager, 254A, Corporation-street, Birmingham. Tenders by April 4.

**Switzerland.**—M. R. Vontobel, of Winterthour, and M. Charles Probst, of Lucerne, have obtained a concession for the construction of a narrow-gauge electric railway from Meiringen to Gletsch. The total cost of the enterprise is estimated at £241,600; £19,600 is to be expended on rolling-stock.

**Hammersmith.**—The Council invite tenders for the supply of boiler flues and economisers; high-pressure steam-pipes; high-pressure feed-water pipes; exhaust steam, feed-water heater, and circulating-water pipes; steam-valves and feed-water heaters; and coal elevator. Tenders by April 5. See advertisement in last issue.

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**London, S.W.**—The London County Council invite tenders (a) for the manufacture, delivery, and erection of eight 500-kw. induction motor-generators for certain sub-stations in connection with the Council's electric tramways, and for the supply and delivery at the Greenwich electricity generating station of (b) general wiring material and (c) low-tension cables, cable boxes, etc. Particulars may be obtained at the County Hall. Tenders by 10 a.m. on April 4.

**Shanghai.**—The Municipal Council invite tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for the single-trolley and double-trolley lines. A pro forma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's agents, Messrs. John Pook and Co., 63, Leadenhall-street, E.C. Tenders by March 31, 1905.

## RESULTS OF TENDERS.

**Todmorden.**—The Corporation have accepted the tender of Messrs. Venner and Co, Old Queen-street, London, S.W., for the supply of electricity meters.

**Poplar.**—The Borough Council have accepted the tender of the Stirling Boiler Company, at £1,950, for the installation of an additional boiler, etc., at the electricity works.

**Derby.**—The Tramways Committee recommend the acceptance of the tender of Messrs. W. Griffiths and Sons, London, at £18,689. 2s. 9d., for the construction of the permanent way and electrical equipment of the Kedleston-road and Walbrook-road routes, and that of the Brush Electrical Engineering Company, Limited, Loughborough, for the supply of four new cars.

**Kirkcaldy.**—The Town Council have received the following tenders for the extension of about 500ft. in length of the present East Pier:

| | | | |
|---|---|---|---|
| J. Best, Edinburgh | £32,562 | 19 | 0 |
| G. Lawson, Rutherglen | 40,629 | 18 | 0 |
| G. Smith and Son, Kirkcaldy | 38,777 | 19 | 8 |
| R. C. Crawford, Strathaven | 31,143 | 0 | 0 |
| G. and R. Cousin, Edinburgh | 51,729 | 17 | 0 |
| Tilbury Contracting and Dredging Company, London | 52,236 | 17 | 6 |
| Sir J. Jackson, Limited, London | 35,110 | 0 | 0 |
| Kirkwood, Kerr, and Co., Glasgow | 28,202 | 0 | 0 |
| Blair and Whyte, Bath-street, Glasgow | 27,858 | 16 | 6 |
| R. McAlpine, Glasgow | 29,797 | 0 | 0 |
| W. Beattie and Sons, Edinburgh | 36,499 | 0 | 0 |
| W. Hill and Co., London | 39,959 | 0 | 0 |
| Muirhead, Greig, and Matthews, London | 34,840 | 0 | 0 |
| Robertson and MacPherson, Dundee | 40,337 | 8 | 0 |
| Kinnear, Moodie, and Co., Edinburgh | 48,548 | 0 | 0 |
| W. Petrie and Co., Grangemouth | 24,415 | 17 | 4 |
| Pearson and Son, Limited, Seaham Harbour | 48,243 | 0 | 0 |
| C. Brand and Son, 65, Renfield street, Glasgow (accepted) | 25,991 | 19 | 7 |

# BUSINESS NOTES.

## TRACTION.

**Pudsey.**—The work of widening the streets in preparation for the trams has been commenced.

**Croydon.**—A motion to rescind certain tramway extensions decided upon by the Corporation was lost.

**Kirkcaldy.**—The Scottish Parliamentary Commissioners have passed the preamble of the Kirkcaldy and Leven Tramway Bill.

**Unopposed Bills.**—The Metropolitan Railway and the West Cumberland Tramway Bills have appeared in the unopposed list.

**Belfast.**—The Corporation have received an intimation from the solicitors for the arbitrator that the award is ready to be taken up.

**Electric Tramway Trust.**—It is reported that an American syndicate is attempting to form a trust of the electric tramways in Toronto.

**Chester.**—After considering the question of motor 'buses, the Corporation have decided to proceed with the electric tram extensions at a cost of £17,000.

**London United Tramways Company.**—The London United Tramways (Extension of Time) Bill has been read a second time in the House of Commons.

**Mansfield.**—The promoters of the light railway scheme have abandoned the proposed additions to same, the terms of the local authorities being too onerous.

**Cheltenham.**—The extensions to the light railway were examined on Tuesday by Major Pringle on behalf of the Board of Trade. The inspection proved quite satisfactory.

**Maidstone.**—An enquiry was held by the Light Railway Commissioners last week into a proposed light railway between Headcorn and Maidstone. After evidence had been taken the matter was adjourned until April 10.

**Aberdare.**—The Urban District Council's Tramway Bill was before the House of Commons Committee last week, when the application of the gas company for a *locus* was disallowed. The Great Western Railway have withdrawn their opposition.

**Paisley.**—The Town Council of Johnstone has received an intimation from the Paisley and District Tramway Company that they are prepared to meet the Council relative to the extension of the tramways from the centre of the town to the boundary of the burgh.

**Ackworth.**—The enquiry by the Light Railway Commissioners into the Ackworth and North Lindsey light railway scheme came to a somewhat abrupt termination, the Commissioners holding that the magnitude of the proposal rendered it a case for Parliament.

**Anglo-Argentine Tramways Co.**—The directors, after transferring £10,000 to the reserve fund and £25,000 to the renewals fund, recommend a final dividend on the ordinary shares of 5s. each, making 8s. per share, or 8 per cent., for the year, carrying forward £5,922.

**Southend.**—A 10 minutes' service with three truck cars has been substituted on the Southchurch section for two bogie cars in a 15 minutes' service. The result has been highly satisfactory, as the traffic returns for the past month averaged 7·72d. per car mile against 6·72d. last year.

**Blackpool.**—The summary of traffic on the Corporation tramways from April 1, 1904, to March 16, 1905, as compared with the corresponding period in 1903-4, shows a large increase in the receipts, the total amounting to no less than £6,228. 10s. 1d. The Promenade and Lytham-road route was especially remunerative.

**Matarieh (Egypt) Railway.**—It is reported that the electrification of this railway, over which there has been some delay, may very shortly be taken in hand by the Egyptian Government, and a call for tenders may be expected. It is now suggested that, starting from Cairo, a line shall be constructed to the Matarieh Oasis *via* Abbas-boulevard.

**Overcrowding.**—In the House of Commons, the Chief Secretary for Ireland stated, in reply to a question, that the Dublin United Tramway Company's by-laws exempted children under three from fares, that he was not aware of any statutory prohibition against the levying of full fares for children under 12, and that the police were instructed to enforce the by-law against overcrowding.

**Wolverhampton.**—According to statements in the local Press, mud has been allowed to collect on certain sections of the tramway system to such an extent that the rails are invisible, with the result that an extra quantity of current is consumed in ploughing through the accumulation. A trial has been made with a motor omnibus with the object of linking up the Penn district with Wolverhampton.

**North-Eastern Railway.**—It is expected that the Ponteland section of the North-Eastern Railway system will be opened for the conveyance of passengers about the beginning of May. A large quantity of goods traffic has already been handled. It is stated that the usual steam locomotives will open the passenger service. It has not yet been decided whether steam or electricity will be used at some later date.

**Swansea.**—In reference to the rejection of the Corporation's Bill by the House of Commons Committee, as reported in our last week's issue, it is hinted in the local Press that the company would not be indisposed to treat for an arrangement providing for the "pooling" of the receipts from all the tramways in the borough, and for the voluntary sale of the company's property to the Corporation—on the basis laid down in the Tramways Act of 1870—after about 35 years' undisturbed possession of the whole system.

**Llanelly.**—At a special meeting of the Urban District Council the chairman made the pleasing announcement that an agreement had been arrived at in connection with the scheme of electric light and traction, as the result of further interviews. The Council have now decided to withdraw their opposition to the Bill of the South Wales Power Company, the company agreeing to contribute £1,000 towards the costs already incurred by the Council. They had also agreed to a penalty clause, and met them on several other points.

**Accident.**—At Wood Green on Monday a car was descending a steep hill when the trolley left the overhead wire. The driver, the only occupant, applied the brakes, but they failed to act, and the vehicle made a tremendous pace down the hill. It jumped the metals, smashed a street lamp, and dashed into the brickwork adjoining a chemist's shop, which was seriously damaged. The driver leapt from the runaway car. Although the scene of the accident is a busy spot, no one was hurt. The front of the tram was wrecked.

**Leeds.**—It is reported that for the financial year just closed the Corporation trams show an increase in receipts of some £17,000, the total revenue being £295,000. The passengers numbered 64,223,666, against 60,739,234 last year. The expenditure has not yet been ascertained, but it is hoped that the profit will equal that of last year, notwithstanding reductions in fares. The mileage was 7,000,000 against 6,091,437 last year, when the receipts per car mile worked out at 10·94d., rather more than that for this year.

**Penny Fares.**—Marseilles had an experience last Sunday in tramway administration which may have some interest for some British municipalities. The suggestion was tried of running universal 1d. fares for the day as a social experiment. In one way it was a great success. About 30,000 more people used the cars than on March 19, 1904, and nearly all crowded into the suburban districts. In its financial results, however, the experiments suggests some reflections. The takings last Sunday, with an increase of nearly 30,000 passengers, and many more cars employed, were £68 less than on March 19 last year.—*Globe.*

**Live Rails.**—In the House of Commons last week Mr. Weir asked the Secretary to the Board of Trade whether he would notify railway companies contemplating electrification that they should obtain specific statutory power, in view of the fact that the North-Eastern Railway, who did not obtain such authority, and consequently did not have their line inspected by the Board, had had 28 accidents, five fatal, through contact with the live rail. Mr. Bonar Law replied in the negative, reiterating an earlier announcement on the subject to the effect that the Board could not compel a railway company to take the step suggested.

**Pneumatic Railway Signals.**—The North-Eastern Railway have completed the last section of the electro-pneumatic signalling apparatus which they have for some time past been installing at Tyne Dock. This system is likely to be extended to the network of

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rails at the entrance to Newcastle Central Station. The cost is estimated at about £50,000, but the money is expected to be saved by the increased control over trains, and the saving in wages due to many fewer operators being required for the work. At Tyne Dock under the new system 169 levers do the work which formerly required 278, and the labour of moving them is greatly reduced.

**Tram Fatality.**—An inquest was held at Devonport upon a labourer named George Adams, who, while laying telephones in a trench underneath the tramrails, was stated to have been knocked down by a tram and so seriously injured that he expired from the wounds. The evidence was of a conflicting character, two witnesses stating that they did not hear any bell ring, while the driver asserted that he rang the bell and reduced speed. Mr. J. W. Endean, manager of the Devonport and District Company's tramways, said that if the deceased had been above the trench when the front of the car reached the spot, the trigger of the lifeguard would have been struck and the lifeguard would have fallen, but that did not happen. The coroner, in summing up, stated that the driver had given his evidence in a straightforward manner, and the jury returned a verdict of accidental death.

**Torquay.**—Representatives of the Dolter Electric Traction Company visited Torquay last week, and with the contractors were driven over the route of the proposed tramways, preparatory to laying down the first section. Delay has been caused by the non-arrival of the decision of the Local Government Board as the outcome of the recent enquiry into the application of the Town Council for a loan of £42,000 for the proposed new electric lighting and power station, from which, according to agreement, the Council are to supply the company with current for working the trams. Pending the receipt of this communication from the Local Government Board, the Dolter Company, desirous of making a beginning, are seeking to come to an arrangement with the Town Council to be provided with a temporary supply of current from the present electricity station. It is stated that the whole of the capital for the Torquay tramways has been subscribed, and that the shareholders wish to see a start made; but, on the other hand, the company's officials are averse to the laying down of £70,000 worth of plant in the town until they know whether they are going to get the necessary current.

**London County Council.**—As the street widenings required in connection with the construction of the tramways from the Tooting terminus to Wandsworth are nearing completion, the Highways Committee recommend a vote of £360,000 for the carrying out of the work. The length of tramway affected is approximately 17½ miles of single line, which on account of the character of the thoroughfares affected, and the fact that they run along a main traffic route to the centre of London, it is proposed to electrify on the conduit system. The Financial Committee conclude their report upon this proposal with the remark that "although this reconstruction involves a large outlay, it is not expected to result in any surplus after the debt charges have been met, at any rate for some years to come." The Highways Committee's recommendation proposes that tenders shall be invited. The receipts for the week ending March 18 amounted to £12,814 against £10,644, and for the period from April 1 the total was £638,045, against £496,134. The Stoke Newington Borough Council have followed the lead of Battersea, Camberwell, and Hackney in passing a resolution approving the County Council over-the-bridge scheme.

**Manchester.**—The elaborate scheme evolved by the Corporation for the conveyance of parcels is to be inaugurated on Monday. Parcels will be carried not only within the city and the area of Greater Manchester, but also dispatched to any part of the kingdom and abroad. During its preliminary stages the new department has been under the charge of a special sub-committee, but a permanent sub-committee has now been created. The general manager (Mr. J. M. M'Elroy) has prepared a handbook headed "Parcels Express," which gives a quantity of information as to the transit of parcels. There are receiving offices in all parts of the city, besides others in the suburban districts. Vans will call at each of the sub-depôts and receiving offices frequently during the day, and at warehouses, shops, or other places of business, for the collection of parcels, on application being made to the parcels superintendent at the chief office. Stamps for prepaid parcels may be purchased at face value in numbers of not less than 25. Within the area of Manchester and its environs a parcel not exceeding 14lb. in weight will be carried for 2d.; under 28lb., 3d; under 56lb., 4d.; and under 112lb., 6d. will be charged. A little more will be charged for collection and delivery beyond the city area. Special parcel-carrying cars are to run over the city system, and the ordinary passenger service cars will be used for the conveyance of parcels up to about 56lb. in weight. Messengers will deliver parcels up to about 28lb. in weight to any address within a reasonable distance of the depôt or line of route. A special feature of the scheme will be an express messenger service. Parcels not exceeding 14lb. in weight can be placed immediately in charge of special express messengers, who will take them to their destination if it is within half a mile of any of the Manchester tram termini or lines of route. For this service the charges are 6d. within one mile from Piccadilly, and 3d. for every additional mile or part of a mile. The conductors of the Corporation passenger cars will receive at any appointed stopping place written applications from the public for a van to call at any address within the prescribed area. The committee have also made arrangements to act as agents for all railway companies. This enterprise will be watched with much interest. The Electricity Committee have decided to appeal in the case of Midwood *v.* the Corporation, reported in our legal column. It is proposed to lay a double line to Chorlton-cum-Hardy at a cost of £10,000. The Improvements Committee have decided to inspect the route.

**Parliamentary Committees.**—Before Mr. Compton Rickett's Select Committee on Monday evidence was taken in regard to the Great Northern, Piccadilly, and Brompton Railway Bill, which seeks to authorise the company to construct an extension of the authorised railway from the Strand under the Thames to Waterloo Station. Mr. Yerkes stated that the Underground Electric Railways Company had spent £3 650,000 on the Great Northern, Piccadilly, and Brompton Railway, and hoped to be ready for the public in 18 months. Ninety-five per cent. of the tunnelling was completed, and contracts were about to be made for the rolling-stock. Replying to the chairman, witness said the capital of the company was £5,000,000, of which half was subscribed. They had, by profit-sharing notes, raised £7,000,000 privately, and had also sold £2 000,000 of securities. These profit-sharing notes were a kind of short debenture; those who advanced the money on them were entitled to half the profit if the shares were sold beyond a certain price. Continuing his evidence on Tuesday, Mr. Yerkes stated, in reply to a question, that to make two lines instead of one would cost £120,000 more. Between Holborn and Surrey-street, Strand, there would in any case be two tracks. The journey from the Strand to Waterloo Station would occupy about 1¾ minutes. After further discussion the chairman announced that the committee were unanimously against a single-tube railway. Sir Ralph Littler suggested that the Bill should be passed with a clause to the effect that the railway under the Thames should not be constructed unless the company obtained power for the laying of two tracks. The chairman replied that the committee would consider the proposal. Evidence favourable to the scheme was also given by Sir C. Owens, general manager of the South-Western Railway Company. On the matter again coming before the committee, Mr. Raskill, K.C., stated that the promoters had had the intimation of the committee under consideration, and they proposed to insert the following clause: "Provided that Railway No. 2 by this Act authorised shall not be opened for traffic unless and until an additional tunnel has been constructed so as to provide separate tunnels for up and down traffic." The committee accepted the clause. Mr. Baggallay, K.C., on behalf of the Thames Conservators, brought up a clause safeguarding their rights and interests in the bed and shores of the river and providing that the position and character of any piling, staging, or other works to be erected in the waterway in connection with the construction of the railway should be subject to the approval of the Conservators. This was agreed to. The committee found the preamble proved, and the Bill, as amended was ordered to be reported for third reading. In the course of the evidence Sir Douglas Fox gave it as his opinion that there would be no difficulty in working the section as a single line. In regard to the Edgware and Hampstead Railway Bill, by which powers are sought to effect a slight deviation of the railway so as to make a more convenient junction with the Charing Cross, Euston, and Hampstead Railway, and to extend the time for the completion of the works, clauses have been agreed with the London County Council and the Hendon Urban District Council, the only petitioners against the Bill, and the measure has been referred to the Committee on Unopposed Bills.

**The District Railway.**—This company dispatched their first electric train in the early hours of Tuesday morning from Mill-hill Park to Bow-road. Among those who took part in the trial were Colonel Yorke and Mr. Trotter (representing the Board of Trade), Mr. John Young, Mr. W. E. Soar, and Mr. King (respectively the general manager, the traffic manager, and the engineer of the District Company), Mr. Ellis (general manager of the Metropolitan Railway), Mr. Jones (electrical engineer of the Metropolitan Railway), Mr. Bullock (assistant general manager of the London, Tilbury, and Southend Railway), Mr. Chapman (electrical engineer of the Underground Electrical Railways Company of London, who has had charge of the electrical equipment of the system), and Mr. Wells, of the British Westinghouse Company. The train was made up of seven vestibule cars, propelled by six motors of 200 h.p., the whole covering a length of 350ft. The trial run was highly satisfactory, although there was a large amount of sparking due to the rust on the rail. Power is obtained from the Lots-road generating station at Chelsea, which transmits the current to 14 sub stations at various places on the line. The time occupied in covering the 12¾ miles from Mill-hill Park to Bow-road was an hour and 10 minutes, including a lengthy stop at Whitechapel to enable the party to inspect the sub-station there. In ordinary running the time occupied, including stoppages at each station, will be about one hour, a great advance on the nine miles an hour which is the scheduled speed of the steam trains. It is believed that the stops at each station need not average more than 20 seconds in lieu of the 35 which the trains are now scheduled to make. It is proposed to solve the difficulty of providing means to discharge passengers without interfering with those wishing to enter the train by making those desirous of alighting leave the car by a door in the centre, while passengers wishing to enter have to do so through the end doors. It is predicted that the electric trains will perform the journey around the Inner Circle, with 26 stops, in 50 minutes, a saving of 20 minutes as compared with the time occupied under present conditions. No final decision has yet been come to on the question of fares, but it has been long settled that the "zone" system is to be put into operation. When the company's Bill was before the Parliamentary Committee it was stated that between certain stations—possibly within the City area—penny fares would be retained. Elaborate precautions are being taken to prevent an outbreak of fire, and the lesson taught by the disaster on the electrical railway in Paris two years ago has been taken to heart. The whole of the sleepers consist of Australian hardwood, the carriages are fireproof, and all wood on the station platforms is being removed and replaced by granolithic. The platforms of the new stations from East Ham to Whitechapel are constructed of stone, and the woodwork of all stopping-places from Mark-lane to Sloane-square has already been taken away. At South Kensington and Earl's Court the work is in hand. The electrification of the Metropolitan Company's system having been completed, as recorded last week, the Inner Circle is now ready for electric operation, but as sufficient rolling-stock of the new type is not yet available passengers must wait a few weeks longer for a regular service of electric trains. An assurance having been given that all the old servants will be retained, the employés have decided to accept the amended terms of pay, but protest against two principles—(1) only one man in the motor-room; (2) the payment of Sunday labour at weekday rate.

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## LIGHTING AND GENERAL.

**Henley.**—The charge for electric energy is to be reduced to 4½d. per unit as from April 1, 1905.

**Southport.**—It is estimated that the cost of laying the local telephone wires underground will be about £25,000.

**New Marconi Station.**—The Canadian Government have decided to place a Marconi wireless telegraph station on Sable Island. It is expected to come into operation by Aug. 1 next.

**Eastern Telegraph Co.**—The directors of the Eastern Telegraph Company have declared an interim dividend of 1¼ per cent. on the ordinary stock in respect of profits for the quarter ended Dec. 31, 1904.

**Whitwell.**—At the annual parish meeting a long discussion took place on the lighting question and proposed scheme of electricity, estimated to cost from £1,600 to £1,800. No definite resolution was passed.

**London Gazette.**—The partnership between Ralph Gooch Tyler and William Evan David Duncan, carrying on business as electrical engineers at 20, New Bridge-street, London, has been dissolved by mutual consent.

**Aberdeen.**—The last report of the Gas and Electricity Committee shows that in February the electric works had generated 421,120 units, as against 401,739 units for the corresponding month of last year, which contained 29 days.

**Paddington Electricity Exhibition.**—An exhibition of electrical appliances, organised by the Metropolitan Electric Supply Company, was formally opened by the Mayor of Paddington at the Paddington Baths, Queen's-road, on Saturday morning.

**Agency.**—Mr. Hilliard Stephens, A.M.I.M.E., A.M.I.E.E., of 39, Victoria-street, Westminster, S.W., informs us that he has severed his connection with Messrs. Mackenzie Bros., and has been appointed sole London agent to the Falkirk Iron Company.

**Pitlochry.**—Considerable interest is being taken in the renewed proposals for the introduction of the telephone to the district. Forty subscribers have been secured, and there is reason to believe that the trunk connection may be made by the end of July.

**Pontnewydd.**—The Llanfrechfa Upper District Council have granted an application of Messrs. Linton Bros., builders, Newport, for a supply of water to enable them to carry out a contract to extend the South Wales Electrical Power Company's station at Cwmbran, at a cost of £9,200.

**Carlisle.**—The underground telegraph cable to the North is now practically completed to Carlisle, and will be opened for public service shortly. The cables, which are of British manufacture, with all the latest improvements in telegraphy, are laid 2ft. below the surface of the ground.

**London County Council.**—On Tuesday it was agreed to lend the Battersea Borough Council £7,306 for electric lighting purposes, and the St. Pancras Borough Council £5,370 for electric light installation and meters. Various notices for extensions of mains in the metropolitan area were assented to.

**Southend.**—The electrical engineer in his last report states that during the month 12 consumers had been connected with the mains, with an equivalent of 618 lamps. One consumer, with 64 equivalents, had been disconnected. There were now 46,288 lamps connected to the mains, and 715 consumers.

**Trowbridge.**—It is reported that the attempts to fix a convenient day for the meeting between the Council's Electricity Supply Committee and Messrs. Seymour, Williams, and Co.'s representative to discuss the question of expenses already incurred in connection with the scheme have so far proved futile.

**Long Eaton.**—An enquiry has been held into the Council's application for sanction to borrow £5,500 for purposes of electric lighting. Mr. Frank Worrall, surveyor and electric light manager, said the total capacity of the existing plant was 13,600 8-c.p. lamps, and that the committee were in a position to double the output.

**Cromer.**—A six days' electrical exhibition is being held in the town hall, Cromer. The promoters are Edmundson's Electricity Supply Corporation, who, in conjunction with the Urban District Council, run the local electricity works. The proceeds of the exhibition will be handed over to the funds of the Cromer Cottage Hospital.

**Hastings.**—The borough electrical engineer (Mr. Ferguson) is experimenting with one of the Union Company's Luna arc lamps (dealt with in another part of this issue) for street-lighting purposes. We understand that Mr. Ferguson is full of confidence as to its advantages, one being that it takes less current than the other street lamps.

**Brighton.**—A letter recently appeared in the *Sussex Daily News* protesting against the nuisance caused by the excessive escape of steam from the electricity works in North-road, Brighton, and as a practical result a petition of about 330 residents and ratepayers has been forwarded to the chairman of the Lighting Committee asking for abatement of the nuisance.

**Guildford.**—The Town Council are about to borrow £2,996 for a water supply for domestic consumption to the highest levels in the extended area. The scheme includes providing and fixing of alternate plant consisting of either electric, gas, or oil power, coupled to three-throw ram pumps, equal to a capacity of 7,000 gallons per hour, estimated at £285. 10s.

**Macclesfield.**—The Board of Trade have granted an extension of the provisional order for supplying the borough with electricity at present held by the Corporation. The Board of Trade have intimated that if at Dec. 31 the Corporation are not putting their scheme into operation, the Board will then have to consider seriously whether they shall not revoke the order.

**A Telephone Curiosity.**—The first telephone erected in England for practical purposes was this week disconnected at Devizes (Wiltshire). It was constructed in 1879 from a description and illustrative sketches of the instruments contributed by Edison to the *Scientific American*, and connected the old town hall with the residence of Mr. A. Cunnington, the constructor.

**Manchester.**—The Special Telephones Committee of the Corporation have decided to recommend the City Council to petition Parliament against, as it seems to them, the undue haste with which the telephone agreement is proposed to be carried through, and to ask that the Corporation representatives shall be heard before the Select Committee to which the agreement is to be referred.

**Wigan.**—The cutting of the first sod in the preparation of land for the erection of a new mill by the Coppull Ring Spinning Company in the village of Coppull took place on Saturday. The mill will be 110 yards in length and 110ft. in breadth, and will be lighted by electricity. The cost of the erection is estimated at about £90,000. The architects are Messrs. Scott and Sons, of Manchester, and the contractors for the building are Messrs. Wrigley and Sons.

**Stock Exchange.**—The Stock Exchange Committee have appointed April 5 special settling day for Henley's (W. T.) Telegraph Works Company's further issue of 5,000 ordinary shares of £5 each fully paid, Nos. 35,001 to 40,000, and have ordered the said securities to be quoted in the official list. The committee has been asked to allow to be quoted in the official list the United River Plate Telephone Company's further issue of 12,000 ordinary shares of £5 each, fully paid.

**Bristol.**—A resolution has been adopted to the effect that in view of the proposal of the Government to acquire by purchase the undertaking of the National Telephone Company, it be an instruction to the Telephones Committee to consider and report to the Council as to the rates charged for telephone service by the company in this city, and in other cities and towns where competition exists, and as to the rates charged by the competing undertakings in such other cities and towns, and also to report to the Council regarding the terms of purchase.

**Dundee.**—The city electrical engineer, Mr. H. Richardson, has reported to the committee a new system he has devised for charging for electrical energy. While based on the maximum demand principle, it is different from the ordinary maximum demand system of charging, in that the charge representing interest and depreciation is varied with the maximum load of the consumer. The result is arrived at in tables for the convenience of the consumer in order to show what price per unit he would have to pay with a given consumption and a given maximum demand.

**Deeside.**—Last year's accounts of the electricity department have been completed, and the Council are this year £910 better off than they were last year. The electrical undertaking has proved very satisfactory. The working expenses were £2,370. 1s. 5d.; interest and repayment charges amounted to £2,810. 8s., both of which sums were received from the revenue. During the year 103 additional consumers were connected, which brought the total up to 620. The committee are now offering motor power for 1½d. per unit, and they are now just about to double their plant, which will meet the requirements for some time to come.

**Camberwell.**—The Council on Wednesday declined to accede to an application of the London Electric Supply Corporation for a map of their area prepared to be certified, because of the difficulties which might arise in the future in reference to the purchasing power of the Council. The Council accepted an offer of the County of London Electric Supply Company, Limited, to provide a stand-by supply of electric light to the Old Kent-road Baths at the rate of 3½d. per unit, upon the understanding that no gaslights for illuminating purposes are to be installed, except in the wash-house portion of the buildings, but that pilot gas fittings are to be allowed in certain parts.

**South Africa.**—The popularising of electric power, says the *African World*, is going on all over South Africa in a remarkable manner. The Durban Town Council have agreed, on the recommendation of the borough electrician, to reduce the tariff for electric power for motors to £5 per motor up to 5 h.p., and £3 per horse-power above that, the first 100 units per month to be charged 2d. per unit, the next 200 units 1¾d. per unit, and all units above 300 to be 1½d., the lighting tariff to be reduced by 10 per cent. on 8d. per unit to all who pay accounts within seven days of being rendered. It is also intended to introduce 6d. slot meters for small consumers, so that such consumers may be able to purchase light cheap, and save trouble with accounts and meter reading. It is intended to hold an international exhibition in Johannesburg in 1907. The Town Council have voted £2,000 towards the fund in connection with the visit of the British Association.

**Postal Telegraphists.**—The committee of the Midland centre of the Postal Telegraph Clerks' Association has been in correspondence with Mr. Chamberlain regarding the recommendations of the Bradford Committee, and he has consented to receive a deputation on the subject when he is in Birmingham at Easter. In a letter to Mr. Chamberlain, the secretary of the Midland centre of the Postal Telegraph Clerks' Association, Mr. Samuel Boden, said the increased wages could be granted by setting aside about 25 per cent. of the five millions of profit annually earned for the State by the postal workers. To this Mr. Chamberlain replied that he could not admit that the profits accruing from the working of the Post Office ought to be any criterion whatever of the wages paid. Those profits were really made out of the business done by the public, and were in the nature of taxation which should go to the Exchequer and relieve taxation generally. In Mr. Chamberlain's opinion the question of wages should be treated separately on its own merits. An appeal has been addressed to Mr. Austen Chamberlain, signed by 32 telegraphists in his constituency of East Worcestershire, urging that when the Post Office and Telegraph Votes on the Civil Service Estimates are taken, he will consider the possibility of supporting the claims of postal servants for the adoption of the Bradford Committee's recommendations. They also ask the Chancellor of the Exchequer to receive a deputation.—*The Times.*

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**East Barnet Valley.**—The North Metropolitan Electric Power Supply Company having acquired the undertaking of the North Metropolitan Electrical Power Distribution Company, propose to include the Urban District Council's district in their Bill now before Parliament, under agreement with the Council. The Council have asked for a copy of the Bill before giving a decision.

**Hanley.**—The report for the tenth complete year of the electricity works shows that the revenue for 1904 amounts to £15,277, the working expenses to £8,384, leaving £6,892, making, with a balance of £195 from the previous year, £7,087 to be dealt with. Of this sum the committee recommended that £1,150 should be applied to the reduction of rates. The accounts have been adopted.

**Partnership.**—Mr. Arnold G. Hansard, consulting electrical engineer, of 53, Victoria-street, S.W., has recently taken into partnership Mr. Henry S. Watson. Mr. Watson, who has taken an engineering degree at Cambridge, has latterly, whilst with the British Westinghouse Company, undertaken the equipment of factories, shipbuilding yards, and blast furnaces for motor driving as his special branch.

**Pudsey.**—The Corporation have commenced laying cables for electric lighting and power supply, and the cables of the South Yorkshire Electric Supply Company have nearly reached the centre of the town. The erection of a new electric transforming station has now been started, and the application for a provisional order for laying electric tramways in Pudsey is expected to pass almost immediately.

**Boston.**—A communication from the Local Government Board with reference to the application by the Town Council for permission to borrow £20,000 for electric lighting, making various suggestions, and recommending the appointment of an electrical engineer, will be considered by the Electric Lighting Committee next week. We understand that the Local Government Board recommend an extended scheme.

**Bermondsey.**—The distributors in the Bermondsey-street area are the most loaded, and an expenditure of £1,213. 18s. has been agreed to for an extension, together with the amount of £64. 17s. 5d., being one-fifth of the amount of extensions to switchboard. The Finance Committee have been requested to present an estimate as to the cost of the whole of the feeders required in accordance with the decision of the Council.

**Hammersmith.**—The premises of 13 additional consumers, representing a maximum of 250 8 c.p. lamps, have been connected to the mains. Six consumers have been disconnected, and the present number of consumers taking current from the mains is 1,562. The Borough Council have decided to appropriate £3,000 of the profits made during the year from the municipal electric light supply to the reduction of the general estimates.

**Exeter.**—At the last City Council meeting Mr. Wreford, moving the adoption of the report of the Electric Lighting Committee, said it was not proposed to employ an expert to make a further test of the machinery at the new electric light station. (We understand the test is to be made by the Council's electrical engineer.) He added that the test proposed to be made would not affect that part of the electric light machinery which was made by Willey and Co.

**Bradford.**—One of the Corporation's electric lighting cables fused on Friday at the junction of Leeds-road and Vicar-lane. There was a slight explosion, but no damage beyond the displacement of a few paving stones. In the course of two or three hours a temporary connection with another cable was established. The new engine and generator which have been installed at the works were started by Mr. H. Hibbert, deputy-chairman of the Electricity Committee, on the 27th inst.

**Finchley.**—The Electricity Committee have prepared the following budget: Estimated revenue—Supply £6,500, meters £120, public lighting £1,820, miscellaneous £70; total, £8,510. Estimated expenditure—Generation £3,025, distribution £250, public lighting (attendance and renewals) £450, management £990, repayment of loans £3,241. 17s. 6d.; total £7,955. 17s. 6d. Estimated net profit, £553. 2s. 6d. The present estimate is based on an estimated average of 25,000 8-c.p. lamps.

**Ripon.**—At the last City Council meeting it was stated that it was the intention of one or two companies to apply for the powers, and, further, the Council had some information as to which of the companies was likely to get the powers. They were given to understand, however, that if the Corporation could submit a reasonable scheme, and would give some evidence of their determination to carry it through, such a scheme would receive priority of consideration, and the others would not have a chance.

**Edinburgh.**—The Edinburgh District Lunacy Board have approved of a report by Messrs. Buchan and Hogarth on the power-station machinery and electric plant for Bangour, which stated that it would be necessary to allow for approximately the equivalent of 2,497 lamps of 16 c.p. for the complete electric lighting of the asylum for 1,000 patients, in addition to some 38 motors for ventilating and power purposes throughout, representing approximately a total of 50 h.p. or 60 b.p. The probable cost of the whole works was estimated at about £15,000.

**Torquay.**—At the last Town Council meeting the town clerk, upon being asked for information concerning the loan of £42,000 which had been applied for for the proposed new electric light and power station, replied that the Local Government Board had required further information. Further than that he could say nothing at present. He had addressed a reply under the instructions of the mayor and the chairman of the Electric Lighting Committee, to whom this matter had been referred as an emergency committee. It was suggested that the letter from the Local Government Board should be read to the Council, but the mayor said he did not think it desirable.

**"Telac."**—A trade-mark stamped on an article is the best method of defeating attempts at imitation, as to copy a trade-mark is a punishable offence. Messrs. J. H. Tucker and Co., of Samson-road, Birmingham, have adopted this precaution as a protection to electrical engineers using their goods, and have registered the word "Telac." This word is derived from the initials of "Tucker's electric lighting accessories." The word will have an enormous circulation on electrical apparatus, and will serve as a security that the articles bearing it come from a firm that has done much to raise the standard of electrical accessories. The registration of this trade-mark is referred to in our advertisement columns.

**Birkdale.**—The lighting company, through their contractors, F. W. Smith and Co., are fitting up a number of houses and shops absolutely free of charge. The minimum charge for current has been also taken off. Consumers who adopt this method of lighting their premises are treated exactly as though they had paid for the fittings outright, the company deciding the approximate positions of the lights, so that in the event of a tenancy being changed the lighting positions will be suitable. The fittings which are supplied free are, we are informed, quite ornamental enough for all ordinary purposes, but consumers are given the option of having better fittings and paying the additional cost only.

**Chester.**—The Lighting Committee recently instructed the electrical engineer (Mr. Britton) to make a further report on his views as to where a reduction can be made in the cost of public lighting, to what extent it can be reduced, and the cost of effecting such reductions. Based upon the report, the Electricity Committee have made the following recommendations, which have been adopted by the City Council: "That it be recommended to the Council that (1) 23 arc lamps situated in Hough Green, Grosvenor-road, Nicholas-street, Seller-street, and Egerton-street be lighted one day a week only; (2) the unnecessary incandescent lamps to be taken down as and when they are required for new districts; (3) when parts can be used for repairs to other lamps, the three and four-way incandescent lamps be converted to ½-ampere Nernst lamps, and (4) the whole of the public lamps in the city be lighted with electricity, the committee being authorised to provide and lay the mains, and provide and fix the lamps and appliances necessary for the purpose (½-ampere Nernst lamps being adopted in the street, and 8 c.p. lamps in courts), at an estimated cost of £1,900, the total charge for public lighting to be reduced to a sum equivalent to a lamp rate of 5½d. in the £ (say £4,400)."

**Poplar.**—The Council will apply for a further instalment of £10,000 on account of the loan of £59,000 for extensions and additional plant approved by the Council in connection with the electricity undertaking. The London County Council have written calling attention to the undertaking given by the Borough Council to provide for renewals and replacements, during the currency of the loan on the electric light undertaking, of any of the plant or machinery provided with the proceeds thereof. It was pointed out that the Poplar undertaking had been established four years; up to March 31 last a sum of £187,946 had been borrowed, mostly for 42 years, and only £2,494 at March 31 last had been paid off the loans. Moreover, since March 31, 1904, the Borough Council had borrowed a further sum of £45 000 for electric lighting purposes. In these circumstances the Finance Committee regard the creation of a reserve or renewal fund as very desirable in the interests of prudent finance, and ask that steps will be taken to form such a fund. In consequence, it has been decided that a depreciation reserve fund, to reach at least £10,000—the approximate cost of one of the large generating sets—be formed by the transfer of £2,500 from the present profit balance of £6,892. 13s. 5d., and by the transfer to the fund of 2½ per cent. of the net annual revenue. This amount, calculated upon present revenue, is approximately £400 per annum. A site in Glaucus-street is to be purchased in view of the necessity for the extension of the electricity works at an early date.

**Kingston.**—The Town Council have adopted a report, including the following recommendations of the Lighting Committee: That Messrs. Nichols and Co. be informed that the committee are prepared to place an electric street lamp in Gloucester-road, near Homersham-road, upon that firm paying £3. 18s. 6d., and upon their undertaking to pay £3. 7s. 6d. per annum for the current consumed; that 12 electric lamps be authorised to be erected in King's-road and Fassett-road, under the direction of Alderman Clarke; that a charge of 7d. per unit be made for electricity consumed through penny-in-the-slot meters; that a number of lamps be erected in other streets; that the General Purposes and Finance Committee be requested to obtain a loan of £4,000 for electric lighting purposes, such amount being a further portion of the amount of £15,850 sanctioned by the Local Government Board; that the charge for electric incandescent street lamps be at the rate of £3. 7s. 6d. per annum per lamp, this to include the cost of painting. It was explained with regard to the change in the charge for current that this was done with the object of encouraging profitable consumers and discouraging those who were not. The committee had made forecasts that the change would cost £700, and that those gentlemen adversely affected would object, and both had been fulfilled. The broad result of the working last year had been that 389 people paid £790 less than they would have done had they been charged under the old scale, and that 86 people paid £136 more; £80. 9s. 5d. was paid by four people, and the remaining £55 was, therefore, divided among 82 persons. Several customers had threatened to leave them and go elsewhere. The Chairman said the question to be answered was, "Shall we suffer anything very serious by the loss of these gentlemen's custom?" He might say in reply to that they had for some time been experimenting in street-lighting, and they had now got a lamp that should suit them very well. The lamps in King's-road compared very favourably with the gas lamps in the neighbourhood, and his opinion, that the lighting in this road was better than when the gas lamps were in use, was confirmed by perfectly independent ratepayers. They also made a substantial profit out of them. If they lost the custom of a gentleman who averaged 4s. per lamp per annum, they could earn nearly 16s. per lamp for street-lighting.

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## PROVISIONAL PATENTS, 1905.

MARCH 20.

**5782. Improvements in electric motor controllers.** The Electric and Ordnance Accessories Company, Limited, Robert Frederick Hall, and Joseph Richardson Garner, 24, Temple-row, Birmingham. (Complete specification.)

**5814. An improved automatic accumulator charging switch.** Hugo Hirst and Ernest Edward Stewart, 71, Queen Victoria-street, London.

**5820. Improvements in brush-holders for dynamo-electric generators and electromotors and other electric apparatus.** Electromotors, Limited, and John Henderson Hamilton, Louisa-street, Openshaw, Manchester.

**5821. Improvements in mercury vapour lamps (electro-thermo-mercury vapour lamp).** Joseph Skwirsky, 36, Newman-street, Oxford street, London.

**5827. Improvements in field systems for continuous-current motor electric meters and/or needle instruments.** Carl Wilhelm John Busch, 65, Chancery-lane, London. (Date applied for under Patents Act, 1901 March 22, 1904, being date of application in Germany.) (Complete specification.)

**5829. An improved contact maker for electrical ignition devices and like uses.** George William Brindley and Sydney James Bale (trading as the Barnstaple Motor Company) and Stephen James Murphy, 10, St. George's-crescent, Liverpool.

**5834. Improvements in the windings of electrical machines.** Siemens Bros. and Co., Limited, Queen Anne's-chambers, Broadway, Westminster, London. (Siemens Schuckertwerke G. m. b. H., Germany.) (Complete specification.)

**5836. Improvements in or connected with electric glow lamps.** Ludwig Scholvien, 37, Essex-street, Strand, London. (Date applied for under Patents Act, 1901, Sept. 29, 1904, being date of application in Germany.) (Complete specification.)

**5863. Improvements in electric train signals.** Albert Walter Sullivan and William Renshaw, Palace-chambers, Westminster, London. (Complete specification.)

**5865. Improvements in the construction of conduits for containing electric cables and wires, and other wires, tubes, pipes, and the like.** Walter Hepworth-Collins, 17, Nicholas-street, Manchester.

**5866. Electrically-operated tubes or bulbs containing rarefied gas or vapour.** Franklin Wise Howorth, 47, Lincoln's-inn-fields, London. (The Moore Electrical Company, United States.) (Complete specification.)

**5882. Manufacture of lithopones by electrolysis of sulphates or chlorides of soda and consecutive production of caustic soda.** Jean Baptiste Candau and Auguste Candau, 65, Chancery-lane, London.

**5887. Improvements in the electrolytic manufacture of copper wire, strip, or the like.** Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

MARCH 21.

**5896. A magnetic automatic motor.** Thomas Graiger, Oak Tree, Bogerstone, Mon.

**5899. Improvements in electric motors.** Mather and Platt, Limited, Edward Hopkinson, and Julius Firth, Salford Ironworks, Manchester.

**5918. Improvements in electric batteries and in electrolytic processes and apparatus.** Chamberlain and Hookham, Limited, and Sydney Holmwood Holden, 18, Southampton-buildings, Chancery-lane, London.

**5944. Improvements in means for controlling electric circuits.** Henry Leitner and Richard Norman Lucas, 4, South-street, Finsbury, London.

**5948. Improvements in or relating to incandescent lamp-holders.** William Winstanley Strode and William Edwin Halston, 111, Hatton-garden, London.

**5976. Improved means for regulating compensated series electric motors and generators.** The Elektrizitäts-Act.-Ges. vormals W. Lahmeyer und Co., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, April 5, 1904, being date of application in Germany.) (Complete specification.)

**5977. Improvements in connection with polyphase alternate-current electric machines provided with commutators.** The Elektrizitäts-Act.-Ges. vormals W. Lahmeyer und Co., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, April 15, 1904, being date of application in Germany.) (Complete specification.)

**5978. Improvements in and relating to methods of and apparatus for synchronising dynamo-electric machines.** The British Thomson-Houston Company, Limited, Hans Sigismund Meyer, and Paul Alphonse Mossay, 83, Cannon-street, London.

**5979. Improvements in articles made of granular materials, such as brushes for dynamo-electric machines, and in methods of manufacturing the same.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

**5980. Improvements in and relating to alternating-current dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

**5981. Improvements in and relating to alternating-current motors.** The British Thomson-Houston Company, Limited, 83 Cannon-street, London. (The General Electric Company, United States.)

**5982. Improvements in means for protection against short-circuits.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

**5983. Improvements in and relating to dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.) (Complete specification.)

**5984. Improvements in electrodes adapted for use in electric furnaces.** Edgar Field Price, George Emerson Cox, and James Gilbert Marshall, Clun House, Surrey-street, London. (Complete specification.)

MARCH 22.

**6052. An air suction contact device for stopping printing machines and the like by electricity.** Emil Wetzel, 15, Hamilton-gardens, St. John's Wood, London.

**6053. Improvements connected with electric lamps for illuminating timepieces and for other uses.** John Collard Vickery, 23, Southampton-buildings, Chancery-lane, London.

**6066. Improvements in or relating to electric clocks.** Frank Hope-Jones, 322, High Holborn, London. (Complete specification.)

**6067. Improvements relating to dynamo-electric machines.** The Phœnix Dynamo Manufacturing Company, Limited, Robert Pohl, and Felix Pohl, 322, High Holborn, London.

**6072. An electric lamp adaptor for oil, gas, or other luminant for motor, cycle, and other lamps.** Gilbert Davenport, 58B, Hatton-garden, London.

**6073. Improvements in electrical mercury switches operated by a vehicle passing along a railway.** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

**6077. Improvements in and relating to apparatus for indicating when the trolley standards of electrically-driven vehicles become "alive," and for guarding the standards when in such a condition.** Percival John Pringle, 323, High Holborn, London.

MARCH 23.

**6089. Improvements in magneto-electric generators.** Thomas William Stainer Hutchins, 17, St. Ann's-square, Manchester.

**6091. Improved means for laying telegraph and like poles.** John Riddell Brown, 55, Market-street, Manchester.

**6176. Improvements in and relating to relays for telephones, telegraphones, and the like.** Jens Herman Christensen, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**6192. Improvements in oscillographs.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

MARCH 24.

**6238. Insulating and acid-resisting sets, comprising of all metallic goods used for secondary batteries be vitreous enamelled.** A. Thomas, 45, Grosvenor-street, Pendlebury, Manchester.

**6245. Accumulator constructed of the pillar type of electrodes.** A. Thomas, 45, Grosvenor street, Pendlebury, near Manchester.

**6257. An automatic reverse-current safety throw-over switch for compound-wound traction generators.** Godfrey Bernard Parlett and George Howard Coxon, 36, John-street, Smethwick.

**6259. Improvements in apparatus for regulating the pressure in direct-current electric mains.** William Buchanan, Prince's-chambers, Wolverhampton.

**6267. Improvements in imitation candles for electric light.** Bernard Mervyn Drake, 66, Victoria-street, Westminster, London.

**6269. Improvements in systems of electric lighting.** Henry Leitner and Richard Norman Lucas, 4, South-street, Finsbury, London.

**6271. Improvements in pressel switches for electric lighting.** George James Bonnella and Arthur Bonnella, 40, Rosoman-street, Clerkenwell, London.

**6272. Improvements in and relating to vapour electric lamps and the like.** British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

**6280. Improvements in and relating to telegraphic transmitters.** Joseph Theodor Szek, 22, Southampton-buildings, Chancery-lane, London.

**6286. Improvements in attaching insulators to tubular or like arms or brackets.** Siemens Bros. and Co., Limited, and George William Perry, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**6307. A new or improved unipolar cell and method and means of converting and/or transforming continuous currents of electricity.** Robert Grisson, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

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MARCH 25.

**6324. An electric stethoscope.** Arthur David Evans and William Charles Snook, 8, Leadenhall-street, London.

**6337. Improvements in magnetic sparking plugs for internal-combustion and other engines.** John Arthur Torrens, Somerset, Coleraine, co. Londonderry, Ireland. (Complete specification.)

**6370. Improvements in the control of electric elevators.** George Andrew Philip Weymouth, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**6376. Improvements in means for regulating variable-speed dynamos.** Henry Leitner and Richard Norman Lucas, 4, South-street, Finsbury, London.

**6383. Improvements in electric switches having resistances.** Edmund Garside, 1, Queen Victoria-street, London.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published April 13.*

1904.

**6560. Automatic electric switches.** Atkinson.

**6646. Call system for telephone stations.** Ammer.

**7064. Mercury and other vapour apparatus for converting and obtaining light from alternating electric currents.** Holz. (Date applied for under International Convention, March 23, 1903.)

**7065. Transmitting alternating electric current through a vapour for rectifying or lighting purposes.** Weintraub. (Date applied for under International Convention, March 23, 1903.)

**7066. Alternating-current rectifying apparatus.** Steinmetz. (Date applied for under International Convention, March 23, 1903.)

**7067. Means for rectifying alternating electric currents.** Weintraub. (Date applied for under International Convention, March 23, 1903.)

**7298. Arc lamp electrodes.** Fleming. (Date applied for under Internation Convention, March 26, 1903.)

**7299. Arc light electrodes and methods of making the same.** Dempster. (Date applied for under International Convention, March 26, 1903.)

**7748. Switches for use in connection with electric lights and the like.** Chisholm.

**9517. Insulators for overhead electric conductors.** Richardson, Heap, Heap, Bailey, Brierley, and Billington.

**10073. Electric telegraphy.** Brown.

**10246. Vapour electric apparatus.** Carolan. (General Electric Company.)

**10460. Electric switches.** British Thomson-Houston Company, Limited. (General Electric Company.)

**11090. Electric switches.** British Thomson-Houston Company, Limited. (General Electric Company.)

**11444. Dynamo-electric machines.** British Thomson-Houston Company, Limited. (General Electric Company.)

**11545. Induction coils.** Gaiffe.

**11649. Incandescent gas, acetylene, and electric arc lamps.** Winkler.

**16985. Arc lamps.** Bermudez.

**20329. Telephone systems.** Young.

**22752. Method of and apparatus for transforming alternating currents of constant voltage and frequency into continuous currents of variable voltage.** Faget.

**25219. Protective systems for electric distribution lines.** Wilson. (Date applied for under International Convention, Nov. 20, 1903.)

**25608. Hertzian-wave projecting and receiving apparatus for locating the position of distant metal objects.** Hülsmeyer.

**26921. Electrodes for arc lamps and method of making the same.** Weedon. (Date applied for under International Convention, Dec. 10, 1903.)

**27063. Electric switches.** Bénassy. (Date applied for under International Convention, Dec. 17, 1903.)

**27861. Electric accumulators.** Gardiner.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ⅝-¾ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 7/16-17/32 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | – | 5¾-6¼ |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | – | 5¾-6 |
| —— 4½ per cent. Mortgage Debentures | 100 | – | 101-104 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 99-101 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | – | 3 3¼ |
| —— 4 per cent. Mortgage Debenture Stock | 100 | – | 91-93 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,751 | 2 | – | ½-¾ |
| —— Non. Cum., 6 per cent. Pref. | 2 | – | 1¼-1⅝ |
| —— 4½ per cent. 1st Debenture Stock | 100 | – | 92-93 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | – | 79-82 |
| Callender's Cable, Debentures | 100 | – | 106-108 |
| —— Ordinary | 5 | – | 11-11¼ |
| —— 5 per cent. Pref. | 5 | – | 5¼-5⅜ |
| Crompton and Co. | 5 | – | 2¼-2⅜ |
| —— 5 per cent. Debentures | 100 | – | 95-98 |
| Edison and Swan United, "A" Shares, 1-88,251 | 5 | – | 1-1¼ |
| —— "A" Shares, 01-017,159 | 5 | – | 1⅜-2¼ |
| —— 5 per cent. Debentures | 100 | – | 86 91 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 85-90 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | – | 1¼-1½ |
| —— 7 per cent. Cumulative Pref. | 2 | – | 2¼-2½ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | – | 97-99 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | – | 9¼-10 |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | – | 91-96 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | – | 12¼-13 xd |
| —— 4½ per cent. Preference | 5 | – | ⅝-⅝ |
| —— 4½ per cent. Debentures | 100 | – | 109-111 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | – | 16-17 |
| —— 4 per cent. Debentures | 100 | – | 100-103 |
| Parker, Thos., Limited, Ordinary | 10 | – | 10-10¼ |
| Telegraph Construction and Maintenance | 12 | – | 26 38 xd |
| —— 5 per cent. Bonds | 100 | – | 103-105 |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary | 10 | – | 12¼-12⅝ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | – | 9⅝-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | – | 11-12 |
| —— 4½ per cent. Debenture Stock. Red. | 100 | – | 105-107 |
| Bromley (Kent) Electric Light and Power Co. | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. 1st Debenture Stock, Red. | 100 | – | 103-106 |
| Brompton and Kensington, Ordinary | 5 | – | 10¼-10⅜ |
| —— 7 per cent. Preference | 5 | – | 10-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 | 5 | – | 9 9¼ |
| —— Nos. 60,001-80,000 | 5 | – | 6¾-7¼ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | – | 12¼-13½ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 105-108 |
| Charing Cross and Strand, Nos. 1-70,000 | 5 | – | 8-8¼ |
| —— 70,001-80,000 | 5 | .. | 7⅜-8¼ |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 5-5¼ |
| —— 40,001-80,000 | 5 | .. | 5-5¼ |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | – | 103-105 |
| Chelsea Electricity Supply | 5 | – | 6⅜-7¼ |
| —— 4½ per cent. Debentures | 100 | – | 109-111 |
| City of London, Ordinary | 10 | – | 11¼-12 xd |
| —— 6 per cent. Cumulative Pref. | 10 | – | 13¼-14 xd |
| —— 5 per cent. Debenture Stock | 100 | – | 123-127 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | – | 103-106 |
| County of London Electric Supply, Ordinary | 10 | – | 9¼-10 |
| —— 6 per cent. Cum. Pref. | 10 | – | 12¼-12⅝ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Red. | 100 | – | 104-106 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. | 100 | .. | 110-113 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | – | 6¼ 6⅜ |
| —— 6 per cent. Cum. Pref. | 5 | – | 6¼-6⅜ |
| —— 4½ per cent. First Mort. Deb. | 100 | – | 106-108 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 2¼-2⅜ |
| —— 5 per cent. Debenture Stock, Red. | 100 | – | 86-91 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | – | 5¼-6 |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | – | 101-104 |
| Havana Electricity, Limited, 1-15,000 | 10 | – | 9¼-10⅛ |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | – | 7⅜-9¼ |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 101-103 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 | 1 | – | 11/16-13/16 |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | | 12¼-13 |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red | 100 | – | 102-104 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅜-10¼ |
| London Electric, Ordinary | 5 | – | 2 9/16-2 13/16 |
| —— 6 per cent. Pref. | 5 | – | 5⅜-6 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | – | 99-101 |
| Metropolitan Ordinary | 10 | – | 18-18½ xd |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | – | 110-115 |
| —— 4½ per cent. Cum. Pref. | 5 | .. | 5⅜-5⅞ |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | – | 97-99 |
| Midland Electric Power Dis., Ld., 4½ p c. 1st Mort. Deb. | 100 | – | 99-101 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | – | 98-101 |
| —— Preference | 4 | – | 100-102 |
| Notting Hill Electric Lighting | 10 | – | 14¼-15½ xd |
| —— 4 per cent. First Mort. Debs. Nos. 1-600 (Reg.) | 100 | – | 102-104 |
| Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,510 | 5 | – | 6¼-6½ xd |
| —— 4 per cent. Debenture Stock | 100 | – | 98-100 |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures | 100 | – | 100-102 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 | – | 2⅜-2¾ |
| —— 4 per cent. Debenture Stock | 100 | – | 79-83 |
| South London, Ordinary | | – | 4 4¼ xd |
| South Metropolitan Electric Light and Power Co., Ord. | 1 | .. | ⅞-1 |
| —— 7 per cent. Cum. Pref. | 1 | .. | 1⅛-1 7/16xd |
| —— 4½ per cent. 1st Mort. Deb. | 100 | .. | 107-110 |
| —— Ditto, June, 1904 | | .. | |
| St. James's and Pall Mall, Ordinary, 101-80,080 | 5 | – | 13¾-14¼ |
| —— 7 per cent. Pref. | 5 | – | 8¼-8⅜ |
| —— 5½ per cent. Deb. | 100 | – | 98-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | – | 5 1/16-5 3/16 |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5 3/16-5 5/16 |
| Westminster, Ordinary | 5 | – | 12¼-13 |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | – | 6¼-6⅜ |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 | 5 | – | 5⅝-5⅞ |
| —— Ord. | 5 | .. | 8⅜-8¾ |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | – | 140-143 |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 105-107 |
| Barcelona Tramways, Limited, Ord., 1-20,000 | 10 | .. | 12-12¼ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 | 10 | .. | 9¼-10 |
| —— 5 per cent. Deb., Red., 1-600 | 100 | .. | 99-102 |
| —— 4½ per cent. Red. Deb. Stock | 100 | .. | 96-100 |
| Bath Elec. Tramways., Ld., Pref. Ord. Shs., 75,001-150,606 | 1 | .. | 13/16-15/16 |
| —— 5 per cent. Cum. Pref. Shares, 1-58,394 | 1 | .. | 15/16-1 1/16 |
| Belfast Street Tramways, Ord., 1-26,600 | 10 | .. | 10¼-11¼ |
| Blackpool and Fleetwood Tramroad | 10 | – | 13¾-15⅛ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | – | 1-1¼ |
| —— 5 per cent. Cum. Pref., Nos. 1 75,000 | 5 | – | 3¾-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 91-98 |
| British Columbia Electric Railway Co., Ord. Def. | 100 | – | 104-107 |
| —— Ord Pref. | 100 | – | 100-103 |
| —— Non. Cum. 5 per cent. Pref. | 10 | – | 10-10¼ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 | – | 105-107 p s |
| —— 4½ per cent. Vancouver Power Deb. | 100 | – | 99-102 |
| British Electric Traction Ord. 1-300,000 & 60,001-80,000 | 10 | – | 9¼-9⅜ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | – | 10¾-11¼ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | – | 123-125 |
| —— 4½ per cent. 2nd Deb. Stock | 100 | | 98-100 |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Buenos Ayres and Belgrano Tram. Ord., 1-100,000 | 5 | 3¾-4 |
| —— "A" 5 per cent. Cm. Pf., 1-40,000 | 5 | 5¼ 5½ |
| —— "B" 5 per cent. Cm. Pf., 1-27,500 | 5 | 5⅜ 5⅝ |
| —— 5 per cent. Deb. Stock, Red. | 100 | 107-109 |
| —— Prov. Cert., all paid | 100 | 103-106 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | 97-99 |
| Calcutta Tramways, Limited, 1-102,268 | 5 | 8⅛-8⅜ |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | 106-108 |
| Cape Electric Tramways Nos. 1-480,000 | 1 | 1⅛-1⅜ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | 4⅞-5⅛ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | 101-104 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | 103-105 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | 9½-10 |
| —— 5 per cent. Cum. Pref. | 10 | 11-12 |
| —— 4 per cent. Debentures | 100 | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | 13½ 14½ |
| —— 5 per cent. Pref., Nos. within 1-60,000 | 10 | 16¼-16¾ |
| —— 5½ per cent. Mort. Debs., 1-3,000, Red. | 100 | 94-97 |
| Imperial Tramways Ordinary | all | 18-19 |
| —— 5 per cent. Cum. Pref. | all | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000 | 5 | 3-3½ |
| —— 4 per cent. Debenture Stock | 100 | 89-92 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | 8 8½ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | 10-10½ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | 98 101 |
| Madras Elec. Trams (1904), Ltd., 5 per cent. Deb. Stk., Red. | 100 | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016. | 1 | 13/32 15/32 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | 1-1 1/16 |
| —— 4½ per cent. Deb. Stock, Red. | 100 | 105-107 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000 | $1,000 | 106-110 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 | 101-104 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 | 103-105 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 54,001-74,000 | 5 | ¼-1½ |

| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | 12½ |
| —— 5 per cent Cum. Pref. | 10 | 9½-9¾ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk. | 100 | 105 108 |
| Potteries Electric Traction, Ordinary 20,001-40,00 | 10 | 9¼-10¼ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | 9¼-10 |
| —— 4½ per cent. Debenture Stock | 100 | 103-107 |
| South Lancashire Electric Traction and Power Company | | |
| —— £250,000 Ordinary | 1 | 1 |
| —— £101,152 5 per cent. Preference | 1 | 1 |
| —— £597,170 4½ per cent. Debenture Stock | 100 p.c. | 100 p.c. |

## Electric Railways.—

| | | |
|---|---|---|
| Central London, Ordinary | 100 | 93 95 |
| —— 4 per cent. Pref. | 100 | 101-103 |
| —— ,, ,, deferred | 100 | 83-86 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | 110-112 |
| City and South London, Consolidated Ordinary | 100 | 44 45 |
| —— 4 per cent. Debenture Stock | 100 | 109-111 |
| —— 5 per cent. Pref. Stock '91 | 100 | 120-123 |
| —— ,, ,, ,, '96 | 100 | 118-121 |
| —— ,, ,, ,, '01 | 100 | 115-118 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | 10-10½ |
| —— Ordinary, 1-50,000 | 10 | 3¾-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — | 99-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | — | 99 -100¼ |
| Waterloo and City, Ordinary | 100 | 92-94 |

## Telephones.—

| | | |
|---|---|---|
| National Telephone, Preferred | 100 | 109½ 110¼ xd |
| —— Deferred Stock | 100 | 103¼-105¼ xd |
| —— 6 per cent. Cum. First Pref. | 10 | 12¼-13¼ xd |
| —— 6 per cent. Cum. Second Pref. | 10 | 12-13 xd |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | 6⅜ 5½ xd |
| —— 3½ per cent. Deb. Stock, Red. | 100 | 100 102 |
| —— 4 per cent. Deb. Stock, Red. | 100 | 104-106 |
| —— 4 per cent. Prov. Cert. | — | 103¼-105¼ xd |
| Oriental Telephone and Electric Company | 1 | 1¼-1⅜ |
| —— 6 per cent. Cum. Pref. | 1 | 1 3/16-1 5/16 |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905. | 1904. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | Mar. 18 | 1,075 | 1,031 | − 5 | + 5,718½ | 19¼ | 19¼ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·14 |
| Ayr Corporation | ,, 25 | 195 | 172 | + 23 | + 654 | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 316,049 | 1·03 | 10·11 | 1,770 | 5 0 |
| Barking Corporation | ,, 25 | 51 | 41 | + 10 | + 231 | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 26 | 975 | 976 | − 1 | − 916 | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,319,701 | 1·158 | 9·98 | 2,383*b* | 6·1 |
| Birmingham Corporation | ,, 25 | 360 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | — | — | — | — | — | 6¼ | 6¼ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 24 | 958 | 765 | + 193 | + 3,567 | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10·94 | — | 4·59 |
| Blackpool Corporation | ,, 23 | 454 | 312 | + 142 | + 6,372 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 25 | 237 | 210 | + 27 | − 59 | 16½ | 16½ | Dec. 31 | 32,021 | 2,253,984 | 600,757 | 3·24 | 12·75 | 2,001 | 7 05 |
| Bolton Corporation | ,, 26 | 1,774 | 1,617 | + 157 | + 955 | 38 | 38 | March 31 | 94,151 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 5,766 | 5·89 |
| Bournemouth Corporation | ,, 22 | 1,051 | 907 | + 144 | + 2,530 | 10·15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | Feb. 25 | 3,553 | 3,360 | + 193 | +29,738 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | Mar. 26 | 860 | 730 | + 130 | + 3,944 | 9 | 7½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 21 | 4,783 | 4,467 | + 316 | — | 51½ | 51½ | Dec. 31*g* | 253,150 | 44,391,439 | 6,033,528 | — | — | — | — |
| Burnley Corporation | ,, 25 | 1,052 | 880 | + 165 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 26 | 333 | 281 | + 19 | — | 8¼ | — | March 31*j* | 11,574 | 2,556,134 | 282,378 | 1·08 | 9·84 | 1,570 | 7·57 |
| Cardiff Corporation | ,, 25 | 1,911 | 1,815 | + 115 | + 2,283 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 25 | 169 | 148 | + 21 | − 284 | — | — | Dec. 31*g* | 9,987 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 25 | 7,025 | 7,280 | − 255 | + 918 | 6 | 6 | ,, 31 | 362,471 | 44,933,938 | 1,292,674*a* | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 26 | 2,873 | 3,155 | − 282 | − 2,503 | 6¼ | 6⅜ | ,, 31 | 165,003*a* | 19,069,319*a* | — | — | — | — | — |
| Colchester Corporation | ,, 22 | 176 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 23 | 453 | 377 | + 76 | — | — | — | ,, 31*g* | 26,657 | 6,353,323 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | ,, 24 | 225 | 205 | + 20 | − 40 | 7·23 | 7·23 | March 31*a* | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 21 | 173 | 163 | + 5 | — | 4½ | 4½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0·94 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | ,, 24 | 102 | 99 | + 3 | + 324 | 7 | 6¾ | Dec. 31*g* | 6,231 | 588,905 | 107,144 | 3·88 | 14·09 | 952 | 7·39 |
| Dublin U. T., electric cars | ,, 24 | 3,735 | 3,572 | + 163 | } — | 47 | 46 | ,, 31*g* | 134,643 | — | 3,429,356 | — | — | — | — *h* |
| Dublin S. District, Electric | ,, 24 | 798 | 727 | + 71 | | | | | | | | | | | |
| Dundee City Tramways | ,, 22 | 794 | 762 | + 32 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 25 | 771 | 610 | + 161 | + 2,191 | 10·77 | 10·75 | March 31 | 34,312 | 12,950,259 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 25 | 14,792 | 13,571 | +1,221 | +31,677*h* | 145 | 123 | May 31*g* | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489*b* | 7·40*d* |
| Gloucester Corporation | ,, 27 | 262 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 22 | 2,613 | 2,457 | + 156 | + 5,510 | 33 | 30½ | March 31 | 68,283 | 16,322,054 | 1,387,885 | 1·0 | 11·79 | 2,069 | 8·77 |
| Huddersfield Corporation | ,, 25 | 1,224 | 1,117 | + 117 | + 4,522 | 35 | 35 | ,, 31 | 65,545 | 11,899,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | ,, 25 | 2,039 | 1,939 | + 99 | +11,672 | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | Feb 25 | 346 | 337 | + 9 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | Mar. 24 | 125 | 138 | − 13 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 22 | 208 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 25 | 5,652 | 5,097 | + 555 | +18,052 | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | ,, 25 | 1,956 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | ,, 18 | 10,075 | 9,533 | + 542 | + 4,483 | 103 | 103 | Dec. 31*g* | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·93 |
| Liverpool Overhead Railway | ,, 26 | 1,524 | 1,596 | − 72 | − 6,944 | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185*a* | 1·82 | 19·30*a* | 5,110 | — *a* |
| London County Council | ,, 18 | 12,301 | 10,644 | +1,657 | +122,460 | 46½ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | Feb. 25 | 120 | 128 | − 8 | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | Mar. 23 | 113 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 25 | 12,515 | 10,913 | +1,602 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 21 | 121 | 99 | + 22 | + 1,434 | 2¾ | — | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newcastle-on-Tyne Corptn. | ,, 25 | 3,577 | 3,457 | + 120 | — | 45 | 38½ | ,, 25 | 185,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111*b* | — |
| Newport (Mon.) Corporation | Feb 11 | 475 | 460 | + 25 | + 1,333 | 15 | — | — | — | — | — | — | — | — | — |
| Oldham Corporation | Mar. 24 | 954 | 525 | + 428 | + 6,298 | 34½ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 25 | 1,691 | 1,352 | + 339 | + 6,874 | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·15 | 12·39 | — | — |
| Reading Corporation | ,, 23 | 581 | 529 | + 53 | — | — | — | — | — | — | — | — | — | — | — |
| Rochdale Corporation | ,, 18 | 441 | 102 | + 339 | + 7,170 | 4½ | 4½ | 31*g* | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 23 | 434 | 424 | + 10 | — | — | — | ,, 31 | 20,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·68 |
| Salford Corporation | ,, 20 | 4,100 | 3,669 | + 431 | — | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 18 | 70 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 26 | 4,563 | 4,355 | + 208 | + 8,214 | 34½ | — | ,, 25*g* | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 22 | 875 | 836 | + 39 | + 2,626 | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 22 | 267 | 217 | + 50 | + 1,655 | 6½ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 24 | 540 | 410 | + 130 | + 8,735 | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 20 | 1,144 | 1,064 | + 80 | + 1,675 | 19·51 | 18·48 | ,, 31 | 62,506 | 14,848,958 | 1,433,463 | 1·01 | 10·46 | — | 6·02 |
| Swindon Corporation | ,, 1 | 151 | — | — | — | 3½ | — | — | — | — | — | — | — | — | — |
| Wallasey U.D.C. | ,, 25 | 705 | 598 | + 107 | + 2,745 | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·60 |
| Warrington Corporation | ,, 23 | 317 | 305 | + 12 | + 615 | 7¼ | — | — | — | — | — | — | — | — | — |
| West Ham Corporation | ,, 25 | 1,2 4 | — | — | — | 8·52 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 22 | 724 | 506 | + 215 | — | 7½ | — | ,, 31*g* | 20,878 | 4,263,066 | 417,335 | — | 12·006 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *e* Including one section of horse traction. *g* 1903. *h* Only eight months—expenditure includes large special items incidental to starting new department. *j* Half-year's figures.

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## NOTES.

**New Publications.**—"Modern Electricity," by James Henry and K. J. Hora (London: Hodder and Stoughton. 5s.). The authors have compiled, in encyclopædic form, a concise and practical manual of the principles and applications of electricity. The volume should meet with appreciation from students and apprentices.

**Personal.**—We are informed that Mr. E. Guarini, who has frequently contributed information to our columns, has been appointed professor of electrical engineering at the technical school at Lima. We wish him every success in his new position, and hope that it will enable him to carry out more original work in connection with wireless telegraphy, for which there may be considerable scope in South America.

**Personal.**—We are glad to see that Lord Kelvin is making good progress after the operation performed upon him at the end of last week. The latest bulletin announces that the distinguished scientist is free from pain, and that his strength is well maintained. Several telegrams of enquiry as to the patient's condition were received from King Edward. Everybody will join in wishing his lordship a speedy and complete recovery.

**American Institute.**—We have received a copy of this association's *Proceedings* for March, which contain papers on "Line Construction for High-Pressure Electric Railroads," by Mr. G. A. Damon; "High-Pressure Line Construction for Alternating-Current Railways," by Mr. T. Varney; and "Track Bonding," by Mr. C. W. Ricker. There are also the discussions on "Acyclic (Homopolar) Dynamos," "Modern Central-Station Design," and "The Maximum Distance to which Power can be economically transmitted."

**Wireless Telegraphy.**—Reports have been current in the Press during the last few days to the effect that the Marconi Transatlantic system has been discontinued. According to a statement that appeared from Mr. Hall, the manager of the company, "long-distance" transmission for private messages has been suspended. It would be interesting to know precisely what is to be understood by this, as the Post Office does not now accept any Transatlantic ethergrams. It is stated, however, that the "ocean daily" will be published as usual.

**Electric Grain Elevators.**—The economy from electric power in loading ships with grain is illustrated by some tests lately carried out at Geelong, Australia. With three machines in operation for 8½ hours no less than 5,320 bags of wheat were handled on a current consumption of 42 kilowatt-hours. At 2½d. per unit the work cost 10s., a remarkably low figure for the quantity of material handled. It is estimated that a ship with a capacity of 20,000 bags of wheat can be loaded on this system for about £1. 15s., while if the elevation to the ship's side were not too great to allow of two or three bags being placed on the belt, the cost of energy would be brought down to little more than half.

**Institution Civil Engineers, France.**—No. 5 of the *Proceedings* of the Soc. Ingénieures Civils de France, just to hand, contains papers read at the March meeting. One is by Mons. P. Besson, on "Radium and Radioactivity," which is divided into the following sections: preparation of radium, the distinctive characteristics of the various rays, their physical, chemical, and biological qualities, and induced radioactivity. The other paper is by Mons. L'Ancel, and deals with high-frequency currents in wireless telegraphy. The next meeting will be held on April 7, when Signor Semenza will read a paper on the "Hydro-Electrical Installations in Upper Italy." There will also be a paper by Mons. K. Sosnowski on "Boilers and Steam-Engines at the St. Louis Exhibition."

**Pneumatic Tube Dispatch.**—According to a statement made in the House of Commons last week by the Postmaster-General, the Pneumatic Tube Dispatch Company's scheme does not stand much chance of seeing the light—if that term is permissible in the case of an essentially subterranean system—for the present. Lord Stanley is apparently unconvinced by the eloquent assurances of the company's engineers that the scheme could be consummated with a minimum of inconvenience to the public by means of the "cut-and-cover" method, which was employed in the construction of the New York underground railway. The scheme may, perhaps, stand in need of revision on certain points, as most of such schemes do, but it promised substantial advantages, and it is therefore regrettable that it should not have an opportunity of being discussed in committee. The system has been substantially a success on the Continent and in the States.

**Telephone Inspection Chambers.**—In the House of Commons last Friday Sir Thomas Dewar interrogated the Postmaster-General as to whether his attention had been called to a recent action to recover damages for personal injuries sustained through a gas explosion in a Regent-street telephone inspection chamber, and whether, having regard to the expression of opinion by the judge and jury, that the accumulation of gas in these chambers should be obviated by some system of ventilation, he would take steps to that end. In reply, Lord Stanley stated that he feared ventilation of the inspection chambers was impracticable, as local authorities were not likely to consent to ventilating pillars being fixed in the footways, and the owners of private houses would not allow him to carry pipes up the walls. Ventilating covers could not be adopted, because they would not keep the cables free from mud and water. He proposed to lay down certain precautions to be observed by the General Post Office staff when opening manholes in which the presence of gas is suspected, but he did not think that, so far as the facts were known to him, any precautions taken by the staff would have prevented the recent explosion in Regent-street.

**Open-Air Telephony.**—America is admittedly progressive in matters telephonic, and the experience gained with the street-corner station shows that innovation to have amply justified itself. In all the cities and towns these stations are located at the corners of likely streets, and are stated to form a highly remunerative part of the business, as much as £50 per month having been collected from a single box. Besides this, they furnish an excellent advertisement, and the maintenance costs are light. The station consists simply of an ordinary private installation placed in a box and supported on a hollow iron post, through which the lines are led. No special wiring is needed. The Bell companies are especially enterprising in the matter of these boxes, which have been found of great utility for communicating with the fire brigade, hospitals, and the police. The boxes are keyless, and open on the handle being turned. There is a device on the gravity principle for payment, and the user, having called up the exchange and ascertained whether the desired connection can be had, deposits a coin in the slot according to the length of service required. It might appear as though the traffic would render it somewhat difficult to hear with an arrangement of this kind, but evidently our Transatlantic friends are not to be disturbed by such considerations. Still more surprising, these boxes, though easily opened, do not appear to have suffered from juvenile curiosity. This may be accounted for by the fact that

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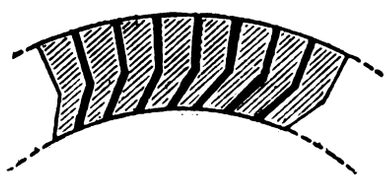
they are usually located in much-frequented places. These stations have the advantage over the public call offices in vogue here that they are accessible at any hour.

**Post Office Employes.**—The terms of the scheme propounded by the Postmaster-General for improving the conditions of service of certain classes of Post Office employés have been announced. It will be remembered that Lord Stanley was unable to accept the recommendations of the Bradford Committee, as these went beyond the terms of the reference. The leading feature of the scheme is the concession to all male telegraphists and sorting clerks aged 25 and over of an increase of 3s. a week in London and 2s. 6d. in the provinces, such increase to cease when the recipient reaches the maximum of his scale, the maximum itself remaining practically as at present. The maximum of the class of senior telegraphists in London, heretofore £160 to £190, is changed to £170 to £200; but no change is made in the corresponding class in he provinces, known as "clerks." The position and emoluments of the female staff both in London and the provinces are left entirely untouched by the new scheme. Male and female "learners" of over two years' service are given increases of pay averaging about 4s. a week, pending the elaboration of a scheme for improving the position of the class. Postmen both in London and the provinces are given small increases in pay and some other concessions. Lord Stanley's scheme was subsequently issued as a parliamentary paper, with an explanatory memorandum by his lordship. From this it appears that the female employees are not entirely ignored, as in London and the larger provincial towns their starting pay is to be increased by 1s. a week. The scheme is estimated to entail an increased expenditure of £224,400 for 1905-6, while in subsequent years the figure is expected to average about £372,300.

**Interlocking Commutator Bar.**—A new design of motor has recently been introduced in the States by Mr. James Burke, of Erie, Pa. A special feature is the interlocking commutator bar (shown in the accompanying illustration), of which a description appears in the *Electrical World* of New York. This is claimed to be the only construction which absolutely locks each bar to the bar adjacent to it throughout the length of the commutator, resulting in the perfection of commutator building and the prevention of irregular surface on the commutator, due to high and low bars and high or low mica. Such a construction is of great importance in variable-speed motors, where



the maximum speeds are often extremely high. Commutator troubles resulting in sparking at the brushes are not absent from ordinary motors, but with the usual motor construction they are accentuated when it comes to the extremely high commutator surface speeds of variable-speed motors. This motor is built for a speed variation of anything desired up to 4 to 1 as standard machines, and up to 6 to 1 as special machines. The entire speed change in all instances is produced by variation of the shunt field of the motors. This is accomplished by means of a drum controller, which also has the steps for reversing the motor, and which gives, when desired, the entire speed range in both directions.

**Over the Bridges.**—The voting on Mr. Whitmore's motion to omit the Embankment clause from the London County Council's Tramway Bill produced a result somewhat uncommon at St. Stephen's, a tie division occurring. Mr. Whitmore's arguments were pretty much what might have been expected; indeed, the subject has been debated so much in various quarters that little scope for novelty remains. He contended that better means of communication would be provided by the pending underground scheme, that æsthetic considerations should not be overlooked, and that it would, at any rate, be premature to sanction the proposal before the London Traffic Commission had rendered its report. Sir F. Banbury, in seconding, expressed the opinion that there was no need for an Embankment tramway, and little or no demand for one. Mr. Causton was ready with statistics in favour of the Bill. He stated that on Friday last, between 4.15 and 8 15 p.m., 930 persons took omnibuses over Blackfriars Bridge to join the trams, and that in the same time two cars left the terminus each minute, carrying 60 passengers apiece. That meant that 30,000 persons used the cars in four hours, and nearly the whole of them would be benefited if the tramway was extended over the bridge. It was no use waiting until the Royal Commission on London Traffic had reported, as that simply meant hanging the matter up indefinitely. He would like to see the Embankment made more useful. All the corporations south of the Thames, save Bermondsey, had petitioned Parliament in favour of the Bill. Mr. John Burns advocated the scheme on the ground that it would not only be a great convenience to the public, but would assist the distribution of traffic. He did not think motor 'buses would solve the problem, as they were larger, dirtier, and dearer than trams. After a few further speeches a division was taken, when it was seen that the efforts of the Bill's supporters had not been in vain, the figures being 171 each way. The Speaker gave his casting vote in favour of the "Noes," the effect of which is that the matter will go before a Select Committee preparatory to a final debate on the "floor of the House." Whatever one's opinion on this vexed question may be, it is as well that it should undergo detailed investigation in committee, as will now be the case.

**Electrolytic Deposition.**—An abstract of an article by Messrs. A. Fischer and R. J. Boddaert upon the electrolytic deposition of the more important metals from moving solutions appears in the *Journal* of the Chemical Society. The ordinary electrolytic methods of estimation of several metals are compared experimentally with the methods using rapidly rotating electrodes, in order to discover how far the estimation can be shortened without sacrifice of accuracy. Except where otherwise noted, a matt platinum dish was used as cathode, and a disc of platinum making up to 800 revolutions per minute as anode. The best conditions observed are as follows—Nickel: Cold saturated solution of ammonium oxalate, 6 to 7 volts, 8 amperes. Time for complete precipitation, 40 minutes, temperature 20deg. to 60deg. Zinc: Good results are obtained with a solution containing sodium acetate and acetic acid, but the most satisfactory deposit was obtained from a strongly alkaline solution containing a little potassium cyanide. Five amperes and 5 to 5 4 volts were used, temperature 95deg., time required 20 minutes. Copper: Good results are obtained with any of the usual solutions; with a current of 5 amperes and working at 95deg., the precipitation is complete in from 10 to 30 minutes, according to the quantity of metal present. It is advisable to add ammonia when most of the copper is deposited and stop the current when the blue colour has disappeared. Bismuth: The metal is always deposited in a spongy condition, and trustworthy results cannot be obtained. Cadmium: Fairly good results were obtained by using a solution acidified with sulphuric

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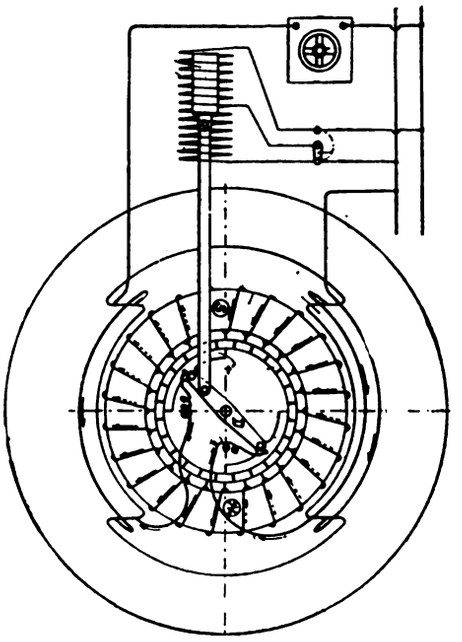
acid; with 5 amperes, 15 to 16 volts, and a temperature of 95deg., the metal is deposited in 10 to 15 minutes, only the last part of it being spongy. Lead: The deposition of lead at the anode in the form of the peroxide is complete in 15 minutes at 95deg., using 10 amperes and 3·5 volts. The precipitation is perfect. Silver: This metal is deposited from the solution in potassium cyanide with a current of 2 amperes and 4·5 volts at 95deg. in 10 to 15 minutes. The results are about 0·2 per cent. low. Mercury is deposited from a solution in nitric acid; the temperature must not be allowed to rise above 45deg., otherwise mercury is volatilised. Using 4 amperes and 5·4 to 6 volts, the deposition is complete in 15 to 20 minutes. Antimony: The metal was used in the form of thioantimonate, polysulphides being removed by adding potassium cyanide. The results were, however, always low, especially with quinquevalent metal, probably owing to some of the antimony going to the anode in the form of a complex anion. Tin: The results were similar to those obtained with antimony, probably for the same reason. In conclusion, the construction of a stand which permits the anode to be rotated and which has suitable electrical connections is described.

**Cantor Lectures.**—Mr. H. L. Webb delivered the last of his series of Cantor lectures at the Society of Arts on Monday last. He commenced by hinting that this lecture, unlike previous ones, might contain controversial matter, but that he was in the happy position of being able to say his say without being answered back. The efficiency of the telephone as regards time was discussed, and it was explained that a telegraph message took on an average one hour twenty-five minutes before the cycle of operations was complete, while a telephone cycle took two minutes forty seconds. Long-distance telephony was hardly comparable with telegraphy either as regards time or cost, because a three minutes' conversation was something so vastly different from any ordinary telegraph message; rather long-distance telephony might be compared to or was the rival of the railway. With regard to telephonic rates, the early pioneers started wrongly in taking the telephone as the unit and imposing a flat rate. The lecturer caustically referred to comparisons made by authors and speakers, deeming them very loose as regards accuracy and mostly unwarranted, neither the flat rate nor the telephone as unit, properly considering the various items making up the cost of the service rendered. The proper unit for charge is the message. Of course, the cost of the unit message varies with the prevailing conditions, and especially with area. A variety of methods of charging were mentioned to show that uniformity was still a long way off; thus at one place there was a flat rate pure and simple, at another a flat rate + cost of building line, at another a flat rate + cost of instrument, at another mileage charges, or, again, variations whether the subscriber was in business, or residential, and so on. The message-rate system was introduced as long ago as 1880, and might be said to have found general favour, but, like the flat rate, it had many variants; thus a flat rate + a charge per message, a charge diminishing with length of time of contract, diminishing with extensive usage, and so on. It is probably best to have a minimum rate. The early common action was explained as a co-operative system, and here were introduced a number of slides showing increasing complexity of apparatus due to extending a single station, to a number of exchanges each connected with the other by junction lines. Another condition often overlooked was that in installing a system the future must be considered, and the necessary provision for extension duly arranged. Not only the future but the changes at the present required due provision. Instances of actual work were given—in one case 20,000 changes took place with a net increase of only 5 500 subscribers; in another, 87,500 changes were made for a net increase of 37,000. Other cases were cited, and especially St. Petersburg and Tokio, where originally the installations were not well considered, for changes and future additions and accommodation to would-be subscribers could not be given. This series of lectures concluded with a hearty and well-deserved vote of thanks to the lecturer.

**Alternating-Current Motor.**—A patent has been granted in the United States to Mr. Robert Lundell for an improved alternating-current motor, which is described in the *Electrical Review* of New York. The invention relates particularly to that class of alternating-current motor which is furnished with a commutator and which may be operated from a two-wire circuit. The object of the invention is primarily to construct a motor which may be self-starting with or without load. Other objects are to provide a motor which may be quickly reversed from a distance without undue complication, which will give a great starting torque and a high efficiency, and which will



operate without injurious sparking at the commutator under various loads and speeds. Mr. Lundell's arrangement is based on the two principles that if a laminated field magnet is used in connection with an ordinary series-wound motor, the same may be made to run on a single-phase alternating-current circuit; and that an armature having a commutator can be made to run in an alternating-current field if certain coils in the said armature are short circuited upon themselves, though wholly disconnected from the primary circuit. Rotation of the partly short-circuited armature is effected by the secondary or the induced currents in the short-circuited coils. The motor consists of a field magnet connected with a source of alternating-current supply and an armature having a winding, the coils of which are connected to a commutator. Means are provided for causing two or more adjacent coils of the armature winding to become traversed by currents from a source of supply, while the remaining sections of the other adjacent armature coils are subjected to the effects of local currents which are induced in them by the field magnet.

**Incandescent Lamps.**—The question of a substitute for the expensive platinum connection between the filament and the leading-in wires of incandescent lamps has engaged

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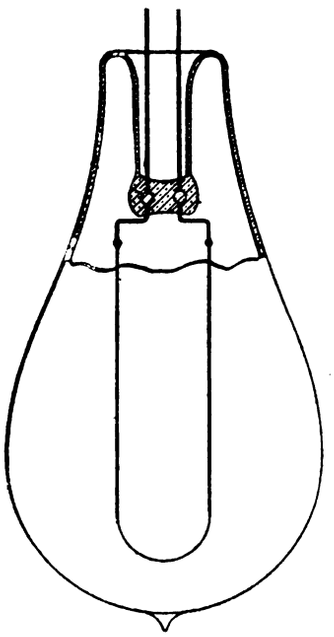
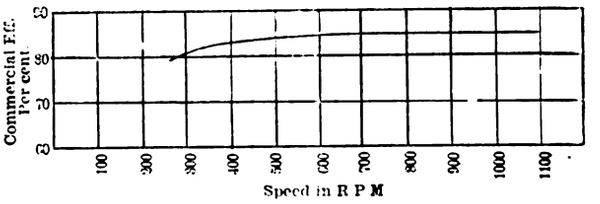
the attention of inventors from time to time, but hitherto without any definite result. It is claimed by Mr. J. H. Guest, of Brooklyn, N Y., that a device, which is described in the *Electrical World*, recently patented by him in the States provides a solution of the problem. From the accompanying illustration, it will be seen that a single conductor is used, one end serving as a filament terminal and the other for connection to the lamp base. As will be noted, that part of the leading-in wire which is sealed in the glass is stamped in such a manner as to introduce a ring into its length, the walls of which are highly attenuated and integral with the straight parts of the conductor. Since copper has about six times the conductivity of platinum, the part of the conductor which constitutes the ring can be made of much smaller cross-section than a platinum wire, and the cross-section of each side of the ring is reduced much more than half that of the wire itself, thus minimising the strain at heating and cooling. It is claimed that owing to the circular form given to the sealed-in portion, any strain due to expansion or contraction is not transferred to the integral straight portions of the conductor on either side. It is stated that some lamps constructed on this principle are still in good condition after burning over

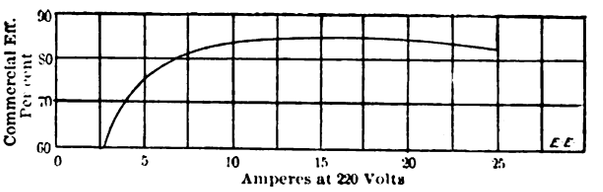


700 hours. Another advantage is claimed for this form of connection with respect to high candle-power lamps, in which two or more pairs of the connections may be easily sealed into the glass. As there are two paths for the current in the ring part of the conductor, and the conductivity is so much greater than that of platinum, the conductor used for a 16-c.p. lamp may be used for a 32-c.p. lamp. The outlay for material being negligible, and the manufacture involving a minimum of manipulation, the inventor's claim that the cost is only a fraction of that attaching to the usual method appears feasible.

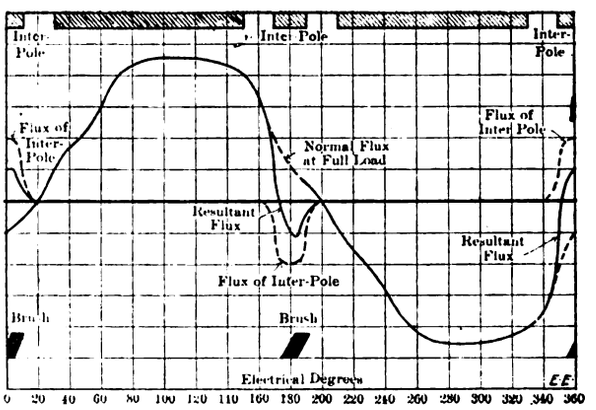
**Variable-Speed Motors.**—The use of auxiliary non-sparking poles to allow of a wide range of speed with shunt-wound motor has recently been referred to in our columns, and the subject is also dealt with in our "Questions and Answers" column this week. We take from the columns of the *Electrical World* of New York the following particulars from a factory at Bayonne, N.J., which has been electrically equipped throughout with motors of this type. It is claimed that variations in speed in the ratio of 1 to 4 are obtained without any sparking at the commutator. In the test of a certain 5-h.p. motor witnessed in the factory by the author of the article, the speed was varied between 275 revolutions and 1,100 revolutions, with a 100 per cent. overload, without any signs of sparking. The motor was then reversed, and the same results obtained without any alterations in the lead of the brushes. The illustrations given here show the efficiency of this motor for this range of speed, and also the efficiency curve for varying loads when run at 750 revolutions. The curve which gives the distribution of magnetic flux around the armature is also interesting, and shows the influence of these non-sparking poles in such a motor. Other curves given in the article show that the




motor had a good speed regulation for varying loads at any of the speeds for which it was designed to run. In order to secure this, however, certain adjustments had to be made in the lead of the brushes. It is evident that, by shifting the brushes from the neutral points, the magnetism in the auxiliary poles may be caused to add to or subtract from the total flux active in producing counter E.M.F.'s between the main brushes, and that thereby the machine may be given the speed characteristics of either a compound or a differential-wound machine. Obviously, with a given setting of the brushes away from the neutral points, the




magnetism introduced by the auxiliary poles will be of relatively a greater value compared with the flux of the main field poles when the latter poles are weak than when they are strong, and that the compound or differential effect will be greater the higher the speed. It is found that, in placing the brushes for a differential effect, it is possible so to adjust the angle from the neutral points that the increase of speed with the weakest main field may




be made just equal to the decrease of speed with the strongest main field, and that, for a certain main field strength, the speed is practically constant for all loads.

**Electrification of Railways.**—Mr. H. W. Wilson's paper before the Liverpool Engineering Society on the 22nd ult. dealt in a comprehensive way with the electrification both of suburban and main line railways. The paper contains a great deal of information which has been published before, but this information is collected together in a most convenient form for comparison. A good deal is

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published about the single-phase systems of traction which are now on trial both in the United States and on the Continent. We notice also that comparative figures of cost for the electrical equipment of 60 miles of inter urban railway are given both for the direct-current system and for alternating current. The figures are those given by Mr. Blanck before the American Institute of Electrical Engineers, and show a saving of £395 per mile from the use of alternating-current motors. This saving is attributable to reduction in the sub-station costs and in the weight of the conductor used for the overhead line. We notice that Mr. Wilson calls attention to a somewhat striking example of the waste of electrical energy consequent upon large numbers of accelerations and retardations as exemplified in the case of the Liverpool Overhead Railway with the new equipment running on that line. "The overhead railway is 6½ miles long, and has 17 stations, averaging 620 yards apart. The time for the complete journey is 20·4 minutes, the average speed all through being 19 miles an hour. A stop of 11 seconds is allowed for at each station. Diagrams which have been published of trial runs on this line show that with an acceleration of about 4ft. per second per second, only 21 per cent. of the energy supplied is usefully employed in driving the trains, 50 per cent. of the energy supplied is wasted during the period of braking; about 11 per cent. is lost in the motor, and 18 per cent. in starting resistances and other minor losses. This is a somewhat striking result, and is due to no defect in the apparatus employed, but simply on account of the special conditions which have to be met. It shows also that the overall efficiency of the electrification of short-distance lines, where large accelerations and retardations are necessary, is not so great as might be anticipated." In this comparison we think the author is distinctly at fault in assuming that because 50 per cent. of the energy supplied is wasted in braking, that this 50 per cent. is not useful energy. The figures show that 71 per cent. of the energy supplied is used for accelerating and driving the trains, and the fact that a large proportion of this energy is afterwards absorbed by the brakes is due to the character of the service, and not to the fact that this service is electrical. We are inclined, on the figures given before us, to put the overall efficiency of the line at 71 per cent. The conclusions arrived at by the author are as follows: firstly, it is exceedingly desirable that if, and when, the electrification of lines other than short local lines, is decided upon, the various railway companies should agree as to the main principles which they decide to follow; secondly, methods of electrification which have been adopted up to the present for short local lines are quite unsuitable for main-line railways on the score of capital cost alone, apart altogether from the vital technical objections which could be raised; thirdly, the Board of Trade requirements as to the maximum voltage to be employed, and also a number of other points, required to be modified; and, fourthly, the necessity for the use of overhead conductors requires to be faced.

**Association of Municipal Corporations.**—A large gathering assembled at the Guildhall on Saturday, when the annual meeting of this association was held. The preliminary proceedings included the re-election of Sir Albert K. Rollit and Sir James Woodhouse as president and vice-president respectively. In moving the adoption of the report for the past year, which was carried unanimously, the president stated that their membership continued to increase, while the accounts showed a balance on the right side. Then Sir Albert plunged straight into the question of municipal trading. Their opponents were constantly repeating the cry of "Debt! Debt! Debt!" and seldom troubled to allude to the assets. These latter included not only actual profits in many cases, but an improvement in the health of the community. Profit-making, he reminded his audience, was not the primary purpose of a municipality, though, on the whole, they could show excellent results in this respect. It was not surprising, however, if young concerns, such as electric lighting undertakings, failed to show a large profit at first. The critics charged them with making inadequate allowance for reserve fund, renewals, repairs, depreciation, obsolescence, etc., which tempted him to recall Sir Edward Boyle Roche's "bull": "Why should we do so much for posterity, which has done so little for us?" We concur in the remark with which Sir Albert concluded this phase of the subject, that the equitable adjustment of such charges between the present generation and posterity provides a field for judicious statesmanship. Other points made by the president were that additional functions, such as education, had been imposed upon local authorities, while their power of raising the necessary funds was restricted by the practice of the Local Government Board in denying them fair terms for the repayment of loans. In this respect he thought the banks created under the Savings Banks Act might be a useful source of supply, besides which the fact of the money being used for municipal works would cause the ratepayer investor to take a closer interest in such affairs. He derided Government auditors as a panacea for the extravagance alleged against municipalities, but would welcome the appointment of professional auditors, as recommended by the Royal Commission on Municipal Trading, whose report had been ignored by the Government. One thing he hoped English municipalities would never descend to was subservience to trusts and "rings," such as was the case with some of the American corporations. The adoption of the report having been briefly seconded by Sir F. Powell, M P., it was agreed to unanimously. The meeting then addressed itself to the various resolutions on the agenda, which dealt with "police pensions," "elementary education," "telephones," and "trust investments." In connection with the last but one, the following resolution was proposed by "A Representative from Newport (Mon.)": "That the attention of the council be drawn to the proposed purchase of the National Telephone Company's undertaking by the Government, with a view to taking all necessary steps to safeguard the interest of municipalities in the matter." The mover intimated that the wayleaves payable to municipalities, the matter of inter-communication, and the reduction of tariffs were important matters for consideration. Alderman Southern, of Manchester, considered that the resolution should go a great deal further. Some active steps should be taken to secure to corporations the option of undertaking the local telephone service. Glasgow had demonstrated how advantageously this could be conducted by the municipality. He advocated prompt representations to Parliament before the agreement between the Government and the company came into operation "automatically." The subject, he knew, was to be considered by a Select Committee, but evidently Alderman Southern has no great confidence in such institutions. Besides this, he informed the audience that the Government's tenure of office was precarious, a General Election might intervene between now and Aug. 31, the date appointed for the agreement to take effect, and then, he implied, there would be little opportunity for the municipalities to ventilate their case. He thought they should at least take steps to present their views before the Select Committee. The original resolution was then submitted, and declared carried, when somebody discovered that Alderman Southern's remarks were not precisely equivalent to seconding it. However, the Mayor of Cardiff came to the rescue by formally seconding the resolution, which was then confirmed.

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## ARMATURE WINDINGS OF THE CLOSED-CIRCUIT TYPE.

BY WM. CRAMP.

*(Continued from page 439.)*

**Law of Double Winding Singly Re-entrant.**

A double winding which is to be singly re-entrant should retain a creep = 4, and yet have an odd number-pitch.

Such a winding is shown in Fig. 22. The number-pitch chosen is 5, while the winding naturally still obeys the formula:

$$w = p\,y \pm 2\,m,$$

$y$ being now an odd number.

The case is worked out for a four-pole machine so that $w = 24$.

It is quite similar to the armature in Fig. 13, and has similar disadvantages, chiefly arising from the fact that the two windings are not independent, and that, therefore, a fault in one means a fault in the other.

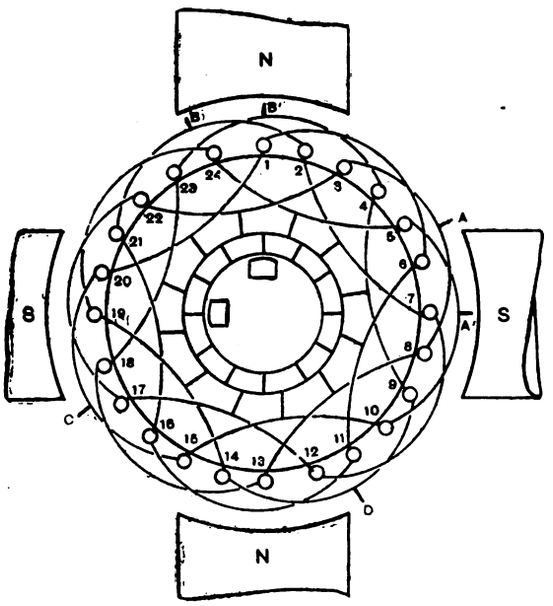


FIG. 22.

We see, then, that if in the general formula we write $m = 2$, while $y$ is an odd number, the winding remains duplex, but the re-entrancy is not double. This suggests that while the number of windings is settled by $m$, the re-entrancy is settled by the relationship between $y$ and $m$. As we look further into it we see that this is indeed the case; for if a winding be, let us say, triplex triply re-entrant, it must be possible to write its formula in either of two ways:

1. In the ordinary form—

$$w = p\,y \pm 2\,m.$$

2. As a multiple of the ordinary form

$$w = p \times 3\,\mathrm{K} \pm 2 \times 3\,n,$$

where K and $2\,n$ are the number-pitch and "creep" respectively of each of the simplex windings of which the triple winding is composed.

If we could not have written the formula in the second way, we should be forced to the conclusion that, although it was triple as given by its "creep," it was not triply re-entrant, because it could not be separated into three simplex windings; and this an example or two soon proves to be correct.

Thus the re-entrancy is clearly given by the highest common factor of $m$ and $y$, and it is useful to bear in mind the difference between two-circuit and multiple-circuit armatures in this respect; for the latter we found the re-entrancy was fixed by the highest common factor of $m$ and $\frac{w}{2}$.

Similarly it is quite possible to have an armature winding *quadruple* yet *doubly* re-entrant. In this case we know that $m$ will be 4, and the H.C.F. of $m$ and $y$ will be 2; such a winding might have a number-pitch of 22, and if it were for a six-pole machine we should have a choice of inductors as follows:

$$w = 6 \times 22 + 2 \times 4 = 140, \text{ or}$$

$$w = 6 \times 22 - 2 \times 4 = 124.$$

Either of these numbers of conductors might be used, according to which was the more suited to the nearest standard armature and to the electromotive force equation.

**Uses of Armatures with Re-entrancy not equal to $m$.**

The disadvantages of windings whose re-entrancy is not equal to $m$ has been referred to, and the question may naturally be asked, why are they then used? The answer is that the disadvantages are comparatively small, while with these armatures it is possible to make use of certain numbers of inductors otherwise impossible.

Take the case just quoted—viz., a quadruple winding doubly re-entrant for which we require either 140 or 124 inductors. The nearest number of inductors that we could possibly use, if the re-entrancy were quadruple (supposing the connections to be the same at both ends of the armature), is either 128 or 160, neither of which might suit the standard number of slots of the particular size of armature.

**Distinctive Uses of Two-Circuit and Multiple-Circuit Windings.**

Before leaving the subject of two-circuit drum windings, it may be well to refer to the question of when they should be used in preference to multiple-circuit.

This is a point which must be left very much to the discretion of the individual designer. Multipolar machines are at present becoming more and more the rule, as also are high voltages. In consequence, one would expect to see more and more of the two-circuit armature, and to a certain extent this anticipation is justified. The two-circuit armature is, on the whole, less liable to parasitic currents, and has the further advantages, in the case of small currents, of never actually needing more than two sets of brushes, and of requiring fewer inductors of larger section than the corresponding multiple-circuit machine.

On medium voltages it is a matter of individual taste: for low voltages the multiple-circuit armature has many obvious advantages, while for voltages of 500 and upwards the two-circuit armature is usually much easier to arrange.

Before giving a summary of the laws which govern two-circuit windings, we shall show how the same system may be applied to armatures of the ring type.

### TWO-CIRCUIT RING WINDINGS.

By a reversal of that process used in Part I. for evolving from the multiple-circuit ring winding the corresponding multiple-circuit drum, we may now from these two-circuit drums evolve two methods of arranging corresponding two-circuit rings.

**Long-Connection Form.**

It will be remembered that the method employed in the former case was that of removing the inner wires from the ring and placing them upon the outside of the armature. Similarly, now, we may

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remove every other inductor from the outside of a two-circuit drum (say, Fig. 14), and let it form a return connection through the ring. We shall in this way obtain a ring armature of nine spirals (Fig. 23), in which the end of spiral No. 1 passes through the armature and is connected to the beginning of spiral No. 6, which in the old winding was inductor No. 11. The next connection joins the end of spiral No. 6 to the beginning of spiral No. 3, and so on round the armature until the winding naturally closes. The number of commutator sections, the position of the brushes, and the necessary number of these are all exactly as in Fig. 14. It will be noticed that the number-pitch is 5, *the same as for the corresponding drum*, and the number of spirals is odd. This type of winding is known as a long-connection series or two-circuit ring. It was, we believe, invented by Prof. Perry.

**Formula for Long-Connection Two-Circuit Ring.**

The formula which fixes the number of spirals for such a winding will obviously be half the number

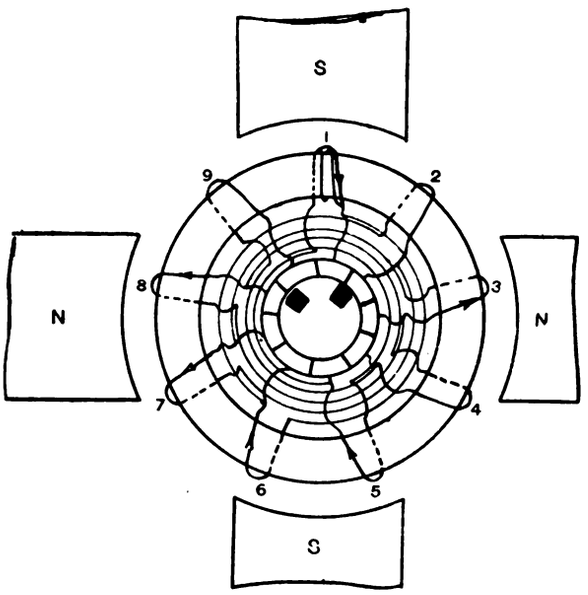


FIG. 23.

of inductors of the corresponding drum. Thus, instead of

$$w = p\,y \pm 2\,m,$$

we have

$$s = \tfrac{1}{2}\,(p\,y \pm 2\,m),$$

or since $y$ is not always divisible by 2, and, as has been shown, remains the same for the ring as for the drum, we may write

$$s = \frac{p}{2}\,y \pm m,$$

where $s$ = number of spirals, and $y$, $p$, and $m$ have meanings as before.

This formula tells us that if $\frac{p}{2}$ is an even number and $m = 1$, there will be an odd number of spirals on the armature; so Fig. 23, which is for a four-pole field, has nine spirals.

**Multiple Two-Circuit Rings.**

In the same way we may develop from Figs. 21 and 22 a double-wound two-circuit ring, either singly or doubly re-entrant, according to the corresponding drum. This is a useful exercise in interchanging ring and drum windings, but it is not of much practical value, since such armatures are very seldom met with. The simplex form as given in Fig. 23 with some modifications is, however, of considerable practical importance for reasons which we must now investigate,

**Advantages of the "Long-Connection" Two-Circuit Ring.**

In using the word "spiral" for a ring armature of this type, and in reckoning the number-pitch, we must not forget that each spiral, as numbered in Fig. 23, might (and in nearly all cases would) consist of several turns round the core, as shown in that diagram at 1; so that each spiral may really consist of a group, just as in the drum windings we have shown in Fig. 20 and elsewhere that each inductor may consist of a group. It will be noticed in Fig. 20 that when we have two groups on a drum armature, forming a coil, every turn of that coil has to proceed along both ends of the armature for some considerable distance. This necessitates a great deal of end room, besides not infrequently causing the close approximation of end connections between which exists a large difference of potential. Now, in the ring winding of Fig. 23 additional turns in series and forming a spiral (so long as the number of commutator sections is not increased) do not mean any additional connections passing from pole to pole at the end of the armature. Hence the winding would seem primarily suited to high voltages; and this is more marked if we consider the potential differences existing between neighbouring inductors in the cases of the drum and of the ring respectively.

Take as an instance of the former Fig. 14, and remember that each inductor adds a definite electromotive force to the circuit in which it lies. Upon counting up we find that between two neighbouring inductors (such as 17 and 18) we have the full potential difference which exists between the brushes. This means that neighbouring inductors must be very carefully insulated from one another, the more so since, as we remember, two-circuit windings are specially used for high-voltage machines. Thus between neighbouring inductors on a tramway generator we might easily have a potential difference of 600 volts.

Turning now to the ring armature of Fig. 23, we notice that the maximum potential difference which can possibly exist between neighbouring spirals, or groups of spirals (such, for instance, as 1 and 2), is that due to three groups—viz., 1, 6, and 2.

It is not necessary ever, upon a two-circuit long-connection ring winding, to have the maximum potential difference which exists at the brushes, as a strain upon the insulation between neighbouring spirals. Thus this form of ring winding is peculiarly suited to high-voltage work, and has been developed for this purpose of recent years. It is obviously both easier to insulate and less crowded at the ends than the corresponding drum. We must bear in mind, however (*a*) that all the end connections have to pass through the armature; (*b*) that a ring armature is never so good mechanically as a drum; and (*c*) that "former" winding is practically out of the question.

Since the chief advantage of these ring windings lies in the fact that they are easily insulated, they are more often used for high voltages than for heavy currents. This is also natural when we remember that the heavier the current that a given coil carries the more difficult is commutation; and ring armatures are always liable to give more trouble at the commutator on account of the fact that the turns are wrapped closely around an iron core, so that the self-induction per coil is considerable. This is the chief reason, then, why here we do not dwell at any length upon the various possibilities of multiplex two-circuit ring armatures.

*(To be continued.)*

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## A NASCENT PROFESSION.

It was reserved to an American to give the up-to-date definition of engineering as the doing for one dollar of something that any fool could do for two. Central-station engineers, of all men, show forth in their practice the value of this dictum, for the rivalry between stations to show the lowest cost per unit generated is intense. But there is a corollary to this definition which has not been given due importance. It is that the one-dollar engineer must appeal to a larger public than the two-dollar fool in order to pay his way. Profits are relative; cost of existence is not far from being absolute. It is astonishing, therefore, that the subject of advertisement in connection with electricity supply undertakings has been to such a large extent neglected in the past. The recent action of the Croydon Council in establishing a publicity department, and the organisation by the directorates of one or two of the larger power schemes of efficient channels of advertisement, have at last shown us that a new profession is in process of birth.

The previous history of central-station advertising is conspicuous either by the absence or crudeness of method. Occasional electrical exhibitions were held, at which rival makers proceeded to revolve rival electromotors at rival stands, and to keep lists of prices and virtues of their wares, which they refused to anybody who could not show a trade card. At other periods the area of supply would be spasmodically deluged with more or less ineffectual literature, resulting possibly in a highly technical controversy in the local Press between the gas manager and the electrical engineer. Or what is known in religious circles as house-to-house visitation was indulged in by the corporation canvasser, sometimes with the lamentable result that an application form was filled in, and a supply promised, in a street where no cables were laid. To a great extent, efforts totally devoid of any system or economical management have been the rule, and the era of true commercial methods of selling what should certainly be regarded as a marketable commodity appears to have only just dawned.

It is a bold statement, but a well-authenticated fact, that among the general public judicious advertising makes as much, if not more, for success as sterling value of goods; it therefore follows that suppliers of electricity must not be content to rest only on the reputation for cheapness and steadiness that their commodity has acquired among their consumers, but also must take the proper steps to place before the remainder of the townsfolk the points which have formed the foundation of good repute. The adventitious aid which novelty first gave to the electric light has died away; electricity is as commonplace as gas. It therefore behoves the electrical engineer to push his wares in the same way that other business houses capture the market.

Why, for example, should not the borough electrical engineer, or one of his assistants, his publicity manager, keep shop? The Gas Light and Coke Company of London, for instance, have long ago realised the value of this method. A customer has not to wend his way to the gasworks, or to enter a building like a lawyer's office in order to pay his bill. He (or she, for it is often the lady of the house who looks after the gas) pushes open the glass door of what appears to be an ironmongery shop and finds within a perfectly affable and non-technical gentleman who will sell her a thousand cubic feet of gas or a cooking range with the same breeziness that a grocer's assistant pats a pound of butter into shape. Comparing this with the vaguely mysterious air of the electric works office, with its sliding scale of tariffs and the utter inability of the expert in charge to tell the lady what she will have to pay at the end of a quarter if she is careful, one cannot wonder that gas is often regarded as a commercial success and electricity as a scientific experiment. The only trouble is really that the business electric light engineer is a *rara avis*.

The principle may be applied further. There has not yet been seen, so far as we are aware, an advertisement in the general Press emanating from an electric supply company of anything like the eye-catching quality of those produced by the ordinary maker of jams or pickles. Yet it is an admitted first principle in business that persistent pushing of one's wares before the public eye is the surest way of getting business. Why should electricity be out of the running? It cannot afford to stand on its dignity. The method of house-to-house canvassing is good and effective so long as the advertising and executive departments work together. This is really the crux of the matter. Hitherto the interrelation of the business and engineering sides of the work has not been sufficiently recognised. The running of the plant has been entrusted to the trained engineer; the exertion of influence among the consumers has been left to non-technical men. The advance of the future will be made by men having three prime qualities: they must be engineers to the finger-tips, they must have an instinct for business, and they must be acquainted with all the ruses of modern advertisement in order that they may display their wares without obvious puffing. Their duties should be specialised into a department. They should direct the introduction of electricity supply to whomsoever it may concern; originate means to this end; supervise advertisements, canvassing, article and letter writing; exhibitions; meet business men on their own grounds; exert private influence where this is possible; and generally take the capabilities of the supply system on the one hand and the manifold needs of the consumers on the other, and mould them one to another. To men having a combination of the requisite qualities a new and lucrative profession is now opening out, for the reason that men of genius for this particular work are hard to get.

## DUNDEE POWER SUPPLY.

The Tramway Committee of the Dundee Corporation have now under consideration a proposed new system of charging for power supply which has been devised by Mr. Harry Richardson, the city electrical and tramways engineer. This he terms the Equitable system of charging for electrical energy. Through the courtesy of Mr. Richardson we reproduce herewith the explanation of the system, which he laid before the Tramway Committee recently. In his report on the subject, he draws attention to the fact that electricity supply stations have been built up to the present mostly for the supply of electric light. Owing to developments in the demand for power, the correct way to view the matter is to design a station and the distributing system for the purpose of supplying power, and then add such lighting as may be required. In this way the cost of power would become exceedingly low. Dealing with the maximum demand system, Mr. Richardson explains that as usually adopted it was not equitable, because it assumed that the standing charges for any consumer's maximum demand should be at the same rate per kilowatt independent of the magnitude of that demand. This point is dealt with in the explanation we print herewith. As regards the determination of the maximum demand, two optional courses are devised—either to take the rated power of the consumer's motors as his maximum demand, or to have a special maximum demand indicator fixed. Mr. Richardson suggests that the choice between these two courses should be left to the consumer. Then if the consumer overworks his motors, it would be advantageous to him to select the first alternative. On the other hand, if the motors are installed with an ample margin, the consumer would benefit from a maximum demand indicator. It seems to us that it would be more fair all round to have a maximum demand indicator installed in every power installation. The minimum price proposed for power supply in Dundee is 2½d. per unit, with reductions worked out in accordance with the formulæ we give below. In order to avoid any misunderstanding, the results have been tabulated by Mr. Richardson for a number of installations of different size. These will enable the consumer to see what his charge per unit would be for the given maximum demand and current consumption. The Tramways Committee have had this report before them, and have had it explained by their engineer, but the full consideration has been deferred until the members have had time to digest the information given. Mr. Richardson's explanation reads as follows.

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## The Equitable System of Charging for Electric Energy.

The cost of generating electricity is made up of various items, of which the following are the most important: coal, water, stores, wages, repairs, management, rates, interest on capital, insurance depreciation, and sinking fund. It is obvious that some of these charges are nearly proportional to the amount of electricity generated, while others are to a great extent independent of that amount. These latter are called *standing* charges, while the former are *running* charges. *Standing charges* may be defined as the cost of being ready to run; *running charges* as the additional expense of producing the output. Going more into detail, the standing charges consist of: (1) all the capital charges (interest, depreciation, sinking fund, etc.); (2) rates; (3) insurance; (4) salaries of engineer and engineering and clerical staffs and establishment charges; (5) part of wages of generating staff; (6) coal necessary to keep boilers and pipes hot. The running charges consist of: (1) coal burnt to supply steam to engines (as distinguished from that required to make good radiation losses); (2) water; (3) oil, waste, and stores; (4) repairs; (5) additional wages for men over and above these required for standing-by plant in readiness to run it; (6) distribution losses, due to the resistance and leakage in cable.

For the financial year ending April 30, 1903, the total number of units sold was 2,609,718.

| | | |
|---|---|---|
| The standing charges were: | £16,400, | or 1·5d. per unit. |
| The running charges were: | 7,800 ,, | ·717d. ,, |
| | £24,200 ,, | 2·217d. ,, |

The capacity of the station is 3,000 kw., and since there are 8,760 hours per annum, the plant if run continuously fully loaded can produce 3,000 × 8,760 units = 26,280,000. The cost of doing this would be:

| | | |
|---|---|---|
| Standing charges: | £17,000, | or ·155d. per unit. |
| Running charges: | 78,000 ,, | ·71d. ,, |
| | £95,000 ,, | ·865d. ,, |

Thus, the total cost of generating electricity depends in a marked degree upon the proportion which the actual output bears to the total possible output of the plant. Put in another way: If the plant were working all the year round at its full capacity, each kilowatt of the plant would produce 8,760 units. In the year considered, each kilowatt actually produced 870 units.

The fraction $\frac{870}{8,760}$, or ·1, is called the *load factor*. It is frequently expressed as a percentage, as, for instance, in the above case, 10 per cent. In order to generate cheaply, then, it is necessary that the load should be as uniform as possible, and in order to keep it uniform it is needful to attract customers who have a "long-hour" load. Under the present tariff such customers are discouraged, an excessive profit being made off them, while the customers who occasionally make a large demand for a short time, but have a small total consumption (conditions which demand a considerable plant at the station generally standing idle), may actually be supplied at a loss to the corporation.

The use electricity is put to has nothing to do with its cost of generation, and it is quite illogical to charge different rates for electricity supply for lighting and power. The practice may, however, be justified on commercial grounds as a matter of policy, on account of the fact that motors generally give a long-hour load. But this is by no means always the case, and the method of charging is crude. The object of a tariff should be to make a uniform profit off each consumer. A change of tariff will not lead a consumer to constantly watch his meter and calculate the cheapest way of lighting his lamps. He will use the current as long as it is convenient for him to do so, and no longer. But the introduction of a sliding scale will attract new consumers whom it would not pay to use electricity under present rates. This is the argument on which is based the maximum demand system of charging. Underlying the whole argument is the assumption that the standing charges debited to each consumer are exactly proportional to his maximum demand. As a direct result the cost per unit to a consumer depends only on his "load factor," and not on the total quantity consumed.

For two consumers having the same load factor, but one consuming 10 units per quarter and the other 500, the cost per unit would be the same. Now, nothing is more certain than that the supply station would find it more economical to supply one large consumer taking 500 units per quarter than 50 small consumers all having the same load factor as the large one, taking 10 units each per quarter, and whose maximum demands all took place at the same time (as is practically the case in lighting). In other words, the *standing charges per kilowatt of maximum lamps* tend to decrease as the maximum demand increases. That this is so can easily be seen by the following considerations: the cost of the electricity meter, connecting a consumer to mains, the clerical work involved in reading the meter and sending in accounts, is nearly the same for a consumer having a maximum demand of ½ kw. and one whose maximum demand is 50 kw. Now to charge the latter 100 times as much as the former for the same thing is obviously unfair. But other components of the standing charges per kilowatt tend to decrease with increased maximum demand. Thus the attendance necessary on a 20-kw. plant would suffice for a 200-kw. plant, the capital cost, and therefore the capital charge per kilowatt of

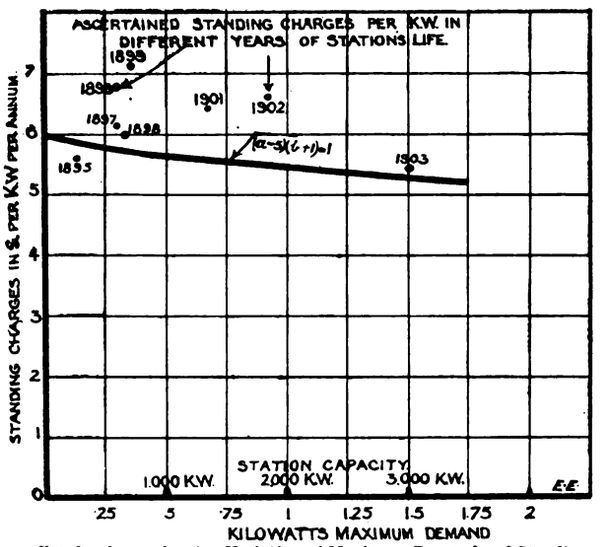


FIG. 1. Curve showing Variation of Maximum Demand and Standing Charges per Kilowatt at Dundee.

engines, dynamos, etc., decreases as their size increases, and the radiating surface of steam-pipes per kilowatt is reduced with increased output in kilowatts. In all the preceding comparisons between a small plant and a large one, the load factors of both have been assumed to be the same for clearness of argument.

The load factor is much more important than the size of the plant in fixing the generating and in consequence the selling costs. Thus a small plant with a good load factor can generate cheaper than a large plant with a poor load factor. But the above considerations indicate that, independently of the load factor, the size of the plant affects the generating costs, and as the plant necessary for each consumer is fixed by his maximum demand, the price charged him should depend in some way on the magnitude of his maximum demand. Mr. Wordingham touched on the relation of the standing charges to the output of the plant as follows: "The various items (of standing charges) enumerated are not actually proportional to the maximum demand in kilowatts. Many of them tend to diminish per kilowatt, as the size of the station increases, but they are all independent of the number of hours the demand is kept up."

*System of Charging — Fundamental Principles.*—Five pounds eight shillings having been found to be the average standing charges per kilowatt maximum demand in Dundee and the average maximum demand per consumer proved to be 1·5 kw., then it may be assumed that the true standing charge for a maximum demand of 1·5 kw. is £5. 8s. per kilowatt. But the standing charge per kilowatt of maximum demand increases with a less and decreases with

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a greater demand. Now, calling $a$ = standing charges per kilowatt in £, and $b$ = maximum demand in kilowatts. Curve 1 assumes the true relation between the cost per kilowatt and maximum demand. Anyway, it fits the equation

$$(a-5)(b+1)=1, \text{ or } a-5=\frac{1}{b+1}, \text{ or } a=5+\frac{1}{b+1} \quad (1)$$

Then again let $c$ = total units consumed per quarter, $d$ = load factor, $e$ = running costs per unit in pence, $x$ = price per unit in pence (profit has not been considered, as it may be added to the formula). Now

$c = 2{,}190 \times d$, there being 2,190 hours per quarter . (2)

definition of $d$ being

$$= \frac{\text{real generation of units per quarter}}{\text{maximum possible generation in units per quarter}}$$

$$d = \frac{c}{2{,}190\,b}$$

or,

$$c = d \times 2{,}190\ b.$$

The standing charges charged to any particular demand would be £$a\,b$. To this must be added the running costs

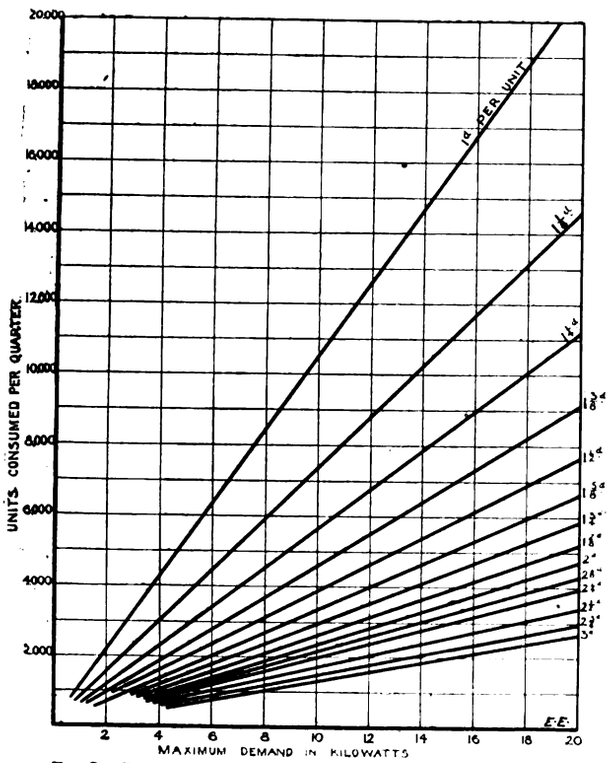


FIG. 2.—Curves connecting Consumption, Maximum Demand, and Price per Unit

per unit to make up the cost (total) of $c$ units (plus profit also). The price of a unit is therefore

$$x = \frac{60\,a\,b}{c} + e,$$

which gives price in pence, giving $c$ its value in equation (2), then

$$x = \frac{60\,a\,b}{2{,}190\,b\,d} + e \quad . \quad . \quad . \quad . \quad . \quad (3)$$

or,

$$\frac{60\,a}{2{,}190\,d} + e.$$

From (1) the value of $a$ may be got for any value of $b$, and then the cost per unit for any maximum demand and load factor may be got at from (3). The curves 2 and 3 accompanying show this applied to many conditions of varying load factors of 2 per cent., 2 5 per cent., 5 per cent., 10 per cent., 15 per cent., 20 per cent., and 50 per cent., and give the price per unit at these factors for any maximum demand from 0 to 100 kw. Taking another line of reasoning from the equation,

$$x = \frac{60\,a\,b}{c} + e.$$

Multiply by $c$, then $c\,x = 60\,a\,b + c\,e$, or $c\,(x-e) = 60\,a\,b$, then

$$c = \frac{60\,a\,b}{x-e.} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Now, by giving $x$ a certain value, an immediate relation is made between $c$ and $b$. For example, fix the price at 2d. per unit, then equation (4) gives

$$c = \frac{60\,a\,b}{2-7} = \frac{60ab}{13}.$$

$a$ is got from (1), so $c$ is easily determined for any value of $b$.

The above explanation and curves as given by Mr. Richardson are worthy of careful study. As the author states, the form of the equation is an equitable one, but the actual constants in the equation have to be varied to suit local conditions. It seems to us that the variation in the standing charge with the maximum demand should be somewhat larger than is given by Mr. Richardson's constants. These have evidently been obtained from average results with small consumers. It needs further experience with a considerable number of large power consumers on the system to ascertain how much the standing charge per kilowatt demanded can be reduced for

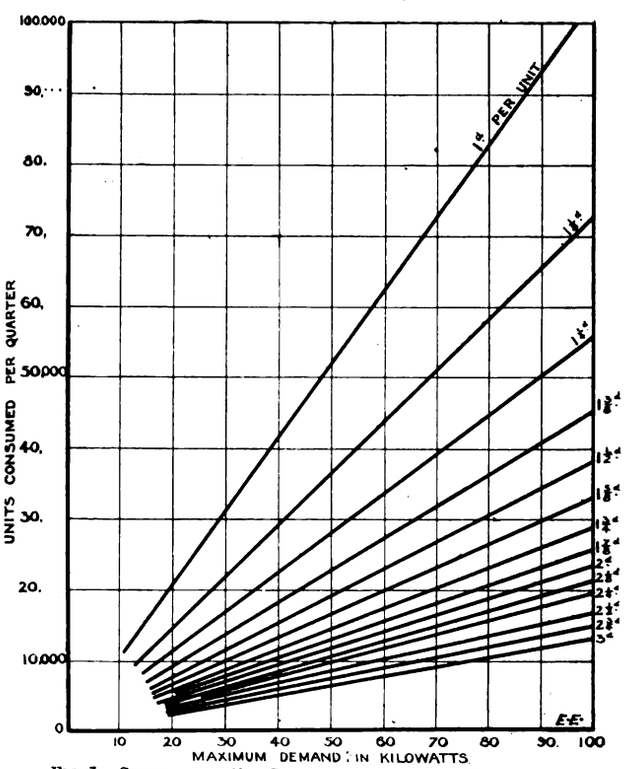


FIG. 3.—Curves connecting Consumption, Maximum Demand, and Price per Unit.

such consumers. Another point which needs to be borne in mind when considering any such scheme is the extreme difficulty of persuading the ordinary consumer of the equity of the maximum demand system of charging, unless he happens to be supplied at a low rate per unit by reason of his long-hour consumption. We wish Mr. Richardson every success in his attempt to reduce the price of electrical energy to power consumers in Dundee.

## APPLICATION OF ELECTRICITY TO INDUSTRIAL PURPOSES.*

BY J. F. C. SNELL, M.I.C.E., MEMBER.

(*Concluded from page 448.*)

### 2. THE COMPARATIVE ADVANTAGES OF DIRECT CURRENT AND ALTERNATING POLYPHASE CURRENTS.

As to the merits of direct current and alternating polyphase currents. The advantages of the direct current are variation of speed over a considerable range, without

* Paper read before the North-East Coast Institute of Engineers and Shipbuilders on Feb. 24.

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undue loss of economy and with utmost simplicity; and in favour of the three-phase motor, the utmost simplicity of mechanical and electrical construction, the total enclosure of the motor, and absence of commutator and of any wearing parts other than the bearings, which are themselves negligible. The costs and weights of motors are in favour of the three-phase type. The starting and stopping are quite as easily and as economically carried out, and the only objection which one can offer to the three-phase motor is its less easy variation in speed when compared with its direct-current competitor. It is true that the pressure of 220 volts direct current is reputed to be safer to persons than 220 volts alternating, but as fatalities have occurred in both cases, and equally, as very many people, like the author, for instance, have had dozens of shock from both systems without harmful results, there is little to be said in favour of either one or the other in this respect. On the whole, therefore, the author is of opinion that the simple three-phase induction motor is much more likely to gain favour than even its quite simple direct-current rival. In point of efficiency, the direct-current motor has the advantage at present, and is probably, from physical reasons, likely to continue to have the advantage. The efficiencies of various motors of both classes are generally as given in the following table:

EFFICIENCIES OF ELECTRICAL MOTORS.

| Three-phase induction motor—220 v. | | | | Direct-current motor—220 v. | | |
|---|---|---|---|---|---|---|
| H P. of motor. | Speed. | Weight Lbs. | Efficiency Per cent. | High speed. | Weight Lbs. | Efficiency Per cent. |
| ¼ | 1,375 | 45 | 67 | 1,600 | 100 | 67 |
| ½ | 1,410 | 80 | 76 | 1,550 | 150 | 74 |
| 1¼ | 1,420 | 100 | 82 | 1,450 | 180 | 78 |
| 2½ | 1,420 | 150 | 83 | 1,320 | 280 | 80 |
| 3½ | 1,425 | 210 | 86 | 1,280 | 365 | 82 |
| 7 | 1,430 | 340 | 86 | 1,250 | 560 | 83 |
| 9 | 1,430 | 520 | 87 | 1,100 | 700 | 84 |
| 11 | 965 | 750 | 86 | 950 | 1,100 | 84 |
| 18 | 965 | 850 | 88 | 850 | 1,320 | 85 |
| 25 | 965 | 1,050 | 89 | 750 | 1,570 | 87 |
| 30 | 965 | 1,300 | 89 | 720 | 2,740 | 89 |
| 45 | 720 | 1,700 | 90 | 640 | 3,240 | 91 |

Particular works must, of course, require particular application, and as the author is able to speak quite disinterestedly, he strongly advises manufacturers to pay the small additional expense incurred by the fees of a recognised electrical expert to advise them upon the application of electricity to their machines. It is lamentable to find (as the author has several times found) that many of the economies which ought to be rightly obtained by the application of electricity, and by the initial expense which it necessarily incurs, are largely discounted by the absurd methods by which motors are applied to their work. In some cases lines of counter-shafting are retained, so as to group a number of sometimes quite large machines driven by one large motor, running often at less than half load, or, in other cases, fans originally running at 200 revolutions per minute are driven electrically at a much increased speed, and the necessarily increased power which the motors take up is a source of amazement to the manufacturer, who sometimes appears ignorant of the fact that as the speed increases, so the power required cubes. These are some of the practical mistakes which a professional consultant can and ought to be able to prevent. The adverse criticism which occasionally falls upon electrical driving, in the author's opinion, creates a real demand for experts of this class at the present juncture, when the tendency is so much towards the adoption of electricity as the driving agent.

The judicious grouping of motors or application of single motors to special tools, and the relation of their initial capital cost to the general working expenses after their installation, is in many works a complicated problem, upon which it is submitted only one who has made a special study of such applications is competent to advise. It would be unfair to the general industries of the country if, when called upon to make the necessarily great sacrifices in scrapping their original methods of driving, and substituting a more efficient electrical motor, every care were not taken to adopt at once the most economical method in outlay, and the most efficient in practice afterwards.

### 3. POSITION WITH RESPECT TO THE BOARD OF TRADE AND THE HOME OFFICE.

The regulations which are being imposed upon electrical users are somewhat confusing and complicated to the uninitiated, and the author thinks it will not be without use if he attempts to put concisely the obligations which users are placed under with respect to their employés by the regulations of the Board of Trade, and more particularly by the regulations issued under Section 79 of the Factory and Workshop Act, 1901, by the Home Office. A works skilfully changed by a competent adviser from steam driving to electrical driving would, necessarily, be protected on all these points. At the same time, the author does not wish to frighten manufacturers, and is of opinion that through the regulations being misunderstood many competent business men are chary of taking the step of changing over from one system to the other, believing that so many regulations imply that electricity is but an "infant" which has to be tenderly nursed, whereas in reality it has quite reached its maturity, so far as its application to machine driving is concerned. The regulations which appear to frighten the uninitiated will become as commonplace in the near future as the fencing in of belts or flywheels. There is no question that such regulations are both necessary and advisable.

First, the question of pressure. The limit of voltage which is imposed by the Home Office, and also by the Board of Trade, is 500 volts. That is the pressure of 500 volts between any two conductors, or 250 volts between any conductor and earth. The author is of opinion that 250 volts for engine works and shipyards is a sufficiently high pressure to adopt. It is a matter of common knowledge, especially with direct current, that if there be two conductors with a difference of, say, 250 volts between them, one of them (the negative) in course of time becomes approximately of the same potential as earth, due to dampness particularly, and to an electrical effect known as osmosis; and then, of course, the other becomes charged at a pressure which is 250 volts above the earth potential, and, therefore, a person touching the bare portion of such a conductor would obtain a shock at this pressure Such a shock, except under very special circumstances, is not in itself dangerous, but should there be in a shipyard, for instance, an electrical winch subject to all weathers, and a workman standing on very damp ground were to grasp the naked part of the "live" cable or part of the machine, he would get a very severe shock which might have even fatal results. But if such conductors be run through an iron pipe, or be surrounded by a lead sheathing, which is itself connected at points to water-pipes, or to other efficient earth-plates, it is an absolute impossibility then for any person to obtain a shock of any kind. Now the cost of running cables under these conditions is very little more than running them by other less thorough means, and as they are protected from so rapid a depreciation as will occur if they are open to all kinds of weather, it really is more economical to make a thorough job of this cabling at the time of the installation. The author regrets to say that too little attention is given to this portion of the work, and would urge upon manufacturers the necessity in their own interests of insisting upon good materials and a complete metallic protection of the cables.

Then take another portion which is operated by all classes of workmen—viz, the controlling switch and starting gear of each motor. Now, in the case of direct-current motors this consists of a simple switch containing many contacts, between each of which is a resistance coil, which is in effect the stop-valve of an engine, and permits the motor to start away easily, and without undue shock or stress; or in the case of a three-phase motor, the even simpler starting switch with its complementary auto-transformer, consisting of a two-way switch, on one side of which is connected a simple device for preventing a too big rush of current to the motor when starting from rest—a sort of by-pass valve—and which is put out of action by simply throwing over the switch when the motor has attained approximately its full speed. In both cases the handles of the switches should only be operative, or able to be touched by the workmen. The rest of the work should be screened by an iron shield, which should in turn be

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metallically connected to the iron pipe containing the cables. This is really very simply done by merely making the end of the iron pipe secure to the casing containing the starting switch by an iron nipple. Then, too, as the motor contains the electrical circuit, any part of which may possibly, though very improbably, come into contact with the iron framework, it is necessary that the motor frame should also be connected to earth. If these three points be carefully observed, then it is absolutely impossible for any employé to obtain a shock. Moreover, in case of a fault in a cable, the fuse controlling that motor will blow, on account of the circuit made with the pipe, and, therefore, with "earth," causing a larger current to flow momentarily. The fault is then easily localised, and the machine restarted with a minimum loss of time.

The more care, of course, requires to be taken with respect to the lighting of workshops and offices, and particularly in the case of arc lamps in open yards. The author sees no objection in many cases to the use of overhead conductors, but then, of course, these will always be out of reach, and no harm can accrue from them. Where overhead conductors are used, however, it is advisable to guard against lightning strokes by fixing proper lightning arresters on the main controlling switchboard, so that, in the event of the line being struck, the discharge will pass to earth without breaking down the insulation of any of the machines on circuit at the time. Incandescent lamps should be swung from light gas-barrel or one of the many iron tubes now to be had, which would be in metallic connection with earth.

Some care is required in laying-out the cables for a large works, and a good deal of unnecessary money may be spent when such systems are not systematically and carefully worked out. Cables may be laid either too large, involving an undue capital expenditure, or too small, involving a too large drop in pressure. Subdivision is a very necessary factor, and it pays in large works to have a large switchboard controlling a number of individual circuits, each governing a group of tools. Tests ought to be insisted upon weekly, and the author suggests that a log book be kept, in which the daily readings of the meters will probably be kept, and which should also contain a record of the weekly tests. By this systematic method much annoyance may be spared the consumer, for weaknesses in any of the circuits are detected in time and put right, and consequent loss of time from machines lying idle will be averted. A simple testing arrangement, such as an ohmmeter and portable generator, costing under £20, will suffice, and is so simple in its application that an untrained boy can operate it and make the records necessary.

Alternating currents of the same nominal pressure as direct currents have to be more carefully guarded, for whereas the virtual or mean voltage is, say, 250, the actual maximum voltage is 250 $\sqrt{2}$, or 352 volts; so that a person getting a shock from an alternating-current circuit of the same nominal voltage as a direct-current circuit will be liable to a pressure of 40 per cent. more. Still, however, such liabilities can be made, and ought to be made, impossible, by adopting the simple expedient of a continuous metallic covering for all cabling, taking care to see that the covering is continuous, shielding the switches and starting gear, and earthing the motor frames. With these precautions there is not so much danger about an electrical system as there is from the belting of an ordinary countershaft. Any liability of fire is altogether removed in this way, providing that common-sense is exercised in guarding each circuit at the distributing switchboard by fuses or automatic cut-outs. Here, again, it is advisable to make these instruments "fool-proof" by having fusible cut-outs supplied with stamped standardised fuses; otherwise, if a motor develops a slight earth, or is overloaded at times and blows the regular fuses, there is too much tendency to put in a piece of copper in place of a fuse, with the result that any safety valve, as it were, to the system is blanked up.

The sooner manufacturers will agree in their own interests to adopt these simple precautions the better for the industry, and the less likely we shall be to undue visitations from Government officials.

4. The Importance and Economy of Standardisation.

There is only one more point to mention, but one by which a manufacturer starting to electrify his works can save a good deal of capital outlay. Wherever possible, it should be the aim to group the machinery and tools in such a way as to adopt three sizes of motor, and let us say, for example, 30 h.p., 15 h.p., and 5 h.p. In this way a spare armature for each type of motor will probably be found to be sufficient, and thus the capital expenditure on spares will be considerably reduced. It is quite true that a complication ensues in many cases from the variety of speeds at which tools have to be driven, but the author does not think that this is as bad as is made out, and in special cases, rather than instal a fourth size of motor, he would be inclined to modify the speed through gearing of some kind, even at the risk of some loss in efficiency. Then, the starting switches, the switchboard panels, and instruments could be made, say, of two sizes to suit the three classes of motor, and thus there will be some system instead of the too frequent and too great variety of instruments one sees installed. In a system carefully laid out, the cables can also probably be arranged to be covered by two sections. The arc lamps should be, if possible, of the same pattern, and the resistance or choking coils in connection with them should be of precisely the same pattern. Thus a very simple and easily understood system will be adopted with a resultant minimum first cost. If continuous-current dynamos be installed, the adoption of the three sizes suggested can also be probably arranged, and the same size of carbon brush (though a different number of each, of course) can be utilised, and thus only one size and style of carbon be kept in stock.

All electrical users having a number of motors will find it convenient to have a small portable blower as an auxiliary, mounted on a trolley, and by means of which the motors can be thoroughly blown out from time to time. It is advisable, of course, to have a totally enclosed motor, although rather more expensive in first cost for the same temperature limit. Yet even in this case it is advisable occasionally to have them thoroughly blown out and freed from dust. One of the greatest difficulties which manufacturers have is to ascertain the size of motor to attach to certain machines. In any case, with direct-current installations, it is always advisable to have the motors compound wound, and in cases of intermittent work, such as with punching and shearing machines, as an extreme example, it is necessary to supplement the motor by a heavy flywheel. These are points, however, upon which it is advisable to get expert advice, and to enter into a discussion of the sizes of motors for various industries would require a paper in itself.

The author is confident that transmission in the future in workshops and other factories will be almost entirely by electrical means, and one important point he would ask users to remember is the quicker rate of doing work which frequently results from the adoption of electricity. He would ask manufacturers to look at the cost of their power squarely. There are too many instances of such figures as ½d. per horse-power hour or less being given, which, when analysed, are soon proved to contain merely the cost of fuel and stores—not the whole of the wages, and only a vague idea of the repairs, with no provision for depreciation of plant, rating, interest on capital outlay, or general superintendence. He knows in many works it is difficult to arrive at a true assessment of some of these figures. That we have entered an era of the almost universal adoption of electricity he is quite certain. At the same time, manufacturers should not hastily adopt the new method, but should take time in laying out their works to the most economical advantage.

The author hopes this paper will be instrumental in making clear the *pros* and *cons.* for each particular user, and be of some assistance to non-electrical engineers who are contemplating the adoption of electricity. He has not entered upon the important question of the supply to collieries, which, under the admirable rules issued by the special commission appointed by the Home Office, will render the use of electricity in mines thoroughly safe, but it does appear as if a very considerable economy could be gained especially in these cases through the adoption

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of electrical transmission. Several important collieries are now installing plant, and in a short time we shall have reliable data upon which to work. Manufacturers are to be congratulated upon the manner in which they have so readily adopted this agent on the North-East Coast, and electricity will, undoubtedly, play an important part in the economics of the district. The recent regulations of the Home Office are appended to the paper, and will be useful to members for reference. The author also recommends the study of the report by the Commission on the Use of Electricity in Mines recently issued. The author is indebted to the Home Office and to H.M. Electrical Inspector of Factories for permission to use these references.

## ADMINISTRATIVE COUNTY OF LONDON AND DISTRICT ELECTRIC POWER BILL.

(*Continued from page 446.*)

On Thursday, March 30, Colonel CROMPTON, R.E, continued his evidence, and stated that the promoters had not made sufficient allowance for depreciation and antiquation of plant. He did not think the promoters would get the results they expected from Newcastle slack. He had had experience of such coal, and found that it deteriorated from conveyance and after storage. The electricity supplied in Kensington and Knightsbridge was procured either from the company's stations or in bulk from the works in Wood-lane. Such works were ample for present demands, and could be extended to meet any expected increase. No economy would be secured by taking electricity in bulk from a new company.

Mr. HIGHFIELD, chief engineer to the Metropolitan Electric Supply Company, gave evidence as to the reduction in cost due to an increase in power-factor of the load, and with his evidence the opposition of the companies to the Bill closed.

Sir R. LITTLER, K C., stated the case for the Corporation of London. Two electric lighting companies had powers to open the streets, and the Corporation strongly objected to a third company having similar powers. Already the streets were crowded with pipes and cables for various purposes, and there was absolutely no room for more. The offer to go round and avoid main thoroughfares was of little avail, for there were no streets in the City that were not crowded during business hours. In the second place, as the purchasing authority the Corporation did not like Clause 69 in the Bill, which would give the promoters power to purchase an existing undertaking without the consent of the local authority. If the promoters were successful in inducing an existing company to sell their undertaking, there would be nothing to prevent the Administrative Company from discarding the existing generating station from which the local supply of electricity was drawn. Then when the time came for the Corporation to exercise their right to purchase, all they would become possessed of would be the mains within their area, and the electricity would have to be taken from the new company. The Corporation wished to remain in the position they now occupied, with power to acquire the generating station should circumstances require it. The City had nothing to gain from the Bill; a cheap supply was secured by existing competition. Let the City be left alone and he had nothing more to say, or he would be content with a provision that the new company should not come in without the consent of the Corporation.

Lord R. CECIL, K.C., called evidence in support of the petitions of 15 metropolitan local authorities, including those of Battersea, Bermondsey, Fulham, Hammersmith, Hampstead, Poplar, St. Marylebone, St. Pancras, Shoreditch, Stoke Newington, Woolwich, Camberwell, Deptford, Lewisham, and Isleworth.

Mr. PHILLIP DAWSON, of the firm of Messrs. Kincaid, Waller, Manville, and Dawson, submitted a number of tables compiled by himself giving particulars of the condition and capacity of the existing generating stations in the various districts. From these he showed how the costs of production decreased with the increase both of the load factor and the output. The average load factor for these stations was about 12 per cent. He did not believe that the promoters would get a 35 per cent. load factor, as neither the tramways nor railways were likely to take a supply from them. He considered that the railway companies could generate as cheaply as the promoters and save the cost of distribution. If the local authorities got a 35 per cent. load factor, they could supply as cheaply as the promoters. Under cross-examination, Mr. Dawson admitted that the capital cost of many of the stations in his table was high, and that this would affect the cost of the supply.

Mr. C. H. WORDINGHAM gave his opinion, after examination of the generating stations of the borough councils, that they were well equipped, had ample means for extension, and were, in fact, actually doing what the promoters proposed to do in the way of cheap supply of power. The advantages claimed from the placing of the proposed generating stations on the riverside were already realised in four of the stations he had inspected. The other advantages claimed from the use of large generating units and the supply of large users could be also secured by the present undertakers. He apprehended trouble from the ring mains, where breakdowns would be extremely serious. He had had experience of the damage done by short-circuits on mains carrying large power, and did not think automatic devices would satisfactorily guard against such damage.

On Friday, March 31, Mr. C. H. Wordingham, cross-examined, said that steam-turbines, like other machinery, were liable to be superseded, but local authorities should take the risk of that and allow for depreciation. Within certain limits the cost of production decreased with the increase of the size of turbines. He would not admit that mains were less liable to depreciation than plant. He had had to take up practically the whole of a large system of rubber cables laid in pipes after five years. He was averse to very large generating stations under the conditions prevailing in London. In reply to questions from the committee, the witness said the crowded state of the ground under the streets presented great difficulties, but not impossibilities. The danger which might result from a fault in the "ring" main he illustrated by an account of a serious explosion that occurred in Manchester two years ago. There was a small fault in the main—a far less powerful main than the proposed "ring"—an inflammable gas was generated from the covering of the cables, and this exploded and caused much destruction of property.

Mr. G. BELL, electrical engineer to the Hammersmith Council, submitted extracts from the accounts to show that the Council carried on their electrical undertaking at a profit and met the local demand for power at 1·07d. per unit. They had expectation of increased demands for traction purposes. The power load at Hammersmith took 31 per cent. of their total output.

Mr. S. BAYNES, electrical engineer for St. Pancras, gave similar evidence as affecting that borough.

Mr. P. V. MACMAHON, electrical engineer to the City and South London Railway, stated that the controllers of that line would not take electricity from the proposed company or from any other, the possession of a generating station of their own being the heart of their system.

Mr. FREEMAN, addressing the committee on behalf of the borough councils, argued that if the Bill were passed his clients would be prevented from supplying electricity for power, a source of profit in view of which they had constructed works at great expense. If they had been guilty of neglect in meeting demands for electricity, if they charged unreasonable prices, or if their supply were bad, he could understand acceptance of the new scheme. But even the promoters made no such allegations against them, and there was absolutely no reason why they should be penalised, as they would be if the Bill became law. No one could deny that there was very strong financial support behind the Bill. That financial strength might be used to ruin competitors by selling electricity below cost price, after which consumers would be at the mercy of the successful undertaking.

The case for the city of Westminster was then heard. The chief evidence given by the town clerk and the city engineer dealt with the purchase clause, and with the nuisance caused by the opening up of the streets by another company.

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Mr. COWARD, representing the London County Council, said that body offered the most strenuous opposition to the Bill. The Council had lent more than £4,500,000 to local authorities in the Metropolis for establishing electrical undertakings, but the security for repayment of the money would be endangered if the scheme before the committee were sanctioned. Moreover, the County Council itself desired one of the powers sought by the promoters—that of buying out existing electrical undertakings.

On Monday, April 3, a statement was submitted by counsel for the promoters, showing in tabular form the Power Acts now in existence and the extent to which companies competed with local authorities in different parts of the country. Upon this a discussion took place on the circumstances and conditions in which areas of urban districts were included in or excluded from the powers conferred upon promoting companies. In most cases local areas were excluded after petitions from borough councils, but there were precedents in either direction, exclusion and inclusion. Where the consent of a local authority was required, such consent did not extend to electricity supplied for power purposes at a point outside the borough to railway, tramway, dock, and canal companies.

Mr. W. TAPPER, electrical engineer to the Stepney Borough Council, said that last year for private lighting the average price had been 2·75d. per unit, for public lighting the cost had been 1·56d., and the charge for power purposes 1·20d. The Council required further land for a new generating station, but he was not prepared to say that it would be more advantageous to take a supply in bulk from the proposed company than to incur the additional capital expenditure. The Council did not supply the docks within their borough, but informal negotiations had been opened in reference to a supply to the London Docks Company. He was sure that the Council would be able to continue to supply electricity for power purposes at the flat rate of 1d. per unit. The new generating station would cost about £260 000.

Mr. W. BULLOCK, electrical engineer to West Ham, explained the condition of the undertaking in that borough. This year it was estimated that three million units, or 50 per cent. of the total output, would be sold for power purposes. He believed they could supply power consumers at less than 1d. per unit. They had the option to buy in bulk from the Charing Cross and City Company upon agreed terms, but did not at present contemplate taking such a supply.

On Tuesday and Wednesday, April 4 and 5, the individual cases of other local authorities were heard in opposition to the promoters' scheme. Thus, the Councils of East Ham, Hackney, Southwark, Ilford, Gravesend, Dartford, Wimbledon, Bexley, Barking, Islington, and Croydon were all represented and offered evidence. This usually took the form of a review of the progress of the municipal undertaking and a statement as to the charges made for power supply. There was thus a considerable amount of similar evidence offered, which, by its weight, may convince the committee. The arguments of the many counsel employed were to the effect that each authority was doing what the promoters wished to have powers to do, and that if the Bill were passed the competition would be an unfair one. They urged that the company would secure all the large power and light consumers, and in this way reduce the value of the local undertaking. The decreased load would then make the local supply unremunerative, which might result in the undertaking being bought up by the promoters. Then it was argued that the prices would be raised.

Mr. PHILLIP DAWSON, recalled, gave the result of a calculation he had made of the cost of laying two mains from the contemplated generating station to Gravesend and Dartford. The capital cost of two mains to Gravesend would be £38 000, and the cost of a transforming station would be £4,000 more. The 20 per cent. on the outlay, which had to be guaranteed by the local authority, would work out at £8,436 as against £4,759, the total cost of production last year with their own generating station. The Dartford mains would not cost so much, but here, again, the 20 per cent. charge was equal to more than the present cost of production.

## THE USE OF ELECTRICAL ENERGY IN MINES AND COLLIERIES.

The excellent paper read by Mr. W. B. Mountain, M.I.E.E, on the 28th ult. before the Manchester Section of the Institution, is one which cannot well be condensed, owing to the extremely wide range covered. The paper was illustrated by diagrams and lantern slides numbering over 70, which would need to be reproduced if the paper were to be given in full. We propose, therefore, to content ourselves with a very brief *résumé* of the paper and of the discussion. In the first place, Mr. Mountain devoted himself to what had been done in the adoption of electrical driving in mines and collieries, rather than to what was to be in the future. He dealt with the parliamentary enquiry on the subject, and also with the rules recently issued as to the same, which allow of the introduction of high voltage into a considerable portion of a colliery. In discussing the advantages of the different systems, three-phase and direct-current, Mr. Mountain concluded that a combination of the two was likely to be of the most advantage. For this purpose double-current generators could be used, or, for larger plant, three-phase currents might be generated, and a certain proportion of the output converted into low-tension direct current. In dealing with the various portions of colliery and mining equipments, great stress was laid on every part being of the best possible type, in view of past experience in mining work. The latter portion of the paper, which was profusely illustrated, showed those present at the meeting what had been done in the various departments of mining as regards electrical driving. Thus, electrical winding gear, electrical pumps of various types, and electrical ventilation were all treated on more or less fully. On electric coal-cutting a great deal of information was given, and some excellent results obtained with the "Pickquick" electric coal-cutter were quoted. Thus, one of these machines, manufactured by Messrs. Mavor and Coulson, actually cut 25,535 tons of coal in 1904. It worked regularly for five nights per week, and the repairs came out under £1 for the year. On the subject of rock and coal drilling, the electric drill is in strong competition with the compressed-air drill. While the costs with the electric drills are considerably lower than with those driven with compressed air, the latter is still largely employed, owing partly to the objection to taking electricity up to the working face. In such cases, considerable saving is secured if the compressed-air drills at the face are supplied from small electrically-driven air-compressors near at hand. Lastly, Mr. Mountain dealt with electric traction, for which he considered there was a still a large field in the mines in this country. The lists given at the end of the paper are specially interesting, as showing the advantages of the electrical working. Actual figures are given in a number of cases of the annual saving which has been secured. Other schedules give the essential details of some of the most prominent British installations in mines, while the third gives the same information for a number of mines on the Continent. The figures as to electric winding gears and electric coal-cutters complete a paper which will be highly appreciated by all colliery engineers.

The following is a *résumé* of the discussion on the above paper:

Mr. C. D. TAITE, the chairman, welcomed the paper as dealing with a subject without which no electrical engineering society's syllabus was now complete.

Mr. A. H. GIBBINGS referred to the difficulty of finding a list of collieries with electrical installations. Nothing appeared to be published of a complete nature. He hoped Mr. Mountain would give details of power required to work the apparatus illustrated. He pointed out some obvious misprints in the proofs distributed. In his opinion the recent papers read before other branches of the Institution, and before the Civils, were not so complete as they might have been.

Mr. G. PREECE thought that a number of mining engineers still required educating up to the advantages of electrical working, and that harm had been done to its good name by some badly executed jobs, for which defective supervision was chiefly to blame. Trouble also arose when unskilled men were employed to run the electrical plant. As regards safety: he agreed with the views recently expressed that high tension was really safer than low tension in practice, as the miners were

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more respectful in their dealings with cables and apparatus working at high potentials; and in the half-naked and perspiring state of the miners a low-tension shock was just as likely to damage as high-tension. There was not much of a demand for rubber-insulated cables as mains now, as bitumen and paper lead-covered were becoming popular on account of their cheapness. Bitumen insulated cables were, in his opinion, the more satisfactory of the two classes for low-tension mains, on account of lightness and waterproof qualities without lead sheathing; also, the ends were more simply insulated. They were not so suitable for high tension, however, as in the multiple-conductor cables used on alternating currents there was a chance of the conductor decentralising through the bitumen; although a layer of paper next to the conductor would minimise that, such as in the paper leadless cables now on the market. For use with coal-cutters and motor connections rubber was still the best on account of its flexibility, but such leads should be suitably protected against the severe usage they had to experience, and he believed that leather braiding, although dearer in first cost, would prove the best form of protection. Some mining engineers preferred their cables to hang free from the surface to the pit bottom, and such an arrangement was in successful use. He preferred cleats for deep shafts, however, but care should be taken that no projections were left for dust, etc., to lodge, or for falling bodies to damage. In the workings cables were best suspended from the props or walls by leather clips, preferably one cable on each side of the road on continuous-current circuits. Although the Board of Trade rules mention wire armour for protection, he recommended a fibrous braiding as less likely to damage the cable itself when heavy weights were dropped on it, and he pointed out the danger to be anticipated from a wire armour rendered alive by being forced through the insulation on to the conductor in a pit where earthing was impossible and where men came in contact with the armour.

Mr. WILLIS accentuated the huge strains that colliery motors were subjected to, so that in some cases keyways were stripped and shafts had broken off close to the motor. With hauling gear, if a truck full of coal went off the line the motor was expected to drag it back on the rails! For such work an elastic gear was required, such as ropes or belts, and direct-current machines stood up to the work better than polyphase.

Mr. A. G. COOPER instanced some early electric experiences in mining work, when enclosed motors were first used, and liquid starters were tried.

Mr. J. D. BAILIE mentioned that the bad water to be met with was more injurious to ram pumps than to the centrifugal type, and stated that a Mather and Platt centrifugal tested to 63 per cent. efficiency. He instanced a total cost of ·54d. per unit at a colliery where the load factor was, singularly enough, 54 per cent. He related the amusing history of an electrical coal-cutting machine, that spent more time at the photographer's and repair shop than in doing work during the period of its useful life.

Mr. A. C. CORMACK recommended continuous current for general use as more adaptable to pumping where sumps were so shallow, etc., as to make a too variable load for three-phase machines.

Mr. MOUNTAIN, in reply, agreed that it was difficult to get details of electrical work in mines, but understood that fuller data were being made now. As regards burying cables under the roads being a more permanent job, he mentioned the probability of their eventual non-accessibility owing to the gradual covering up by *débris*; and in reference to some speakers' anxiety as to the trouble of getting bulky machines down to their positions underground, he assured them that mining machinery was made in sections specially suitable for the job of transport and erection in mines.

## BOSTON ELECTRIC LIGHTING SCHEME.

### Local Government Board Decision.

**The Corporation of Boston recently applied to the Local Government Board for a loan of £20,000 for electric lighting purposes. The usual enquiry was held, but the evidence was not such as to convince the Board of the soundness of the proposed scheme. The result is that the whole matter is referred back to the Corporation. In view of the closeness with which the details of all such schemes are now examined when loans are applied for, the following letters are of general interest:**

BOSTON ELECTRIC LIGHTING ORDER.

Local Government Board, Whitehall, S.W., March 14, 1905.

Sir,—I am directed by the Local Government Board to state that they have had under consideration the report made by their inspector, Mr. Hooper, after the enquiry held by him with reference to the application of the Town Council of Boston for sanction to borrow £20,000 for purposes of electric lighting.

The Board are not satisfied upon the information before them that the establishment of an electric lighting installation in accordance with the scheme as at present designed would be likely to be successful from the financial point of view, and they are advised that, apart from this question, there are several matters in connection with the proposed scheme which require attention.

The Board think, therefore, that the Town Council would be well advised to reconsider the whole matter, with particular reference to the following points:

1. The substitution of electric lighting for the present system of gas lighting in many of the streets would admittedly entail a considerable increase in the public expenditure on lighting; but it was not satisfactorily shown that there would be any material improvement in the lighting of these streets, and looking to the arrangement of the arc lights shown on the block plan, it is even possible that the illuminating effect of the electric light might be inferior to that of the present method of lighting by gas.
2. The Board understand that there is already a modern and efficient plant in operation for lighting the docks by means of electricity, and as at present advised they are doubtful whether the proposal of the Town Council to supersede this plant and to light the docks from the general installation proposed would be economical. If this proposal is adhered to, the Town Council should obtain comparative figures of the cost of lighting the docks from the present plant and from the proposed installation (taking into account the capital expenditure involved by the present proposal), and submit them to the Board with the revised scheme.
3. The Board are advised that the laying of distributing mains along several of the routes chosen would be likely to prove unremunerative, and, in their opinion, the whole question of the routes for the mains should be carefully reconsidered with the view of omitting from any scheme those streets in which it is clear that there would be no adequate return on the expenditure. In this connection the Board direct me to enclose a copy of a letter which they have received from the Board of Trade.
4. The Board are also advised that the arrangement of the generating station is capable of considerable improvement, especially with regard to possible future extensions. They direct me further to point out that the evidence given at the enquiry indicated that the spare unit would have to be used daily in order to carry the estimated peak load.

Looking to the large amount of expenditure proposed, and having regard to the fact that the ultimate success of schemes of electric lighting so largely depends upon the original design of the works and upon the primary arrangements and the details of the scheme, the Board would recommend the Town Council to consult an electrical engineer of high qualifications and experience before finally deciding on a revised scheme.

The plans relating to the present scheme are returned herewith.—I am, sir, your obedient servant,

NOEL T. KERSHAW, Assistant Secretary.

The Town Clerk, Boston.

Copy of letter from the Board of Trade referred to in a letter from the Local Government Board:

Board of Trade (Harbour Department),
7, Whitehall-gardens, S.W., Feb. 14, 1905.

BOSTON ELECTRIC LIGHTING ORDER, 1900.

Sir,—I am directed by the Board of Trade to acknowledge the receipt of Mr. Kershaw's letter of the 9th inst., on the subject of the above-mentioned order, and, in reply, I am to point out that the order imposes upon the Corporation of Boston an obligation to lay mains in all the streets specified in the third schedule to the order.

Should, however, the Corporation establish an electricity scheme which does not include the laying of mains in some of the scheduled streets, the Board of Trade would not be likely themselves to raise any question in the matter unless representations were made to them, but if representations were made the Board would have to consider them.—I am, sir, your obedient servant,

T. H. W. PELHAM.

The Secretary, Local Government Board.

**These letters have been considered both by the Lighting Committee and the full Council of the Boston Corporation, but so far no definite decision has been come to. Such a result is discouraging to those responsible for the scheme, but it is to the interest of all in Boston that the electric supply undertaking should be started on economic lines, and with due regard to probable extensions. With gas at 4s. 4d. per 1,000 there must be a good opening for electric lighting. With the aid of a good consulting engineer the Corporation should promptly reconsider their plans. It is obviously better to revise the scheme now than to find after completion that the undertaking is too large and a burden on the town.**

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## TRADE NOTICES AND NOVELTIES

### The Meridian Lamp.

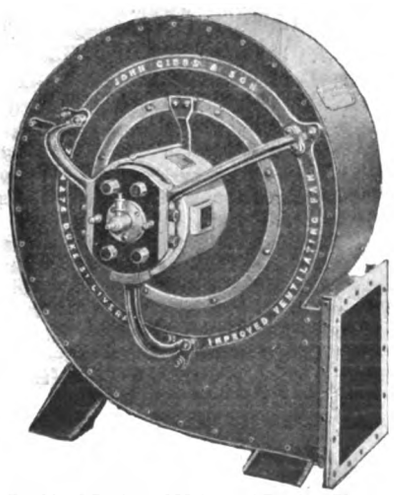
The lamp which we illustrate herewith is made by the British Thomson-Houston Company, of Rugby, and has been given the above name. Its object is to secure a good distribution of light on a horizontal surface when the lamp is arranged vertically. In order that this may be accurately done, to get the best effect from the energy expended the following points have been carefully attended to. In the first place, the shape of the filament and its position in the bulb is special, and also the exact shape of the reflector is the result of careful study. This special prismatic glass shade is rigidly fixed to the lampholder, so that the Meridian lamp can be burned in any position, and the same distribution of light obtained as when arranged vertically.

B.T.H. Meridian Lamp.

Hitherto these lamps have only been made for use on 100-125-volt circuits, but we understand that the British Thomson-Company have, after a series of exhaustive experiments, developed a 120-watt Meridian lamp for burning in multiple on circuits of from 200 to 250 volts, and are prepared to fill customers' orders immediately from stock. The attractive appearance and neat design of the Meridian lamp makes it particularly desirable for all kinds of interior decorative work where a downward distribution of light is required.

### Electric Fans.

It is well known that Messrs. John Gibbs and Son, Duke-street, Liverpool, have given a large amount of attention to the question of mechanical ventilation. We would refer here more particularly to the success which has rewarded their efforts afloat. Thus some of the finest and largest steamships in




Combined Dustproof Motor and Peerless Blower.

the world, including the Cunard R.M. ships "Campania," "Lucania," "Caronia," and still more recently the turbine steamer "Carmania," have been fitted with the firm's patent weatherproof ventilators. By means of the system adopted on these vessels the air in all the third-class passenger spaces is renewed each five minutes, the temperature being adjusted according to the atmospheric conditions prevailing. It speaks well for the practical success of the system that after thorough tests on the two first-mentioned ships it should have been adopted on the latest additions to the Cunard fleet.

However, Messrs. John Gibbs and Son by no means confine themselves to marine work. They have also, among other departures, specialised the design of plants for warming and ventilating workshops, mills, and factories, and for collecting dust from polishing shops, woodworking machinery, etc. The accompanying illustration shows one of their newest forms of combined patent dustproof motor and Peerless blower, a most convenient form of apparatus, which has given highly satisfactory proofs of efficiency on test. The makers are, therefore, able to recommend this fan with every confidence as giving the best possible results for the power expended.

### Wirt Brushes for Dynamos and Motors.

We had occasion as recently as October last to comment favourably on these brushes, but a good thing cannot be too well known, and a price-list just issued by Messrs. J. Defries and Sons, Limited, 146-147, Houndsditch, London, E.C., the sole licensees and makers, contains some further information to which we would call attention here. It is claimed that Wirt brushes give to machines designed for metal brushes the advantage in respect of sparkless commutation which has hitherto had to be sought in carbon brushes, without the increase of dimensions and waste of current which carbon brushes entail, and with a substantially increased life of commutator and brush. Each brush consists of a series of very thin laminæ

Wirt Brush-holder.

of metals of special compositions and degrees of resistance, held along most of their length between two spring cheeks, and fixed together solidly at the end which enters the holder. The laminæ by which the current is most readily conveyed are of copper, being sandwiched between a series of anti-friction metal laminæ of increasingly higher resistance, so that the brush cuts out and cuts in each armature coil through resistance, which tends to prevent sparking, without wasting current by a needlessly high resistance. The composition and sequence of the resistance metals vary with the type of machine for which the brush is intended. The operation is to some extent analogous to that of starting a motor through a resistance which is gradually cut out as the E.M.F. of the motor approaches that of the line. The individual elasticity of the laminæ causes it to make good contact on the commutator with very little bearing pressure, and it has repeatedly been found that a Wirt brush will, through its "cushion" touch, make perfect contact on a commutator so rough as to cause any other brush to fail. On alternating-current collector rings, where the question of sparkless working does not arise, this quality makes the Wirt brush convenient and profitable in wear. The large proportion of anti-friction metal in the Wirt brush causes its wear on the commutator to be almost imperceptible, the worst cutting of a commutator occurring through the friction of copper on copper. Wirt brushes can be fitted to any existing dynamo or motor designed for any form of metal brushes, but are usually unsuitable for machines originally fitted with carbon brushes. In "arc dynamos" they cannot suppress sparking to the same extent as in other machines, owing to the relatively high resistance of the armature and the high tension; what is obtained by their use on such machines is reduction of sparking, improved smoothness of running, increased life of brush, and less frequent need of attention. We understand that for plating and electrolytic purposes these brushes are working successfully up to 4,000 amperes, and are already in very extensive use. Several excellent testimonials are included in the list under review, also some illustrated notes on the care of Wirt brushes, which should be widely appreciated.

### Chamberlain and Hookham Meters.

The new catalogue of Messrs. Chamberlain and Hookham has just reached us, and contains descriptions of several new features in the electricity meters manufactured by this firm. The list of stations where these meters are employed gets longer with every issue of the catalogue, which speaks well not only for the meters, but also for the commercial organisation of the firm. Amongst the old friends in the catalogue we notice the battery meters for recording the charge and discharge of accumulators in central stations. Two meters are employed, one for the charging current and the other for the discharging. The current goes through the two meters in series, but only one meter can revolve when the current is going in a definite direction. When the current is reversed the other meter commences to record, the armature of the first being held by means of a rachet and pawl. These meters are now supplied handsomely mounted in brass cases for mounting direct on switchboards. The new feature in this list is the form of watt-hour meter which we illustrate herewith. It is a modification of the

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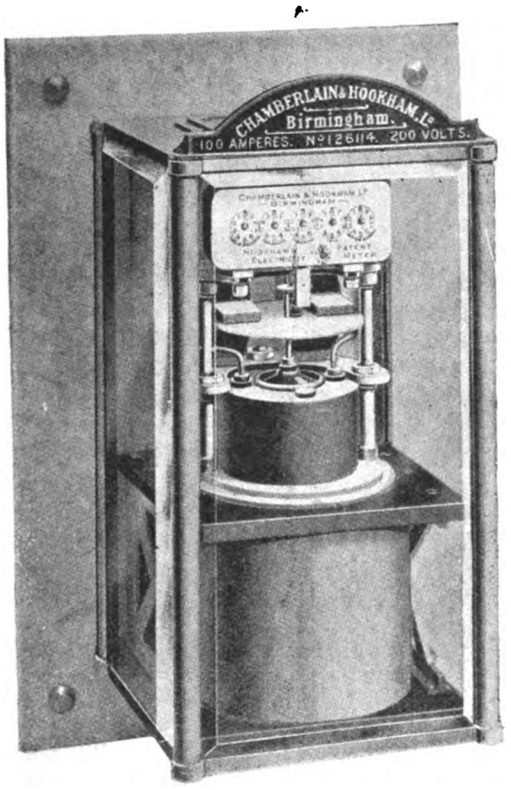
ampere-hour type, in which the permanent magnets are replaced by an electromagnet energised by a shunt coil across the mains. These meters are for use in stations supplying tramways, or power circuits where a considerable variation of voltage may occur. Although the driving field is electromagnetic, permanent magnets are still retained for the brake. The following description brings out the new details in this meter. The armature is cylindrical and similar to those supplied in the 1902 type of meter, and carries on its spindle the aluminium brake disc. The mercury is contained in a chamber bored out of an ebonite block and having conducting strips embedded in it. The pole-piece of the electromagnet projects up inside the armature and carries the bottom pivot on which the armature runs. In order that the field of the electromagnet may respond perfectly and instantly to changes of pressure there is no external pole-piece to the outside of the armature, so that the magnetic circuit is completed through the air. The coil of the electromagnet (which is of fine wire) is below the mercury bath. It is wound upon a straight core which carries the one pole-piece at its upper extremity. In order to ensure entire absence of residual magnetic effects in this core a special method of construction has been adopted. Instead of being made of a solid bar, it is made up of a pile of iron washers with insulation between them. When magnetised, therefore, the entire iron circuit is made up of a number of very short magnets in proportion to their length. These magnets have a




Chamberlain and Hookham Meter.

great self-demagnetising tendency, which operates the moment the magnetising current is withdrawn or diminished. It will be seen from the above that the electromagnet field is made independent of residual magnetism in the iron circuit by introducing a considerable amount of air resistance into the same. In this way a magnetic field is produced which is strictly proportional to the current in the magnetising coil, and hence to the voltage across the mains. As the current only passes through the armature of the meter, a short-circuit does not affect the magnet. These meters are constructed to carry 50 amperes maximum, and if larger currents have to be measured they are passed through a shunt, the ends of which are connected to the meter terminals. These meters are usually mounted in polished cases with glass fronts and sides for placing on switchboards. The other details of the meter are worked out in accordance with Messrs. Chamberlain and Hookham's usual practice, and in this type, again, the weight of the armature is entirely borne by mercury, so that there is no tendency for the pivots to wear.

## Catalogues Received.

TRANSPORT CELLS.—We have received from Messrs. Siemens Bros. a number of recently issued publications, including a leaflet describing their patent transport cells, which combine the advantages of both wet and dry types of primary batteries. It is designed especially for motorcar ignition. Essentially it is a wet cell, and, consequently, the electrolyte can be renewed when required, but the mechanical construction is so arranged that there is no chance of the liquid escaping unless the cell has been severely damaged. Another advantage of the type is that they can be kept for any length of time in a dry condition. If desired, they can be emptied after use, rinsed out with warm water, and then laid aside for future use. All that is then required is to introduce a solution of a special salt, recommended by the makers, into the cell to put it again into working order. It can be worked, however, with ordinary salammoniac. The batteries are made in four different sizes, the voltage of the cell being 1·5. For use with motor bicycles three of the middle-size cells are recommended, which weigh in all 8¾lb. The other lists received from this firm give particulars of their open-type dynamos and motors, with standard dimensions of the same. We have also received a list which shows the leading dimensions of the S. K. cut-outs manufactured by Messrs. Siemens Bros.

"BROCHIPEL" ARC LAMPS.—Several new types of enclosed arc lamps are dealt with in the latest list issued by the Brockie-Pell Arc Lamp Company, Limited, 60, Worship-street, London, E.C. These types include the ordinary pattern for streets, factories, wharves, mills, yards, etc., the shop window pattern, the twin carbon pattern, and ornamental patterns.

D.C. MOTORS.—Messrs. Vickers, Sons, and Maxim, Limited, Sheffield, have sent us a copy of their D.C. catalogue, Section 1, which deals with direct-current protected and enclosed constant-speed motors for outputs ranging from 5 b.h.p. to 50 b.h.p.

SMALL MOTORS.—From the British Thomson-Houston Company, Limited, Rugby, we have an illustrated circular showing various special applications of their small-size motors.

HOLMES AND CO.'S LISTS.—Messrs. J. H. Holmes and Co., Newcastle-on-Tyne, have sent us a list of the electrical plants which they have supplied to engineering firms, shipyards, railways, and dockyards; also an interesting illustrated description of the Holmes-Chatworthy system of operating newspaper web rotary printing machines, which has already been extensively adopted.

WILLANS ENGINES.—The economy of the Willans engine is dealt with in an illustrated pamphlet recently issued by Messrs. Willans and Robinson, Limited, Rugby. Some excellent results are recorded.

CONDENSING PLANT.—We have received from the Mirrlees-Watson Company, Limited, Glasgow, a well-illustrated pamphlet describing the various types of condensing plant manufactured by them and the conditions for which each type is most suitable.

ARC LAMPS AND ACCESSORIES.—The Sun Electrical Company, Limited, 118-120, Charing Cross-road, London, W.C., have sent us an illustrated list of the arc lamps and accessories which they supply.

ELECTRICAL COMPANY'S LITERATURE.—From the Electrical Company, Limited, 121-125, Charing Cross-road, London, W.C., we have two illustrated circulars, one of which deals with their projector Nernst lamp, and the other with high-voltage wall sockets and plugs; also three sheets illustrating respectively the generating station at the Grand Hornu Colliery, a large electric winding engine, and a group of three-phase motors supplied to the Western Australian Government.

SIMPLEX STEEL CONDUIT.—A useful little reference list, in a red cover, for the pocket has been issued by the Simplex Steel Conduit Company, Limited.

## PERSONAL.

CORRECTION.—We regret that in our last issue in referring to the appointment of a third engineer-in-charge at Bermondsey the name of A. B. Gundry was given as the successful candidate, instead of that of Mr. W. Panpred, of Manchester, who was actually appointed. There were over 90 applications for the post.

The Derby Electricity Committee recommend the appointment of Mr. J. Hebb as canvassing engineer, at a salary of 2bs. per week, together with a commission of ½d. per 8-c.p. lamp up to 10 000 lamps obtained by him in one year, and 1d. per lamp above 10,000 obtained by him in the same year.

The Liverpool City Council have increased the salary of Mr. C. R. Bellamy, the tramways manager, from £1,200 to £1,500 per annum.

## APPOINTMENTS VACANT.

**Tramways Inspector,** Birmingham Corporation. Salary about £4 per week. Applications by April 12. See advertisement in last issue.

**Assistant Lecturer in Engineering,** Swindon Education Committee. Salary, £150 per annum. Applications by April 29. See advertisement.

**Agents** for switchboards, transformers, instruments. See advertisement.

**Pupil,** L. H. King, Council Offices, Whitby, Yorkshire. See advertisement.

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THE
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### TO CORRESPONDENTS.

*All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

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## TRAINING, EDUCATING, PIONEERING.

It is not customary to refer to the social functions resuscitated by the Dynamicables, yet the chairman, Mr. J. Fletcher Moulton, M.P., at the annual meeting on Wednesday, in responding to the toast of the society, made several references which ought always to be kept in mind. Referring to the earlier history of the society, it was suggested that in those days everybody who cared to dub himself an electrical engineer was acknowledged as such; in fact, the world took him at his own estimation. Usually the aspirant to the profession was full of imagination, one of the most vivid of the imaginings being that the discovery or the mixture of a new coloured paint was enough to ensure him a valid patent for a new dynamo. Brains were somewhat at a discount, but the lapse of a quarter of a century or so has largely changed these views. Nowadays the inventor, the improver, is a man who must have undergone a long, strict, and thorough training—one who knows the whole ins and outs of his subject. Thus the brain energy of the professional nation is awake, eager to compete in the race with all and every, and, according to the witty and learned chairman, our present position is one that does not fear comparison with the position of other enterprising nations, and is one which, if continued with energy and ability, will not fail to put us again into the supreme position amongst engineering nations we so long enjoyed. It is not, however, to the marked advance in knowledge and ability that we desire to direct attention, but to the strong indictment of the scurvy method of treatment to which British pioneer workers and investors have been subjected, which treatment lost us the race and makes it an arduous task to regain the lead. Pioneer work takes great risks and determines many problems, and surely the equitable result would be for those who take the risks and solve the problems to reap a commensurate monetary reward. The history of this nation, however, is very largely a history of ruined pioneers, a history of shattered hopes, and a history of the great success of those who simply took advantage of the work of others, reaping where they had not sown, and gathering riches at someone else's expense. There is not a single direction among the industries of this country wherein glaring instances of these things cannot be found. It matters not whether we look upon the literary, scientific, or mechanical work, the same thing holds good. The successful issue of a paper of snippets is followed by others as nearly resembling it as can be. One political paper has a column devoted to fashions, another and another follows suit—the pioneer gets no return for his original conception. In applied electricity we have very glaring cases of pioneer work not being adequately remunerated, nor adequately considered. At the present time pioneer lighting and power installations are threatened with extinction, because their success has shown how to provide something simpler and cheaper. As Colonel Holden says in the *Times* of April 5: "As regards the capital outlay involved and the interest thereon, and the depreciation of plant, it is pretty obvious that those who are the latest comers are, or should be, able to profit by the experience of others, and should be able therefore to select not only the best but the most economical type of generating machinery for their stations, and they ought, moreover, to select the most suitable sites and sizes for their stations. It is, therefore, only reasonable to suppose that in these respects the advantage should be on their side when compared with existing undertakings as regards cost of production and lower depreciation." These remarks only corroborate those of Mr. Moulton. In each case it is shown that the pioneer suffers

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by competition with those who have learned from the experience of their predecessors. Where exactly the line can be drawn to satisfy the pioneer, and at the same time to satisfy the conditions of progress, it is difficult to say, but in some cases the correct method of treatment is clearly indicated. Take the case of an installation of light, power, or telephony in town or district called A. This installation is carried out under certain estimates of success. If those estimates have influenced the capital to take the risks, and those estimates are obtained in practice, it seems to us that capital has nothing to grumble at. If, on the other hand, those estimates are detrimental to the public—that is, make something more costly than it was before—or time shows those estimates to have been utterly untrustworthy, fanciful, and unwarranted, interference may be justified. Further, if the estimates were warranted by the facts of the case, and before the time had elapsed when full success could be obtained improvements were indicated, it does not absolutely follow that the pioneer capital should be jeopardised in order to let someone compete against it with the very improvements it has brought about. Here is the matter in another way. A has a house lighted by candles or oil. A seller, B, offers to *enter into an agreement* with him for twenty-one or forty-two years to light the house electrically—better and cheaper than it is lighted at the time of the agreement. A and B make such agreement. Ten years after C comes along and promises to undersell B because he can produce cheaper than B by means of experience gained from B. Is it altogether equitable that A or C should be allowed by some new legal dispensation to break the agreement? Yea, verily, pioneers have a hard time.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### CONTINUOUS-CURRENT TRANSFORMER.

SIR,—I should like to correct a statement which "Research" makes in his answer to Question No. 767, which is about a breakdown between the high-tension and low-tension windings on a continuous-current transformer. He says that after the fuses on the faulty machine have blown, etc, the battery will commence to discharge through the boosters unless they are fitted with automatic switches to connect the battery straight on to the 'bus bars and to cut out the boosters. I now quote from his answer:

"If there is no device of this kind, the current will be flowing in the reverse direction through the battery booster armature, and as the shunt winding will remain the same, the booster will tend to run as motor in reverse direction, whilst the balancers are striving to run in the ordinary direction, with bad results for the battery booster."

I quite agree with him that the armature current will be in the opposite direction, and that the shunt field will be in the same direction as previously, but obviously it is incorrect to say that the booster armature will tend to run in the contrary direction to what it was previously running in.

If "Research" applies the right-hand rule to the case when running as a generator, and the left-hand rule to that when running as a motor, he will see the fallacy of his statement.—Yours, etc., ERNEST R. ALEXANDER.

### THE LONDON COUNTY COUNCIL TRAMWAYS BILL.

SIR,—My attention has been called to a circular letter which has been issued by Messrs. Thomas Tilling, Limited, omnibus proprietors, with the intention of exciting opposition to the proposal contained in the Council's Tramways Bill of the present session for the construction of tramways over Westminster Bridge, along the Victoria-embankment and over Blackfriars Bridge, to connect the existing tramway termini in Westminster Bridge-road and Blackfriars-road. The letter contains the following paragraph:

"You can safely affirm that these tramways are not self-paying, and that a better service can be given to the travelling public with motor omnibuses by private enterprise, and without being a burden to the rates."

This statement is to my mind likely to so seriously mislead the House of Commons in its consideration of the Council's proposals, that I desire to trespass shortly upon your space to indicate what are the facts concerning the working of the Council's tramways.

The Council's tramways have from the first year that it acquired control of any lines in London been entirely self-supporting, and they will continue to be so. Even during the years when the bulk of the tramways south of the Thames were being reconstructed for electrical traction, entirely disorganising the ordinary traffic (some of the lines being closed altogether), the tramways account has never been a charge to the extent of a single penny upon the rates. On the contrary, the tramways have already during the past eight years paid from surplus revenue in reduction of rates, after the provision of interest and sinking fund charges, a sum of over £293,000, divided between the northern and southern systems.

The following details as to the application of the moneys received from the tramways account during the past eight years, in respect of the Council's systems north and south of the Thames, indicate the absolute inaccuracy of Messrs. Tilling's statement:

| | |
|---|---|
| Applied in reduction of rates, over | £293,000 |
| Amount paid for sinking fund charges in reduction of debt during the same period (northern system which has been in Council's hands for eight years, £117,044; southern system, which has been in Council's hands six years, £210,195; and general, £6,997) | 335,236 |
| Amount paid for interest on capital | 414,000 |
| Amount set aside as a reconstruction renewals reserve fund for the southern system | 66,000 |
| Amount paid in rates and taxes in respect of the southern system during the past six years | 90,000 |
| Amount paid in reduction of debt from proceeds of sale of horses, rolling-stock, surplus property, etc. | 126,220 |

During the four years from 1899 to 1903, the 48 miles of tramways north of the river, which are leased by the Council, earned as profit, after paying interest and sinking fund charges, £153,700; while the 24 miles on the south side of the Thames, worked by the Council itself during the same period, provided, after paying corresponding charges, the sum of £72,900.

The following facts are of importance in any institution of a comparison between the results from the system north of the Thames, leased to a company, and the lines south of the river worked by the Council itself. These illustrate the advantages that have been secured to the travelling public and the amelioration of the conditions of labour of the tramways employés obtained from the Council's immediate control:

1. 200,000,000 passengers were carried at ½d. fares, as compared with 1d., the minimum fare on the north. This represents a very considerable money value to the travelling public on the south side of the river.

2. Workmen's cars, running up to 8 a.m., have been instituted with a fare of 1d. for any distance for a single journey on the existing lines, and 2d. for a return journey, which means a very valuable boon to workers using the southern lines. In addition, all-night cars services have been established.

3. The Council has conceded to its employés a six days' week and a 10 hours' day, which with certain other improvements in the conditions of labour, represent an expenditure beyond that involved under this head when the tramways were acquired of over £30,000 a year. This ensured the granting of conditions of labour which were considered necessary to secure efficient service.

During the period of reconstruction there was a deficiency in the southern tramways accounts of £2,250 in 1902-3, and of £8,284 in 1903-4. This result was brought about by the Council paying interest and sinking fund charges of £12,300 on expenditure incurred for reconstruction before a single electric car was run on the lines creating

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those charges. Moreover, during the first-named year a sum of £11,000 was set aside out of revenue for the renewals fund for the horse lines which were, at the time, entirely disappearing. The result of this was to give to the Council as an asset in the way of a renewals reserve fund a sum of £30,750 at the commencement of electrical working, before any wear and tear had begun, and the "account deficiency" is thus amply covered by assets more than corresponding thereto.

The facts, therefore, only serve to illustrate the soundness of the Council's tramways finance policy. In regarding this aspect of the matter I should like to point out that, contrary to company practice, the capital expenditure, a term by no means elastically interpreted by the Council, is being steadily paid off, and the tramways are being put in a better financial position every year, a constantly increasing sum being available by way of surplus receipts. In other words, a leasehold property is being rapidly converted into a freehold one, while a company undertaking remains a perpetual leasehold. The importance of this point cannot be over-estimated.

As the period of reconstruction passes away the "account deficiencies" will entirely disappear, and it is important to note that the accounts for the present year show a very substantial surplus, after the payment of the very heavy capital charges upon the lines that have been reconstructed. To the impartial expert it would appear that the Council has surmounted the difficulties of traffic maintenance and organisation during the trying period that comes in the history of every horse-propelled tramways undertaking when improved methods of traction have to be applied to the lines, with remarkable success.

In criticising Messrs. Tilling's letter in the light of the actual facts, I can only think that they are not prepared to rely upon the efficiency of the motor omnibus service as a means of locomotion in fair and open competition with the tramways service. I cannot otherwise account for the methods adopted by them in their endeavour to defeat the Council's efforts to improve the locomotion system of London in the best interests of the travelling public.—

Yours, etc. J ALLEN BAKER,
Chairman of the Highways Committee.

County Hall, Spring-gardens, S.W., March 31, 1905.

## IRON AND STEEL INSTITUTE.

The annual meeting of this body will be held at the Institution of Civil Engineers on Thursday and Friday, May 11 and 12, commencing each day at 10 30 a m. The following is the programme of the proceedings:

THURSDAY, MAY 11.

The retiring president, Andrew Carnegie, Esq., LL.D., will induct into the chair the president-elect, R. A. Hadfield, Esq. The Bessemer gold medal for 1905 will be presented to Prof. J. O. Arnold (Sheffield) The awards of the Andrew Carnegie gold medal and research scholarships for 1905 will be announced. The president will deliver his inaugural address. A selection of papers will be read and discussed.

FRIDAY, MAY 12.

A selection of papers will be read and discussed.

In the evening the annual dinner will be held in the Grand Hall of the Hotel Cecil.

The following is a list of papers that are expected to be submitted:

1. "On Experiments on the Fusibility of Blast-Furnace Slags." By O. Boudouard, D.Sc., Carnegie Research Medallist, 1903 (Paris).

2. "On Recent Developments of the Bertrand-Thiel Process. By J. H. Darby (Brymbo) and G. Hatton (Brierley Hill).

3. "On the Application of Dry-Air Blast to the Manufacture of Iron." By James Gayley (New York). Supplement to paper read on Oct. 26, 1904.

4. "On the Effect Produced by Liquid Air Temperature on the Mechanical and Other Properties of Iron." By R. A. Hadfield, president.

5 "On the Cleaning of Blast-Furnace Gas." By Axel Sahlin (London).

6 "On the Failure of an Iron Plate through Fatigue" By S. A. Houghton (London).

7. "On the Continuous Steelmaking Process in Fixed Open-Hearth Furnaces." By S. Surzycki (Czenstochowa, Poland).

8. "On Accidents due to the Asphyxiation of Blast-Furnace Workmen." By B. H. Thwaite (London).

9 "On the Behaviour of the Sulphur in Coke in the Blast Furnace." By Prof. F. Wüst, Ph.Dd., and P. Wolff (Aachen)

Reports on research work carried out during the past year will be submitted by C. O. Bannister (London), J. Dixon Brunton (Musselburgh), H. C. H. Carpenter (Teddington), J. C. Gardner (Oldbury), G. Dillner and A. F. Enström (Stockholm), E. G. L. Roberts and E. A. Wraight (London), Frank Rogers (Cambridge), and Walter Rosenhain (Birmingham)—Andrew Carnegie Research Scholars.

Members who intend to take part in the discussions will, on notifying such intention to the secretary, have copies of the papers forwarded to them a week in advance, as far as that may be found possible. Visitors' tickets will also be forwarded upon application.

By the courtesy of the Great Western, the Midland, the Caledonian, the London and North-Western, the Great Northern, the Lancashire and Yorkshire, the Great Central, and other railway companies, special arrangements have been made enabling members attending the meeting to obtain return tickets on payment of a single fare and a quarter on production of a certificate of membership, which may be obtained at the institute offices.

## FORTHCOMING EVENTS.

FRIDAY, APRIL 7.

**Royal Institution.**—At 9 p.m., "American Industry," by Mr. Mosely.

**Institution of Electrical Engineers (Manchester Students' Section).**—At 7.30 p.m., "Electric Cranes," by Mr. Jennison.

SATURDAY, APRIL 8.

**Birmingham Electric Club.**—At 7.30 p.m., "Lightning Conductors," by Mr. W. H. Whitehouse.

MONDAY, APRIL 10.

**Institution of Civil Engineers.**—At 8 p.m., Thirteenth "James Forrest" lecture, entitled "Unsolved Problems in Electrical Engineering," by Colonel R. E. B. Crompton.

**Institution of Mechanical Engineers (Graduates' Section)**—"Commercial Vehicles Propelled by Internal-Combustion Engines," by Mr. Edwd. Reeve.

TUESDAY, APRIL 11.

**Institution of Electrical Engineers (Manchester Section).**—At 7 30 p.m., annual general meeting. Mr. J. F ith will read a paper, entitled "Labour-Saving Formulæ in the Design of Direct-Current Dynamos."

**Institution of Electrical Engineers (Glasgow Section).**—At 8 p.m., author's reply to discussion on "Earthing," by Mr. W. W. Lackie; paper by Mr. H. Watson, entitled "Fittings."

WEDNESDAY APRIL 12.

**Institution of Electrical Engineers (Students' Section).**—At 7.30 p.m., "The Measurement of Resistance," by Mr. A. Cunnington.

THURSDAY, APRIL 13.

**Royal Institution.**—At 5 p.m., "Synthetic Chemistry," by Prof. R. Meldola.

**Institution of Electrical Engineers.**—At 8 p.m., "The Alternating-Current Series Motor," by Mr. F. Creedy.

**Institution of Mechanical Engineers.**—Annual dinner at the Hotel Cecil.

FRIDAY, APRIL 14.

**Institution of Mechanical Engineers.**—At 8 p.m., address by the President. Conclusion of the discussion on the "Steam-Engine Research Report," and reply by Prof. Capper.

**Royal Institution.**—At 9 p.m., "The Law of Pressure of Gases below Atmosphere," by Lord Rayleigh.

**Compatriots' Club.**—At 5 30 p.m., "The Revenue Aspect of Mr. Chamberlain's Proposals," by S r C. J. Follett.

**Physical Society.**—"Ellipsoidal Lenses," by Mr. R J. Sowter; "The Determination of the Moment of Inertia of the Magnets used in the Measurement of the Horizontal Component of the Earth's Field," by Dr. W. Watson; and a series of lecture experiments illustrating the properties of the gaseous ions produced by radium and other sources, by Dr. W. Watson.

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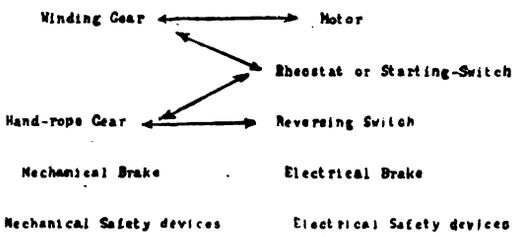
## ELECTRICALLY-DRIVEN LIFTS.*

BY F. O. HUNT.

An electrically-driven lift is very frequently a mixture of the work of two designers—the one generally a specialist on the mechanical side, and the other, too often, an electrical specialist, and nothing more. In this case, as in nearly all forms of combined plant, most of the troubles are traceable to this dual origin and the want of sympathy between the two designing minds. To use the words of a well-known lift specialist, "The electrical engineer thinks a lift is nothing but a box with a string to it," and, on the other hand, the mechanical designer is apt to consider that the electrical apparatus, other than the motor, simply performs the office of the familiar water-tap, and is, therefore, worthy of but scant consideration. It is true that the last three or four years have obliterated many of the anomalies in this direction, but as there still appears to be room for improvement it is hoped that this paper will induce discussion with that end in view.

An electrically-driven lift, in its simplest form, may have its mechanical and electrical parts tabulated somewhat as follows, where the double arrows show inter-relation between the parts thus marked :




The only electrical portion which cannot be said to have a mechanical counterpart is the rheostat, or device for reducing the value of inserted resistance as speed is attained.

*Winding Gear and Motor.*—Since the combination of these is merely a matter of direct coupling, it presents no problems essentially different from the direct driving of any other class of machinery, and has, therefore, assumed a well-defined condition of standardisation. Owing to the essential difference in economical speed of the electrical and mechanical parts, worm gear is almost universally employed as the means of combination, occasionally, where conditions of price will allow, two worms with balanced thrust being adopted.

The question of the most suitable type of motor is one which more nearly concerns us, and is a matter upon which considerable difference of opinion still exists. In some few cases series-wound motors have been used, but the practice can only be condemned as hopelessly bad. The choice lies, therefore, between shunt and compound winding. At present the

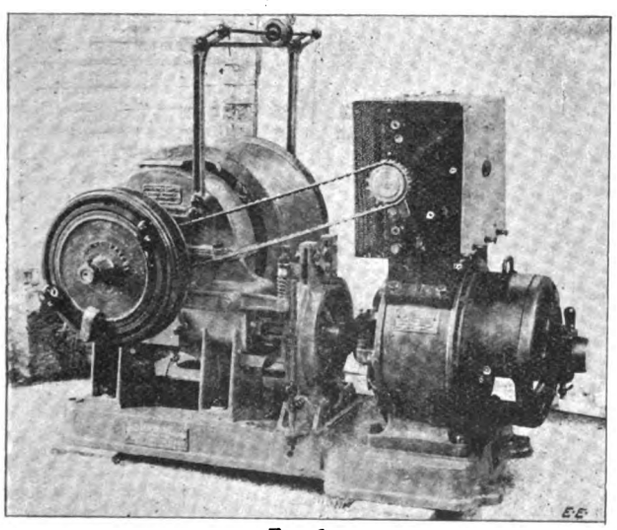


FIG. 1.

balance of opinion seems to be fairly even. The reasons given by the advocates of shunt winding are mainly greater simplicity of only one magnet winding, less space taken by insulation, and greater simplicity of the controller. Where, however, shunt winding is used, it is usually designed as if for a lower voltage than that on which the machine is to be used, and a resistance is placed in series with it. During the process of starting this resistance is short-circuited, thus making the machine take an abnormally large shunt current and producing the required extra torque to accelerate the load. Alteration of

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, March 20.

grouping of the shunt coils on a multipolar motor is also adopted by some firms, but in either case the nett result is to obtain the required increase of ampere-turns by an addition to the shunt current taken by the motor. Seeing, however, that the greatest trouble with lifts supplied from public lighting mains is their tendency to cause fluctuation of voltage by their demand on the mains at the instant of starting, it is difficult to see how the shunt winding can be really as satisfactory as a

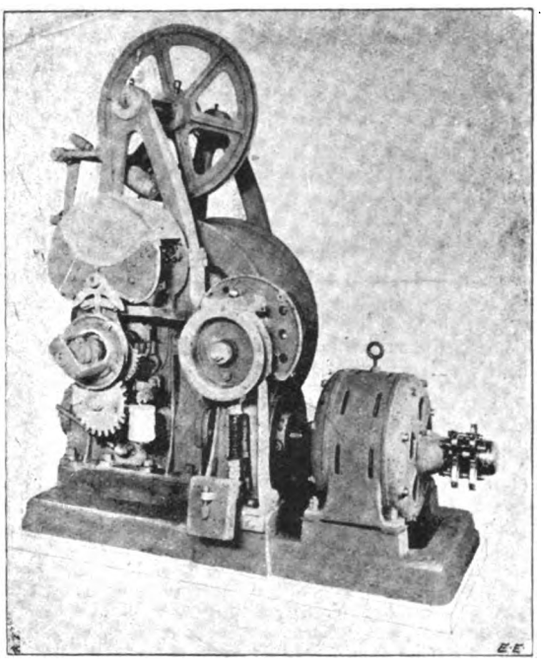


FIG. 1A.

properly designed compound-wound motor arranged to have its compound coils cut out after the process of accelerating is accomplished. The compounding merely takes the place of the last section of the starting resistance, so the complication of the controller is more imaginary than real. In this case the increase in ampere-turns is obtained by an alteration of the number of active turns, while the current value remains unchanged. In whichever way the increased excitation is obtained, it is essential that the magnetic density in the field magnet should be kept low, so that the temporary increase in excitation shall be as effective as possible in augmenting the field strength, and consequently the starting torque, of the motor.

Silence in running is also frequently a highly important matter, owing to the fact that the running machinery is located

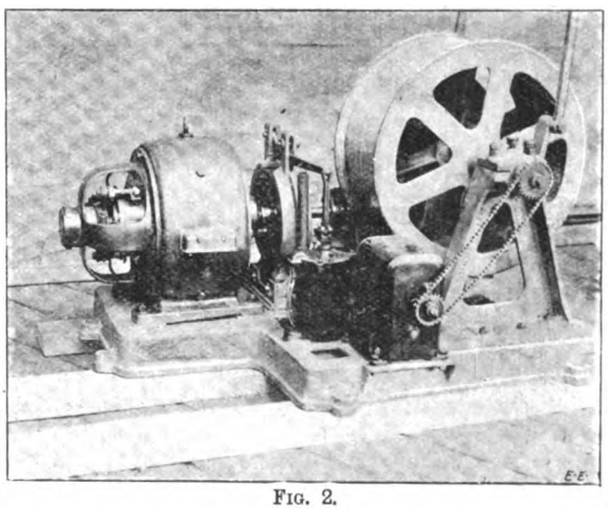


FIG. 2.

close to offices or dwelling apartments. It is, therefore, more than usually essential that the motor shall be capable of retaining a first-class surface on its commutator, and that the class of brush-holder should be such as to avoid "singing." The box type of holder so much in favour for other work is, perhaps, the most difficult to keep silent. The magnetic density in the teeth of the armature is also a matter which requires to be watched in this connection.

*Hand-Rope Gear and Reversing Switch.*—Where cheapness is an essential, hand-rope gear is at present the commonest method of operating the reversing and circuit-breaking switches. It usually consists of a more or less direct mechanical connection

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between what is virtually the handle of the switch and a rope, which passes through the cage, and is, therefore, available for a

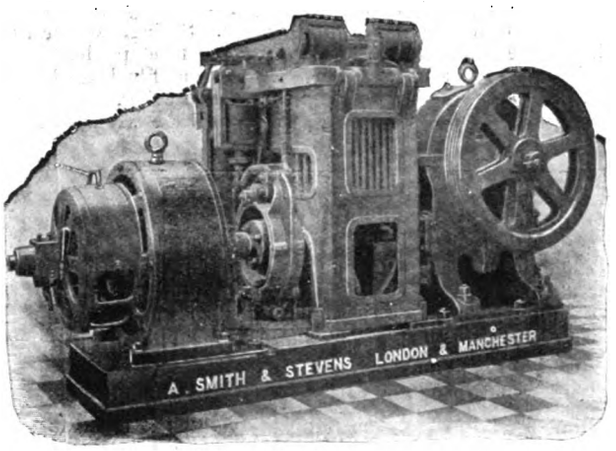


FIG. 2D.

man in the cage to set the switch or switches in any position he may desire. Examples of this method of control are shown in

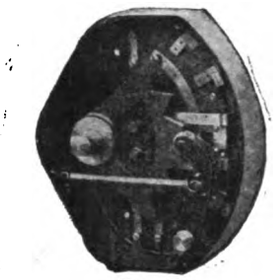

FIG. 3E.

Figs. 1, 1A, etc. (Note.—Illustrations of any one method of working have the same number, those having the same letter

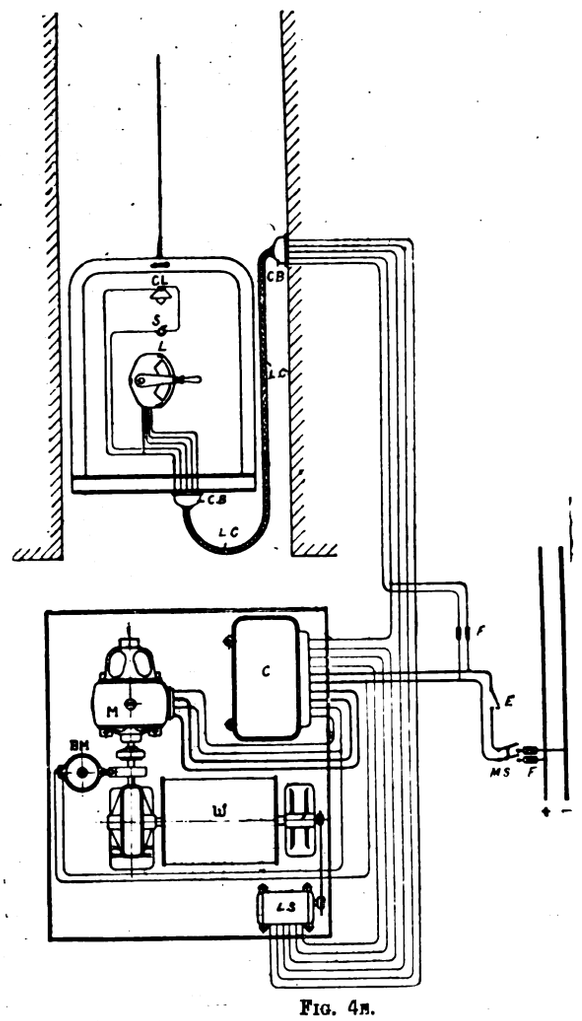


FIG. 4B.

attached are all the work of the same firm.) In many cases the reversing and circuit-breaking functions are both performed by the same switch, but there appears to be a tendency to separate the two operations. Probably this arises from the fact that

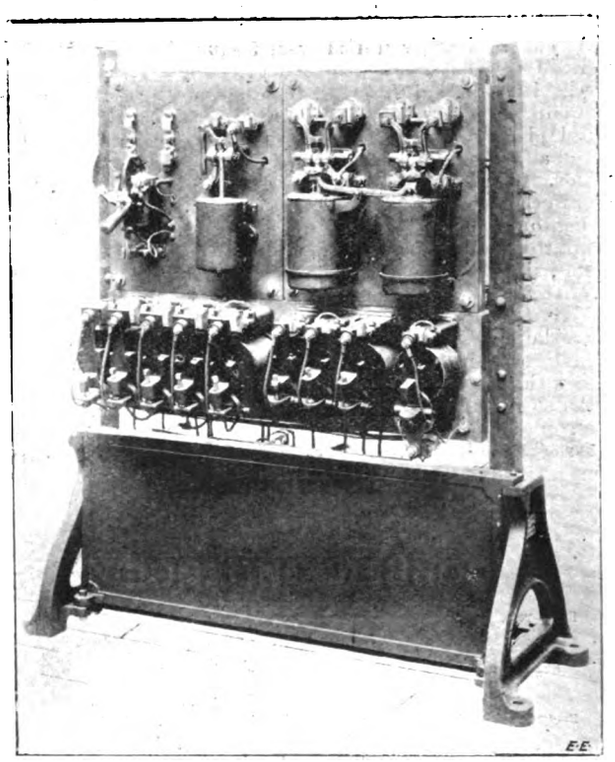

FIG. 5A.

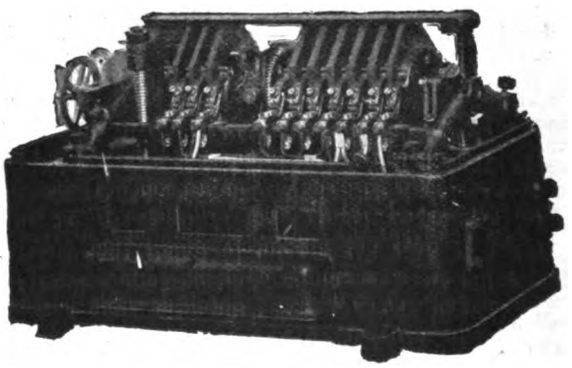

FIG. 5B.

with this arrangement it is possible to adopt more effective measures for magnetically blowing out the inevitable arc at the contacts.

Here is one of the points where differences are apt to arise between the mechanical and electrical men. The mechanical

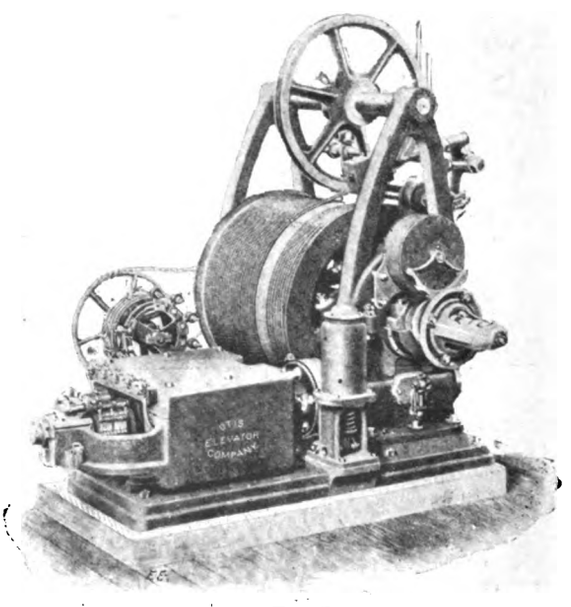


FIG. 7A.

man frequently contends that sparking at switches is purely the electrical man's concern. As a matter of fact, however, it

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appears to be almost impossible, under commercial conditions, to design a switch which cannot be destroyed by sparking, unless some degree of common-sense be assumed in the working of it. Since it is impossible for the man at the rope to know the position of his switches by the use of his eyes, it is necessary that mechanical aids be given him to supply the deficiency. Even when a definite bias of position is given to

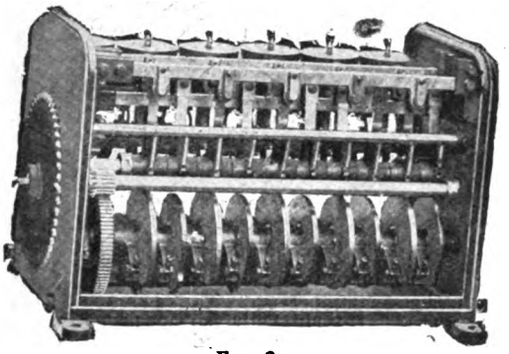

FIG. 3E.

the hand-rope, unless it is so strong as to almost overpower the man destruction of switch contacts goes on very rapidly owing to an unskilful attendant "inching" the cage to bring it exactly to a floor. Of course, switches for such service are nearly always designed with easily-renewable contacts; but it does not strike one as good engineering to make provision for vaporising brass and copper unless there is absolutely no other way out of the difficulty. This difficulty in adapting the apparently simple hand-rope idea to the operation of switches,

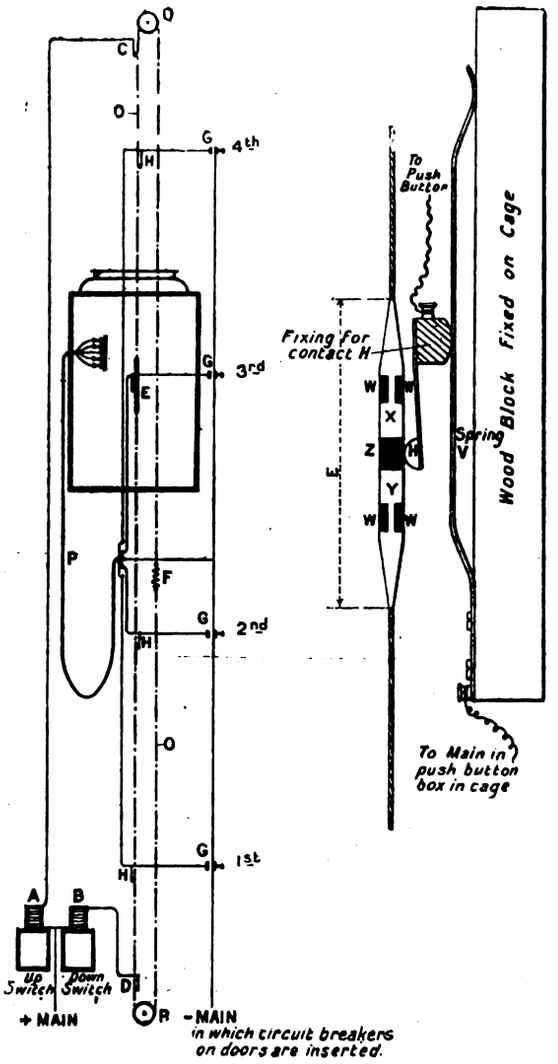


FIG. 9C.

and also the difficulty of accurate stoppage at a floor, become more and more important as the working speed of the lift is increased. In consequence, when speeds of more than 160ft. per minute are required it is now becoming usual to supersede the mechanical hand-rope transmission by an electrical method, in which the attendant merely moves a switch in the cage. Where the cage-switch method is used, the general practice is to avoid taking the actual power circuit to the cage, owing to the probabilities of trouble where heavy flexible cable is required. An independent circuit carrying a comparatively small current is led into the cage, this current being used to energise the operating solenoids of the power switches.

Figs. 2, 2D, etc., represent general views of the hoisting gear suitable for this class of control. Figs. 3E, 4E, and 5E respectively show cage switch, connection arrangements, and forms of automatic rheostat for this class of service.

Where it is desired to dispense with the services of a lift attendant, and consequently no skill on the part of the user can be assumed, the cage-switch method is supplanted by a further developed form of electrical transmission known as the "push-button" system, varieties of which are now supplied by several makers. In this system it is generally found necessary to still further reduce the current in the circuits leading to the cage or car owing not only to the difficulty of dealing with large currents on push-button contacts, but also to the similar though perhaps greater difficulty with the door contacts, which are practically indispensable on this class of work. In such cases the majority of makers insert a relay between the push-button and the circuit of the solenoid switch. Of course, this introduction of relays must mean so many more places where faults are liable to develop, but as the relays are all grouped together under cover in the motor-room, this disadvantage is perhaps not so great as at first sight appears.

Fig. 7A is a general view of such a gear. Fig. 8E is an example of the relay arrangements. Figs. 9E, 9C, indicate the arrangements of connections. Fig. 10C is interesting as an example of a push-button designed to deal with currents of the same strength as those used with switch control, and thus avoid the use of relays.

*Reversing and Circuit-Breaking Switches.*—In conjunction with the hand-rope method of working a reversing switch of the rotary type is frequently adopted, and in some cases a partial rotary motion is used, but is adapted to switches of the knife-blade type. Fig. 11C shows an example of such a switch mounted on the top of its rheostat. The straight line push-and-pull form of reversing switch, which at first sight seems especially suitable for operation by rope, appears to have only come into use for small amounts of power, such as are required on service lifts. It seems rather a difficult matter to find a

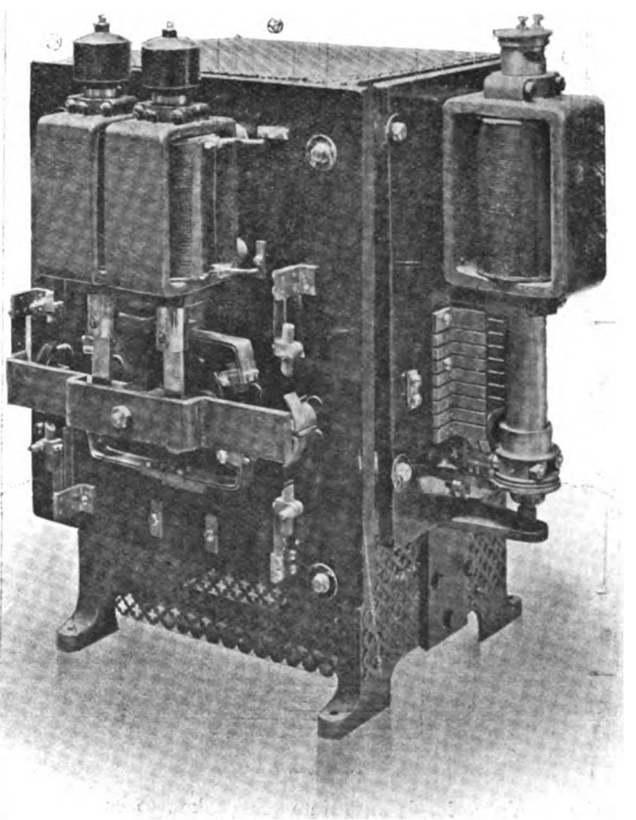

FIG. 11C.

satisfactory reason for this trend of general practice. When the hand-rope is superseded by either form of electrical transmission, it is usual to combine the reversing and circuit-breaking functions, but to divide the reversing arrangement into two switches, one of which is in use on the up travel and the other on the down journey.

*Rheostats.*—Formerly the American method of causing the

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motor to mechanically provide the motion necessary to cut out its own starting resistance was very much in favour, and it is still retained by some makers owing to its inherent properties of preventing the motor being started against an overload, and also the certainty of a definite time being taken to cut out the starting resistance. It has, however, the serious drawback that, unless further auxiliary apparatus is employed, it is necessary that sufficient current to start the motor shall pass through it on the first contact stud. General practice now appears to tend in the direction of obtaining this motion electrically even when hand-rope control is in use. The time element during the process of acceleration is usually obtained by means of an air or oil dash-pot. Instances are to be seen in Figs. 11G and 11C. To avoid the use of a dash-pot, which as a piece of mechanism has doubtless received a worse character than it deserves, some makers adopt the clockmaker's striking-clock governor—viz., an air-vane geared up to run at a very high speed. An example of this can be seen in Fig. 5E. There appears, however, to be still room for improvement, as all methods of slowly-moving contact makers over studs are more destructive than intelligent hand working. What is wanted is a quick movement from one stud to the next and a prolonged pause on each stud, but an intermittent motion such as this is always difficult to obtain by mechanism that is at once cheap and reliable.

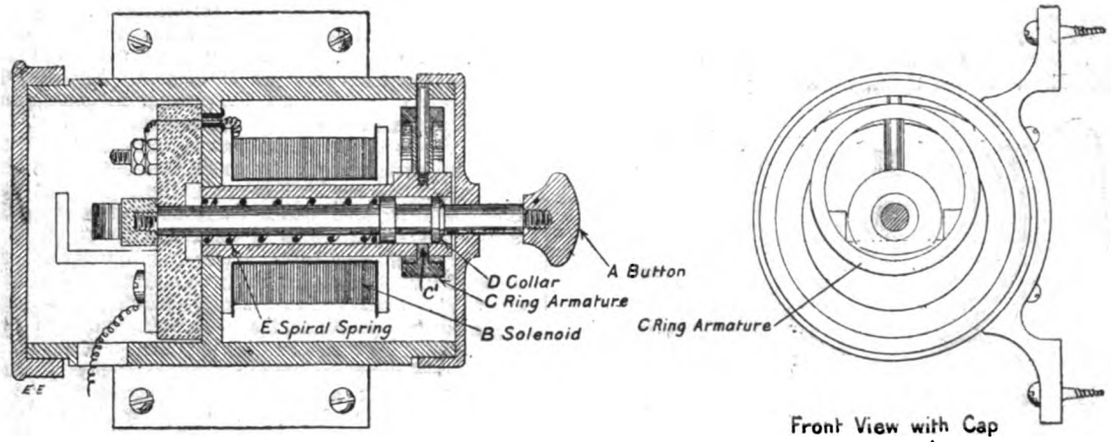


FIG. 10C

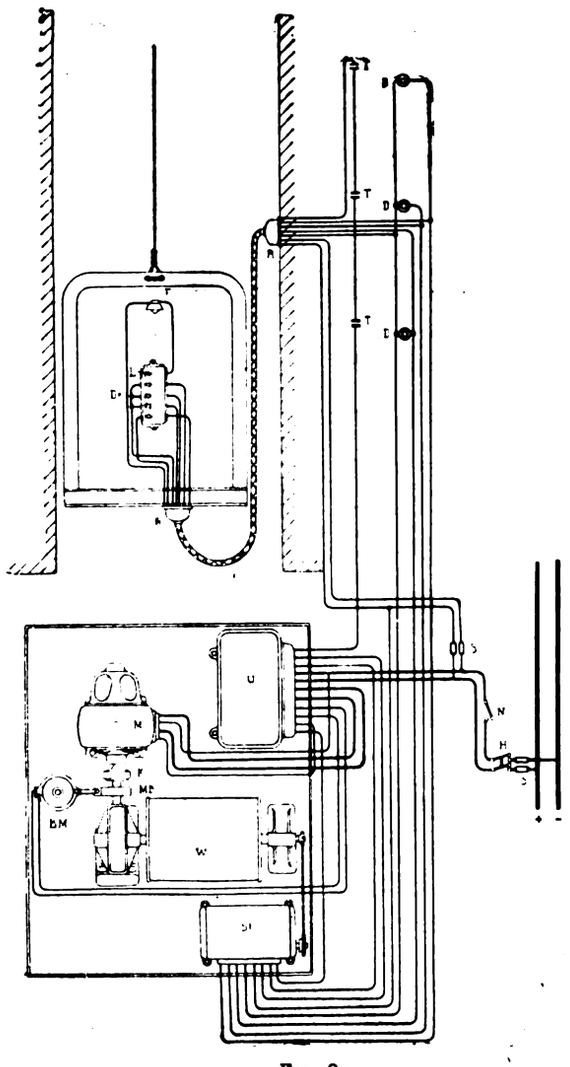

FIG. 9E.

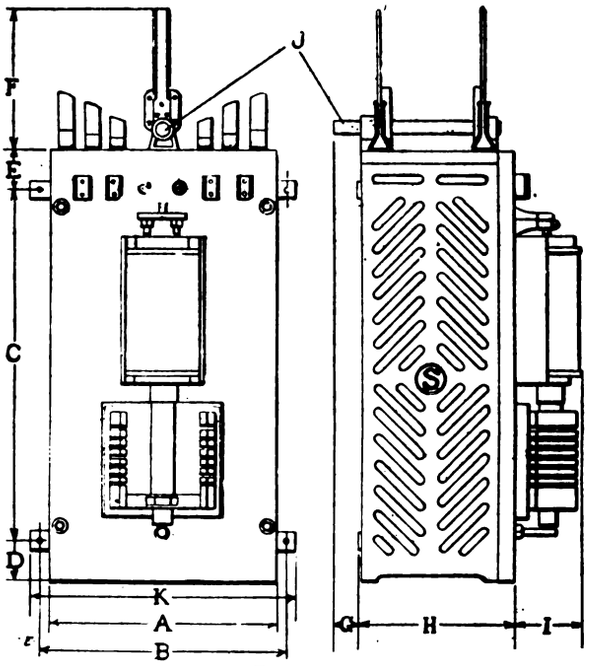


FIG. 11G.

*(To be continued.)*

## PHYSICAL SOCIETY.

At the meeting of this society on March 24, Prof. J. H. Poynting, F.R.S., president, in the chair,

**Mr. W. C. Clinton** read a "**Note on the Voltage Ratios of an Inverted Rotary Converter.**" The values of the voltage ratios usually given for an inverted rotary converter make no allowance for the resistance of the armature. In this note terms due to the effect of armature resistance are introduced into the ordinary theoretical equations. The resultant voltage on the alternate-current side is found to be less than that given by the usual rule. The calculation is only made for open circuit conditions on the alternate-current side.

A paper "**On the Flux of Light from the Electric Arc with varying Power Supply**" was read by **Mr. G. B. Dyke.** The paper records the results of experiments made on the electric arc with the following objects: (1) to obtain a series of curves for alternating and continuous arcs of different lengths showing the relation between the mean spherical candle-power and the power supplied to the arc; (2) to compare the efficiencies of the alternating and continuous arcs under different conditions of arc length and power supply. The subject being too wide to deal with in its entirety, the following restrictions were made: The carbons used were 12mm. diameter cored (upper) and 10mm. solid (lower). The frequency of the alternating current was 80 cycles. The mean spherical candle-power was determined directly by means of an integrating photometer described by the author in a paper read before the society in November, 1904. Curves connecting the M.S.C.P. with the watts are given for eight arc lengths

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varying from $\frac{1}{16}$in. to $\frac{1}{8}$in., for both continuous and alternating currents. These curves are found to be straight lines which cut the axis of watts at points between 200 and 400 watts. Alternate and continuous-current curves for the same arc length are found to meet the axis of watts in the same point, showing the equality of the losses by dissipation of energy in other forms than that of light. For normal arc lengths the alternating-current efficiency is about two-thirds of the continuous-current efficiency. If the arc length is reduced below $\frac{1}{8}$in., the alternating current curve rises towards the continuous-current curve until at an arc length of about $\frac{3}{32}$in. the two efficiencies practically coincide. On further reducing the arc length the alternate-current curve rises above the continuous-current curve. An approximate analysis of the case of equal efficiencies is given, the results of which give an arc length similar to that obtained experimentally.

**Dr. J. A. Fleming** congratulated the author, and referred to the practical value of the experiments. The ordinary method of comparing lamps by their M.H.C.P. was unscientific. What was wanted was the total flux of light per watt, and this important figure was obtained at once by the integrating photometer used by the author. Prof. Fleming instanced the case of a Nernst lamp and an ordinary carbon-filament lamp, pointing out that the ordinary tests indicated that the Nernst lamp was twice as efficient as the ordinary lamp, whereas a comparison of the total flux per watt showed an increased efficiency in the Nernst lamp of only 25 per cent.

**Mr. Patterson** expressed his interest in the paper, and referred to the photometrical work at present being carried out at the National Physical Laboratory. He pointed out that the variation of the light from an electric arc necessitated a great number of readings in order to get a satisfactory mean value. The photometer used by the author only integrated the light in one plane, and it would be more satisfactory to integrate in two planes at right angles to one another.

A paper "**On the Application of the Cymometer to the Measurement of Coefficiencies of Coupling of Oscillation Transformers**" was read by **Dr. J. A. Fleming**. This paper deals first with the latest pattern of instrument, called by the author a cymometer, designed for the measurement of the frequency of electric oscillations, and also the length of long electric waves. It consists of a sliding tubular condenser, consisting of two brass tubes, separated by a thin ebonite tube, the outer tube being capable of sliding off the inner tube. Parallel with this sliding condenser is placed an inductance coil or helix, of bare copper wire, wound on an ebonite tube. The outer brass tube of the sliding condenser carries a collar, which in turn carries a rod with a crutch at the end resting upon the inductance coil. The circuit of the instrument is completed by a copper bar, which joins one end of the inductance coil with the inner surface of the sliding condenser. When the outer tube of the condenser is moved by an insulating handle, the same motion reduces equally the capacity of the condenser and the portion of the inductance coil included in the closed circuit. The circuit therefore consists of a variable capacity and inductance in series. The author calls the square root of the product of the capacity and inductance in any position, the *oscillation constant* of the instrument. A scale is provided parallel with the inductance coil, on which is engraved the oscillation constant and the corresponding frequencies connected therewith by the formula

$$n = 1/2\pi\sqrt{C L}.$$

In addition to this, the instrument is provided with a vacuum tube, preferably a neon vacuum, which is connected between the inner and outer surfaces of the condenser. The instrument is used in the following manner. The copper bar is placed parallel and near to a circuit in which oscillations are taking place, and the handle of the instrument is moved, thus varying the oscillation constant, until the vacuum tube glows most brightly. Under these circumstances, it is known that the circuit of the cymometer is in resonance with that of the circuit being tested, and their oscillation constants are therefore the same, hence the scale reading gives the product of the capacity and inductance of the circuit being tested. The instrument is also provided with a rectangular wire circuit, the inductance of which is known. If this circuit is joined up with any unknown capacity and oscillations set up in it, the cymometer can be used as above, to determine the product of capacity and inductance in the circuit being tested, and the inductance being known, the capacity is therefore known also. Again, if we have any oscillation transformer, we can join up the primary and secondary circuits, so as to inductively oppose or aid one another. If we call L and N the inductance of the primary and secondary circuit respectively, and M their mutual inductance, the effective inductances, $L_1$ and $L_2$ of the two circuits joined in the two ways are respectively given by

$$L_1 = L + 2M + N. \qquad L_2 = L - 2M + N.$$

Hence we have $M = \frac{L_1 - L_2}{4}$ and $L + N = \frac{L_1 - L_2}{2}$.

If, then, either L or N is separately measured, and if the resultant inductance of the compound circuit is measured, we can find the coefficient of coupling $\frac{M}{\sqrt{L N}}$ of the oscillation transformer. The inductance of any circuit can be ascertained for the high-frequency currents by the cymometer in the following manner: The circuit to be tested is joined up in series with a known capacity, and the rectangular circuit provided with the instrument. Two measurements are then made: (1) when the inductance to be tested is included in the circuit, and (2) when excluded from it. If the observed oscillation constants under the two conditions are called $O_1$ $O_2$, then we have the following expression for the unknown inductance: $L' = \frac{O_1^2 - O_2^2}{C}$

The instrument can also be used for measuring the oscillation constant or the frequency in an open oscillating circuit, such as that of a wireless telegraph aerial, and by means of it the wave-length which is being sent out from the aerial can be measured, and also the wave length of waves being received on any aerial. The instrument can also be employed to analyse a compound oscillation taking place in a circuit and determine the component frequencies. It thus acts as an electrical equivalent of a spectroscope.

**Dr. W. Watson** expressed his interest in the paper, and said that the cymometer, on account of its simplicity, would be useful for lecture purposes. He asked Dr. Fleming if he thought that any of the anomalous results which had been obtained in determining specific inductive capacity by methods involving the mutual induction between two circuits might be due to the fact that oscillations of two different frequencies were induced in the secondary circuit. How did a change in the coefficient of coupling affect the energy transmitted to a secondary circuit?

**Prof. A. W. Reinold** said that the accuracy of the experiments depended upon the use of neon tubes, and he expressed the hope that it would soon be possible to obtain them easily. Referring to the fact that oscillations in a circuit containing capacity and inductance induced in a neighbouring circuit oscillations of two distinct periods, he asked Dr. Fleming what it was that determined the energies of the two oscillations. He also asked how, when measuring the wave-lengths of waves incident on an aerial, the fact that two oscillations were necessarily induced in the cymometer affected the utility of the instrument.

**Mr. A. Campbell** pointed out that ebonite was used as the dielectric in the sliding condenser, and asked if there was any variation in the capacity with change of frequency.

**Dr. Fleming**, in reply to Dr. Watson's question, said that undoubtedly errors might result in employing methods involving the mutual induction of two circuits for the determination of specific inductive capacities if the observer were not acquainted with the peculiarities of coupled circuits and high-frequency oscillations. The general theorem involved is that if there be two circuits, each having inductance and capacity, and oscillations are set up in one circuit by disruptive discharge in the other, then we have a compound oscillation set up in the secondary circuit which may be resolved into two frequencies which are different from the free natural frequency of each circuit separately. The theory has been fully worked out by A. Oberbeck (*Wied. Ann. der Physik*, 1895). Hence, if it were assumed that the resulting oscillation in the secondary circuit, even if it had the same natural period as the primary, was a single oscillation of the same period, an error would undoubtedly be made. Oberbeck has not given expressions for the respective energies of the two oscillations, but he has shown that the two oscillations have different damping. The coefficient of coupling determines the respective energies of the two oscillations, but Dr. Fleming said he had not yet given sufficient attention to the theoretical side of the subject to be able to furnish expressions for the energies of the two oscillations. In reply to Prof. Reinold, he said that if the mutual inductance between the aerial wire and the cymometer were small, as it was in the case of the instrument exhibited, then the cymometer only detected the oscillations which existed in the aerial. There was no creation of duplicate oscillations in and by the cymometer itself. In reply to Mr. Campbell, Dr. Fleming said that it had been shown by Prof. J. J. Thomson and others that the variation in dielectric constant with frequency was very small or even absent in the case of ebonite. That was the reason why ebonite was chosen for the dielectric tube. In the case of glass there is a large change in dielectric constant with frequency. As regards the commercial production of neon vacuum tubes, that subject was engaging his attention, and he hoped that they might soon be placed on the market. The beautiful process devised by Sir James Dewar of absorbing the common constituents of air by cocoanut charcoal at low temperatures enabled neon and helium to be prepared from the air without much trouble.

## LEGAL INTELLIGENCE.

### CITY OF LONDON LIGHTING COMPANY v. MASON, CATTLEY, AND CO.

In the City of London Court on Tuesday the plaintiffs sued the defendants for £9. 12s., for electric current supplied.

**Mr. D. M. Hogg**, counsel for the plaintiffs, said the case was a somewhat unusual one. The plaintiffs were suing for current supplied from July, 1900, to April, 1904. In 1894 the plaintiffs contracted with the defendants to give them a supply of electric light, and from then until 1900 there was no dispute between the parties. In 1900 the voltage of the company's current was changed, as also was the defendants' meter. The reading of the plaintiffs' meter was, under their Act of Parliament, conclusive evidence of the total amount of electric current consumed, in the absence of fraud. A new meter was put in in 1900, but the meter did not represent on the face of it the amount of current consumed. It was necessary to multiply the voltage registered by the meter by its constant. The defendants' old meter had had a constant of ·02. The new meter had a constant of just twice as much. Owing to a mistake in the company's office the books continued to show ·02 as the constant. The result was that for four years the defendants were only paying for half the current they used. The mistake was discovered in June, 1904, and although several letters were sent to the defendants they had not replied. There had been several mistakes of the same kind during the past year, and sometimes they were in favour of the consumer. The defendants' meter was tested by the city of London electric lighting inspector, Mr. Voysey, and the constant was proved to be ·04.

**Judge Lumley Smith**: I expect the defence is that if you make blunders you must stick to them.

**Mr. Hogg**: That is not the law.

Evidence having been given, **Mr. Harper**, for the defendants, submitted that the plaintiffs could not recover. He pointed out the

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enormous inconvenience to customers of electric light current if they were to be called upon four years afterwards to pay suggested arrears. Books had been balanced and accounts closed. The defendants' contract was a contract to pay what had been ascertained in a particular way. The company had sent in their accounts, and the defendants had done what was required of them in paying them. If a meter was found to be wrong, or any calculation was inaccurate, the company could not be compelled to refund to the consumer beyond the preceding quarter.

**Judge Lumley Smith** said he thought the energy sued for had been supplied and not paid for. Therefore, judgment must be given for the plaintiffs, but without costs.

**His Honour** enquired whether the plaintiff company had ever refunded any money to anybody.

**Mr. Hogg** said they paid back the sum of £460 recently for an error the other way.

# COMPANIES' MEETINGS AND REPORTS

## WILLANS AND ROBINSON.

The half-yearly meeting of this Company was held at the Cannon-street Hotel on Wednesday, Mr. Mark Robinson presiding. Particulars of the report appeared in our last week's issue.

The **Chairman** opened his remarks with a candid statement that the figures he had to bring before the shareholders were worse than any in the history of the Company. To a great extent the unfavourable position was due to industrial depression, but a very large part of it was accounted for by the fact that the selling price per horse-power had fallen by some 26 per cent. in the same period—a fall in itself sufficient to wipe out even a very high rate of profit and turn it into a loss. The shareholders would appreciate that when the change in conditions had such an effect upon the old-established Rugby business, it was bound to exercise a great influence upon the new undertaking at Queen's Ferry, where the Company was trying to create a trade in competition with established firms, while struggling with troubles and disadvantages. Reverting to the Rugby figures, he was glad to say there were prospects of improvement in the engine business, and of some return towards remunerative prices. The directors held very hopeful views of the Company's new steam-turbine business. The success of the earlier turbines, already at work, had been remarkable. The Company was further fortunate in having control over other valuable patents for improvements in turbines, and in that connection he was sure it would be a satisfaction to shareholders to know that, in quitting the Board, Captain Sankey had left behind him a patent which the directors believed to be of great importance. Although the turbines were too new a development to be in a position to make a profit already, the directors could say with confidence that everything about it had so far gone with a success fully up to their expectations, and that their hopes were of the highest. The prospects of the large gas-engine had undergone some transition, and the directors did not now attach so much urgency to this branch. Regarding Queen's Ferry, he thought the directors could at least say that no money had been lost by restarting, and that if present appearances might be trusted the steelworks were likely to pay their full share of the necessary general charges of the place and to yield a substantial profit. Both the Admiralty and the War Office showed interest in the Company's speciality, and all the auguries were favourable. When depreciation was allowed for and the effect of some exceptional writings-down of stocks, etc., were allowed for, the real loss upon working on—perhaps he should say upon not working—was less for the past half-year than for the half-year before, not by £3,026 as the accounts appeared to show, but by as much as £8 674. Further, the loss shown was in no small part due to a breakdown of one of the large hydraulic pumping engines in October, which almost entirely stopped work in the tube works, and, indirectly, in the machine shop, for nearly half the period covered by the accounts. With regard to the proposed resolution for reducing the number of directors, the Board was of opinion that that course was eminently wise, as the duties to be performed distributed themselves to advantage among that number. It had been suggested that there should be a separate Board for Queen's Ferry, having a majority of its members unconnected with the Rugby Board. The Board could not endorse that scheme. Considerable reductions in staff and expenses generally had gradually taken effect during the last half-year.

**Mr. Anderson**, a director, said that he came to the conclusion that it would be better to work the Queen's Ferry works rather than let them lie idle waiting for a purchaser. The steelworks were now turning out 150 tons a week. There was every prospect of that department becoming a valuable part of the business.

**Mr. J. C. Peache**, director, in giving particulars of the turbine business, said that he was perfectly confident that it was an assured success.

The **Chairman**, replying to questions, agreed that more enterprise was needed at Queen's Ferry, but they had no capital for that purpose. He hoped that the Queen's Ferry might be separated from the other part of the business, but it would be necessary first to show the world what could be done there.

The report was adopted with one dissentient, and it was resolved to reduce the number of directors to five. Mr. Mark Robinson was re-elected for the usual period.

## SWANSEA IMPROVEMENTS AND TRAMWAYS.

The half-yearly meeting of this Company was held in London, Mr. C. G. Tegetmeier presiding. The report showed that the gross receipts amounted to £15 361. 11s. 2d. during the half-year ended December last, which was a decrease of £124 6s. 5d. upon the corresponding period of the previous year. The expenses amounted to £10 598 5s. 6d., an increase of £476. 10s. 10d. The profit on the half-year was £4 763. 5s. 8d., to which was added the £2,775. 8s. 2d. brought forward. The directors recommended that the sum should be allocated as follows: £1 000 to the reserve fund, £1,987. 10s. 4d. to be carried forward, and the balance in dividends at the rates of 6 per cent. on the preference shares, 5 per cent. on the second preference shares, and 2½ per cent. on the ordinary shares.

In moving the adoption of the report, the **Chairman** explained that part of the decrease in the receipts was due to the interference with traffic through alterations and extensions.

The report was adopted.

## WINCHESTER ELECTRIC LIGHT AND POWER.

At the annual meeting of this Company good progress was reported. A net profit of £5 706 was made during the year, and a dividend of 5½ per cent. per annum was declared.

## GATESHEAD AND DISTRICT TRAMWAYS.

The twenty-third annual general meeting of this Company was held last week at the London offices of the Company, Norfolk-street, Strand, Mr. C. R. Green presiding

The **Chairman**, in moving the adoption of the report, said that the total revenue for the past year showed an increase of £717, and the expenditure a decrease of £229. He thought these figures might be considered highly satisfactory, trade in the North having been very bad. Business was however, beginning to improve. The amount to be placed to depreciation and reserve fund had been increased by £500 as compared with last year. The directors had succeeded in obtaining a reduction in their rate assessment from £911 to £583, and from Jan. 1 next a new arrangement is expected to result in a saving of from £1,500 to £2 000 per annum for current.

The report was adopted unanimously.

Mr. W. J. Greer and Mr. H. S Day were re-elected directors, and Mr. J. W. Armstrong auditor at a remuneration of 20 guineas.

## DEVONPORT AND DISTRICT TRAMWAYS.

The thirteenth half-yearly meeting of this Company was held at Donington House, London, on Friday last, Mr. W. G. Bond, chairman of directors, presiding.

The report showed that the total revenue for the six months amounted to £14,713, and after deducting all expenses chargeable to revenue, there was a profit of £2 0/0. Adding to this £2,159 brought forward from the previous account, there was an available balance of £4,230 which the directors proposed should be applied: to depreciation and reserve fund, £1,500; dividend at the rate of 4 per cent. per annum, £2,649; to next account, £80. The receipts again showed an increase as compared with those of the corresponding half of 1903, but, as the directors pointed out in their last report, the lines leased from the Corporation were not yet self-supporting, the profits for the half-year being reduced accordingly. The enquiry in reference to the application to the Light Railway Commissioners for power to construct light railways in Devonport and Plymouth was held on Nov. 23 last, when the Commissioners expressed their intention of sanctioning light railways from the present terminus at Stuart-road to the Plymouth boundary in Saltash-road. Owing to pressure of other business, Mr. J. S. Rayworth had resigned the chairmanship of the Board, and Mr. W. G. Bond had been elected in his place. The number of passengers carried in the last half-year was 2,929,228, compared with 2,830,626 for the previous half-year; the average receipts per passenger 1·18d. against 1·11d.; the average expenditure per passenger (apart from line rent), ·84d. against ·79d.; and the proportion of expenses to receipts 71 per cent. against 70·7 per cent.

The **Chairman**, in moving the adoption of the report, remarked that, owing to the gradients, which involved a relatively heavy current consumption and other peculiar expenses, Devonport could never be a cheap system to work, but the directors kept a watchful eye on every item of expenditure for saving current. The building operations going on in the neighbourhood might be expected to bring more traffic.

The report was unanimously adopted.

## SOUTH WALES ELECTRICAL POWER DISTRIBUTION.

The third ordinary meeting of this Company was held at Cardiff on Saturday.

**Mr. Robert Forrest, J.P.**, the chairman, in moving the adoption of the report (particulars of which we gave in our issue of the 24th ult.), stated that the difficulty of obtaining plant from the contractors had now disappeared, but the customers had experienced the same delay in getting their plant delivered. Hence the Company were two years late in obtaining the substantial revenue which their orders and contracts would eventually give them.

The report was unanimously agreed to.

## BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY.

The annual meeting of this Company was held at its London offices, Mr. A. H. Sanderson, J.P., chairman of the Company, presiding.

Particulars of the report and accounts appeared in our issue of the 17th ult. There was an increase in gross receipts of £4,756, and a

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dividend at the rate of 7 per cent. was proposed. The Richmond Company is reported to be making good progress.

The report was adopted, and it was decided to increase the capital by a further issue of 10,000 preference shares at £10 each, and 10,000 ordinary shares at £10.

## RHODES ELECTRICAL MANUFACTURING.

The first annual meeting of this Company was held last week, Mr. A. L. Rhodes presiding.

The **Chairman** stated that their turnover was on the up grade, notwithstanding the fact that prices had gone down considerably. After providing for all expenses, and putting aside a reserve of 20 per cent. for goods out on approval, the net profits for the year amounted to £3,714. The report was agreed to, and it was resolved to confirm the interim dividend paid, and to sanction a final one for the current financial year of 6 per cent.

## GUILDFORD ELECTRICITY SUPPLY.

The annual meeting of this Company was held last week, Dr. F. R. Russell presiding.

The **Chairman** having generally reviewed the report (of which we gave particulars last week), the same was adopted, dividends of 6 per cent. and 3 per cent. being declared on the preference and ordinary shares respectively.

A sum of £100 was voted to the directors for their services since 1896.

## CHISWICK ELECTRICITY SUPPLY.

The report for the 12 months ending Dec. 31, 1904, states that the business of the Corporation shows a steady increase, and to meet this extensions have been made from time to time. During the year £10 937. 10s. 9d. has been expended on capital account for new machinery, mains, etc. At Chiswick, at the end of 1904, the equivalent of 29,658 lamps was wired to the mains, as compared with 25 159 at the end of 1903; and at Aberystwyth the equivalent of 11,902 lamps as compared with 11 286. Chiswick being a rapidly growing district, there is every reason to believe that the rate of progress indicated by these figures will be fully maintained. During the year the capacity of the Chiswick generating station was increased by the addition of a new 500 h.p. generating set. The station can now supply 50,000 lamps connected to the mains, and efforts are being made to get the new machinery well loaded up without delay. The economy effected by the use of the condenser, which started working a year ago, will be apparent from the accounts. The total profit made by the Corporation for the year amounted to £4,370. 10s. 8d. Out of this sum interest on debentures and loans, amounting to £1 513 8s. 2d., has been paid, £184 11s. 6d has been carried to depreciation reserve account, a balance of £2,673 being carried to the credit of profit and loss account. This latter the directors propose to apply to the payment of a dividend on the ordinary shares at the rate of 4½ per cent. per annum for the year.

## KIDDERMINSTER ELECTRIC LIGHTING AND TRACTION.

The gross receipts for 1904 total £6,300, including £2 000 received as dividend on 5,720 3½ per cent. shares held in the Kidderminster and Stourport Electric Traction Company. After deduction of increased expenses and interest on loans, the net improvement is £200. The carry forward, however, is reduced by £300, the reason being that £500 is now applied to depreciation and reserve, for which no appropriation was made last year.

## MERTHYR ELECTRIC TRACTION AND LIGHTING.

This Company's report for 1904 shows much the same result as for the previous year, the gross gain being £350. On the other hand, there is an increase of £700 in expenses—mainly on account of exceptional repairs in the lighting department. Reserve and depreciation receive £500 in lieu of £250, but there is no dividend for the £30,000 of ordinary capital, which got 2½ per cent. for 1903.

## CALCUTTA TRAMWAYS.

The report for the year 1904 shows gross traffic receipts £127,780, working expenditure under all heads £64 553, and a revenue balance, after crediting sundry receipts, of £63,513. The interest on debentures, less the amount earned by the employment of moneys in hand, has taken £14,255, and the interim dividend paid in October last £15 340, leaving £33,917, in addition to the amount brought in from the accounts of 1903, £2,351, or in all £36,268 to be now dealt with. In October last the 2,732 shares which had not been applied for by shareholders when the previous issue of capital was made were sold, and a premium of £6,557 over their par value was obtained. This sum has been credited to the depreciation fund. From the net revenue balance of £36,268 the directors propose to allocate a further sum of £8 442 to the depreciation fund, making a total addition for the year of £15,000 and bringing the amount at credit of that account to £42,792. The balance then remaining will be £27,826, from which the directors recommend that a final dividend of 5s. per share, absorbing £26,250, be now paid, which, with the interim dividend paid in October, gives a return of 8 per cent. for the year, free of tax, and the balance of £1,576 is carried forward. During the currency of the year large sums have been expended in consolidating and improving the system, and in preparing for the additional demands which will be made upon its resources to meet the requirements of the extensions shortly to come into operation, as well as those which are rendered necessary by the expansion now taking place on the existing system.

## ANGLO-ARGENTINE TRAMWAYS.

The report for the year 1904 states that the gross receipts amounted to £418 093, the working expenses to £327 528 and debenture interest and sinking fund to £16 562, leaving a net profit of £174 003. The directors recommend a final dividend of 5s. per share on the ordinary shares, absorbing £42,500, which, with the 3s. per share paid in October last, will make 8s. per share, or 8 per cent. for the year, and £5 922 is carried forward The working expenses amount to 54·42 per cent., as compared with 53·02 per cent. in 1903. The gross receipts for the year as compared with 1903 show an increase of £39,099, and the expenses show an increase of £53 102. The item "premium on debenture stock." amounting to £38,635, for some years appearing on the debit side of the balance-sheet, has been written off "cost of concessions, etc." The Board also considered it advisable to write off so much of the old reserve account as was not represented by investments, and a sum of £50,172 has been written off accordingly. The Company took over the City of Buenos Ayres Tramways Company's system on Jan. 1 last. The electrical conversion of those lines is in active progress, and will, it is expected, be completed within the next 18 months. Towards the end of last year a strike occurred amongst the employés of some of the railway and tramway companies in Buenos Ayres. This Company was not directly affected, but the result was that a general and uniform scale of revised wages and hours of labour was adopted by all the electrical tramway companies, which will entail some increase in the wages account in the current and future years.

## BABCOCK AND WILCOX.

The report for 1904 states that the net profit, after deducting depreciation on plant, etc., amounts to £289 748. To this has to be added the balance brought forward from last account, £26 820 (less £1 050 voted to the directors as bonus), making a balance of £315 519. The interim dividends to June 30, 1904 (paid Oct. 1, 1904), of 3 per cent. on the preference shares and of 8 per cent on the ordinary shares, absorbed £245,400, leaving a balance of £270,119 From this the directors recommend that the following dividends be paid for the half-year ended Dec. 31: dividend of 3 per cent. on the preference shares (from which income tax is to be deducted), £3 000; dividend of 8 per cent. on the ordinary shares (free of income tax), £242,400; and bonus of 4 per cent. on the ordinary shares (free of income tax), £21,200. After placing to the reserve fund £175 000, there remains a balance to be carried forward of £28 519. The directors report increased profits during 1904, the increase being mainly due to important export orders that were executed during the year. As some of the reserve fund now forms part of the working capital, the directors have under consideration a proposal that this should be taken from the reserve fund and added to the capital account.

## TYNEMOUTH AND DISTRICT ELECTRIC TRACTION.

The annual meeting of this Company was held in London on Friday last, Mr. W. J. Greer presiding.

The **Chairman**, in moving the adoption of the report, said that industrial depression had been responsible for a reduction in the receipts of £1 027. 8s. 10d. as compared with last year. Notwithstanding this there was a profit on the year's working of £5 965 8s. 7d. This profit had been earned by the closest possible attention to each item of expenditure, with the result that the total expenditure for the year on power, running expenses, and repairs and maintenance, showed a reduction, as compared with the previous year, of £792. 15s. 2d. The chairman then paid a tribute to the efforts of the local directors and the manager. In August an interim dividend on the ordinary shares at the rate of 5 per cent. per annum was paid. The net profit available for distribution for the year, including the balance brought forward from the previous year, amounted to £6,205. 17s. 8d. Out of this sum the preference dividends, which fell due on Sept. 15 and March 15, had already been paid, and it was proposed to apply the balance at the rate of 9 per cent. per annum on the ordinary shares for the last half-year, making 7 per cent. for the whole year, and to place, as usual, £1,500 to depreciation and reserve fund, leaving a balance of £170 to be carried forward.

The report was adopted unanimously.

## POTTERIES ELECTRIC TRACTION.

The report for the year ended Dec. 31 last, to be submitted at the meeting on the 11th inst., states that gross receipts for the year have amounted to £103 294. After deducting all expenses chargeable to revenue, including repairs and maintenance and interest on loans and debenture stock, there remains a profit of £26,705. To this has to be added £766 brought forward from the previous account, making an available balance of £27,471. The directors propose to transfer to depreciation and reserve fund £2,500, to pay a dividend on the ordinary shares of 5 per cent. for the year, and to carry forward £472. An issue of £25 000 4½ per cent. debenture stock was made in May last. The capital expended during the year amounted to £16,730, which provided for the Hartshill and Sneyd Green extensions, etc. These two extensions were opened for public traffic on Feb. 23, 1904, and July 7, 1904, respectively. With reference to the Potteries Light Railways (Extensions) Order, 1902, an application recently made to the Board of Trade for an extension of time for the construction of some of the railways authorised and for the abandonment of others has been granted. Arrangements have been made with the local authorities concerned for the Company to

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construct some of these railways within one year and others within two years. It has been decided to test the traffic possibilities of routes beyond the existing tramways and light railways by means of motor omnibuses, and three such vehicles are on order and will shortly be delivered. It is proposed to commence shortly a service between Newcastle and Trentham, and it is probable that other routes will be tested in due course with a view to feeding the Company's existing lines.

### INDO-EUROPEAN TELEGRAPH.

The directors have decided, subject to final audit, to recommend the payment of a dividend for the six months ended Dec. 31, 1904, of 17s. 6d. per share, making, with the interim dividend already paid 6 per cent. for the year, and a bonus of 20s. per share, both free of income tax. They have decided also to recommend a special distribution of 15s. per share, free of income tax, out of the interest accrued during the year upon the reserve fund investments.

## NEW COMPANIES REGISTERED.

**Singapore Electric Tramways, Limited.**—Capital, $400,000 Objects: to acquire the business of the Singapore Tramways, Limited (incorporated in 1901); to adopt an agreement with the East India Construction Syndicate, Limited; to construct or acquire, equip, maintain, and work (either by electrical, steam, horse, or other power) tramways, railways, and other means of communication in Singapore and other parts of the Straits Settlements, or elsewhere.

### Liens Registered.

**Stanley Electric Carriage Company, Limited (London).**—£6,000 6 per cent. debentures, created and dated Jan. 23, 1905, charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees. Holder: Major-General E. H. Sartorius, K.C.B., Old Swan House, Chelsea.

**Anglo-Portuguese Telephone Company, Limited.**—A trust deed, dated March 4, 1905, to secure £50 000 5 per cent. mortgage debenture stock, has been registered. The company covenants with the trustees to execute and do all necessary instruments and acts in Portugal to charge the company's telephone undertaking, and charges (as a floating security) its other assets, present and future, including uncalled capital. Trustees: W. R. Davis, 10, Moorgate-street, E.C., and H. Allen, 88, Chancery-lane, W.C.

**Cambridge Electric Supply Company, Limited.**—Particulars of £30 000 debentures, created by resolution dated Dec. 2, 1904, have been filed, pursuant to Section 14 (4) of the Companies Act, 1900. Property charged: the company's undertaking and property, present and future, except uncalled capital. No trustees.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Cartagena.**—The Public Works Department, Madrid, require tenders for electrification of the local tramways.

**Christiania.**—The Post and Telegraph Department require tenders for 8,000 kilos. of 4 mm. bronze wire. Tenders by April 10.

**Erith (Kent).**—The Urban District Council invite tenders for the wiring of their car depôt and workshops. Tenders by April 17.

**Swindon.**—The Corporation invite tenders for the supply of electric motors for a period of three years. Tenders by April 17. See advertisement.

**Stockport.**—The Gas and Electricity Committee invite tenders for the supply of one 500-kw. steam generator. Tenders by April 26. See advertisement.

**Devonport.**—The Electricity Department invite tenders for the supply of one surface condenser with electrically-driven pumps. Tenders by April 18. See advertisement.

**Lisbon.**—The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

**French West Africa.**—The Governor-General of French West Africa, at Dakar, requires tenders for the erection and equipment of a central station at that place. Tenders by May 15.

**Brussels.**—The Government Railways require tenders for electric lamps and accessories in 21 lots. Specification No. 620 may be obtained from their Brussels office. Tenders by April 12.

**Bilbao.**—The Public Works Department at Madrid require tenders for the concession of an electric tramway in Bilbao, from the Calle de Hurtado de Amézaga to Plaza Circular. Tenders by April 24.

**Laventhem (Belgium).**—The Municipality require tenders for erection of central station, laying of mains, etc. Particulars (3s. 4d.) may be obtained from the Secretary of the Mayor of that place.

**Glasgow.**—The Corporation invite tenders for the supply of (1) main cables, (2) electricity meters, and (3) carbons for a period of 12 months from 31st prox. Tenders by April 17. See advertisement.

**Utrecht.**—The Municipal Authorities require tenders for 20 electric motors for the tramways. Specifications may be obtained at 5s. from the Municipal Secretary, Town Hall, Utrecht. Tenders by 2 p.m. on April 8.

**Nuneaton.**—The Electricity Committee of the Nuneaton and Chilvers Coton Urban District Council invite tenders for the supply and delivery of cables and joint-boxes. Tenders by April 10. See advertisement.

**Antwerp.**—Tenders will shortly be invited by the Belgian State Railways for the installation of electric light in their local railway station. Specification No. 619 may be obtained from the Government Railways Office, Brussels.

**Wimbledon.**—The Urban District Council invite tenders for the supply and erection of a 1,000-kw. steam-driven turbo-alternator, with condensing plant, high-tension switchgear, and pipework. Tenders by April 28. See advertisement.

**Glasgow.**—The Trustees of the Clyde Navigation invite tenders for electric power generating and lighting plant for Clydebank Dock. Specifications, etc., may be obtained from Mr. T. R. Mackenzie, 16, Robertson-street, Glasgow. Tenders by April 17.

**Batley.**—The Corporation invite tenders for tramway extensions—viz.: (Contract No. 14) permanent-way construction and paving; (15) overhead equipment, steel poles, etc.; (16) feeder cables, conduits, and accessories. Tenders to the Town Clerk by April 17.

**Cardiff.**—The Corporation invite tenders for the following plant for their power station on the extra high-tension system: extra high-tension three-phase main switchboard for power station; switchboards for sub-stations; motor-generators; rotary converters, etc. Tenders by April 17.

**Switzerland.**—M. R. Vontobel, of Winterthour, and M. Charles Probst, of Lucerne, have obtained a concession for the construction of a narrow-gauge electric railway from Meiringen to Gletsch. The total cost of the enterprise is estimated at £241,600; £19,600 is to be expended on rolling-stock.

**Antwerp.**—Tenders are invited for supply to the Belgian State Railways of materials for electric lighting. Tenders, by registered letter, must be addressed to the Administration des Chemins de fer de l'Etat, direction de la traction et du matérial, rue de Louvain, 13, Brussels. Plans, models, and samples are deposited at the Bureau des Adjudications, Musée Commercial, rue des Augustin, 15, Brussels, whence the special conditions of contract (No. 620) can be obtained. A copy of the general conditions and of the special conditions of contract may be examined at the offices of the Commercial Intelligence Branch of the Board of Trade. Tenders by April 12.

### RESULTS OF TENDERS.

**Matlock.**—The Urban District Council have accepted the tender of Mr. Shaw, of Sheffield, at 22s. 6d. per cwt., which is over £100 for a new cable for the tramway.

**Ilford.**—The Urban District Council have accepted the tender of the Cwmaman Coal Company, Cardiff, at 19s. 7d. a ton, for annual coal supplies for the electricity station.

**Rochdale.**—Messrs. Bruce Peebles and Co., Limited, East Pilton, Edinburgh, have received an order from the Corporation for three 120-kw. motor converters on the Peebles-Bragstad-La Cour patent system.

**London.**—The South-Eastern Railway Company have accepted the tender of W. R. Sykes Interlock Signal Company, at £7,000, to fit with electric signals the section of their line between London Bridge and Grove Park.

**Manchester.**—The Guardians of the Chorlton Union have accepted the tender of Messrs. H. Underwood and Co., Hulme, Manchester, for electric wiring of the four new infirm blocks at the new buildings at Withington Workhouse.

**Southend-on-Sea.**—The Corporation have awarded the Hart Accumulator Company, Limited, Marshgate-lane, Stratford, London, E., the contract for renewing battery at their electricity works, London-road, with 132 standard lighting type cells.

**Bolton.**—The Corporation have placed an order with the Key Engineering Company, Limited, Scottish Life-buildings, 38, Deansgate, Manchester, for "Cowan-Andrews" remote-control switchgear for their high-tension three-phase extensions, amounting to £466. 10s.

**Stoke Newington.**—Messrs. Bruce Peebles and Co., Limited, East Pilton, Edinburgh, have received the order for two 120 kw. motor-driven balancers, each consisting of a 120-kw. Peebles-Bragstad-La Cour motor converter, seven 50-kw. transformers, switchgear, etc., for stepping down 10,000-volt primary current.

**Leith.**—The Tramways Committee have accepted the tender of the British Insulated and Helsby Cable Company for the grooved wire required in the overhead installation for the new tramway system, at £1,195. 0s. 6d.; and the tender of S. Dixon and Son for the fittings to be used in connection with the wire, at £894. 7s. 9d.

**Fulham.**—The Borough Council have accepted the following tenders: Worthington Pump Company, at £1,119. 10s., for providing and fixing condensing plant (26in. vacuum); E. Green and Son, at £2,640, for providing and fixing an economiser; and the Underfeed Stoker Company, at £454, for the fitting of two existing boilers with their standard type of stoker.

**Shoreditch.**—The Borough Council have accepted the following tenders for annual supplies: J. Gibb and Co., Limited, Fenchurch-street, E.C., Contracts 1-4; Johnson and Phillips, Old Charlton, Contracts 5 and 13-23; Siemens Bros. and Co., Limited, Westminster, S.W., Contracts 10-12; Western Electric Company, Queen Victoria-street, E.C., Contracts 6-9.

**Bermondsey.**—The Electricity Committee have accepted the following tenders: Veritys, arc lamp carbons; Doulton and Co., conduits; Alexander, Duckham, and Co., engine oils; Reason Manufacturing Company and Chamberlain and Hookham, various electricity meters, indicators, and main fuses; Johnson and Phillips, meter boards, india-rubber cable jointing material, and lead-covered cables; Simplified Underground Conductor Company, compounds.

**Port Elizabeth.**—The following tenders have been accepted for the municipal electricity works recently advertised by Messrs. Davis and Soper: Tinker and Co., Manchester, boilers, superheaters, economisers,

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etc.; Brush Electrical Company, engines, including turbine-generators, etc.; Western Electric Company, cables, mains, etc.; Electrical Power Storage Company, accumulators and boosters; J. H. Spagnoletti, switchboard instruments; J. Spencer and Co., crane; General Electric Company, public and street lighting; Reason Manufacturing Company, meters; G. Hatch and Co., workshops, tools, etc.

**Gloucester.**—The Electricity Supply Committee have accepted the following tenders for the supply and erection of plant for the municipal electricity works: Boilers, H. and T. Danks, Limited, Crown Boiler Works, Netherton, near Dudley, £1,751. 10s.; generating plant, Phœnix Dynamo Manufacturing Company, Thornbury Works, Bradford, £3,093; condensing plant, Mirrlees-Watson Company, Limited, Scotland-street, Glasgow, £1,669; pipework, E. Le Bas and Co., Dock House, Billiter-street, London, £1,545; feed pump, British Electric Plant Company, Limited, Alloa, N.B., £238. 10s.

**South Shields.**—The Tramways Committee have accepted the tender of Messrs. Wm. Underwood and Bro., of Dukinfield, for the construction of the permanent way and track—part 1—of the new electric tram system, for £42,903; and their tender for the construction of copper rail bonds and bonding on tramways—part 2—for £770, has also been recommended for acceptance. The Electrical Committee of the Corporation have recommended the acceptance of the tenders of Messrs. Dick, Kerr, and Co., Limited, amounting to £2,695, for generators, and for conduits, cables, and overhead equipment, amounting to £12,321; and that of Messrs. J. and H. McLaren, Leeds, amounting to £8,400, for engines. The following tenders have been provisionally accepted: Messrs. Hurst, Nelson, and Co., Limited, 10 electric tramcars with Brill trucks, £5,307; Messrs. J. T. Eltringham and Co., South Shields, boiler, £1,365; the British Thomson-Houston Company, switchboard £665, pumps, foundations, etc., £2,500.

**Grimsby.**—The Electricity Committee have accepted the following tenders (1) for electrical plant: Crompton and Co., motors; Lassen and Bjort, 52, Queen Victoria-street, water purifier; Keighley Electrical Engineering Company, Keighley, starters; and (2) for supply of oil, stores, arc lamp carbons and globes, lamps, tools, rubber goods, cables, etc., required by the electricity department of the Corporation: C. Snowden and Sons, Grimsby, wood troughing; Marsh, Son, and Co., Upper Priory, Birmingham, wires, etc.; Midland Rubber Company, Ryland-street, Birmingham, rubber goods; Western Electric Company, North Woolwich, rubber-covered cables; British Insulated and Helsby Cables, Limited, Prescot, tapes; City Glass Company, East India Dock-road, Poplar, arc lamp globes; Crompton and Co., London, arc lamp carbons; E. L. Gowthorpe and Son, London-road, Nottingham, Jena gauge glasses; Electrical Company, Charing Cross-road, London, Nernst lamps and spares; General Electric Company, Newcastle-on-Tyne, incandescent lamps; A. Cook, Old Market Place, Grimsby, picks, spades, hammer shafts, files, and sundry tools; A. Duckham and Co., Phœnix Wharf, West Ferry-road, Millwall, oils.

# BUSINESS NOTES.

## TRACTION.

**Keighley.**—Tramway tickets at the rate of 10d. a dozen are to be issued.

**Stockport.**—The work of reconstructing the Hazel Grove route was commenced last week.

**Darlington.**—The Corporation have decided to abolish ½d. fares, but to increase the number of 1d. stages.

**York.**—The company having refused an offer of £9,000 for their undertaking, the Corporation have decided to discontinue negotiations.

**Penge.**—At a meeting of the Urban District Council last week it was decided to refer the preliminary estimates for the trams to the Finance Committee.

**Aberavon.**—Consequent upon a favourable report by Colonel Druitt, the Board of Trade intimate that a provisional order for this electric tramway will be granted.

**Ilford.**—Colonel Druitt, on behalf of the Board of Trade, inspected last Friday the track over Roding Bridge, which connects the Ilford and East Ham tramways, and found same satisfactory.

**Wigan.**—The Hindley and Poolstock routes were inspected last week by Colonel Druitt, who expressed his approval, and the service was opened to the public. Other routes are nearing completion.

**West Cumberland.**—This Bill, which seeks a further extension of time for the completion of the tramways, has been passed by the Commons Committee, and will be reported for third reading.

**Sheffield.**—It is reported that, consequent upon the adoption of a universal 1d. fare, the Corporation find themselves much handicapped in regard to extensions of the system, as the profits have been greatly reduced.

**Dundee.**—The first ordinary general meeting of the Dundee, Broughty Ferry, and District Tramways Company was held in London on Monday. The proceedings, which were conducted in private, were of a formal character.

**Parliamentary Bills.**—The Tyneside Tramways, the West Cumberland Tramways, the Metropolitan Railway, and the Metropolitan District Railway Bills have been read a third time in the House of Lords and passed. The South Lancashire Tramways Bill has been read a second time. In the House of Commons the London Southern Tramways Bill has been read a second time.

**Bradford.**—The official returns for the 12 months ending March 31 show a total revenue of £328,648, compared with £197,437 in the previous year, an increase of £31,211. The total number of passengers carried during the year was 47,108 000, against some 40 000,000 in the previous year, an increase of nearly 19 per cent. A gratifying feature is the increase in the revenue per car mile from 10·421d. to 10·88d. The number of cars has been increased during the year from 229 to 239. The number of car miles run was 5,040,452, or an increase of 493 510.

**Wallasey.**—The Urban District Council's tramway returns for March show: passengers, 571,018, against 497 351 last year; car mileage, 66,858, against 63,607; receipts, £3,995, against £3,598; average per car mile, 10·74d., against 9·8d. For the year ending March 31 the figures are: car miles, 778 072, against 757,688 for the year, an increase of £20 384; passengers 7,123,870 against 6 564,493, an increase of 559,377; receipts, £38 033 against £35,147, an increase of £2 886; and average per car mile, 11·73d., against 11·13d., an increase of ·6d.

**Derby.**—The receipts of the Corporation trams for the five weeks ended March 25 amounted to £3,030, more than double the figure for the corresponding period of last year. A petition has been received from the ratepayers on Kedleston-road asking for wood paving to be laid on the whole of that road in connection with the construction of the electrical tramways, and the committee have informed the petitioners that they cannot accede to the request. The committee have decided to run all cars from the Market-place to Alvaston between 5.24 p.m. and 6.10 p.m. daily, as workmen's cars, as an experiment.

**New Zealand.**—Westrumite is being tried on a portion of the Auckland Electric Tramways Company's lines. A high wind and plenty of traffic put the preparation to the test recently, and it answered very well, although handicapped by clouds of dust blown from side streets. The engineer's report on tramway extension, adopted by the Wellington City Council, gives details of proposed lines to Island Bay, Kilbirnie, and Brooklyn. The Island Bay section consists of 6,865ft. single track, the Kilbirnie section 8 100ft., including tunnel through Mount Victoria, while the total length of the Brooklyn section is 6,000ft.

**Aston.**—At Wednesday's meeting of the Town Council a discussion took place upon the proposal of the British Electric Traction Company and the City of Birmingham Tramway Company, that the city authorities should be substituted for those companies for the purpose of working the tramways within the borough. The report of the Public Works Committee stated that the town clerk had replied to the communication informing Mr. Lycett that in the event of the city authorities being willing to take the place of the tramway companies, under the agreement of June 9, 1903, the committee would be prepared to recommend the Council to enter into such agreements as might be necessary to bring about that end. The report was adopted.

**Middlesex Light Railways.**—Sir H. Jekyll heard an application at the Board of Trade on Wednesday on behalf of the Middlesex County Council, who sought power to complete certain light railways, authorised in 1901, which had not been completed before the expiration of the period limited by the order of 1904, and with slight alterations to bring the form of the order into harmony with more recent procedure. Sir H. Jekyll after hearing counsel, said the immediate question was whether it would be desirable or permissible to alter the general law, or make any variation in the general law of rating on an extension of time order. He doubted whether the Board of Trade would be disposed to entertain such an application. The decision will be announced in due course.

**Aberdeen.**—At Monday's meeting of the Council the renewal of the permanent way between Union-street and Kittybrewster was agreed upon, the estimated expense being £12,500. After discussion and a division, the agreement between the Corporation and the Suburban Tramways Company was renewed on the same terms as at present for another year, subject to certain alterations as to the number of through cars to be run over the lines of the Corporation, the wearing by the motormen and conductors of uniforms, etc. It was remitted to the Tramways Committee to watch over the interests of the Council, and take such action as they may deem expedient, in connection with the application of the Great North of Scotland Railway Company for power to run motorcars in districts served by their system.

**Swansea.**—The electrical equipment over the North Dock and New Cut will be of an interesting character. The trolley wires over each bridge will move with the bridge contact being automatically made with the trolley wires on the land by means of automatic switches. In the case of the drawbridge there will be an arm on the Port Tennant side of the bridge, which will make contact horizontally with the land. This arm attached to the bridge is raised in a vertical position when the bridge is open, thus preventing any ships' yards from coming into contact. The equipment is arranged so that is impossible for a car, in the event of a bridge being open, to get within a dangerous distance of the opening, the current being automatically cut of for a distance as soon as the bridge moves. The borough electrical engineer designed this equipment.

**Liverpool.**—The general manager of the Corporation tramways, Mr. C. R. Bellamy, has issued his fourth annual report, which records good all-round progress. As showing the effects of the top cover it is pointed out that the average maximum number of cars for 1904 was 398 as against 407 for 1903, while the passengers carried increased by 3,585,429. The number of passengers carried in 1904 was 116 642 663; the miles run were 12,166,419, and the total receipts were £540,850, an increase over 1903 of 3·2 per cent. in passengers and 3·1 per cent. in receipts. The increase for 1904 over 1897, the last year of the late company's control, was: passengers, 203·68 per cent.; mileage, 102·33 per cent.; and receipts, 86·02 per cent. Dealing with the overhead equipment, Mr. Bellamy reports that the total cost of energy last year was £94,937, as against £80,956 for the previous year. The units consumed (including Bootle) were 20,045,629 against 17,978,718. During the year 123 people fell in front of the cars or were knocked

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down, but the life-guard did its work well, only three cases of fracture occurring.

**Belfast.**—The arbitrator, Mr. Macassey, has delivered his award, and the net result is that the company will receive £304 448. The company's claim totalled £392,345, which they slightly reduced subsequently, while the Corporation put the value at £252 428. The items around which the difference occurred were the permanent way, physical junctions, depôts and machinery, cars and other vehicles, horses, harness, and miscellaneous stores. On the other items (Sydenham and Ligoniel undertakings, allowance under 1888 Act, etc.) the parties were agreed. A sum of £7,500 is awarded to the directors and other officials by way of compensation. Besides this, the Corporation take over the liability of £60,000 debentures. The costs of the arbitration devolve upon the Corporation. A short discussion ensued when the report was presented at a meeting of the Tramways and the Finance Committees, but, whilst one or two members considered the award somewhat high, the majority joined with the Lord Mayor in regarding the result as satisfactory. Good progress is reported with the work of reconstruction. The manager having advised against top covers for the present, the point was debated by the Corporation, and finally it was agreed that it should be an instruction to the Tramways Committee to look into the matter, and, if desirable, to order 20 or 30 top covers.

**Exeter.**—The new electric tramways were opened on Tuesday by the mayor (Mr. E. C. Perry) in the presence of a large concourse of people. The routes already equipped run from Livery Dole, the boundary between the city and Heavitree, to Eastgate, and thence, *via* High-street and Queen-street, to St. David's Station, while another line starting from the Cemetery-road runs through Blackboy-road and Sidwell-street to join the former at Eastgate. This line will be carried through to Dunsford Gate, St. Thomas, as soon as the removal of existing obstructions has been completed, while an extension to Cross Park, Heavitree, of the first route is rapidly being constructed. Powers have also been obtained in the Act of Parliament for the construction of tramways in other parts of the city, but these will not be proceeded with probably until it is found that the sections opened on Tuesday are a financial success. The ceremony was commenced with a satisfactory inaugural trip, in which the mayor and several members of the Corporation, with their ladies, the city electrical engineer (Mr. H. D. Munro), the consulting engineer (Mr. J. E. Waller), the chief officer of tramways (Mr. Hedertedt). Mr. A. Windsor (representing Messrs. Dick, Kerr, and Co.). Mr. Gauntlett (representing the Westinghouse Company) and a number of others participated. The tramways were subsequently declared open, and promptly gained liberal patronage. In the evening a public dinner was held at the New London Hotel to commemorate the occasion, a large company being present.

**New Car Design.**—The members of the Salford Corporation had a trial trip last week on the new single-deck car which has been built by Messrs. Dick, Kerr, and Co., according to the design of Mr. E. Hatton, late manager of the Corporation tramways. The new car, which is the first of 20 single-decked cars ordered for use in the borough, is a combination of English and American systems. It has an open centre and a closed compartment at each end, each with accommodation for 12 passengers. These closed compartments are so arranged that in the summer months the windows may be lowered and the car converted into an open car throughout. Entrance is obtained to the car by means of two steps in the middle of the vehicle, and there is a centre gangway running from end to end, which enables the conductor to collect the fares without the risks attendant upon stepping on to the footplate. Passengers in the open or centre of the car will be able to protect themselves against the cold or sudden storm by means of strong blinds, strengthened by stays, which may be used to keep out the wind and rain. The new car supplies a solution of the dry seat difficulty, for passengers may enjoy all the advantages of open-air travelling, their seating accommodation meanwhile being perfectly dry. Special provision has been made for the ventilation and lighting of the cars. Ventilators are placed in the roof, as are also the lighting arrangements, the lamps being placed in elaborate bronze fittings. The new car provides dry seats for 48 passengers, as compared with 22 inside passengers and 32 inside passengers in the present small and large bogie cars respectively.

**Dudley.**—The negotiations between the Corporation and the British Electric Traction Company in reference to the tramways in the borough seem now to show some prospect of an early settlement. So hopeless became the prospect that only a few months ago the Town Council resolved to refer the whole question to arbitration by the Board of Trade. Apparently as the result of this, the company formulated new terms, as the result of which it is now proposed to postpone the purchase of the tramways from the company for a period of 21 years as from August, 1902, when the Corporation acquired powers of compulsory purchase. The Corporation will retain the exclusive right of supplying electricity required for working all the tramways within the borough for the period named, and, in addition to a fixed annual minimum in regard to the quantity of electricity for which the company will be held responsible for payment, there will be a readjustment of the prices at which the company will be provided with the current for tramway purposes. The new conditions, if mutually agreed to, will, it is estimated, result in a considerable increase in the annual revenue from the supply of current to the company, which, it is hoped, will be applied towards the reduction of the rates. Another important condition is that the tramway to Tipton shall be electrically equipped forthwith. A communication embodying the proposals indicated was discussed by the Town Council in private the other evening, and the whole matter was referred to a sub-committee. The general impression, however, appears to be that a settlement will be arrived at without recourse to the Board of Trade.

**Metropolitan Railway.**—During the past week or so the electric service on the "Extension" has been increased, steam trains running only to stations north of Harrow. The latter, however, start from Baker-street, so that the passenger does not get the benefit of the improved traction in the tunnels, though against this is set the advantage that these trains as a rule make Willesden Green Station the first stopping place—according to the time-table, that is. Unfortunately, the breakdowns of the electric trains have been somewhat frequent of late, especially last week, but without doubt the experience on the "Extension" will be valuable when these trains run on the "Circle," where such events would be more harmful to the company, though not less annoying to the public. The new cars now in use are an improvement on the "old" ones. In place of the gates these cars have wood and glass panels, the sides of which form doors. These, by means of pulleys worked by the guard, open by sliding into recesses at the back of the end seats. By this arrangement the clanging of gates and the strong draughts of the older cars are avoided. The upholstery of the cars has also been improved, so that they may now be described as handsome. The cross seats have at the solid ends facing the gangways the company's monogram in copper, which looks very effective. The first-class cars have red carpet down the centre, but in the third-class there is no floor covering. The seat covers are not of uniform colour, and there is more walnut-coloured woodwork than in the cars first delivered. The company must be congratulated upon the appearance of the new trains.

**London United Tramways Co.**—On Monday the work of constructing the various extensions into Surrey was commenced. The route length of these lines will be over 17½ miles, and the districts covered embrace Molesey, Thames Ditton, Surbiton Kingston, New Malden, Wimbledon, Merton, and Upper and Lower Tooting, meeting the lines of the London County Council. Asked by an interviewer as to whether it would be possible, having regard to the different systems of electrification, for the company's cars to run over the London County Council's lines and *vice versâ*, Mr. Clifton Robinson said that nothing could be easier. A shoe could easily be dropped by the company's cars so as to obtain the motive power from below when it was on the London County Council's lines, and the overhead pole could be tied down. The London County Council's trams could be fitted with overhead connection. Mixed traction has been employed in Paris for some time. The electric power for working the Surrey system would not, Mr. Robinson stated, be obtained from the company's central power station at Chiswick, but would be supplied from the power station of the Underground Railways at Chelsea. The Court of Referees presided over by Mr. H. D. Greene, M.P., sat on Wednesday to consider several petitions for *locus* to be heard against the company's extension of time bill. The Wimbledon Urban District Council, the Coombe and Malden Urban District Council and the Croydon Rural District Council appeared by counsel, and contended that there had been much delay on the part of the company. Mr. Balfour Browne, K.C., opposing the applications, explained that the scheme was a very large one, extensive street widenings had to be effected, and the company were proceeding as fast as possible. All the applications were refused.

**Inquest.**—An inquest was held on Monday in the case of a little girl of three years, named Bates, who was knocked down by an electric car in Hyde-road, Manchester, while running across the roadway. The driver of the car, seeing an accident could not be averted, tried to work the gate and the lifeguard, but the latter failed to act, and the child went underneath the car, and was found lying near the motor. One or two witnesses said that the driver did all he could, and was in no way to blame. Mr. Eades (the manager of the tramcar shed) said all the cars were examined every night, and all defects entered up. In the present instance they had no record of the car being defective. The car was all right the night before, but when he examined it after the accident he found it was defective. There was a set screw missing, so that the cradle would not drop. The coroner asked whether the absence of the set screw would have been noticed when the car was examined. The witness replied in the affirmative, as the greaser would have observed it, because he would have to grease that part of the car. The only explanation the witness knew of was that the screw must have fallen out during the course of the day on which the accident happened. Mr. Eades added that on the evening following the accident he examined all the cars, and not one, other than the car which had been the subject of the accident, was out of order. The jury returned a verdict of accidental death. They considered something should be done to meet the defect resulting from the loss of the screw. Mr. Bell (representing the Corporation) said the Tramways Committee were very desirous of doing what they could to prevent accidents, and any suggestions would be carefully considered. The coroner corroborated the Corporation's willingness to always adopt useful suggestions for the operation of the cars.

**Aberdare.**—Continuing the consideration of the Urban District Council's Tramway Bill, the House of Commons Select Committee heard several witnesses in favour of the measure, including a representative of the Marquis of Bute. Mr. Owen Williams, surveyor and engineer to the District Council, described the scheme in detail. The entire length of the tramway route would be 4 miles 6 furlongs 4·7 chains. The population of the district was 47,101, 34 500 of whom lived within five minutes' walk of the proposed route. He calculated that the service would be availed of by 40,000 and from statistics gathered from other quarters he computed that the total number of passengers would be 3 600 000 per annum. In two months in 1902 the Taff Vale Railway Company only carried 1 045 passengers between Aberdare and Aberaman, the two stations with which the tram services could be said to be likely to compete, and in a certain month this year the railway company only carried 847 passengers. His estimate, including the construction and equipment of the permanent way, the construction of the power station, cars, electric motors, and car-sheds, amounted altogether to £65,495. 9s. 11d. A 10-minute service of cars would be provided. There would be 12 cars to seat 48 passengers, and most of them would be double-deck cars.

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He estimated the cost of the street widenings at £12,396, and the cost in respect of the refuse destructor at £14 300. Mr. Stephen Sellon and Mr. Alfred Baker, manager of the Birmingham Corporation tramways, subsequently gave evidence in support of the Bill. Counsel for the frontagers contended that the tramways could not possibly carry the collier population, because the men had all to be at their work by a certain time, and no tramway service could possibly accommodate the whole of the men at one time. Several engineering and other witnesses gave evidence on behalf of the opposition. Mr. Hopkins, engineer, Westminster, considered the roads too narrow and the gradients too steep. Mr. Reece, barrister, Aberdare, thought there was no necessity for the line, the neighbourhood being sufficiently served by the Taff Vale Railway. Mr. R. Llewellyn, mining engineer, stated that there was little demand for the trams, and the general manager of the Taff Vale Railway gave similar evidence. At the request of the chairman, counsel for the promoters supplied an estimate of the anticipated financial results of the tramway, which showed a profit of £1,000.

**London County Council.**—The Highway Committee's proposal to spend £351,900 upon the reconstruction of the Council's Wandsworth routes for electricity was postponed last week, but came before the Council again on Tuesday. In the course of a short discussion Mr. J. Williams Benn, M.P., said that those who opposed the extension of the Council's electric system alleged that the electric tramway was doomed, and that it would soon be run off the roads by the motor 'bus. Let them suppose that this was the case, and that there were services of motor 'buses converging upon the Elephant and Castle. At the present time, in the busiest part of the day, 436 electric trams passed that spot during one hour. They would need 1,000 motor 'buses to carry the same number of passengers, and when they remembered the space occupied by these vehicles, their freedom in the course they took, to say nothing of the aroma they left behind, they would see that the idea was an impossible one. The motor 'bus cut up the roads, but although it escaped the burden imposed on the electric car, they did not fear its competition. The motor 'bus was a useful vehicle, and had, he believed, a great future, and it would be as a feeder of, and not a competitor with, electric tramcars. An amendment moved by Sir Melvill Beachcroft in favour of a reference back on the ground that the district was a suitable one in which to combine the overhead and conduit systems of traction, and so effect a saving on the capital cost, was lost, and the recommendation of the committee was then agreed to. The Council is in communication with the Metropolitan Water Board in reference to the diversion of pipes. A spirited reply from Mr. J. Allen Baker, chairman of the Highways Committee, to a statement by Mr. Richard Tilling (of Thos. Tilling, Limited), that the Council trams are not self-supporting, appears in another column. The remarkable vote in the House of Commons upon the Embankment scheme is also referred to in another part of this issue. All the metropolitan Liberal members supported the scheme. Of the Ministerialists, 11 of the London members supported it and 20 opposed it. The Premier, Sir M. Hicks-Beach, Mr. Broderick, Mr. Akers-Douglas, Sir R. Finlay, Sir E. Carson, and Mr. Walter Long were against bringing the trams over the bridges; while Sir H. Campbell-Bannerman, Sir Henry Fowler, Sir Robt. Reid, Mr. Herbert Gladstone, Mr. Winston Churchill, Mr. Labouchere, and Mr. Lloyd-George favoured the measure.

## LIGHTING AND GENERAL.

**Folkestone Electricity Co.**—The directors announce a half-yearly dividend of 7½ per cent.

**Doncaster.**—The Corporation propose to expend £7,500 in the extension of their electricity works.

**Sale of Plant.**—Particulars of a sale of second-hand electric generating sets appear in another column.

**Erith.**—Sanction has been received to the borrowing of £19,878 for the purposes of the electric lighting undertaking.

**Bath.**—Application is to be made for a loan of £9,000 to cover excesses of expenditure over the last sanction (1903) of £30,000.

**Worksop.**—The electrical engineer, in a report on a recent breakdown, says that it was caused by a dead short-circuit in a three-way box.

**Cheshunt.**—The Board of Trade have agreed to defer the question of revoking the Council's electric lighting order until the end of the year.

**Alliance Electrical Co.**—The directors recommend a dividend at the rate of 4 per cent. per annum, leaving £304 to be carried forward.

**Liverpool.**—Mr. C. R. Bellamy, in his report for the year 1904, states that 2 981 electric meters have been tested, 36 of which were rejected as incorrect.

**Calendar.**—We have recived a wall calendar, March 1905 6, from the Western Electric Company, 171, Queen Victoria-street, London, E.C. (works, North Woolwich).

**Edinburgh.**—The Cleansing and Lighting Committee have recommended that an expert be consulted as to the illuminating power of both the gas and electric light of the city.

**Glossop.**—The Lighting Committee have decided to recommend the Council to enter into a contract with the Urban Electric Supply Company for the lighting of several roads.

**Central London School District.**—The Board have decided that their schools should be placed in telephonic communication with London by means of the Post Office system.

**Direct United States Cable Co.**—The directors have declared an interim dividend of 3s. per share, being at the rate of 3 per cent. per annum for the quarter ended March 31, 1905.

**Horsforth.**—The Horsforth District Council have decided to ask for a 12 months' extension with regard to their electric lighting provisional order, which will otherwise expire this year.

**Leyton.**—An enquiry has been held into an application to borrow £5 000 for purposes of electric lighting. Mr. Lewis, the electrical engineer, gave evidence in support of the Council's scheme.

**Weybridge and Walton Electric Supply Bill.**—The Urban District Council have not been successful in their attempt to oppose this Bill before a select committee of the House of Commons.

**Brighton Telephones.**—The Telephones Committee have adopted an agreement with Mr. A. R. Bennett with reference to the terms upon which he is to continue to act as consulting engineer to the Corporation telephone undertaking, and to make periodical visits.

**Cleckheaton.**—The Electricity Committee have resolved to recommend the Council to reduce the charge for lighting purposes from 5d. to 4d. per unit, and to adopt a fresh minimum as regards the supply for power purposes, which will be also equivalent to a reduction.

**Eastern Extension, Australasia, and China Telegraph Co.**—The directors have declared a dividend for the quarter ended Dec. 31 of 2s. 6d. per share, together with a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1904.

**Dover.**—The estimate of revenue and expenditure on account of the Corporation electricity undertaking for the year ending March 31, 1906, shows receipts amounting to £17,568. After payment of all expenditure, including interest and sinking fund on the loan of £150,000, a surplus of £542 remains.

**Hampstead.**—The Council have placed a cottage at the disposal of the Electric Lighting Committee's outdoor foreman, who is to occupy the same, with coal and lighting, at a weekly rental of 8s., in consideration of his services being placed at the disposal of the Council at night in case of breakdown.

**Andover.**—The Board of Trade have issued an electric lighting provisional order with a view to the same being included in a Confirmation Bill about to be introduced into Parliament to the Corporation authorising them to supply electrical energy for the public and private purposes within the borough.

**Norwich.**—An enquiry was held on Tuesday into the application of the Town Council for sanction to borrow £30 000 for electric lighting purposes. The Town Clerk in his evidence said that whereas in 1902, the last year of the company, there were 2 635 consumers, there were now 3 277, and the 8-c.p. lamps equivalent was 125,700 now against 99 180 then.

**Stock Exchange.**—Applications have been made to the Stock Exchange Committee to allow the Newcastle-upon-Tyne Electric Supply Company's 57 009 ordinary shares of £5 each, fully paid, 17,991 ordinary shares of £5 each, 57,009 5 per cent. preference shares of £5 each, fully paid, and 17,991 5 per cent. preference shares of £5 each to be quoted in the official list.

**Metropolitan Asylums Board.**—Mr. A. C. Scovell presided on Saturday at the meeting of the Board at the offices, Victoria-embankment. The Local Government Board wrote sanctioning the proposal to enter into a contract with a selected firm or firms for the installation of electric lighting, telephone, and fire-alarm systems at the Southern Hospital without first advertising for tenders.

**Telephones in Cab Shelters.**—The chief constable (Mr. McKenzie) has submitted a report to the Cardiff Cabs Committee as to the progress of the installation of telephones in three cab shelters to be placed by the Corporation in various streets. The penny-in-the-slot arrangement is to be adopted, and the general public will be permitted to enter the shelters to telephone to other shelters and for general purposes.

**Greenock.**—The Corporation have agreed on a revised scale of charges for electricity for the next five years, subject to certain conditions on the eve of settlement. The rates are as follows: first 500 000 units at 1½d. per unit, next 200,000 units at 1¼d. per unit, then 200,000 units at 1d., and anything further at ·85 d. per unit. The revenue from these sources is expected to amount to about £5,000 per annum.

**London Gazette.**—The partnership between Edward Bakewell and Henry Nelson Bundy, carrying on business as electrical engineers at 50, Narrow-street, Peterborough, has been dissolved by mutual consent. The partnership between George Charles Ching, Henry George Kettle, and Charles John Edwards, carrying on business as motor manufacturers and electrical engineers at Ipswich, has been dissolved by mutual consent.

**Loughborough.**—The Electricity Committee have resolved that if the consumption of electricity by any consumer exceeds 1 500 units per quarter a charge of 4d. per unit be made, the ordinary price of 5d per unit to be charged for a consumption below that quantity. The electrical engineer has been requested to make enquiries as to the probable demand by manufacturers and others with a view of a revision of the charges for power purposes.

**Halifax Telephones.**—The Corporation and the Chamber of Commerce are addressing to the National Telephone Company a joint complaint with regard to the insufficiency of the service between Halifax and Bradford. It is pointed out that in Halifax there is only one central station for all this large town, and that the company ought either to extend the area in which they gave their ordinary rates or to provide a second station, as in Bradford.

**Oriental Telephone and Electric Co.**—The directors have resolved to recommend the payment of a dividend at the rate of 6 per cent. per annum on the preference shares for the half year ended Dec. 31, less income tax, and a final dividend of 3½ per cent. on the ordinary shares issued, free of income tax, making a total of 6½ per cent. for the year. The share transfer books of the company will be closed from April 17 to 28, both days inclusive.

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**Aberdeen.**—The Town Council have decided that the rule as to disconnecting the electricity demand indicator should be altered so as to provide that consumers on any particular occasion (but not exceeding one in each month, and three days at one time) requiring an extra supply of electricity, might, by giving the Corporation 24 hours' notice in writing, have arrangements made whereby their indicators would not register the demand on the occasion so notified.

**Electrical Accessories.**—We are informed that the Lister Electric Manufacturing Company, Dursley, have just purchased the entire business of Headley, Limited, recently carried on at Moresk Mills, Truro, with branches and agencies at London, Edinburgh, Manchester, and elsewhere. The stock-in-trade, plant, and tools are now being transferred to the Dursley Works, where the business will in future be carried on under the direct personal supervision of Mr. Headley.

**Derby.**—The following estimate of expenditure on capital account for the year ending March 31, 1906 has been approved by the Electric Lighting Committee—viz.: drill, lathe, and smith's hearth. £100; one 500 kw. turbine and dynamo and condensing plant, £4 400; piping £150; foundations, £100; mains, £3 000; services, £600; switchboard panels, £300; meters and instruments, £400; transformer chamber and switchgear, £50; contingencies, £500—total, £9,600. A loan is required.

**"Robertson" Electric Lamp Fire Brigade.**—The members of this important branch of the lampmaking staff at Brook Green held a Cinderella dance in the large hall of the Brook Green Works on Saturday evening, March 25 and judging by the success of the proceedings, it is likely to become an annual institution. About 300 friends and visitors were present, taxing to the full the capacity of the excellent hall provided by the firm for the recreation of the employés of the Robertson Electric Lamp Works.

**Wellington (N.Z.).**—The installation of the metallic return system for the telephones in Wellington will probably occupy two years. The material is in hand, and the work will begin at once. The tender of Messrs. Trevor and Sons, of Wellington, has been accepted by the Public Works Department for the erection of new post and telegraph offices at Palmerston North. The Public Works Department have accepted the tender of James Trevor and Sons (£5,254) for the erection of the Palmerston North Post Office.—*N.Z. Mining, etc., Journal.*

**Hammersmith.**—The Council on Wednesday agreed that, from and after the reading of the meters at the end of the next September quarter, the present method of charging for the supply of electricity for private lighting upon the maximum demand indicator system be abolished, and that in lieu thereof a flat-rate charge of 3d. per unit be adopted. The premises of 21 additional consumers, representing a maximum of 373 8-c.p. lamps, have been connected to the mains, and 20 consumers have been disconnected. The present number of consumers taking current from the mains is 1 563.

**French Cable in Venezuela.**—A Reuter's telegram from Caracas, April 2, says that the grounds for the Court's recent decision annulling the French cable concession were that the cable company had contracted to lay a submarine cable between La Guaira and the United States, but had built a land line across San Domingo, where repeated revolutions had interrupted communication, causing loss to Venezuelan commerce. The company had also contracted to construct a national coast-wise line, but had made the line international from Puerto Cabello to Coro by touching at Curacao.

**Middlesbrough.**—The Council have referred a notice from the Cleveland and Durham Power Company of intention to lay cables in various streets to the electrical engineer for report. The engineer (Mr. Taylor) in his last report stated that the number of units sold was 116,336, against 61,860 in March last year. The revenue was £1,478, against £860, and the works cost £341, against £229 in March last year. The total cost of production for the month was £497, or 1d. per unit, compared with ·32d. per unit last year. They had thus made a profit on the month of £980, exclusive of interest and redemption.

**St. Pancras.**—The Borough Council last night decided to accept the offer of the Underground Electric Railways Company of London, Limited, respecting the supply to their eight stations in the St. Pancras area. The company will take the supply continuously for 23 hours each day throughout the year, which is practically a 100 per cent. load factor, and will guarantee a minimum consumption at each station of 5 000 units per annum, for a period of five years. They will pay 1¼ d. per unit, which is the same as they have agreed with the Islington Borough Council for the supply to their stations in the Islington district.

**Municipal Wiring.**—A deputation from the Sheffield Electrical Contractors' Association complained to the last meeting of the Sheffield City Council against the competition of the Corporation's wiring and fitting department. Specific instances in which there was cause for complaint were pointed out, and a demand was made that the Corporation's department should be closed altogether. We understand that in reply it was stated that it would be impossible to close these departments, as this would involve too big a loss to be put upon the rates. A promise, however, was made to investigate the specific cases which were made in confidence.

**Holborn and Finsbury Exhibition.**—The exhibition, which closed on Wednesday after nearly three weeks' run, has been successful to a degree that one would hardly have anticipated. The exhibitors are unanimous in their enthusiasm in regard to the really good business results. A big amount of business has already been transacted, in some cases to figures of considerable amount, and the number of enquiries from influential firms have been most gratifying. The power section especially has come to the fore in this respect, and the County of London Company have every reason to anticipate considerable and immediate increase in their already heavy power supply. A dinner is being arranged by the exhibitors, and will take place early next week.

**Electric Main Dangers.**—In the House of Commons on Tuesday Mr. Bonar Law said the attention of the Board of Trade had been called to an action in which the Manchester Corporation had to pay for damage caused by a fire which had resulted from an explosion in one of the Corporation's mains. An improved system, in which the mains were separated into sections connected by suitable fuses, and whereby the difficulty in localising leakage and consequent risk were much reduced, had received the consideration of the Board of Trade, and had been adopted in all undertakings established during the last two years in London and elsewhere. He understood that the improved system had been applied voluntarily to many existing undertakings in London.

**Coventry.**—Business at the electricity works during the past year, which closed at the end of March, has been of a steadily increasing character. According to the chairman of the committee, as much current is now being sold at night as during the day. This is due to three causes: (1) the reduction in the price of electricity; (2) the installation and hiring out of motors; (3) the fact that many people who hitherto have only used the current for lighting purposes in certain parts of their premises, now have it installed throughout. An increasing number of motors are being used by manufacturers, one of the largest firms in Coventry having discarded their steam-engines for driving machinery, and are now using electric motors hired from the department. The extensions at the electricity works are making good progress.

**Eastbourne.**—The annual cost of lighting Orchard-road by means of ½-ampere Nernst lamps is estimated at £3. 10s. 2d. per lamp, including interest and sinking fund charges on the capital expenditure, while the annual cost of a gas lamp is, it is stated, £3. 5s. The above figures are exclusive of lighting and extinguishing. Three specimens of a special type of fitting for improving the lighting by incandescent lamps will be supplied by the Reason Manufacturing Company on the condition that no charge for them will be made if they do not give satisfaction. Further enquiries are to be made with regard to the system to be adopted for laying new electric mains at the East End. The chief details in connection with the proposed laying of the two high-tension feeders from the works to the town and the provision of spare ducts in the conduits for future extensions are those in reference to the best type of conduit to lay. The total estimated cost is £3,518.

**Hastings.**—In the note which appeared on p. 464 of our last issue respecting the "Luna" arc lamp at Hastings we regret to say there is a serious error. These lamps, as is well known, are manufactured by the Electrical Company, of 121 125, Charing Cross-road, W.C., and not by the firm mentioned in the note in question. We understand that experiments were made at Hastings on a number of types of flame lamps, and that the Luna lamp was on trial near the Memorial. The Electricity Committee and Mr. Ferguson were so pleased with the results obtained that they have adopted this type of lamp for their street-lighting. The first order will comprise between 50 and 100 lamps to be used in lighting the front. In this work they will replace an older type of open arc, giving much more light with a smaller consumption of electrical energy. These lamps have also been on competitive trial at Sheffield, where they have been adopted by Mr. Fedden for the lighting of the town hall.

**Burslem.**—Mr. Ashton Bremner, the borough electrical engineer, has issued a descriptive pamphlet in view of the approaching completion of the electrical works. The works include also a destructor plant. As a result of negotiations between the Burslem and Tunstall Councils, application has been made to extend the area of supply to Tunstall and the necessary provisional order only awaits the formal consent of Parliament. Arrangements are now being made to ensure a supply over the extended area of Burslem, Wolstanton, and Tunstall. The cost of the scheme is estimated at £24,000. The scale of charges for current will be as follows: for lighting 5d. per unit, or, at the option of the consumer, on the maximum demand system of 7d. per unit for the first hour each day and 2d. per unit afterwards; for motors, 2d. per unit, or, at the option of the Corporation, 10s. per quarter per horse-power installed and 1½ d. per unit. It is expected that the supply will commence about Sept. 1.

**City Telephone Fire.**—Dr. F. J. Waldo on Tuesday opened an enquiry at the City Mortuary, under the City Fires Inquest Act, with reference to the fires which occurred simultaneously at the premises of the National Telephone Company in Oxford-court, Cannon-street, and Mansion House chambers, Queen Victoria-street. It will be remembered that the telephone system in the Metropolis was seriously affected for some days by the outbreak. The Coroner said the Telephone Company had their Bank exchange in the upper floor of Mansion House chambers. There the fire broke out at two o'clock on the morning of Tuesday, Feb. 28, and destroyed two little wooden structures on the roof known as the test-room. The fire at the Oxford-court premises of the company broke out in the telephone distributing room on the topmost floor. The distributing room was closed at the time. It appeared from what he had been informed that some tests were then being carried out on the Inner Circle on the District Railway, which rendered necessary some alterations in the telephone wires in the tunnels, and the conductor rails were charged. One of the telephone cables came into contact with the live rail, an arc occurred, and the lead sheeting was melted off the cable. The telephone wires, used to carrying only a voltage of 22 or 24 volts, received the current of 600 volts from the rail. That current was carried to the test-room of the Bank exchange and the cable-room, and caused fires at both places. The Board of Trade had intimated that the fire "did not appear to be a matter in regard to which the Board of Trade have any power to order an enquiry," and he had decided, therefore, to hold an inquest. After some evidence had been given, the enquiry was adjourned.

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**Bermondsey.**—At the last meeting of the Borough Council the Electric Lighting Committee presented a report in reference to an excess charge of £6,946. 11s. 6d. in excess of £11,078 estimated for cost of mains laid in Rotherhithe. The details of expenditure were: contract with cable company and cables ordered, £10 268. 5s. 1d.; look crossings, £2,652. 12s. 9d.; labour, £5,163. 13s. 8d.—total, £18,024. 11s. 6d. A sum of £2,652. 12s. 9d. of the total excess expenditure had been passed by the Council for the work involved in taking the mains across the Surrey and Lavender Docks, the balance of £4,293. 18s. 9d. was attributable to the greater expense involved in opening up and reinstating the roadway, especially in Union-road, where the conduits had to be laid at a depth of 4ft., and in crossing Southwark Park-road at 18ft. deep. Extra labour and tackle had been required in supporting the large number of pipes exposed in excavations. A large number of extra brick chambers had also to be provided, additional labour in pulling cables, and the difficulties occasioned by wet weather.

**Lancaster.**—The Mayor, in moving the adoption of the Electricity Committee's minutes at the last Town Council meeting, said that there had been a falling off in the total consumption and the amount received for the sale of current, principally on account of tramways, but there had been a slight increase in the consumption for lighting purposes. As a set off they had reduced the price of electricity for power from 3d. to 2½d. per unit, and the charge to the tramways by 5 per cent. from last September. The estimates for next year showed a profit of £2574, and the actual profit last year was £2521, which they had placed to the reserve fund. The estimated profit was £729, so that they had realised £200 short of the estimate. It was pointed out that the Tramways Committee obtained the current for 2d. per unit less 5 per cent, whereas the current generated at the works cost 2·6d., so that the committee were supplying the tramways absolutely below cost. Mr. Frank Shaw, of the Technical Schools, Manchester, and lecturer in electrotechnics at the Storey Institute, delivered a popular lecture on "Electric Lighting and Lamps" at the Storey Institute.

**London County Council.**—On Tuesday tenders were received (*a*) for the manufacture, etc., of eight induction motor-generators for tramways sub-stations; (*b*) for the supply, etc., of general wiring material at the Greenwich electricity generating station; (*c*) for the supply, etc., of low-tension cables, cable boxes, etc., at the Greenwich electricity generating station. It was agreed to lend the Hackney Borough Council £11,085 for electric lighting and street-lighting. The Housing Committee recommended that an agreement be entered into with the County of London Electric Supply Company, Limited, for the supply, on the automatic prepayment system, of electric light to the cottages in course of erection on Section B of the Totterdown Fields Estate; that the agreement do provide for the wiring of the cottages before the walls are plastered, subject to the work being carried out to the satisfaction of the Council, and to the company bearing such additional expense as may be due to the work being done in that manner; that the solicitor do prepare, and obtain the execution of, the agreement; and that the seal of the Council be affixed to the agreement when ready.

**Hull Telephones.**—At the last meeting of the Hull and District Chamber of Trades, the following letter was read from Sir H. Seymour King, M.P., in reply to a resolution of the Council recommending that the National telephones should only be purchased on terms which will permit of the low rates of the competitive system being maintained: "I am afraid that your Council hardly appreciate the position in which the Government were *vis-a-vis* the Telephone Company. As a matter of fact, Parliament is under an obligation to purchase the telephone system at the expiration of the license, or else to renew the license, which most people think would be a most unfortunate and unbusiness-like thing to do. Of course, the agreement with the Telephone Company contains no guarantee that cheaper rates shall be charged. Why should it? It has nothing to do with purchase from the Telephone Company; it is a question between the Government and the country, as to which Parliament will no doubt use the proper pressure through the representatives of the towns in due course. The Government is bound to purchase at the value of the plant on tramway terms at the expiration of the license. No other terms would be possible." The engineer has been authorised to advertise for tenders for the cables required in connection with the extensions.

**Fire Pumping Plant.**—Messrs. Gwynnes, Limited, engineers, of London, have been entrusted with an order from Lord St. Levan, of St. Michael's Mount, for probably the most up-to-date fire pumping plant in the country. It consists of a set of electrically-driven centrifugal pressure pumps in duplicate, automatic in action, placed in the engine-room, situate about 400 yards from the castle. An electric storage battery, always charged day and night, will be fitted, of sufficient size to run either fire pump for one hour. After this time arrangements are made whereby the pumps can be driven continuously from the generating plant. In the castle itself, in convenient positions, will be situated 12 hydrants, each with a long length of hose and nozzle, ready for immediate use; also, in convenient places, nine fire-alarm switches. It will only be necessary for any one of these switches to be moved over to start the first set of the electrically-driven fire pumps in the engine-room. The same switch will start electric bells ringing over the other eight switches in the castle, and it will also ring an electric bell in each of the cottages at the bottom of St. Michael's Mount. The fire plant, electric switches, and bells are all in duplicate, and if by chance, therefore, it is found that the first plant is out of order, it will only be necessary for one of the attendants to start one of the other nine switches controlling the other set, when the second set will immediately come into operation. Arrangements have been made whereby two hydrants can be turned on practically to any part of the castle should a fire break out.—*Cornwall Gazette.*

**Islington.**—At to-night's meeting it will be proposed (1) that in response to an application from the Hornsey Town Council that the south-west side of Stroud Green-road be lighted by 10 arc lamps at a cost of £800; (2) that a low-tension main be laid in the City-road at a cost of £50; and (3) that an expenditure of £4 500 for mechanical stokers, be agreed to. The committee recently made some tests at the electric lighting station with mechanical stokers of an improved type, and have submitted a report stating that small bituminous coal at the present price of 9s. 7d. per ton can be used in the furnaces with almost as good an evaporative efficiency as can be obtained by hand firing on the other boilers with Welsh coal at 16s. 3d. per ton. They consider it desirable, however, that only a proportion of the total number of the boilers in the works should be fitted with mechanical appliances, and propose that the boilers in the new boiler-house only should be so fitted at present. They think it is essential in connection with mechanical stoking, and in view of the large increase in the consumption of small bituminous coal necessitated by the adoption of this proposal, that bunkers should be provided to keep separate the two classes of coal in use, as well as to increase the coal storage accommodation. They suggest that overhead bunkers, having a capacity of 500 tons, be erected in the new boiler-house, and that conveying machinery be employed for the purpose of the more efficient handling of the coal in question. The electrical engineer's estimate for the work is as follows: six mechanical stokers, at £300 each, £1 800; excavations, foundations, etc., for above, £400; one overhead steel bunker capable of holding 500 tons of small coal, £1 000; coal elevator and conveyor, £500; motors and accessories, £300; labour in connection with erection, £500—total, £4 500. With regard to an account for income tax on electricity profits, amounting to £629. 3s., a statement has been prepared by the borough treasurer showing that the taxable income from all sources amounts to £12 583. The committee will report to-night as follows: "Income tax at 1s. in the £ on this sum amounts to £629 3s. There is, however, a substantial set-off against this charge in the amount of income tax deducted by the Council from interest on loans raised for the electricity undertaking. In a recent decision of the House of Lords in the case of the Attorney-General *v.* The London County Council, it was held that where the interest on the loans is paid out of profits the person who makes the payments and deducts the income tax is not accountable to the Crown for the duty deducted. The figures for the current year are not available, but we may mention that last year the amount of income tax deducted from interest on loans was £393. 16s. 3d. We are satisfied that the amount of £629. 3s. is properly payable, and we have accordingly included it in our list of proposed payments."

**Brighton.**—The Town Council have received a report from Mr. Arthur Wright, manager of the Brighton Corporation electricity undertaking, in which he stated that there was not the slightest chance of the general body of ratepayers having to contribute towards the Southwick station scheme, as it could always be made to be as self-supporting as the Brighton electricity undertaking had invariably been in the past; also the cost of carrying out the scheme would be very much less than was estimated in 1900. The Southwick scheme was not only the best solution of the problem of how to furnish the additional supply required for Brighton, but its advantages over the only other alternative—viz., of putting up a new power station in Brighton—could now be shown to be even greater than were foreshadowed in 1899. The sum of £144,628 had on Jan. 31, 1905, been expended in connection with the Southwick scheme (including North-road sub-station). The probable further expenditure that would be incurred in completing the work of providing the additional electric generating and converting plant contemplated in his estimates of March, 1900, would be about £168,522. The great economy obtainable when the new power station was at work would in all probability make it very advisable to order in the year 1906 one additional turbine generating set with the necessary boilers, and the converting machinery for North-road. He estimated that the plant now being erected at Southwick would supply six millions of the units sold per annum in Brighton. The sale of electricity during the present financial year for lighting and tramways in Brighton would be nearly eight million units, and the demand would probably exceed ten million units in five years' time. He considered that the Corporation's electricity undertaking had had the unusual merit of being from its first year of working entirely self-supporting, the general body of ratepayers never having had to contribute towards its maintenance. Judging from recent experience, the undertaking would realise, if sold, more than twice as much money as it had cost to build up. The continued increase of business had been remarkable considering the size of the town, there being now no less than 60 units of electricity consumed per inhabitant per annum, a figure which was not nearly approached by any other town in England. The accumulated profits now allocated for reserve fund purposes amounted to over £15,000 and if the Council followed his advice this year, the reserve fund would probably reach £18 000. The average prices at which electricity was supplied in Brighton to private consumers, street lamps, and to the tramway department—namely, 3·1d., 1·6d., and 1 5d. respectively—were lower than in any other electricity undertaking similarly handicapped as regarded the high cost of coal. Fourteen thousand pounds had been paid out of the net profits in past years towards the relief of the general rates. Over £100,000 would have been, by the end of this financial year, set aside out of the gross profits for the repayment of capital. Only two interruptions of the general supply had occurred during the whole 14 years that the undertaking had existed. The plant at North-road and all the mains in Brighton had been continuously kept in thorough working order and proper repair out of profits, and the cost of all useless and obsolete plant had been written off. The Lighting Committee have resolved that Mr. Wright be engaged as consulting electrical engineer to the Corporation, for six years from April 19 next, to superintend all present and future capital expenditure in connection with the electrical undertaking, at a salary of £600 per annum, and that he be paid a further sum in any year of the said

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period in which a profit exceeding £5,000, after payment of all debt charges, interest, and working expenses is made, equal to 5 per cent. on the amount of such profit. The committee have been in negotiation for the purchase of premises adjoining the electricity works, and, subject to the approval of the Council, have arranged to purchase the freehold of the premises at the price of £1,800. The cost of erecting the necessary buildings on the site is estimated at £3 200. The committee recommend that application be made for sanction to a loan of £5,009.

## PROVISIONAL PATENTS, 1905.

MARCH 27.

6400. **Improvements in hangers or ears for overhead electric wires.** Joseph Fitzalan Simpson, 6, Bank-street, Manchester.

6419. **Novel method and means for automatically reversing the direction of a trolley current collector upon an overhead conductor for electric traction systems.** Benjamin Smith, 17, Haymarket, Sheffield.

6453. **New or improved method and means for measuring electricity with or without recording or registering apparatus or/and prepayment mechanism.** Charles Orme Bastian and George Calvert, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

6455. **An improved means for fastening together the ears or clips of overhead electric trolley wires and wires used in conjunction therewith.** Arthur Rogers, 88, Chancery-lane, London.

6456. **Improvements in or connected with incandescent electric lamps.** Leo Sunderland and Gilbert Cecil Pillinger, Norfolk House, Norfolk-street, London.

6468. **Process and apparatus for the electrical production of cast iron, more particularly with a view to the manufacture of steel.** Société Electro-Metallurgique Française, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, March 25, 1904, being date of application in France.) (Complete specification.)

6469. **Electromagnetic speed gear for automobile vehicles and boats.** Société en Participation des Automobiles "La Magnetique," Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Oct. 24, 1904, being date of application in France.) (Complete specification.)

MARCH 28.

6523. **Improvements in trolley poles for overhead electric traction.** William Williamson and John Collinson, 6, Bank-street, Manchester.

6535. **An electric wire connecter.** Archibald John Ware, 3, South-road, Handsworth, Birmingham.

6542. **Improvements in electric light fittings, applicable also to gas, oil, and candle light fittings.** Hugo Hirst and Frederick Thomas Cash, 71, Queen Victoria-street, London.

6551. **Improvements in the manufacture of troughs and conduits for the distribution of electricity, water, steam, and the like.** William Hall Keys and George Henry Shakespeare, Prudential-buildings, Corporation-street, Birmingham.

6552. **Improvements in systems of electrical distribution by means of vapour rectifying apparatus.** Peter Cooper Hewitt, The Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, April 8, 1904, being date of application in United States.) (Complete specification.)

6557. **Improvements in apparatus for electric telegraphs.** Siemens Bros. and Co., Limited, and George Sylvester Grimston, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

6567. **Improvements in electric controllers.** Henry Clay Little, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6593. **Improvements in or relating to starting apparatus for electric motors.** Alphonse Constant Reyrolle and Johannes Schuil, 46, Lincoln's-inn-fields, London.

6594. **Improvements in insulation for electric heating devices.** The British Thomson-Houston Company, Limited, 83 Cannon-street, London (General Electric Company, United States)

6595. **Improvements in and relating to dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

6597. **Improvements in devices for detecting leakage in electric transmission systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

MARCH 29.

6640. **Improvements in and relating to electricity meters.** Carl Wilhelm, John Busch, and Hugo Roosen, 65, Chancery-lane, London. (Complete specification.)

6650. **Improvements in or relating to galvanic cells.** Walter Schenk, 111, Hatton-garden, London. (Complete specification.)

6679. **Improvements connected with electric railways.** James Dain Lawson and Thomas Littlefair, 70, Chancery-lane, London.

6681. **Improvements in and relating to electric lighting systems and in apparatus therefor.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

6690. **Improvements in and relating to means for electrically maintaining and reproducing recurring movements particularly applicable to clock movements and time transmission.** Robert Mann Lowne and the Lowne Electric Clock and Appliances Company, Limited, 22, Southampton-buildings, Chancery-lane, London.

6691. **Electric safety apparatus for cars or trains.** William Pollard Robertson, 23, Southampton-building, Chancery-lane, London. (Date applied for under Patents Act, 1901, May 12, 1904, being date of application in United States.) (Complete specification.)

MARCH 30.

6721. **Collecting gear for alternating-current machines, homopolar machines, and for conducting electric currents for rotating parts of machinery generally.** Wilhelm Svensson Winkler, 37, West Nile-street, Glasgow.

6752. **Improvements in dynamo-electric machines.** Jakob Emil Noeggerath, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, March 30, 1904, being date of application in United States.) (Complete specification.)

6755. **Improvements in or relating to mercury vapour electric lamps.** Charles Andrew Lee, 24, Cleveland-square, Hyde Park, London.

6760. **Improvements in the electrolytic production of copper wire, strip, or the like.** Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

6775. **Improvements in polyphase current electromotors.** Georges Meller, 18, Buckingham-street, Strand, London.

6786. **Improvements in the construction of plates for accumulators or secondary batteries.** Frederick Julius Gerard and Lotkar Fiedler, 22, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MARCH 31.

6802. **Improvements in automatic electric tramway signals.** Harry Storm and Thomas Simpson, 165, Cathedral-road, Cardiff.

6822. **Improvements in electrical switches.** John Henry Tucker, 128, Colmore-row, Birmingham.

6838. **Improvements in or relating to the suspension of overhead conductors for electrically-operated railways and the like.** Budd John Jones, The Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, April 2, 1904, being date of application in United States.) (Complete specification.)

6865. **Improvements in micro-telephones or instruments containing a telephonic receiver and transmitter in one casing.** Isidore Bernard Birnbaum, 322, High Holborn, London. (The Telephon Fabrik Akt.-Ges. vormals J. Berliner, Austria. (Complete specification.)

6867. **Improvements in the method of wiring or connecting electric conductors and in patterices, junction boxes, and the like therefor.** Herbert Bailey, 6, Lord-street, Liverpool.

6872. **Improvements in apparatus for the electrolysis of gases.** Robert Francis Wood-Smith, 4, South-street Finsbury, London.

APRIL 1.

6882. **A portable gear-coupled water-motor and dynamo, for recharging motorcar electric ignition accumulators and the like.** Frederick John Matson, 11, Gladstone-street, Leeds-road, Bradford, Yorks.

6891. **Improvements in contact breakers for use in connection with electrically-fired internal-combustion engines.** The Electric Ignition Company, Limited, and Frederick Harold Hall, 24, Temple-row, Birmingham.

6904. **An improved method or arrangement for preventing accident or loss of life through the breakage of overhead electric tramcar wires.** George William Fowler and George Hildreth, 6, Finkle-street, Stockton-on-Tees.

6922. **A device for preventing the telephone handle being turned more than once.** Eduard Doye, 17, Mythenstrasse, Zürich, Switzerland.

6946. **Electric fire-alarms.** Fred Francombe, 4, Hill-street, Johnstreet, Kingswood, Bristol.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published April 20.*

1904.

7610. **Electric arc lamps.** Foster, Grote, and Ely.

7614. **Apparatus for generating and applying electricity on railway and other vehicles.** Beaumont and Still.

7807. **Machines for transforming or converting electric currents.** La Cour and Rich.

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**7814. Electric roasting and heating apparatus.** Bauer. (Dutertre and Nodet.)

**7937. Electric meters.** Krausse.

**8316. Electric machine tools.** Fairfax.

**8737. Mechanically-replaced annunciator movements for telephone switchboards.** Oppenheimer. (Act.-Ges. Mix und Genest.)

**9658. Machines for making incandescent electric lamps.** British Thomson-Houston Company, Limited. (General Electric Company.)

**9711. Apparatus for starting and controlling electromotors and circuit breakers adapted for use therein.** Dadge and Lord.

**9718. Electric lamps, especially applicable to electric lamps of the character known as "vapour arc lamps" or "luminous vapour" electric lamps.** Bastian.

**10341. Vapour electric rectifiers and like electric apparatus.** Carolan. (General Electric Company.)

**10559. Galvanic batteries.** Siemens Bros. and Co., Limited, and Eichenauer.

**10681. Methods of conducting chemical reactions by means of a mercury vapour arc.** Carolan. (General Electric Company.)

**11056. Ceiling or wall rosettes for electric lighting and heating.** Lundberg and Lundberg.

**11073. Electric switches.** British Thomson-Houston Company, Limited. (Allgemeine Elektricitäts-Ges.)

**11650. Incandescent gas, acetylene, and electric arc lamps.** Winkler.

**11943. Electric miner's safety lamps.** Rees.

**12123. Alternating-current electric motors.** Davies.

**12247. Electrodes and lamps for arc lighting.** Carolan. (General Electric Company.)

**12267. Electrical resistances.** Davy.

**12334. Construction of dynamo-electric machines.** British Thomson-Houston Company, Limited. (Allgemeine Elektricitäts-Ges.)

**12335. Dynamo-electric machines.** British Thomson-Houston Company, Limited. (Allgemeine Elektricitäts-Ges.)

**12336. Alternating-current electric meters.** British Thomson-Houston Company, Limited. (Allgemeine Elektricitäts-Ges.)

**15772. Manufacture of insulated electric conductors and apparatus therefor.** Siemens Bros. and Co., Limited, and Dieselhorst.

**21322. Process for the etching of metal plates by the aid of electrolysis.** Strecker and Strecker.

**21848. Telegraph recorder.** Roussel and King.

**22326b. Electricity transmission systems.** Justice. (Voltage Controller Company.) (Date applied for under Patents Rule 9, Oct. 17, 1904.)

**22839. Method of supporting electric tramway overhead power-transmitting or trolley wires.** Allen.

**23150. Apparatus for the distribution of alternating electric current.** Berry. (Date applied for under International Convention, Oct. 29, 1903.)

**26095. Controlling systems for electric motors.** Eastwood. (Date applied for under International Convention, March 21, 1904.)

**26099. Electric motor controlling systems.** Eastwood. (Date applied for under International Convention, June 10, 1904.)

**26220. Troughs or conduits for underground electric mains or cables, and for similar purposes.** Wilkinson.

**26282. Switch installations for telephone exchanges and switches therefor.** Siemens Bros. and Co., Limited. (Siemens und Halske, Act.-Ges.)

**27901. Storage cells.** Gardiner.

**27905. Grid or element for secondary batteries.** Gardiner.

**28018. Safety discharge apparatus for excessive voltages in electric circuits.** Siemens Bros. and Co., Limited. (Siemens-Schuckertwerke G. m. b. H.)

**28471. Combined starting and braking device for electric motors.** Hultqvist.

1905.

**3554. Detonator fuses for electric blasting.** Render.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ⅝-¾ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 7/16-17/32 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | – | 5¼-6 xd |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | – | 5¾-6 |
| —— 4½ per cent. Mortgage Debentures | 100 | – | 101-104 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 99-101 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | – | 2¼-3¼ |
| —— 4 per cent. Mortgage Debenture Stock | 100 | – | 91-93 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,751 | 2 | – | ½-¾ |
| —— Non. Cum., 6 per cent. Pref. | 2 | – | 1½-2 |
| —— 4½ per cent. 1st Debenture Stock | 100 | – | 92-95 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | – | 79-82 |
| Callender's Cable, Debentures | 100 | – | 107-109 |
| —— Ordinary | 5 | – | 11 11½ |
| —— 5 per cent. Pref. | 5 | – | 5¼-5½ |
| Crompton and Co. | 5 | – | 2¼ 2⅜ |
| —— 5 per cent. Debentures | 100 | – | 96 98 |
| Edison and Swan United, "A" Shares, 1-99,261 | 5 | – | 1-1¼ |
| —— "A" Shares, 01-017,139 | 5 | – | 1⅜ 2¼ |
| —— 5 per cent. Debentures | 100 | – | 85 90 xd |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 80-85 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | – | 1⅛ 1¼ |
| —— 7 per cent. Cumulative Pref. | 2 | – | 2¼ 2½ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | – | 97 99 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | – | 9-10 |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | – | 97-101 xd |
| W. T. Henley's Telegraph Works, Ordinary | 5 | – | 12¼ 12⅝ |
| —— 4½ per cent. Preference | 5 | – | 5⅜ ⅜ |
| —— 4½ per cent. Debentures | 100 | – | 109 111 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | – | 16 17 |
| —— 4 per cent. Debentures | 100 | – | 100 103 xd |
| Parker, Thos., Limited, Ordinary | 10 | – | 10 10¼ |
| Telegraph Construction and Maintenance | 12 | – | 36 38 |
| —— 5 per cent. Bonds | 100 | – | 103 105 |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary | 10 | – | 11½-12 xd |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | – | 9¾-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | – | 11-12 |
| —— 4½ per cent. Debenture Stock, Red. | 100 | – | 105-107 |
| Bromley (Kent) Electric Light and Power Co. | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. 1st Debenture Stock, Red. | 100 | – | 103-106 |
| Brompton and Kensington, Ordinary | 5 | – | 9¼ 10½ xd |
| —— 7 per cent. Preference | 5 | – | 9¾-10⅛ xd |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 | 5 | – | 9 9¼ |
| —— Nos. 60,001-80,000 | 5 | – | 6¾ 7¼ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | – | 12¼-13¼ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 105 108 |
| Charing Cross and Strand, 70,001-80,000 | 5 | – | 7⅛-8⅛ |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5⅝-5⅞ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 5-5⅛ |
| —— 40,001-80,000 | 5 | .. | 5-5⅛ |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | – | 105 107 |
| Chelsea Electricity Supply | 5 | – | 6¾ 7 |
| —— 4½ per cent. Debentures | 100 | – | 109 111 |
| City of London, Ordinary | 10 | – | 11-12 |
| —— 6 per cent. Cumulative Pref. | 10 | – | 13¼-14 |
| —— 5 per cent. Debenture Stock | 100 | – | 123-127 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | – | 103-105 |
| County of London Electric Supply, Ordinary | 10 | – | 9-9⅛ xd |
| —— 6 per cent. Cum. Pref. | 10 | – | 12-12¼ xd |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 104-106 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. | 100 | .. | 110-113 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | – | 6-6¼ |
| —— 6 per cent. Cum. Pref. | 5 | – | 6¼ 6⅜ |
| —— 4½ per cent. First Mort. Deb. | 100 | – | 106-108 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 2¼-2⅜ |
| —— 5 per cent. Debenture Stock, Red. | 100 | – | 86-91 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | – | 5¼-6 |
| —— 4½ per cent. First Deb Stock, Red. | 100 | – | 101-104 |
| Havana Electricity, Limited, 1-15,000 | 10 | – | 9¼-10¼ |
| Hove Electric Lighting, Limited Ord., 1-13,000 | 5 | – | 7⅜-7¾ |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 101-103 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 | 1 | – | 11/16-13/16 |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | | 12-13 |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red. | 100 | – | 101-103 xd |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅝-10¼ |
| London Electric, Ordinary | 3 | – | 2¼-3 |
| —— 6 per cent. Pref. | 5 | – | 5¼ 6 |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | – | 99-101 |
| Metropolitan Ordinary | 10 | – | 17½ 8¼ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | – | 109-114 |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5⅜ 5¼ |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | – | 97-99 |
| Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb. | 100 | – | 99-101 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | – | 98-101 |
| —— Preference | 4 | – | 100-102 |
| Notting Hill Electric Lighting | 10 | – | 14¼-15¼ |
| —— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.) | 100 | – | 102-104 |
| Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,510 | 5 | – | 6¼-6½ |
| —— 4 per cent. Debenture Stock | 100 | – | 98 100 |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures | 100 | – | 98 100 xd |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 | – | 2⅜ 3¼ |
| —— 4 per cent. Debenture Stock | 100 | – | 79-83 |
| South London, Ordinary | | – | 3¾-4¼ |
| South Metropolitan Electric Light and Power Co., Ord. | 1 | .. | ⅝-1 |
| —— 7 per cent. Cum. Pref. | 1 | .. | 1⅛-1 7/16 |
| —— 4½ per cent. 1st Mort. Deb. | 100 | .. | 105 108 xd |
| —— Ditto, June, 1904 | | – | |
| St. James's and Pall Mall, Ordinary, 101-80,080 | 5 | – | 13¾-14¼ |
| —— 7 per cent. Pref. | 5 | – | 8¼-8¾ |
| —— 5½ per cent. Deb. | 100 | – | 98-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | – | 4 15/16-5 1/16xd |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5-5¼ xd |
| Westminster, Ordinary | 5 | – | 12 13 |
| —— 5 per cent. Cum. Pref., 110,101-138,851 | 5 | – | 6¼-6⅜ |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 | 5 | – | 5⅛-5⅜ |
| —— Ord. | 5 | .. | 8¼-8¾ |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | – | 140-145 |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 105-107 |
| Barcelona Tramways, Limited, Ord., 1-20,000 | 10 | .. | 12-12¼ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 | 10 | .. | 9-10 |
| —— 5 per cent. Deb., Red., 1-600 | 100 | .. | 99-102 |
| —— 4½ per cent. Red. Deb. Stock | 100 | .. | 96-100 |
| Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606 | 1 | .. | 13/16-15/16 |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 | 1 | .. | 15/16-1 1/16 |
| Belfast Street Tramways, Ord., 1-26,600 | 10 | .. | 10½-11¼ xd |
| Blackpool and Fleetwood Tramroad | 10 | – | 13⅝-15⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | – | 1-1⅛ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | – | 3¾-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 91-98 |
| British Columbia Electric Railway Co., Ord. Def. | 100 | – | 104-107 |
| —— Ord Pref. | 100 | – | 100-103 |
| —— Non. Cum. 5 per cent. Pref. | 10 | – | 10-10¼ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 | – | 105 107 p c |
| —— 4½ per cent. Vancouver Power Deb. | 100 | – | 99-102 |
| British Electric Traction Ord. 1-500,000 & 60,001-80,000 | 10 | – | 9-9¼ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | – | 10¾-11⅛ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | – | 121-123 xd |
| —— 4½ per cent. 2nd Deb. Stock | 100 | | 98-100 |

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| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| | £ | | £ |
| Buenos Ayres and Belgrano Tram. Ord., 1-100,000 | 5 | .. | 3¾-4 |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | | 5⅛ 5⅛ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | | 5⅜ 5⅜ |
| —— 5 per cent. Deb. Stock, Red. | 100 | | 107-109 |
| —— Prov. Cert., all paid | 100 | | 103 106 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | | 97-99 |
| Calcutta Tramways, Limited, 1-102,268 | 5 | .. | 8¼-9 |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | .. | 106-108 |
| Cape Electric Tramways Nos. 1-480,000 | 1 | | 1⅛-1⅜ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | | 4⅞-5⅛ |
| —— 4 per cent. 1st Mortgage Deb., 1-5,000 (1917) | 100 | | 101-104 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | | 103-105 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | | 9½-10 |
| —— 5 per cent. Cum. Pref. | 10 | | 11-12 |
| —— 4 per cent. Debentures | 100 | | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | | 13¼ 14¼ |
| —— 5 per cent. Pref., Nos. within 1-60,000 | 10 | | 15⅝ 16⅛ |
| —— 5 per cent. Mort. Debs., 1-5,000, Red. | 100 | | 94-97 |
| Imperial Tramways Ordinary | all | | 18-19 |
| —— 5 per cent. Cum. Pref. | all | | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 | | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000 | 5 | | 3-3½ |
| —— 4 per cent. Debenture Stock | 100 | | 89-92 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | | 8 8½ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | | 10-10½ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | | 99 102 |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 | .. | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016. | 1 | .. | 13/32 15/32 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | .. | 1-1 1/16 |
| —— 4½ per cent. Deb. Stock, Red. | 100 | .. | 105-107 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000 | $1,000 | .. | 106-110 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 | .. | 101-104 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 | .. | 103-105 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000 | 5 | | ¼-1½ |

| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| | £ | | £ |
| Oldham, Aston, and Hyde Tramway, Ordinary | 10 | | 12½ |
| —— 6 per cent Cum. Pref. | 10 | | 9⅜-9⅞ |
| Perak Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk. | 100 | | 105 108 |
| Potteries Electric Traction, Ordinary 20,001-40,00 | 10 | | 9⅜ 10¼ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | | 9¼-10 |
| —— 4½ per cent. Debenture Stock | 100 | | 103-107 |
| South Lancashire Electric Traction and Power Company | | | |
| —— £250,000 Ordinary | 1 | | 1 |
| —— £101,132 5 per cent. Preference | 1 | | 1 |
| —— £597,170 4½ per cent. Debenture Stock | 100 p.c. | | 100 p.c. |

## Electric Railways.—

| | | | |
|---|---|---|---|
| Central London, Ordinary | 100 | | 93-95 |
| —— 4 per cent. Pref. | 100 | | 101-103 |
| —— " " deferred | 100 | | 83-86 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | | 111-113 |
| City and South London, Consolidated Ordinary | 100 | | 44-45 |
| —— 4 per cent. Debenture Stock | 100 | | 109-111 |
| —— 5 per cent. Pref. Stock '91 | 100 | | 120-123 |
| —— " " " '96 | 100 | | 118-121 |
| —— " " " '01 | 100 | | 115-118 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | | 10-10½ |
| —— Ordinary, 1-50,000 | 10 | | 3⅜-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — | | 98-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | — | | 99-100½ |
| Waterloo and City, Ordinary | 100 | | 98-99 |

## Telephones.—

| | | | |
|---|---|---|---|
| National Telephone, Preferred | 100 | | 109-110 |
| —— Deferred Stock | 100 | | 102-104 |
| —— 6 per cent. Cum. First Pref. | 10 | | 12½-13½ |
| —— 6 per cent. Cum. Second Pref. | 10 | | 11⅛ 12⅛ |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | | 5¼-5⅝ |
| —— 5½ per cent. Deb. Stock, Red. | 100 | | 100 102 |
| —— 4 per cent. Deb. Stock, Red. | 100 | | 104-106 |
| —— 4 per cent. Prov. Cert. | — | .. | 103½-105½ |
| Oriental Telephone and Electric Company | 1 | | 1⅛-1⅜ |
| —— 6 per cent. Cum. Pref. | 1 | .. | 1 3/16-1 5/16 |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905 | 1904. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | April 1 | 1,110 | 1,166 | − 56 | + 5,628½ | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·14 |
| Ayr Corporation | ,, 1 | 193 | 184 | + 9 | + 675 | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 336,049 | 1·03 | 10·11 | 1,770 | 5 0 |
| Barking Corporation | ,, 1 | 48 | 41 | + 7 | + 305 | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 2 | 1,034 | 938 | + 36 | — | 23·55 | 23½ | March 31 | 56,073 | 11,327,932 | 1,319,701 | 1·158 | 9·98 | 2,383b | 6·1 |
| Birmingham Corporation | ,, 1 | 359 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | — | — | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | Mar. 31 | 611 | 748 | − 136 | — | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10 94 | — | 4·59 |
| Blackpool Corporation | ,, 30 | 414 | 337 | + 77 | + 6,488 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | April 1 | 270 | 439 | − 169 | − 223 | 16½ | 16½ | Dec. 31 | 32,021 | 2,253,984 | 600,757 | 3·34 | 12·75 | 2,001 | 7 05 |
| Bolton Corporation | ,, 2 | 1,862 | 2,041 | − 179 | − 47 | 38 | 38 | March 31 | 94,161 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·89 |
| Bournemouth Corporation | Mar. 24 | 992 | 821 | + 163 | + 2,583 | 10·15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 25 | 3,939 | 3,620 | + 319 | +31,361 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | April 2 | 849 | 923 | − 74 | + 4,054 | 9 | 7½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | Mar. 31 | 4,521 | 4,608 | − 84 | — | 51½ | 51½ | Dec. 31g | 253,150 | 44,391,439 | 6,033,528 | — | — | — | — |
| Burnley Corporation | April 1 | 1,099 | 1,255 | − 154 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 2 | 305 | 339 | − 34 | — | 8½ | — | March 31f | 11,574 | 2,556,134 | 282,378 | 1·08 | 9·84 | 1,570 | 7·57 |
| Cardiff Corporation | Mar. 25 | 1,911 | 1,815 | + 115 | + 2,283 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | April 1 | 151 | 194 | − 43 | − 347 | — | — | Dec. 31g | 9,937 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 1 | 7,054 | 6,297 | + 757 | + 1,575 | 6 | 6 | ,, 31 | 362,471 | 44,933,938 | 1,292,674a | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 2 | 2,697 | 2,712 | − 15 | − 2,518 | 6½ | 6⅜ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Colchester Corporation | Mar. 29 | 176 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. P. and L. Company | ,, 30 | 417 | 397 | + 20 | — | — | — | ,, 31g | 25,657 | 6,355,323 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | ,, 31 | 227 | 275 | − 48 | — | 7·23 | 7·23 | March 31g | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 2 | 173 | 164 | + 5 | — | 4½ | 4½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0 94 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | ,, 31 | 100 | 00 | — | + 324 | 7 | 6¾ | Dec. 31g | 6,234 | 688,905 | 107,164 | 3·88 | 14·09 | 952 | 7·38 |
| Dublin U. T., electric cars | ,, 31 | 3,604 | 3,504 | + 100 | } — | 47 | 46 | ,, 31g | 134,643 | — | 3,429,356 | — | — | — | — h |
| Dublin S. District, Electric | ,, 31 | 773 | 776 | + 67 | | | | | | | | | | | |
| Dundee City Tramways | ,, 29 | 791 | 767 | + 28 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | April 1 | 744 | 718 | + 25 | + 2,226 | 10·77 | 10·75 | March 31 | 34,312 | 12,950,269 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 1 | 14,682 | 13,411 | +1,271 | +32,948 | 145 | 123 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Gloucester Corporation | Mar. 30 | 249 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 22 | 2,614 | 2,457 | + 157 | + 5 510 | 33 | 30½ | March 31 | 68,283 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,069 | 8·77 |
| Huddersfield Corporation | ,, 25 | 1,224 | 1,117 | + 117 | + 4,522 | 35 | 35 | ,, 31 | 65,545 | 11,893,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | April 1 | 2,211 | 2,144 | + 67 | +12,009 | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | — | — | — | — | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | Mar. 29 | 116 | 132 | − 16 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 29 | 121 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | April 1 | 5,471 | 5,318 | + 153 | + 5,471 | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | ,, 1 | 1,964 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | Mar. 25 | 10 300 | 10,016 | + 284 | + 4 914 | 103 | 103 | Dec. 31g | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | April 2 | 1 4 9 | 1,547 | − 58 | − 752 | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — e |
| London County Council | Mar. 25 | 13 375 | 10 452 | +2,943 | +125,383 | 46½ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | ,, 31 | 100 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | April 1 | 11 923 | 11,563 | + 360 | — | 131¼ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 1 | 112 | — | — | — | 2½ | — | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newcastle-on-Tyne Corptn. | ,, 1 | 3,566 | 3,515 | − 49 | — | 45 | 38½ | ,, 25 | 185,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111b | — |
| Newport (Mon.) Corporation | — | — | — | — | — | 15 | — | — | — | — | — | — | — | — | — |
| Oldham Corporation | ,, 2 | 1 552 | 1 134 | + 418 | + 432 | 34½ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 1 | 1,626 | 1,706 | − 80 | + 6,794 | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·16 | 12·39 | — | — |
| Reading Corporation | Mar. 30 | 562 | 569 | − 7 | — | — | — | — | — | — | — | — | — | — | — |
| Rochdale Corporation | ,, 25 | 440 | 101 | + 339 | + 7,742 | 4½ | 4½ | 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·65 |
| Rotherham Corporation | ,, 30 | 401 | 422 | − 21 | — | — | — | ,, 31 | 20,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·68 |
| Salford Corporation | April 3 | 4,050 | 4,377 | − 327 | +11,003 | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 1 | 73 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 2 | 4,682 | 4,371 | + 311 | − 690 | 34½ | — | ,, 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | Mar. 29 | 815 | 854 | − 11 | − 2,637 | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 29 | 257 | 211 | + 46 | + 1,711 | 6½ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 31 | 487 | 5 3 | − 85 | + 8,814 | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 20 | 1,144 | 1,064 | + 80 | + 1 675 | 19 51 | 18·48 | ,, 31 | 62,506 | 14,948,958 | 1,433,463 | 1 01 | 10·46 | — | 6·02 |
| Swindon Corporation | ,, 1 | 151 | — | — | — | 3½ | — | — | — | — | — | — | — | — | — |
| Wallasey U D C | ,, 25 | 705 | 593 | + 107 | + 2,745 | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·50 |
| Warrington Corporation | ,, 25 | 317 | 305 | + 12 | + 643 | 7½ | — | — | — | — | — | — | — | — | — |
| West Ham Corporation | ,, 30 | 1,1 7 | — | — | — | 8·62 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 29 | 703 | 464 | + 214 | — | 7½ | — | ,, 31g | 20,878 | 4,263,066 | 417,335 | — | 12·005 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Per mile of single track. b Include rail and tram. c Including depreciation. d Including one section of horse traction. e 1905. f Only eight months—expenditure includes large special items incidental to starting new department. g Train mile. h Half-year's figures.

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## NOTES.

**Australian Patents.**—Messrs. W. P. Thompson and Co., patent agents, Liverpool, communicate a decision respecting Australian patents which will doubtless be of great interest to holders of such grants. It appears that the decision of the Comptroller not to convert State patents into Commonwealth patents has been reversed. The effect of this is that any State patent can be at once so changed without incurring the fees of each of the various States.

**The Institution.**—The subject for discussion at last week's meeting was "Systems of Electric Units," which was dealt with at the St. Louis International Congress. Mr. W. H. Duddell, hon. secretary to the English delegation, opened the proceedings, and the subsequent speakers included Mr. R. K. Gray, Lord Rayleigh, and Mr. A. P. Trotter, but the hour for adjournment arrived without the discussion being concluded. A summary of the complete discussion will appear in our next issue.

**Side-Slip.**—The committee of the Cyclists' Touring Club announce that nearly 60 devices have been entered for competition for the large monetary prizes offered for a satisfactory solution of the side-slipping problem, while at least an equal number of inventors have put forward their theories without actually entering. The trials themselves will probably take place in the neighbourhood of London during Whit-week upon natural and artificial surfaces calculated to test the merits of the devices to the utmost.

**Royal Institution.**—The following are the lecture arrangements at the Royal Institution after Easter: Prof. L. C. Miall, Fullerian professor of physiology, R.I., three lectures on "The Study of Extinct Animals"; the Rev. H. G. Woods (master of the Temple), three lectures on "Velazquez"; Prof. Sir James Dewar, Fullerian professor of chemistry, R.I., three lectures on "Flame"; Prof. J. A. Fleming, three lectures on "Electromagnetic Waves" (the Tyndall lectures); Prof. H. Marshall Ward, two lectures on "Moulds" and "Mouldiness"; Dr. J. G. Frazer, two lectures on "The Evolution of the Kingship in Early Society"; and Mr. A. H. Savage Landor, two lectures on "Exploration in the Philippines." The Friday evening meetings will be resumed on May 5, when a discourse will be delivered by Prof. H. E. Armstrong on "Problems Underlying Nutrition." Succeeding discourses will probably be given by Prof. E. Fox Nicholls, Sir Charles Eliot, K.C.M.G., Prof. J. W. Brühl, Mr. George Henschel, and Sir William H. White.

**Electrolysis with Alternating Current.** — An abstract of an article on this subject by Mr. Carlo Rossi appears in the *Journal* of the Chemical Society. Solutions of potassium chlorate acidified with sulphuric acid exhibit complicated phenomena when subjected to the action of an alternating current between copper or iron electrodes. The copper electrodes become coated with cuprous chloride, copper dissolves, and a bluish-green basic chlorate, $Cu(ClO_3)_2,3Cu(OH)_2$, separates from the solution. When a direct current is used, cuprous chloride is formed at the anode, together with smaller quantities of basic chlorate and chloride; the solution, from which a complex mixture of cupric hydroxide, cupric oxide, copper, and cupric chloride separates out, does not contain dissolved copper. It is supposed that the copper passes into solution at the anode as cuprous ion, which reduces the chlorate, cupric copper being then precipitated by the alkali formed at the cathode. The non-reversibility of the change at the electrodes when alternating currents are used is probably due to the rapid removal of the cuprous ions in this manner. When, on the other hand, the potassium chlorate is replaced by sodium chloride, the alternating current dissolves very little copper. With iron electrodes similar phenomena were observed.

**Motor Omnibuses.**—Tramway undertakers, in promoting their schemes, have had to contend with a large amount of opposition through the jealousy of railway companies. Now that the latter are competing for the street traffic by running motor 'buses, tramway owners consider it is their turn to go in for protection, and to this end conferences have been held in which both municipal and private undertakers have participated. At the adjourned meeting held at the Westminster Palace Hotel on Saturday, it was reported that the Midland and the Great Western Companies had withdrawn their omnibus clauses, and that the North-Eastern Railway Company were prepared to make some concessions in order to meet the views of municipal and other tramway owners. Sir Edward Grey, M.P., as a director of the North-Eastern Company, intimated that, whilst they would try to meet the objections of tramway owners in urban districts, they desired full liberty for giving motor omnibus facilities in country districts. The meeting was adjourned to consider what amendments the North-Eastern Company are willing to make in their motor omnibus clause.

**Electricity in Workshops.**—At Newcastle last Friday, under the presidency of Mr. Gerald Stoney, a lecture upon "The Electric Equipment of Workshops and Shipyards" was delivered to the local students of the Institution of Civil Engineers by Mr. Wilfrid Hill. After alluding to the great industrial development of electricity in recent years, the lecturer remarked that this form of power might greatly tend to modify economic conditions in the near future. Electrical engineers had rendered no small service to manufacturers by calling attention to the actual cost of power. Mr. Hill then discussed the comparative cost and advantages of steam, gas, and electricity as forms of motive power, and showed that in general electricity was the most economical in actual cost, as also in the amount of space required. Having briefly referred to the considerations which govern the choice of system when laying out an electric installation, and also to the question of public *v.* private supply, the lecturer gave a description of various types of motors, making special reference to induction motors, on account of their suitability for shipyards and places here they might be subject to rough usage.

**Hygienic Telephony.**—A little while back the telephone authorities at Paris introduced a simple arrangement for disinfecting telephone transmitters, and now our General Post Office has followed suit. The contrivance consists of a cap containing an antiseptic pad, hinged to a piece that attaches the whole in a simple manner to the transmitter, and included with the outfit is a bottle of a pleasantly perfumed but powerful disinfectant, a few drops of which poured on the pad every three or four weeks keeps the interior of the mouthpiece pure. When the conversation is finished, the cap is simply snapped by the user over the mouthpiece, rendering it germ-proof. The General Post Office supplies this outfit, which is designated "telephonine," at 5s. Another item of telephonic news is that in September next direct communication between Vienna and Trent (Italy) is expected to be an accomplished fact, and this will probably lead to direct communication between Rome and Berlin. Another matter upon which the Postmaster-General was questioned in the House referred to the telephonic rates between London and Paris, which, Lord Stanley implied, were as reasonable as the conditions would allow, and, consequently, he did not propose to take any steps for their reduction.

**Street Railways in the States.**—The American Census Office on Street and Electric Railways has just issued

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a voluminous report, which contains a quantity of information upon all phases of this subject; but it serves to illustrate none more conspicuously than the effect of such services in transferring the population from the centre of large cities to the suburbs for residential and, in some cases, industrial purposes. The Manhattan borough of New York, which is some seven miles from the city, practically doubled its population during the decade 1890-1900, and the great majority of its wage-earners made daily use of the street railways. Other suburbs also show substantial increases in this respect. The same process has been going on in Boston, for while the centre of the city is rapidly becoming depopulated from the residential point of view, the outlying areas show enormous expansion. Philadelphia, again, presents a similar aspect. The cities named exemplify the influence in the most marked degree, but there are many others where it is scarcely less pronounced. In Philadelphia especially the transport facilities have led to the utilisation of the outlying areas for manufacturing operations, the various industries assembling themselves in specialised centres. Electric traction greatly predominates, and electricity is the chief illuminant on the cars. The almost universal fare for the urban lines is 2½d., reductions being made for books of tickets.

**Central Technical College.**—We have received a copy of "The Central," dated March, which contains an illustrated article on "Victoria Falls Bridge: Design and Construction of Steelwork," by Ralph Freeman; a continuation of the article entitled "The Mechanism of Combustion," by H. E. Armstrong; a short description of London University; an illustrated article on "The Klingenberg Carriage Switchgear," by J. Griffin; and "Old Student Notes." Mr. Griffin considers the type of switchboard most suited to high-pressure stations, and lays down 11 conditions which should be satisfied. These, he thinks, are best met by the switchgear lately developed by Dr. Klingenberg, the distinguishing feature of whose system is the assemblage of all the apparatus belonging to any generator, feeder, or distributor upon an iron framework fixed upon a number of wheels, which enable the so formed carriage to be moved along a pair of rails. Upon the back of this carriage are fixed a number of carefully insulated plugs or blades, which fit into a corresponding number of similarly insulated contacts forming the terminals of a generator, feeder, or distributor on the one hand, and the ends of connections to the 'bus bars on the other. By this simple arrangement it is possible, by pushing the plugs or blades on the back of the carriage into the contacts behind the same, to connect the generator, feeder, or distributor, through an oil switch, with the 'bus bars. A simple locking device renders it impossible either to push the carriage on to or to withdraw it from the contacts with the oil switch closed.

**Societe Belge d'Electriciens.**—In the April *Bulletin* of this society there appears the conclusion of an excellent article by Mr. J. Carlier on the apparatus for measuring time, speeds, and acceleration of railways. The author is an engineer of the State railways of Belgium, and is able to give a number of illustrations from actual experience on the same. The first part of this article deals with apparatus for measuring cyclic variations in speed such as are interesting to the designer of alternators which have to work in parallel. The last portion of the article deals with the automatic recording of acceleration. Amongst the instrument described for this object is the Desdouits dynamometer, which depends for its action upon the inertia of a pendulum. By means of this any changes in speed are exactly recorded on the cylinder. Again, if the driving force is discontinued the apparatus measures the negative acceleration of the train due to the running friction. In connection with this apparatus a second pencil is provided to record the actual revolutions of the wheel, so that there is a means of determining the exact points on the railway represented by the points on the acceleration curve. An actual diagram is reproduced which was taken with this apparatus on the line from Paris to Niort. This clearly shows that the negative acceleration in braking is between two and three times that which could be obtained by the locomotive used to accelerate the train. An instrument designed by Mr. Carlier himself is also illustrated and described, and this, again, depends for its action on the inertia of a pendulum. Acceleration meters which depend on the movement of a liquid are also briefly referred to. One such instrument designed by Mr. Gisbert Kapp is particularly mentioned. The article is one which will repay careful study by tramway and railway engineers who are investigating the actual performance of their rolling-stock.

**The Trans-Siberian Railway.**—The Electrotechnical Association of St. Petersburg recently considered the proposed electrification of the Trans-Siberian Railway, to which we briefly referred a few months back. Apart from the abnormal conditions due to the Far East campaign, the traffic, both passenger and goods, is stated to have expanded to such an extent that the present service is inadequate. Two important obstacles in the way of speed acceleration are lightness of the rails and insufficiency of water, though the latter difficulty might perhaps be met by "canalisation." The relaying of the track, however, would entail a heavy expenditure of time and money, and this has led to the suggestion that the system should be electrified. Prominent among the advocates of this plan is Count A. F. Lubienski, who holds that the conversion is imperative. The existing track would be utilised, and electric trains on the multiple-unit system would not be handicapped by the numerous curves and gradients to the same extent as are the steam locomotives. The rivers and waterfalls along the route would probably be utilised for generating energy, the power stations being located at intervals of 60 to 120 miles, whence the current would be distributed at a pressure of 100,000 volts to sub-stations in both directions. The scheme seems well worthy of consideration, though the Russian Government is not likely to have much money to spend in this direction just yet. When peace has been declared, perhaps another railway loan could be raised in France, which already has large financial interests in the undertaking. Another project that was discussed on the same occasion refers to the electrification of the Caucasian railways, for which the district is well adapted on account of its abundance of waterfalls. This proposal also seems to merit further attention, but here, too, financial considerations are likely to be an obstacle to early action.

**Telephone Transfer.**—The employés of the National Telephone Company have shown great activity in regard to their status on the undertaking being transferred to the Government. In the House of Commons the other day, the Postmaster-General, in reply to a question, stated that he had received two memorials requesting him to receive a deputation, which he hoped to be able to do shortly. In the meantime, he might say that it would probably be found necessary to transfer to the Post Office service all efficient members of the executive staff previously required by the company. Those persons who were appointed to the established staff of the Post Office would at once benefit by the conditions as to pensions which applied to their staff, but he could hold out no hope that operators and other classes, who were not entitled to any pension under their present employment in the company's service, could be allowed to have the period of that service taken

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into account in reckoning their Post Office service. In the case of those members of the staff who contributed to the present pension fund it was expressly stipulated in the agreement that any obligation arising out of their service previous to their transfer fell to be met by the company, and he had no reason to suppose that the company would not meet that very fully. It would be open to the Select Committee to consider the agreement and hear representations from the company's staff. The Postal Telegraph Clerks' Conference has likewise been active. Apparently the concessions promised by Lord Stanley are far from satisfying the employés, who want the recommendations of the Bradford Committee adopted in their entirety. It will be remembered that Lord Stanley stated not long ago that this was impossible, the committee having exceeded its function. Amongst other things it was decided at the conference to again recommend the introduction of the threepenny telegrams, on the ground that this would give a stimulus to telegraphy, and so improve the operators' prospects.

**Bell Telephone Company.**—The annual report of the American Telephone and Telegraph Company shows that the remarkable growth of the Bell system continues unabated. The increase during 1904 of instruments in the hands of Bell licensees was 701,047, or more than the total number at the beginning of 1896, while the increase of stations was 274,466, the total number eight years ago being 281,695. The aggregate of stations at the beginning of the present year was nearly 1,800,000, and the total mileage of line just short of 3,500,000 miles. Approximately the receipts for the year were £4,000,000, the dividends paid amounting to £2,000,000, while £120,000 was placed to reserve and £180,000 carried forward. The revenue showed an increase of more than £400,000 over the previous year, the expenditure rising from £1,200,000 to £1,480,000. In connection with the agitation that has been going on respecting the costliness of the public services, we note that the New York Telephone Company (a Bell concern) has decided to reduce its tariff from May 1 as follows:

| No. of messages. | Old schedule. | New schedule. |
|---|---|---|
| 600 | £15 | £12 |
| 1,200 | 22 | 18 |
| 1,800 | 28 | 22 |
| 2,400 | 33 | 27 |
| 3,000 | 37 | 32 |
| 3,600 | 40 | 36 |
| 4,500 | 46 | 40 |

This company has pursued an open policy respecting its finances, having given an independent committee unrestricted access to its books, which is expected to go a long way in allaying hostility to companies which own public concessions. The drawback to this publicity is that the unthinking section of the community will not always interpret the accounts aright. Respecting return on capital, for example, due allowance would probably not be made for plant which had been "scrapped" in order to keep march with scientific progress. The New York Telephone Company has thrice completely reconstructed its exchanges.

**A Freight Subway.**—Some half-dozen years ago the Illinois Telegraph and Telephone Company started the construction of a series of tunnels under the streets of Chicago for the cables of the company's telephone system. This network of tunnels is now utilised for a subterranean goods transport system, of which a description is given in the *Scientific American* The tunnels are about 20ft. below the street level, and consist of trunk and branch lines. The track is of 2ft. gauge, laid with 56lb. T rails. Part of the line is on the overhead trolley principle, the remainder being on the Morgan third-rail system. This latter consists of a perforated metal plate (½in. thick and 4in. wide), forming a rack, which is bolted between two lines of timber stringers, which serve to protect and support the rail. The locomotives are of the class used in mine haulage work, but are peculiar in the method of taking current. The rack rail serves both for traction and as a power conductor, the current being led to the motors, which are geared to the axles with suitable controlling devices. The track rails are used for the return current. One important advantage of this system is to relieve the streets of the city from a great quantity of traffic. Thousands of tons of coal, ashes, and refuse from the excavation of houses in course of building are thus conveyed. Besides this, the system is daily used for hauling large consignments of mixed freights formerly transported over the streets, and the company, which is named the Illinois Tunnel Company, recently entered into a contract with the Government under which a large proportion of the mails will be carried from the railway stations to the Post Office by the same means. A further plan to utilise the tunnels for mail purposes involves the building of chutes connecting the post boxes with the tunnel, so that the mails can be collected by the cars. It is estimated that altogether more than 112,000 tons of mixed freights are moved to and from the numerous Chicago railway stations daily, which caused great congestion in the streets, and this the subways have relieved. The cars of the tunnel company are run directly into the railway freight houses, loaded, and run through the tunnels to the consignees. Here the cars are run into the basement of the warehouse through an opening cut in the masonry, raised to the desired floor on elevators, and unloaded. If the goods are not intended for immediate delivery, the cars are run into the company's storehouses and kept there till required. Every building on the route of the tunnel can be connected to it by a lateral shaft.

**Junior Institution of Engineers.**—A large number of members of this institution visited the Willesden power-house of the North Metropolitan Electric Power Supply Company at Taylor's-lane last week, when they were conducted round by the station superintendent (Mr. F. D. Napier) and his assistants, in the unavoidable absence of the engineer, Mr. E. T. Ruthven Murray. The continuous current is generated directly at a pressure of from 490 to 540 volts suitable for the 2 by 240-volt network surrounding the works, and this fixes the average pressure of the alternating-current terminals of the same generator at 316 volts, the machines being, as it were, rotary converters driven by engines. Step-up transformers with a ratio of 1 : 9 are employed, raising the pressure to an average of about 2,850 volts, at which it is transmitted to the sub-station. There variable-rate step-down transformers and rotary converters once more reduce the pressure down to that suitable for a 240-volt three-wire continuous-current distribution. The site of the station occupies an area of 3½ acres, and adjoins the Midland and South-Western Junction Railway, by which access can be gained to all the great northern lines. The boilers are of the Babcock-Wilcox type, arranged in pairs, built in glazed brick settings. Draught gauges are fitted, and an "Ados" registering $CO_2$ recorder. There are Hall steam feed pumps, and a Mather and Platt electrically-driven pump, the latter having a special device for effecting its regulation. The arrangement of steam mains is novel. A jet condenser by Ashton, Frost, and Co. is provided for the two 300-kw. sets, while the other sets have their own surface condensers. There is a cooling plant, supplied by Korting Bros., on which are four lines of spraying jets. The surface of the pond is 30ft. by 200ft., and it is capable of dealing with 100,000 gallons of water per hour, which is

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the storage capacity of the pond. All water is softened by a Brunn-Lowener apparatus, in which milk of lime and soda is used. For the general arrangement, and for the design of many of the special details of the low-tension continuous-current switchboard, Mr. Ruthven Murray was responsible. His object was to arrange a switchboard embodying the distinctive and valuable features of the Ferranti high-pressure cellular type of switchgear for low-pressure working. The principal feature of novelty in the low-tension switchboard is that four separate 'bus bars are provided, and there are "selector switches," which enable any machine or feeder to be connected to any 'bus bar. The battery-room contains 250 Tudor cells, with a capacity of 840 ampere-hours at a 10-hour discharge rate.

**Alloys of Copper and Bismuth.**—At the meeting of the Faraday Society last week Mr. A. H. Hiorns gave an illustrated lecture on this subject. The results of previous researches on copper alloys appeared in the society's *Transactions* for April of last year. The author alluded to the investigations into the effect of bismuth, from 0·1 to 0·5 per cent., on copper made by Prof. Arnold, who found that the investing membranes surrounding the grains of copper appeared to be split down the centre, presenting a definite plane of cleavage. Dr. Gautier obtained a freezing-point curve similar to the author's, but his temperatures are generally higher. The microscopic evidence mainly confirms the records of the freezing-point curves, of which there are four branches—pure copper and pure bismuth at the extremes and solid solutions of copper in bismuth or bismuth in copper at intermediate points. The types of pattern on the etched surfaces depend on the position of the freezing points on the curve. The eutectic points occur at 243deg. C. and 1,020deg. C., with a transition point at 858deg. C. From this point with increase of bismuth in alloys containing 30 to 43 per cent. of copper, the curve is practically a horizontal line showing little differences in the freezing points. In this region two possible chemical compounds may be present—viz., $Cu_3Bi_2$ and $Cu_2Bi$—but there are no well-marked indications of such, either in the freezing-point curve or in the micro-sections. Such compounds can, therefore, only exist in contact with solutions containing excess of bismuth. The above-mentioned transition point is the transition point between solutions of copper in bismuth and bismuth in copper, and at this point the two solutions have probably the same freezing points, each being lowered by the addition of the other, thus forming a conglomerate of the two mixed crystals, which here exist in equilibrium. Copper with small percentages of bismuth consists of polygonal grains, the boundaries of which contain a thin line of bismuthide. When such copper is broken the line of fracture follows this line. With 2 per cent. bismuth the surface shows a characteristic eutectic structure. With increase of bismuth gradually widening boundaries to the grains appear, and the interior is of a eutectic nature, which also increases with the addition of bismuth. With 57 per cent. bismuth the whole surface is composed of grains of the two solid solutions, one of a light-grey and the other of a light-red colour. With 60 to 67 per cent. bismuth the alloys are composed of the two solid solutions mentioned above, with the addition of dark-blue grains, probably the compound $Cu_2Bi$. With 70 to 90 per cent. of bismuth there are two main constituents, consisting of the red solid solution in a eutectic mixture. With 97·2 per cent. of bismuth the whole is decidedly a eutectic mixture. The structure of alloys containing 98 per cent. bismuth and upwards resembles pure bismuth. The chairman, Prof. A. K. Huntington, remarked that previous observers had not noted the eutectic point of pure copper and copper-bismuth solution at 1,020deg. C., shown at D on the author's cooling curve. He hoped Mr. Hiorns would make his study more complete by systematically examining chilled alloys as Heycock and Neville had done in the case of the copper-tin series. Mr. Hiorns, in reply, said that repeated experiments justified his belief in the existence of the eutectic at 1,020deg. C.

**Lightning Conductors.**—On Saturday last, Mr. W. H. Whitehouse, M.I.E.E., read a paper before the members of the Birmingham and District Electric Club on "Lightning Conductors." Quoting from Fuller's "Church History," that "scarcely a great abbey or cathedral in England exists which once at least was not burned with lightning from Heaven," and Sir W. Snow Harriss's evidence as to the annual damage done to the British Navy, he referred to Sir W. Preece's statement before the Institution of Electrical Engineers in 1889, that in 1872 19 per cent. of the telegraph instruments were damaged by lightning. Against this the number damaged in the year 1889 was only 1·3 per cent, this result being due to the employment of an ordinary galvanised No. 4 iron wire down each pole. During the year 1899 the following casualties were mentioned in the British Press: people killed, 25; injured, 114; churches and chapels struck, 17; hotels, 12; castles and country mansions, 5; houses, cottages, and buildings, 237; while in America during the same year there were 562 killed and over 800 injured. The lecturer then proceeded to describe the phenomenon of the lightning discharge—forked, sheet, and globular, St. Elmos fire, thunder, etc. He alluded to the work of Franklin at Philadelphia and M. Dalibard at Marby-la-Villa in proving the identity of lightning with ordinary frictional or static electricity as shown by the action of the Leyden jar, electroscopes, etc. [Apparently the lecturer did not introduce any mention of that neglected scientist, Prohop Dilwisch (which the erudite have Latinised into Procopius Divisa) who preceded Franklin in the construction of the lightning conductor] He referred to the difference of opinion as to the relative merits of points or knobs on the top of a conductor, which gave rise to such heated discussion in the reign of George III. During the past 20 years, owing to increased knowledge of electrical science, the theory of lightning has been entirely changed, it having been discovered that the discharge is a high-frequency alternating current, and not a direct one, as formerly supposed. As the laws of ohmic resistance do not apply, neither does the superiority of copper over iron as a conductor. Attention was directed to the papers read by Sir Oliver Lodge before the Society of Arts, the British Association, and the Institution of Electrical Engineers in 1888-9, when Sir Oliver showed some interesting experiments with syntonic Leyden jars connected to alternative paths, and giving impulsive rush discharges. The experiments bearing on the new theory were fully explained and illustrated on the screen, and the lecturer, in concluding, gave a summary of what may be deemed (in our present knowledge of the subject) the essentials of a proper system of lightning conductors. Through the kindness of Mr. A. Hands (Messrs. G. W. Grey and Sons, Leadenhall-street, E.C.), the paper was illustrated by a number of photo slides of churches and buildings damaged by lightning.

**Single-Phase Railway.**—A description appears in the *Western Electrician* of the Bloomington, Pontiac, and Joliet Electric Railway, which is equipped with the single-phase tracks and system of the General Electric Company. It is intended to operate the line at 3,000 volts without any feeders by simply connecting the power station at one end to two No. 00 trolley wires with which the line is equipped. The trolley wires are hung from three 8in.

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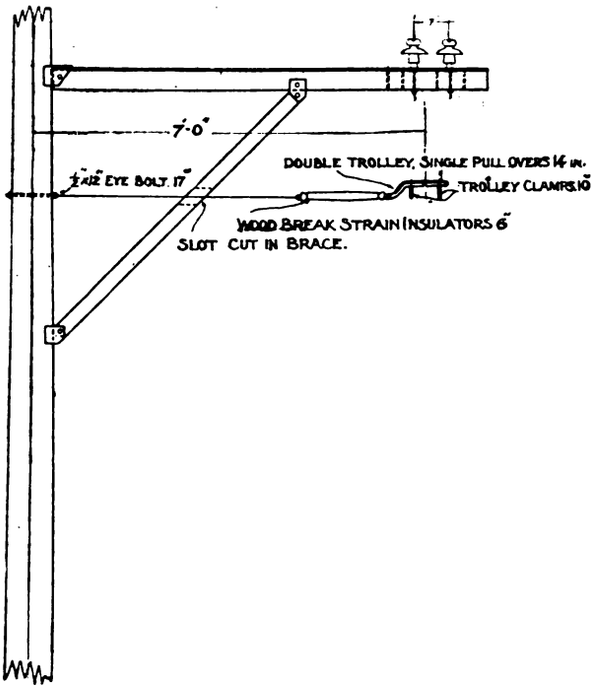
steel stranded catenary conductors, from which they will be supported every 10ft., though at present the supports are placed only every 100ft. midway between the poles, which are 7ft. from the centre of the track, and are fitted with a wooden instead of an iron bracket. The trolley wires are supported 9ft. 6in. from the track, and the catenaries are insulated by Thomas insulators placed 10in. apart, these insulators being secured on malleable iron pins with Portland cement. The trolley wire is supported by mechanical clips having bronze hooks, which latter slip over the catenary cable and are then hammered down so as to prevent them from coming loose. We reproduce an illustration of the overhead equipment. Within the limits of Pontiac a side pole instead of bracket construction is used. Both the trolley wires and catenary cables are supported from span wires, the catenary spans, which are just above the trolley spans, being used for safety. Both the trolley and catenary strain insulators are of impregnated wood 24in. long, similar to those on the Schenectady-Ballston line, on which the first General Electric single-phase equipment was made. Additional insulation is secured by porcelain insulators located at the




pole to which the span wire is attached. The ordinary form of trolley pole and wheel is used, exceptional precautions being taken, however, to insulate the trolley base. The cars are equipped with four 75-h.p. General Electric 25-cycle, series compensated motors. Unlike the cars on the Schenectady-Ballston line, which operate on both direct and alternating current, the cars are equipped for alternating supply alone and with a method of control which varies the speed by varying the potential by means of a transformer.

**Direct-Current Commutation.** — Patents have recently been issued in the States to Mr. F. M. Young and Mr. G. S. Dunn, and assigned by them to the Crocker-Wheeler Company. The common object of the patents, which are described in the *Electrical World* of New York, is to improve the method of commutation in direct-current machines by increasing the resistance in the path of the current from the live brush into the advancing terminal of the commutating coil without increasing the resistance between the live brush and the trailing terminal of the commutating coil, so as to accelerate the reversal of the current in the coil. For this purpose the inventors use auxiliary "dead" brushes, which are insulated not only from the live brush and its holder, but from every other part of the machine, so that they are completely dead except for their contact with the commutator bars. In the accompanying illustrations D is the live brush, while the dead brushes are represented by E, the insulation surrounding each of the dead brushes being indicated by the letter F. As will be seen in Fig. 2, coil *a* is receiving current from

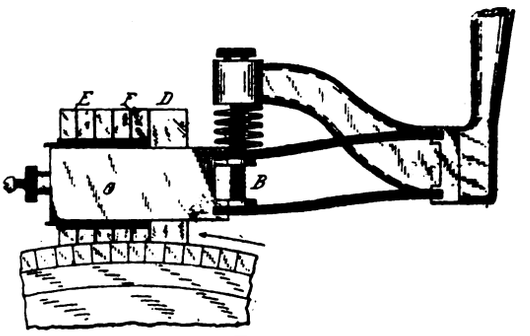



FIG. 1.

its left-hand or leading terminal, which flows out at the trailing terminal and into the coils to the right. When the coil *a* reaches the position of coil 1, it is short-circuited through the live brush, but owing to the inductance current continues to flow in the same direction as before, although of a diminished value. When the coil *a* reaches position 2, it is short-circuited through a dead brush, and current tends to flow from the live brush in at the trailing

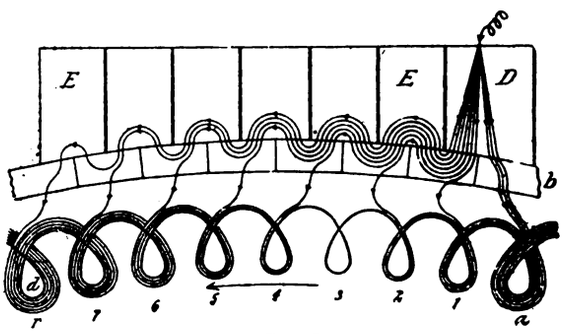



FIG. 2.

terminal; but this, which would effect a reversal of the current in the coil, is opposed by the self-induction of same. Current also tends to flow from the live brush and in at the leading terminal, but this is opposed by the two additional surface contacts between the commutator bar and the first dead brush and this brush and the next commutator bar. It will be seen from Fig. 3 that the planes of separation between the brushes are inclined relatively to the strips of mica on the commutator for the purpose of preventing an instant of absolute rupture of the commutating

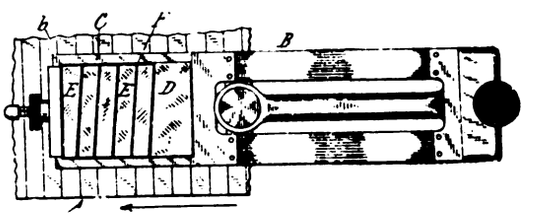



FIG. 3.

current when the trailing side of the live brush leaves the commutator bar, thereby avoiding any sparking at the brushes or burning of the commutator bars. An effect of this arrangement is that a gradually increasing resistance is introduced not only into the advancing terminal of one, but into the advancing terminals of a number of successive coils, in such a way that at each terminal a resistance of different amount from that at any other terminal is produced at a given time, forming as many paths of current as there are different resistances.

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## ARMATURE WINDINGS OF THE CLOSED-CIRCUIT TYPE.

BY WM. CRAMP.

*(Continued from page 475.)*

### Two-Circuit "Short-Connection" Rings.

Further consideration of Fig. 14 suggests the possibility of another form of two-circuit ring. We may use the system of end connections in Fig. 14 for connecting in series the spirals of a ring-wound armature.

Fig. 24 illustrates such a case. In it we have simply taken a ring armature and placed upon it 18 groups of spirals, which are then connected according to the scheme used for the drum in Fig. 14. Thus group 1 is connected to group 6, and group 6 to group 11, and so on regularly until the winding closes. If we reduce each of the groups in Fig. 24 to one single inductor, we have exactly the same winding as Fig. 14; consequently this may be described as simply a method of placing several turns per commutator section in series upon a two-circuit drum-wound armature, without the necessity of each turn passing any great distance along

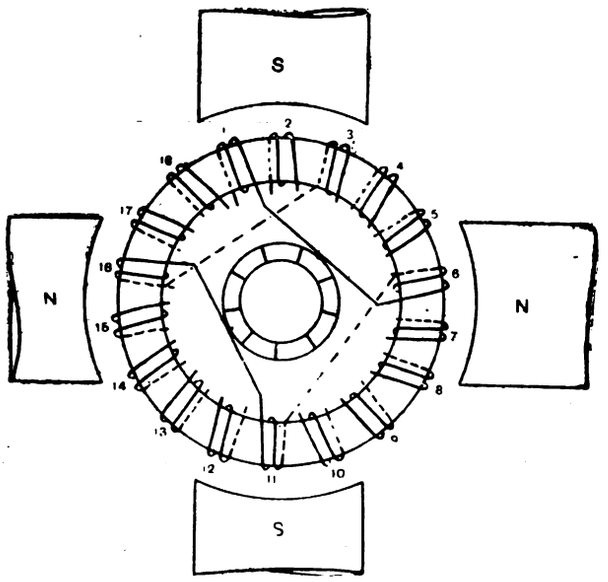


FIG. 24.

the periphery. We carry this out by providing the drum winding with a ring core, and connecting the turns in series through this core. (Of course the same sort of system could be applied to any drum armature.) This has all the disadvantages of a drum winding, except for the fact that with the same number of turns upon the armature the number of end connections will be less, so that less end room is required. All the other characteristics of the drum, such as maximum voltage existing between neighbouring wires, no end connections passing through the armature, etc., are still retained.

The form of ring winding (Fig. 24) is known as the "short-connection" type, for reasons which are obvious when contrasting Figs. 23 and 24. It is not much used, and never for low-voltage, high-current machines; consequently there is no interest in discussing the possibilities of multiple winding, which, of course, are precisely those of the two-circuit drum.

### Formula for Two-Circuit "Short-Connection" Rings.

We have simply to substitute in the formula for two-circuit drums the letter $s$, indicating the number of sets of spirals for $w$, the number of groups of inductors, so that it will read

$$s = p\,y \pm 2\,m.$$

This is the last form of two-circuit winding of any importance, and we will therefore summarise our results.

### Laws of Two-Circuit Windings, Drum or Ring.

Two-circuit armatures are of two classes—drum and ring.

*Drum Armatures.*—These are of necessity "wave" windings, the system of end connections being such that they pass continually in one direction around the armature periphery when the winding is reduced to its simplest form—*i.e.*, with two inductors per commutator section.

These armatures may be simplex, duplex, triplex, etc. (or simple double triple, etc.), according to the number of parallel paths (through the armature) from brush to brush.

A multiplex winding may be singly or multi-re-entrant; this re-entrancy depends upon the relation ship between the number-pitch and the number of windings.

There must be in all cases an even number of inductors which must be a multiple of the number of commutator sections (and also in the case of a slotted armature of the number of slots).

The rules for connection are given by the general formula

$$w = p\,y \pm 2\,m,$$

where $w$ is the number of inductors;
$p$ is the number of poles;
$m$ is the number of windings required;
$y$ is the mean number-pitch.

$y$ must for all simplex windings be either an odd number, or two number-pitches must be used alternately $(y + 1)$ and $(y - 1)$.

For multiplex windings, $y$ should be either an odd number or "$m$" times an odd number, or some multiple of an odd number less than $m$. Attention to this will obviate the use of different pitches at the two ends of the armature.

The re-entrancy is given by the H.C.F. of $m$ and $y$.

The number of sets of brushes absolutely essential is two, one positive and one negative. But there may be more sets in parallel with these according to the number of poles. Each brush must cover a number of segments on the commutator greater than $m - 1$.

Of two-circuit ring windings we may say: They are of the two kinds known as the "long-" and the "short-connection" respectively.

The former consist of $s$ spirals (or sets of spirals connected according to the formula

$$s = p\,y \pm m,$$

and $s$ may be even or odd according to the number of poles of the machine.

The latter consist of $s$ spirals or sets of spirals connected according to the formula

$$s = p\,y \pm 2\,m,$$

and $s$ must be an even number.

In other respects these ring windings follow the same laws as the two-circuit drum windings, as already explained. But as they possess no advantages except for high voltages, the multiple (×) forms of them possess no practical interest.

In calculating the voltage of a two-circuit ring winding, the same principles apply as were pointed

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out in the comparison of multiple-circuit rings with multiple-circuit drums. A two-circuit ring of 37 spirals would, in a certain field, at a certain speed give the same voltage as a two-circuit drum with 37 inductors, if such a thing were possible; and the connection between the two-circuit and multiple-circuit form of armature lies in the fact that, if the above ring of 37 spirals were connected as a multiple-circuit armature, the voltage would be, in the latter case, $\frac{2}{p}$ of the voltage in the former, while the current would be proportionally increased. (Lines per pole and speed are assumed to be constant.)

We have already compared to some extent the value of multiple and two circuit windings, and to accentuate this we may well here give an example similar to that for multiple-circuit windings given on page 302.

**Example of a Two-Circuit Winding.**

We will assume that the same size of field frame and armature which were used on page 302 are again required to give 2 kw., but this time the maximum electromotive force is to be 470 volts. From the formula we again calculate the number of inductors, and find that it is 2,360. This means that if the winding is multiple-circuit, there will be 1,180 inductors per pair of poles. The wire which will be used for winding in the multiple-circuit case must carry 1·12 amperes, and there will be 40 of these wires per slot with 60 slots.

Such a winding is difficult on account of the small size of the wire, and wasteful on account of the room in the slot taken up by the wire coverings. We turn, then, to the two-circuit formula to see what number of slots it is possible to use.

We find from the formula that

$$w = p.y \pm 2m$$

or

$$118 = 4 \times 29 + 2,$$

which shows that a simple armature may be wound with 59 slots, and number-pitches of 29, and 59 commutator sections. This armature will have two inductors per commutator section, and will give (from the electromotive force formula) 47·2 volts. Obviously, then, if we take 20 inductors per section—*i.e.*, wind ten turns in place of one—we have in each slot two half-coils in place of the two inductors arranged above. The last turn of half-coil No. 1 (in slot 1) will be connected to the commutators, and then to the first turn of half-coil No. 30, which lies in slot No. 15, exactly as described on page 402.

The number of conductors on the armature will be 1,180, and the gauge of wire necessary is No. 21 S.W.G. This is obviously a very much superior arrangement to that of the multiple-circuit winding, and we may therefore decide to adopt it. Consequently we have

| | |
|---|---|
| Inductors | 1,180 |
| Number of commutator sections | 59 |
| Gauge of wire | No. 21 |
| Re-entrancy | Single |
| Symbol | o |

A comparison of these two armatures with that arranged on page 302 will throw light upon the relative advantages of multiple and two circuit windings.

In the first place, had the standard armature of page 302 possessed 59 slots, it might have been used for both multiple and two circuit windings, provided that there were 59 sections in the commutator. This emphasises the very important point that in getting out standard discs *it is the two-circuit windings which should be considered;* since any number of slots whatever can be used for multiple-circuit armatures.

Next, a comparison of the two armatures just arranged shows how with a two-circuit four-pole winding half the number of inductors only are required for a given voltage; and we are enabled to use a wire of stouter gauge. This, again, is an important point, not only from the winder's point of view, but also on account of the room taken up in the slot by the insulation of many small wires.

Finally, we may point out that these differences between multiple and two circuit armatures increase with the number of poles. Thus: if a 10-pole machine with a given number of inductors be arranged as multiple and as two circuit respectively, in the latter case it will give five times the voltage and one-fifth of the current that it did in the former, with the same number of lines per pole and at the same speed.

(*To be continued.*)

## EXETER ELECTRIC TRAMWAYS.

**In our last issue we briefly announced the fact that the first portion of the above tramways were opened by the Mayor of Exeter on Tuesday, the 4th inst. The following details of the system and of the generating station from which these tramways are supplied are of interest. The tramway conversion scheme has been the subject of heated controversy in Exeter since it was first suggested in 1900, but the Corporation has succeeded in its policy of making the tramways a municipal undertaking.**

**The routes already equipped and opened for traffic run from Livery Dole to Eastgate, and thence, *vid* High-street and Queen-street, to St. David's Station, while another line, starting from the Cemetery-road, runs through Blackboy-road and Sidwell-street to join the former at Eastgate. This line will be carried through to Dunsford Gate, St. Thomas, as soon as the removal of existing obstructions has been completed, while an extension to Cross Park, Heavitree, of the first route has already been agreed upon and is rapidly being constructed. The construction work has been carried out to the specifications of the Council's engineers—Mr. J. E. Waller (consulting engineer), Mr. Thomas Moulding (city engineer and surveyor), and Mr. H. D. Munro (city electrical engineer)—acting jointly. The latter two gentlemen supervised the work upon the spot. The contractors for the tramways are Messrs. Dick, Kerr, and Co., of London and Preston. The car-shed has been built to the designs of the city engineer, the contractor being Mr. William Blake, of Plymouth. The generating plant has been installed under the superintendence of the city electrical engineer, the contractors being the British Westinghouse Company, of London and Manchester, and Messrs. Bruce Peebles and Co., of Edinburgh.**

**The routes now nearly equipped are 4¼ street miles in length, and the tracks consist of 2⅜ miles of double line and 2⅜ miles of single line, with passing places. Double line and interlacing line has been constructed in the busiest thoroughfares in order to facilitate the ordinary traffic of the streets. The gauge adopted is 3ft. 6in. The rails are steel of the girder type, 6in. in depth, and weigh 90lb. per lineal yard. The foundation for the rails (Fig. 1) and paving is constructed of cement concrete 6in. thick. In addition to this concrete underbed, the rails are packed up to the true alignment by fine cement concrete, averaging ¾in. in thickness. The points and crossings were supplied by Messrs. Hadfields, Limited, of Sheffield, and are made of their patent manganese steel, which is so hard that it can only be ground true with the aid of an emery wheel.**

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All the special work at the corners of streets and in the car-shed was laid out at Messrs. Hadfield's works prior to being fixed in position. The road between the rails and for a distance of 18in. on each side of the rail is paved with Welsh and Devonshire granite setts, except in Queen-street, High-street, Sidwell-street, and Cowick-street, and in front of several places of worship, where the granite setts are replaced with hardwood paving. The whole of High-street and parts of Queen-street and Cowick-street is paved with hardwood blocks, and this forms an incidental improvement, which is already much appreciated. The steepest gradients are as follows: Fore-street, 1 in 11½ to 1 in 13; St. David's-hill, 1 in 16; and Pinhoe-road, 1 in 19. The sharpest curves are at the corners of Queen-street and Paris-street—viz., 35ft. radius.

MR. THOMAS MOULDING, A.M.I.C.E., CITY SURVEYOR.

COUNCILLOR EDWIN C. PERRY, MAYOR OF EXETER, AND CHAIRMAN OF THE TRAMWAYS COMMITTEE.

MR. H. D. MUNRO, M.I.E.E., CITY ELECTRICAL ENGINEER.

These are arranged as centre poles, side-bracket poles, or span-wire poles, according to the requirements of the individual routes. The lines are so arranged that the trolley wheel runs centrally wherever feasible, but full advantage is taken of its swivelling power at certain points on the route. The lines are double insulated throughout. All the section boxes are connected by telephone with the generating station and the car-shed in Paris-street, and the test wires required by the Board of Trade run to the ends of all routes. The telephone and test wires are carried underground as far as the conduits extend, and are then continued by small overhead wires attached by brackets and insulators to the poles. Guard wires, as required by the Board of Trade, are fixed above the trolley lines wherever overhead telegraph or telephone wires might possibly fall upon them. Frogs, switches, and crossings are provided on the trolley lines to correspond with those on the track below.

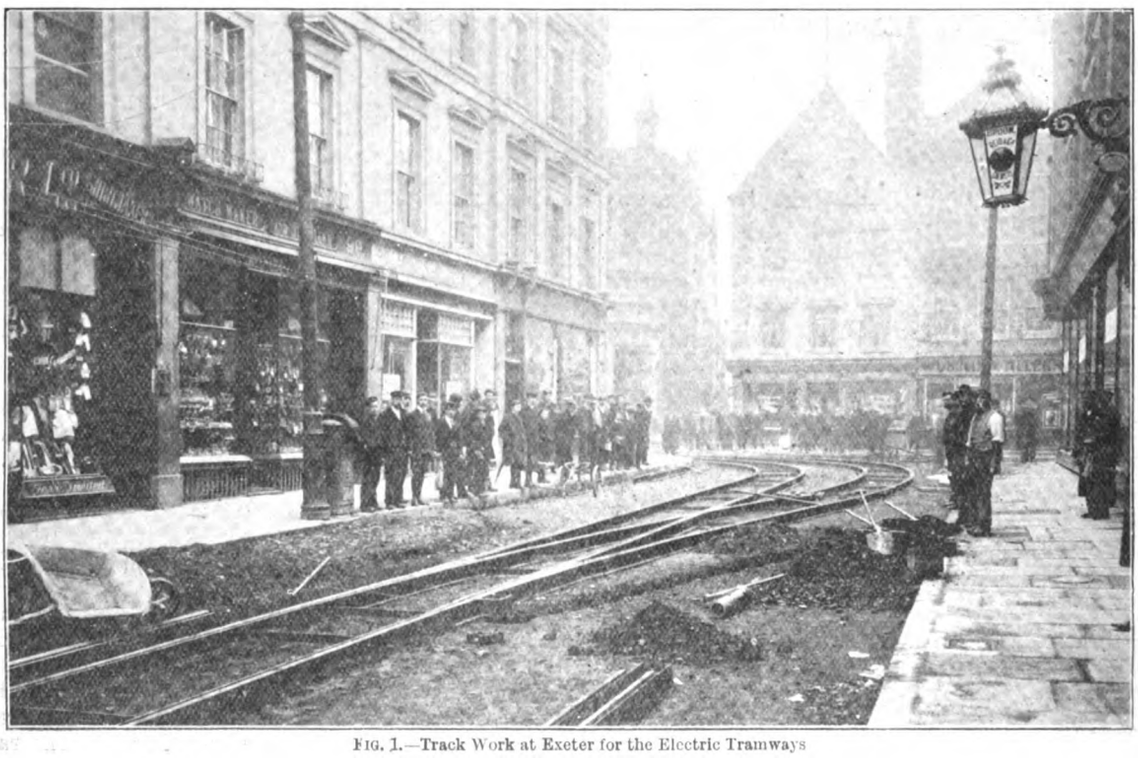

FIG. 1.—Track Work at Exeter for the Electric Tramways

The current for the tramways is conveyed from the generating station by means of lead-covered feeder cables running through stoneware conduits to section pillars, each half-mile section of route being separately supplied so as to be independent of any other section. From the section pillars the current is conducted up the poles to the overhead trolley lines, which are double throughout, and are supported from sectional steel poles.

There are for the routes now converted 12 cars (Fig. 2), built and equipped at the Preston works of Messrs. Dick, Kerr, and Co. They are of the double-deck type, with a seating capacity of 20 passengers inside and 22 outside. The stairways are of the semi-reversed type, giving increased accommodation on the roof and protection

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from the weather on the platforms. The inside seating is of woven rattan cane, with perforated veneer backs, for cleanliness, and the outside seats are of the garden type, with reversible backs. The internal ventilation is by a special device of the makers, which is effective without creating draughts. Each car weighs 8½ tons without passengers, and is 26ft. long over all. They are equipped with two electric motors of 25 h.p. each. In addition to the ordinary hand-brake, they are provided with the Newell magnetic track brake, which is capable of holding a heavily loaded car upon any gradient independently of the electric power from the line. They are further provided with an electric brake which automatically

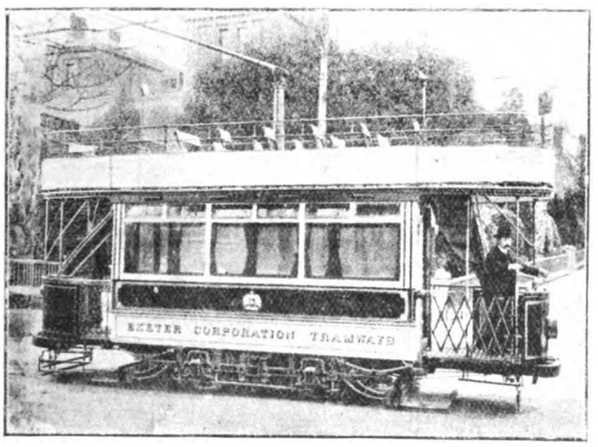


FIG. 2.—Exeter Electric Car.

prevents a car from running backwards on a gradient should the trolley come off the trolley wire. The Philipson patent lifeguard is fitted to all the cars, as also a patent folding step interlocking with the folding gate upon the platform in such a way that the step and gate open and close together. This prevents a passenger from boarding the front platform, and hence removes the cause of many accidents. The cars are thus fitted with every device which experience has suggested for the comfort and safety of the public. They are painted in dark green and gold, with the city arms emblazoned on the side panels.

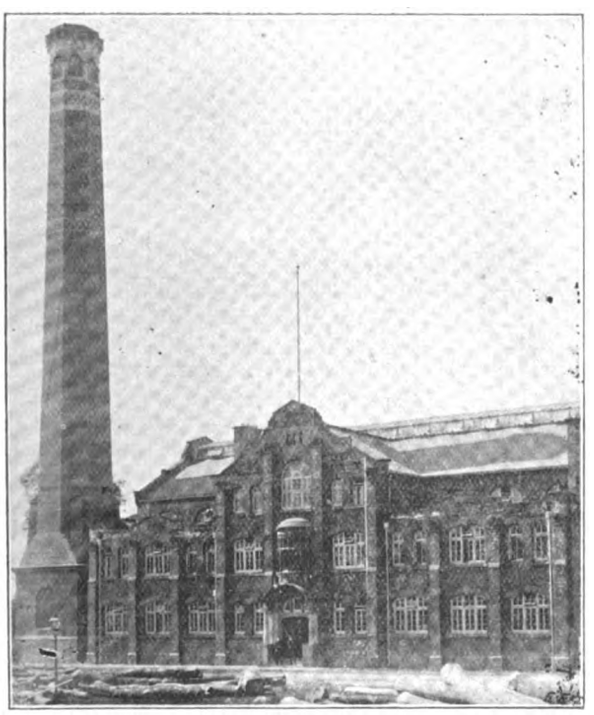

FIG. 3.—The New Generating Station at Exeter.

The car-shed and offices are located at the bottom of Paris-street, which is nearly the centre of the routes served by the tramways. The building is of brick with Portland stone dressings, the floors of the offices and stores being of wood blocks fixed on breeze concrete. The roof of the shed, which is glazed with Rendle's patent glazing, is carried on steel stanchions and steel lattice girders, with light steel roof principals. The shed provides for housing 15 cars, and comprises repair shop, smithy, paint shop, paint and oil stores, foreman's room, messroom, and general stores and conveniences. The offices have a committee-room, manager's room, general offices, conductors' room, strong-room, and necessary lavatory accommodation. The whole of the building is well lighted, and generally very conveniently designed. To provide for a possible enlargement, the south-east side of the shed has been constructed of wood between the steel stanchions, which can easily be removed when an extension is found necessary.

The following is the approximate cost of the tramways when completed throughout: track, including wood paving, £34,000; overhead equipment, £4,700; feeder cables, £3,000; cars, £7,000; car-shed, etc., £5,700; additional generating plant, £4,000. This makes a grand total of £58,400.

### THE GENERATING STATION.

The tramways are supplied with current from the new electric power station of the Corporation, opened a year ago on a site adjoining the Exeter City Basin. This is shown in Fig. 3. The buildings cover a space of 150ft. by 150ft., and are divided into bays constituting the boiler-house, engine room, and offices respectively, with annex buildings for economisers, boiler feed pumps, etc., and a chimney shaft 155ft. high, with an internal diameter of 8ft. 6in. The boiler-house (Fig. 4) is 102ft. long and 55ft. wide,

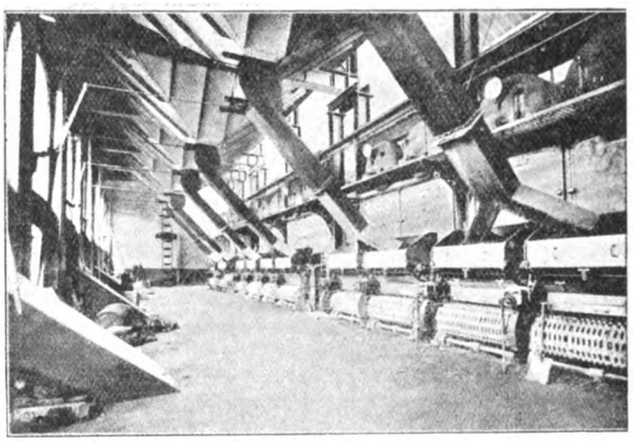

FIG. 4.—The Boiler Room, showing Coal Shoots and Babcock Chain Grate Stokers.

containing six water-tube boilers, fitted with superheaters, capable of supplying steam to engines of 2,700 h.p. A steam-pipe ring on the boiler-house wall carries the steam into the engine-room, and is so arranged that any boiler or engine can be isolated without affecting the general supply. The main flue behind the boilers carries the hot gases through the economisers on the way to the chimney. The feature of the boiler-house is the complete system for the handling of coal and its economical combustion. The coal is delivered into shoots which convey it to the automatic filler of the gravity bucket coal conveyor. This is electrically driven by a 10-h.p. two-phase motor, and conveys the coal to a series of large coal bunkers above (which will hold 500 tons), from which it is discharged in measured amounts to the hoppers of the chain-grate mechanical stokers of the boilers. These stokers, which are electrically driven by a 10-h.p. two-phase motor, in their turn automatically carry the coal into the furnaces and discharge the ashes and clinker into the basement, whence the conveyor removes them to the ash bunker. A railway siding completes the arrangements. The stokers will burn the cheapest classes of coal without smoke, and the arrangements generally represent the best modern practice for economical working.

The engine-room (Fig. 5) is a lofty and well-lighted building, 102ft. long by 45ft. wide, lined throughout with glazed bricks, with a floor of terrazzo marble paving to ensure the utmost cleanliness. Galleries are provided to give immediate access from the various offices and the boiler-house. The room is spanned by an overhead travelling crane to handle parts of machinery up to 10 tons in

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weight for erection or repairs. There are at present installed four steam alternators of a total capacity of 1,300 kw., which can deal with the supply to 50,000 lamps or their equivalent. One 200-kw. steam-driven generator is provided for the tramway supply, and also a LaCour motor-generator of equal capacity which takes two-phase current from the alternators and converts it into direct current for use on the tramways. This converter, manufactured by Messrs. Bruce Peebles and Co., is a new type, possessing all the advantages of a rotary converter combined with those of a motor-generator. It avoids the use of static transformers. We hope to give a full description of this converter at an early date. Each steam alternator consists of a high-speed vertical steam-engine, with forced oil lubrication, direct-coupled to a two-phase Westinghouse alternator and exciter. The exhaust steam leaving the engines is dealt with by jet condensers in the basement, which draw their cooling water from a large well outside the building which is connected with the basin, and discharge it again into the basin after use.

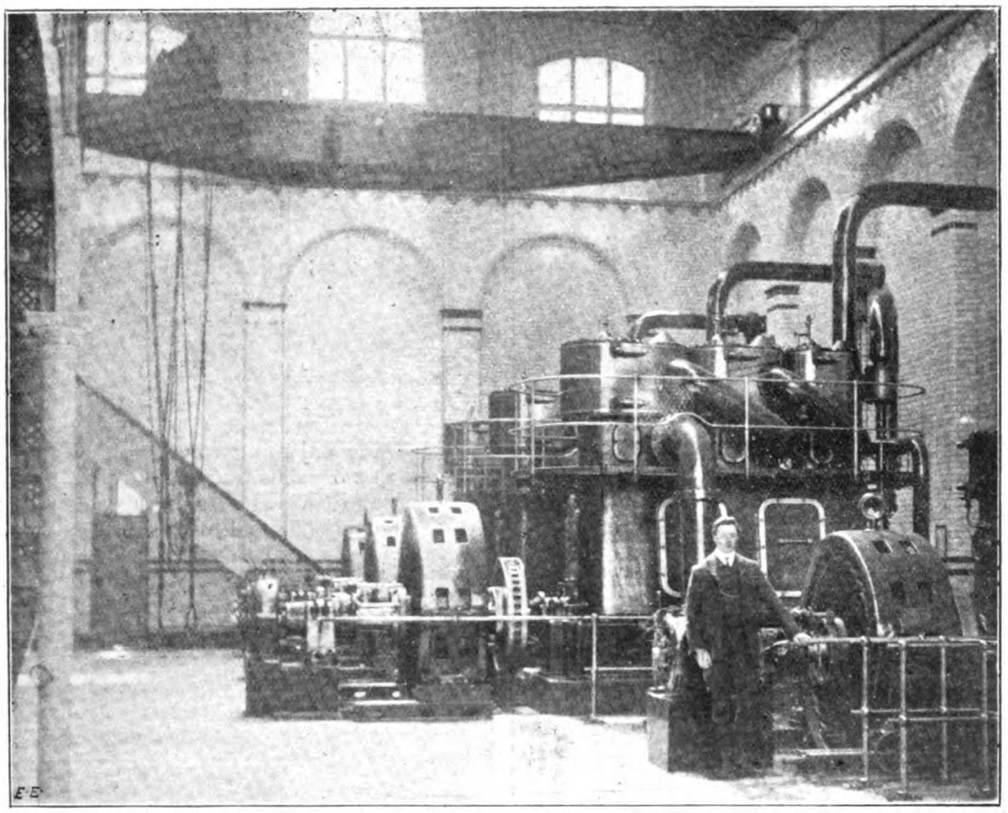

FIG. 5.—The Engine Room, showing Dick-Kerr Alternators and Howden Engines.

The current from the alternators and tramway generators is led by cables in stoneware conduits beneath the floor to the switchboards on the main gallery, from which it is distributed throughout the city by main feeder cables also laid in stoneware conduits. The Westinghouse lighting switchboard (Fig. 6) consists of marble panels for each alternator, and for each section of the main feeder cables, fitted with all necessary switches, indicating and recording instruments, and regulating apparatus. Automatic circuit breakers are used in each feeder. A separate switchboard similarly controls the tramway generators and feeder cables. They are so arranged that all parts carrying the high-

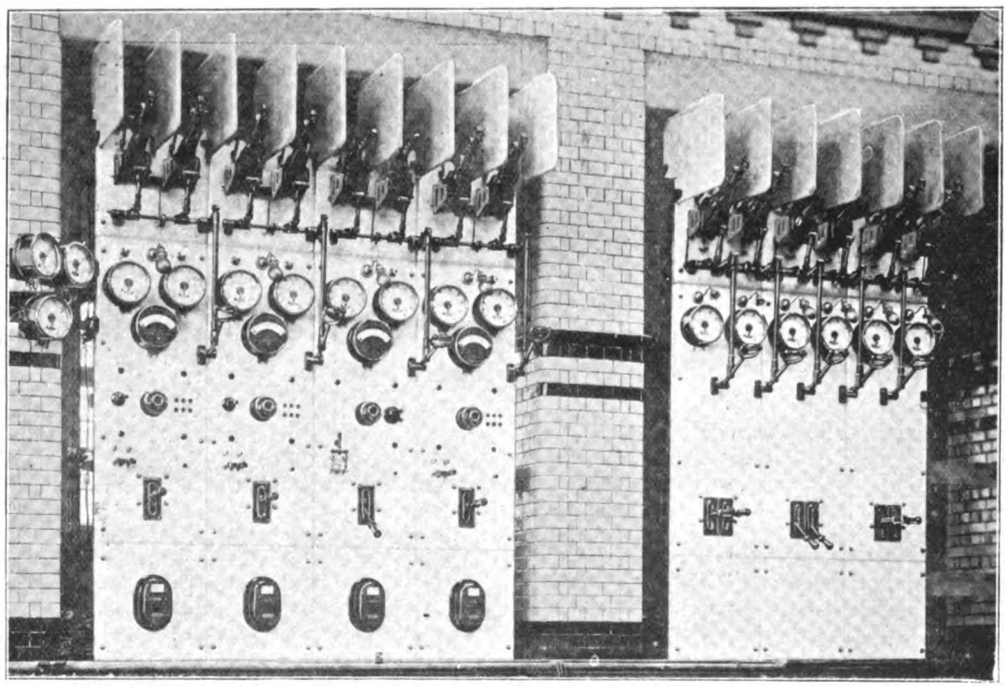

FIG. 6.—The Westinghouse Two-Phase Switchboard at Exeter.

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pressure current are guarded from access by unauthorised persons, but at the same time always open to inspection.

The offices, etc., face the road, and comprise an office for the chief engineer on the second floor, a general office on the first floor, test-rooms, storerooms, messrooms for the staff on duty, entrance hall, lavatories, etc.; and there are also on the ground floor a repairs shop, fitted with electrically-driven tools, and a cable-room for testing the mains, etc. The whole station, which at present covers about one-fourth of the available site, has been carefully designed on the most modern lines to accommodate the largest machinery which the future may require, and to be capable of extension when necessary without disturbance of the original design.

The tramway load is being supplied at the rate of $1\frac{7}{8}$d. per unit for the first 100,000 units and $1\frac{3}{8}$d. per unit for all energy taken above this quantity. The meters for measuring the consumption are placed on the switchboard, and the feeders are supplied by the tramway department. The extra load will help to reduce the station costs. We have to thank the city electrical engineer (Mr. H. D. Munro) for the photographs from which our illustrations are prepared and for the information respecting the tramways and power station.

## THE WATER STERILISATION WORKS AT SAINT-MAUR.

BY EMILE GUARINI.

Experimental works for the sterilisation of water by the use of ozone were lately started at the municipal waterworks of the city of Paris at Saint-Maur. The plant is operated on Count de Frise's system. It is well known that ozone has exceptional advantages for completing the purification of drinking water. Without introducing any new element into the water, it destroys all discolouring organic matters, all unpleasant odours and tastes, and with certainty the pathogenic and other bacteria, with the exception of a few harmless spore-bearing bacilli which the water may contain. Count de Frise's ozonising plant erected on the grounds of the Saint-Maur pumping station treats filtered water of the Marne river. As it sterilises up to 150 cubic metres of water per hour, it has a sufficient capacity for the water supply of a town of moderate size.

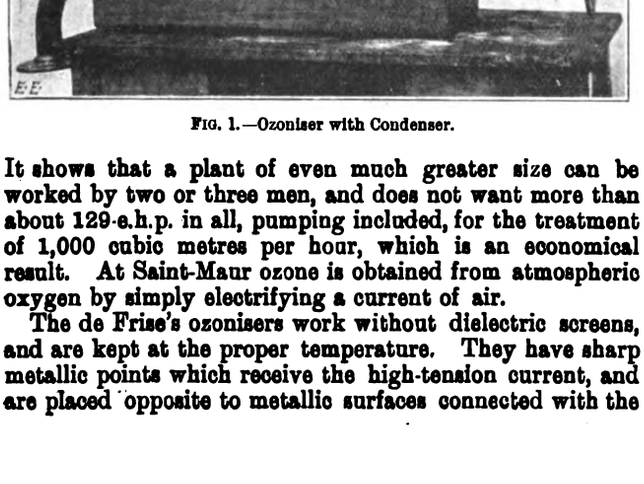

FIG. 1.—Ozoniser with Condenser.

It shows that a plant of even much greater size can be worked by two or three men, and does not want more than about 129 e.h.p. in all, pumping included, for the treatment of 1,000 cubic metres per hour, which is an economical result. At Saint-Maur ozone is obtained from atmospheric oxygen by simply electrifying a current of air.

The de Frise's ozonisers work without dielectric screens, and are kept at the proper temperature. They have sharp metallic points which receive the high-tension current, and are placed opposite to metallic surfaces connected with the earth. They are worked with tensions higher than 20,000 volts. The air is drawn through them by pumps which force it, when ozonised, through the steriliser. The apparatus are either horizontal or vertical. The vertical type occupies less room than the horizontal one, which is easier to supervise. At the Saint-Maur works the ozonisers are horizontal. There are two series of them, each consisting of three groups of three elements. Fig. 1 shows an ozoniser with condenser, and Fig. 2 an ozoniser with resistances. Each element is made of a horizontal brass half-cylindrical trough, fitted with a plate-glass cover and a cast-iron water-jacket. The trough is earthed and makes one of the poles. Across the trough at regular distances,

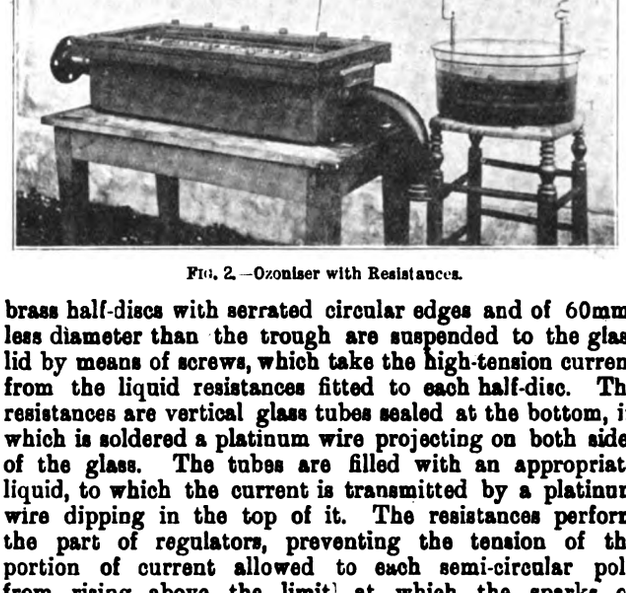

FIG. 2.—Ozoniser with Resistances.

brass half-discs with serrated circular edges and of 60mm. less diameter than the trough are suspended to the glass lid by means of screws, which take the high-tension current from the liquid resistances fitted to each half-disc. The resistances are vertical glass tubes sealed at the bottom, in which is soldered a platinum wire projecting on both sides of the glass. The tubes are filled with an appropriate liquid, to which the current is transmitted by a platinum wire dipping in the top of it. The resistances perform the part of regulators, preventing the tension of the portion of current allowed to each semi-circular pole from rising above the limit at which the sparks or voltaic arcs are produced. Silent discharges (Fig. 3) are produced between the sharp points of the semi-circular poles and the inner surface of the earthed troughs. The troughs are closed at both ends, and fitted with an air

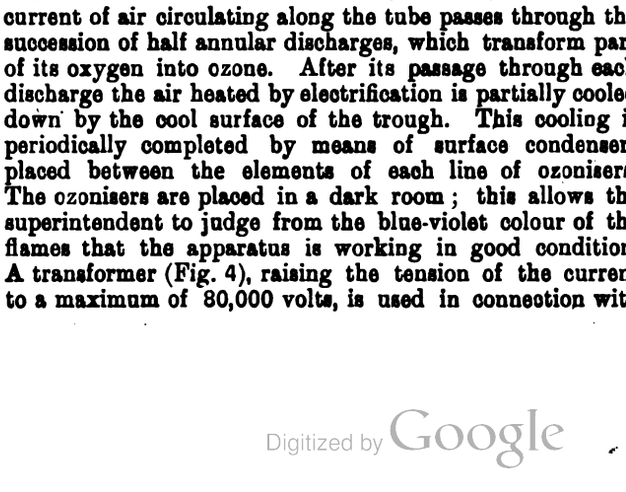

FIG. 3.—Silent Discharge.

inlet at one end and an air outlet at the other. The current of air circulating along the tube passes through the succession of half annular discharges, which transform part of its oxygen into ozone. After its passage through each discharge the air heated by electrification is partially cooled down by the cool surface of the trough. This cooling is periodically completed by means of surface condensers placed between the elements of each line of ozonisers. The ozonisers are placed in a dark room; this allows the superintendent to judge from the blue-violet colour of the flames that the apparatus is working in good condition. A transformer (Fig. 4), raising the tension of the current to a maximum of 80,000 volts, is used in connection with

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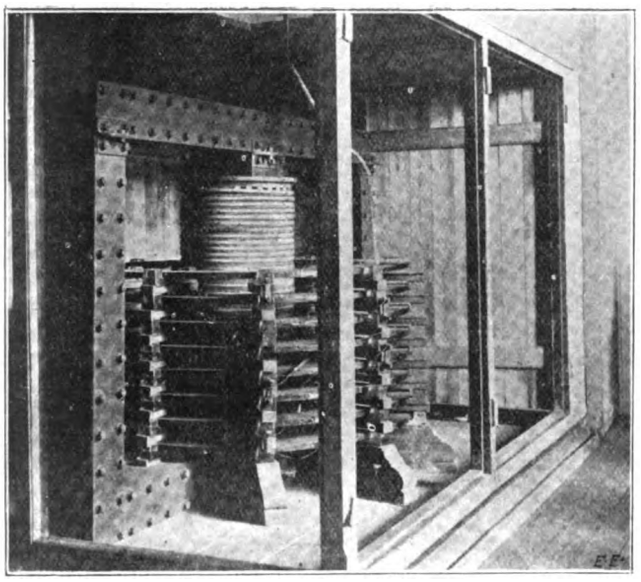
the ozonisers. The ozonised air is used over again and again, the inlet of the ozonisers being connected with the outlet of the sterilisers, arrangements being also provided to free the air from moisture and to make up, by fresh air, the oxygen which has been consumed in the shape of ozone.

The sterilisers (Fig. 5) are made on the washer principle. They are provided with a number of carefully levelled, finely-perforated trays, making the ozonised air bubble several times through the water. The sterilisers are cast-iron vertical cylinders enamelled inside. They are built up in parts, 50cm. high, between the flanges of which are fitted horizontal celluloid diaphragms perforated with a great number of small holes of $\frac{1}{10}$mm. diameter. The water and the ozonised air are introduced together into the lowest compartment of the sterilisers by means of an injector, which makes use of the momentum of the water arriving under pressure to assist in promoting the circulation of the ozonised air. Air and water ascend together to the top of the steriliser, being intimately mixed at the passage of each finely perforated diaphragm. The sterilising columns are fitted with inspection glasses and arrangements for collecting samples. The sterilised water flows from a general main into a tank placed in the open air, from which it goes into the covered reservoir for filtered water for supply to the city.



4.—Transformer.

A third steriliser at Saint-Maur belongs to the type in which the water is injected, in the shape of a fine spray, into the mass of ozonised air. The spray collects in the lower part of the column as solid water, into which the ozonised air is forced through the apertures of a perforated diaphragm, which makes it bubble, in minute bubbles, through the water before reaching the spray. The waste air of the three sterilisers is collected by simple connection of the outlet of the sterilising columns with the inlet of the ozonisers, to be ozonised over again. Well-balanced air-valves admit sufficient fresh air to make up any deficiency in oxygen. The ozonised air is compressed by double-acting vertical pumps of 150mm. diameter and 200mm. stroke. They draw the air through the ozonisers and force it into the sterilisers. The sterilised water-collecting tank is provided with a weir to measure the quantity of water discharged per hour.

Two rapid pressure filters (Fig. 6) are used in conjunction with the Saint-Maur ozonising plant. Each of these filters consists actually of three separate filters, built the one on the top of the other. The three have a common central inlet pipe, and each has its own bottom, its own outlet valve communicating with the discharge main, and its own outlet for cleaning water. A central shaft works the three rakes, which agitate, during the cleaning process, the crushed flint with which each filter is filled. Each triple filter is washed by revolving the agitators, and admitting, by the outlet valves, the filtered water of its neighbour under the layer of flint, through which it passes upward to be draw off by the special outlet mentioned above. The cellars contain the motor, with its shafting, a centrifugal pump to raise the water, the alternators for the ozonisers and the electrical light, two air dryers and the sterilisers, the tops of which reach the first floor. The prime mover is a semi-portable 45-i h p. steam-engine. The centrifugal pump is able to deliver 150 cubic metres of water per hour against a head of 150m.

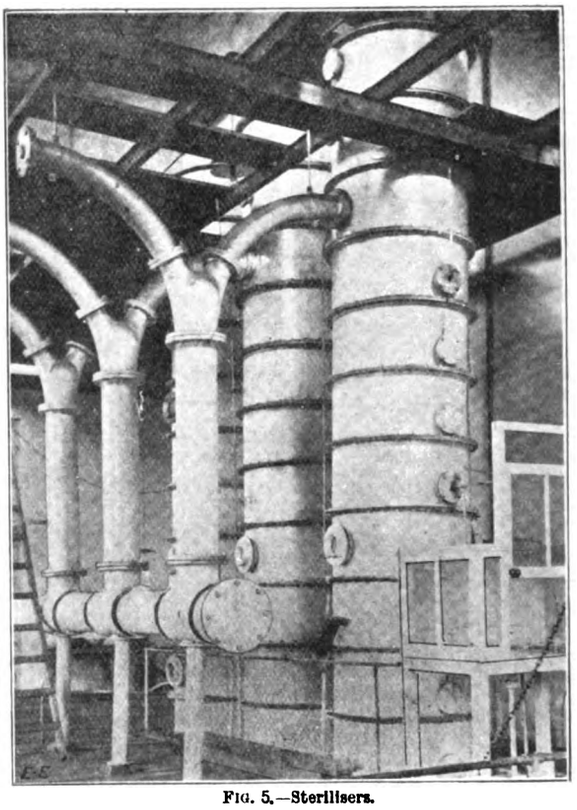


Fig. 5.—Sterilisers.

The alternators are Mordey 110-volt alternating-current machines. The ground floor contains the offices, the laboratory, the switchboard (provided with the usual fittings), the transformer, the ozonisers, and the ozonised air compressor. The first floor and part of the remainder of the building are unoccupied. The building is of sufficient size to contain apparatus for treating 30,000 cubic metres per day.

The Saint-Maur works have quite the size of a water-works destined to supply with drinking water a town with several thousands of inhabitants. It treats up to 150 cubic metres of Marne water per hour, taken either from the slow

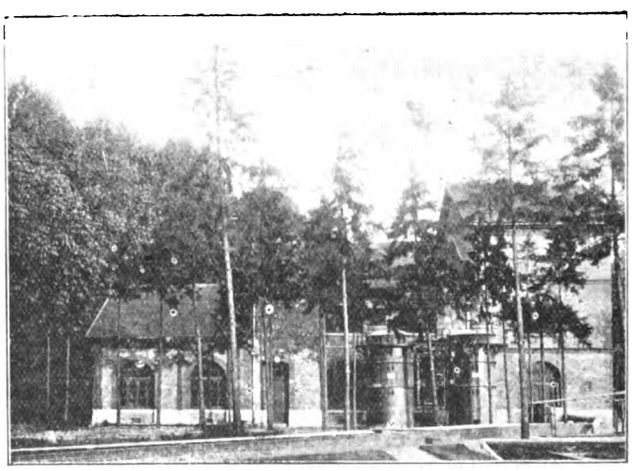


Fig. 6.—St. Maur Plant—Rapid Pressure Filters.

sand filters of the city of Paris or from the river and filtered, without adding any coagulant, by the above-mentioned mechanical filters filled with crushed flint. The system has proved quite efficient. Of five flasks tested by Prof. Bezançon, chief of the bacteriological laboratory of the medical faculty of Paris, three remained absolutely sterile, and two developed bacilli.

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## THE ARNHEIM PARTY-LINE TELEPHONE SYSTEM.

The use of a single telephone line from the exchange to a number of subscribers is an obvious method of reducing the cost of telephonic connections in those cases where the use of the telephone is likely to be infrequent. The use of one line, consisting usually of a lead and a return, to supply a number of people has hence been adopted in a

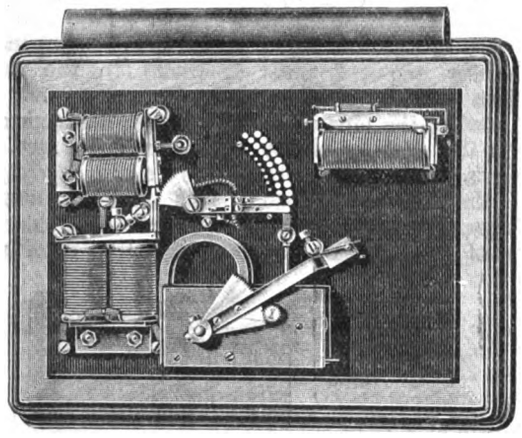

FIG 1.—The Arnheim Automatic Selector Switch.

number of districts. A good many systems of party-wire telephony have been devised in order to overcome the objections which arise from the use of the common line. In the earlier systems distinctive ringing was adopted, and when one subscriber of the group was called by the exchange, all the other subscribers on the same line would have their bells rung, but would know from the intervals in the ringing that they were not required. The fact that the bells were rung, however, was apt to call a subscriber to the instrument, and also advise him as to who was making use of the party line. This difficulty has been overcome to a limited extent by various systems of selective ringing. For instance, by using an earth connection the exchange operator could send either a positive or negative current over each of the line wires and thus give four signals, each of which would only affect one subscriber. With this system and four subscribers only the ringing difficulty was overcome. There remained the quite as serious fault that when a conversation was being conducted over the party line by one subscriber, he could be overheard and interrupted by any other subscriber who liked to remove his receiver from the hook. To obviate

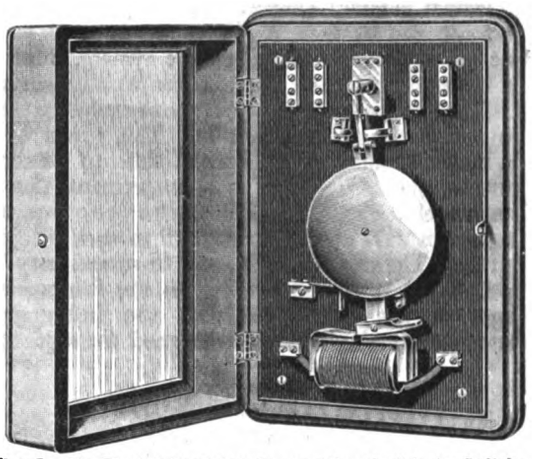

FIG. 3.—The Electric Pendulum for operating the Selector Switch.

this, a number of lock-out systems were introduced, involving a great deal of complicated mechanism requiring delicate adjustment and constant supervision. Again, with any of these systems one subscriber could practically block the line if he failed to work his instrument in the way directed.

The Arnheim party-line system, which has been developed by the Berliner Telephone Company, has been designed to overcome these shortcomings, and to make the joint use of the common line by a number of subscribers as secret as if they each had individual connection with the exchange. In a few words, this system consists of a selector switch placed at the subscriber's end of the line, from which individual lines are run to each instrument in the group. This selector switch is connected by a lead and return wire

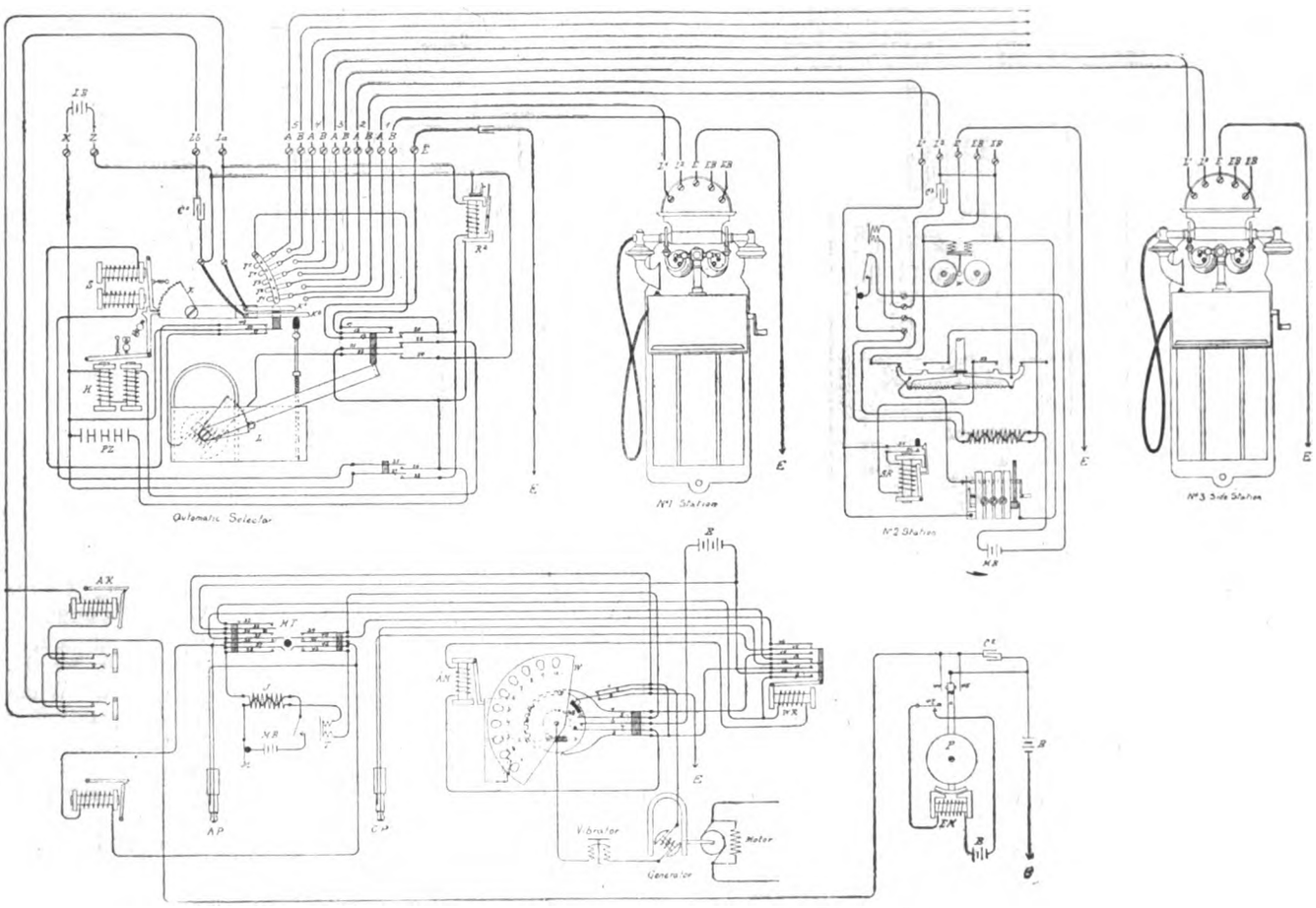

FIG. 2.—Diagram of Connections of the Arnheim Party Line Telephone System.

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with the exchange. The switch can be operated by any subscriber or by the exchange, and it can only connect one subscriber at any one time on to the exchange. In the meanwhile, all the other subscribers have to wait until the conversations of the original caller is completed. This system gives distinctive ringing and absolute secrecy in speech. It is the exact opposite in this respect to the ordinary party-line system. The difference is carried so far that with the Arnheim device one subscriber of the group cannot possibly converse with any of the other subscribers supplied by the same line.

To come now to the details of the system, these will be made more clear by the illustrations which we give herewith. The two wires from the telephone exchange terminate in the automatic selector (Fig. 1). This would be placed in the block of offices or residential flats to be served by the line in question. From this instrument, the connections of which are shown in Fig. 2, two line wires, or three if the earth is not available, are led to each telephone in the group. The number which can be served may be anything from 10 to 20, depending on the frequency of the messages of the subscribers, but the instruments we inspected on Monday last were designed for a group of 10.

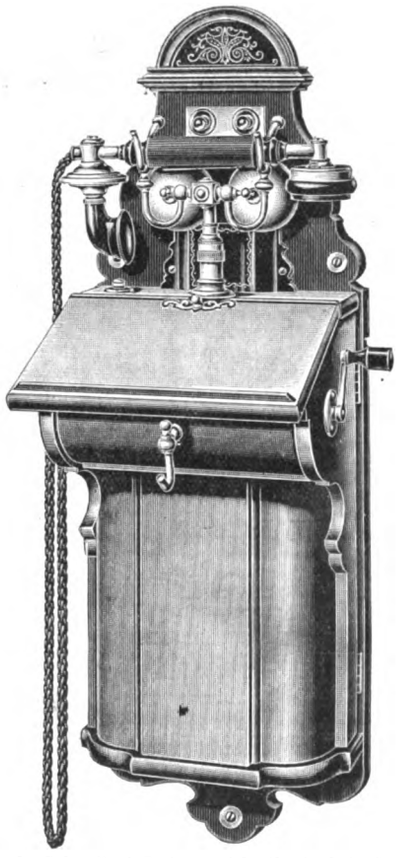

FIG. 4.—Subscriber's Instrument for the Arnheim System.

The switch in this automatic selector which connects the subscribers successively to the line, is operated through a relay by means of periodic currents from the exchange. The periodic currents are dispatched by means of an electric pendulum, seen to the right-hand side of Fig. 2, and illustrated more fully by Fig. 3. The impulses caused by the making and breaking of the circuit by this pendulum operate the sector, X, of the automatic switch, and cause this switch to move step by step over the subscriber's line wire contacts. A small dial at the exchange numbered from 1 upward is used by the exchange operator to give the right number of impulses to move the switch to the subscriber required. In the case of the subscriber a small push button only is needed to release the electromagnet locking device in the selector switch. This then moves round until it reaches the subscriber's terminals, when it is again locked. The push button on the subscriber's instrument then rises to show that the line is clear, and he proceeds to call up the exchange by the magneto in the usual way. If the push button seen at the left-hand side of Fig. 4 does not rise when the hand combination is lifted, it shows that the line is engaged. If, however, the line is clear, conversation may now proceed. At close of conversation the subscriber gives the ring-off signal to the exchange in the usual manner.

So far we have only dealt with the calling from the subscriber to the exchange. If now a call is made from the exchange to one of the subscribers of the party line, the operator inserts the plug into the party-line jack in the usual manner, and selects the party required by means of a dial (Fig. 5) provided with as many finger-holes as there are numbers on the party line. To call, the operator inserts her finger in the hole corresponding to the party required, pulls it round to the stop, and releases it. She then momentarily presses her ringing key, closing the circuit of the releasing mechanism, which allows the dial to slowly rotate back to zero. In so doing a series of contacts are made corresponding with the number selected. This allows a number of impulses to pass out on to the line, actuating the selecting relay of the automatic selector as before described, and

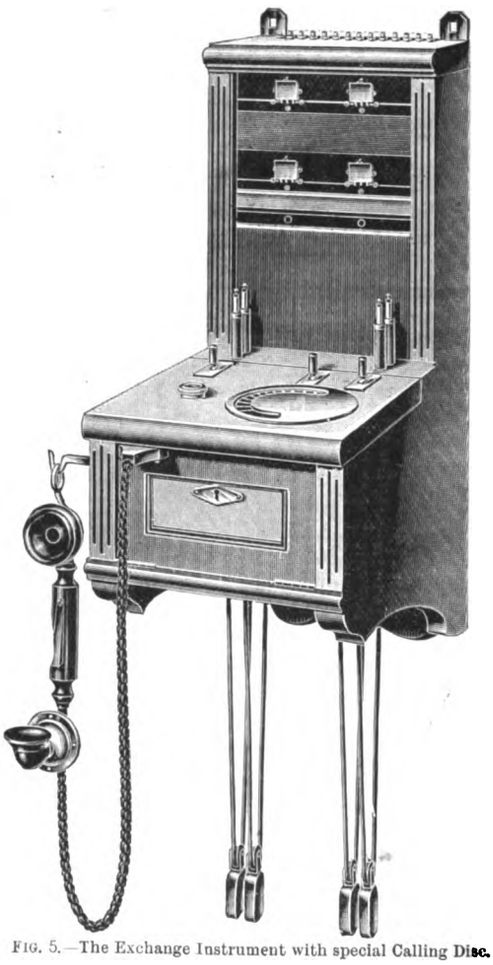

FIG. 5.—The Exchange Instrument with special Calling Disc.

causing the selecting mechanism to make a number of steps corresponding with the impulses sent. When the impulses cease, the selector, having reached the required number, is locked, and the final contact made automatically by the hand selector rings the bell of the party required. When the automatic selector leaves the rest position, a timing device is set into action which keeps the connection closed for 50 seconds, during which time, should the subscriber not answer the exchange, operator may ring him repeatedly. If at the end of 50 seconds the subscriber has not replied, the whole connections are restored automatically, and the operator is set at liberty to select any other number she may require. If, however, the subscriber answers during the 50 seconds, the contact is locked and conversation may be carried on as long as required. At the close of conversation the hand combination is replaced, and the ring-off signal given in the usual way. The operation has been detailed only for magneto exchanges, but the system is equally applicable for common battery, and as such is now being tried by the National Telephone Company at their Holborn exchange.

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The method of operation is exactly the same, except, of course, the generator at the subscriber's instrument is no longer required, and the mere lifting and replacing of the receiver is all that is necessary to originate or finish a call.

It will be seen from the above that unless a conversation is actually proceeding the line cannot be blocked for more than the 50 seconds mentioned above, or other set interval as may be decided on when the adjustment of the timing device is made. In the event of a conversation lasting too long, to the detriment of other subscribers, the operator at the exchange can clear the line. This apparatus is being tried by the National Telephone Company at their Holborn exchange. It appears to us to have considerable advantages for use in residential flats, and it saves the use of the attendant now required when the ordinary extension telephones are used. That the ten subscribers on the party line cannot converse with each other is an objection to the system which will prevent friends from sharing the same party line. This fault is to be preferred to a want of secrecy.

## ADMINISTRATIVE COUNTY OF LONDON AND DISTRICT ELECTRIC POWER BILL.

(*Continued from page 482.*)

The case on behalf of the local authorities around London in opposition to this measure was concluded on Friday last.

Mr. JEEVES, on behalf of the Kingston Corporation, and Mr. READER HARRIS, for the Corporation of Ealing and the District Council of Barnes, addressed the committee against the Bill, which, they contended, would not confer benefits on their districts, but would injure them after they had incurred heavy expenditure for electrical development.

The opposition of private companies was then taken, the first witness being Sir GEORGE LIVESEY, chairman of the South Metropolitan Gas Company, who objected to the promoters acquiring compulsory powers over land belonging to his company at Greenwich, thus preventing access to the river side of their property. He had no fear of the competition of electric lighting companies, for he believed in competition, but he objected to the promoters taking the property of his company for their own purposes.

Mr. FITZGERALD, K.C., said the promoters were willing to withdraw the request to use the land, and ask only for permission to use a siding on it on arbitration terms.

Mr. BALFOUR BROWNE said the promoters were changing their front as they went along.

Mr. DEVONSHIRE, director of the North Metropolitan Electric Supply Company, which provides electricity both for lighting and power in a large area in Middlesex, Hertfordshire, and a portion of Essex, also gave evidence in opposition to the scheme, and asked that the whole of Stoke Newington should be struck out of the Bill.

Mr. FITZGERALD: Is it a financial benefit to the local authorities to supply them with electric power?

WITNESS: I think there can be no doubt about that.

Mr. MOON, K.C., objected to the witness being used for the purpose of getting evidence in support of the Bill. It was quite unfair, and it was a most inconvenient practice.

The CHAIRMAN: It may be an inconvenient practice, but it has been in operation in this committee.

Replying to Mr. Balfour Browne, WITNESS said that his company was prepared to meet all the electrical requirements of the district.

After evidence had been tendered on behalf of other companies,

Mr. BALFOUR BROWNE addressed the committee for the whole of the electric lighting companies, contending that the Bill sinned against the principles of the whole of the best legislation of London. The promoters had launched their case by making certain allegations against the London electric lighting companies, and to meet that he had shown how much capital had been expended by them to meet the requirements of the public. The competition which they had to meet should be fair, but he submitted that this Bill would expose them to unfair competition. It was the scheme of a huge combination which would result in a monopoly. He knew it was said that it would be a monopoly of cheapness, but that was always the sentiment in the mouth of monopolists. It generally ended in a monopoly of dearness.

Mr. FITZGERALD, on behalf of the promoters, contended that the Bill before the committee proposed the only proper way of dealing with the supply of electricity to the county of London and the adjoining districts. It was the only way in which they could ensure to the consumers that cheap supply which was necessary to enable the manufacturing interests in London to be on a par with rivals, whether in this country or abroad. It was only in this way that they could remove from London the reproach that electricity was dearer in the Metropolis, notwithstanding its size, than in almost any other large town in the United Kingdom. Dealing with the question of the maximum price, he observed that it must of necessity be fixed to meet the most unfavourable circumstances as against the company. The sliding scale provisions gave absolute security for equitable charges. The power asked for by the Bill to enable the company to purchase existing electrical undertakings was inserted with the object of giving opportunities to local authorities and companies carrying on their own undertakings at a loss to transfer their businesses to the company by agreement subject to the consent of the Board of Trade. Similar provisions had been inserted in other Power Bills, but the promoters did not attach any special value to it. That there was no clause in the Bill authorising the purchase of the company's undertaking by local authorities was due to the recommendation of the joint committee of both Houses presided over by Lord Cross that where public advantage could be shown powers might be given over a district, including the areas of several local authorities, involving plant of exceptional dimensions and high voltage, on conditions differing from those previously existing.

The CHAIRMAN: It is unnecessary to argue the question of making the undertakings of large companies like this purchaseable by the local authorities. The committee has no intention of departing from the recommendation of Lord Cross's Committee.

Mr. FITZGERALD then proceeded to argue that the absence of the power of purchase was no injustice, as there was nothing to prevent an existing company from keeping up its generating station, or, on the other hand, if the directors found that it would be commercially to their advantage taking a supply in bulk and giving up its own generating station and plant. When the local authority came into possession, the supply in bulk would be continued by the Administrative Company on advantageous terms, or the local authority would erect its own station. Counsel concluded his speech by contrasting the present means of supply with the facilities offered by the proposed scheme, and dwelt once more on the urgent necessity of a cheap power supply for London.

This concluded the case, the committee reserving their decision.

Owing to the indisposition of Lord Romilly, the East London and Lower Thames Bill will be adjourned until after Easter.

## LIVERPOOL CORPORATION TRAMWAYS.

We gave last week a brief *résumé* of the operation of this system for the year 1904, which showed excellent progress. The length of track (103 miles) was practically the same as in the previous year, but the revenue advanced from £517,935 to £557,888, although the average length of the penny stages was slightly increased. The car mileage totalled 12,166,419 against 11,724,097 for the previous year, while the passengers numbered 116,642,663 against 113,057,234. The car-mile earnings were 10·67d. against 10·34d. The total operating costs per car mile showed an increase, the figure being 7·256d. against 6·884d., and the percentage of operating costs to revenue advanced fractionally, the 65 per cent. for 1903 being increased to 65·9 per cent. The chief items responsible for the additional expenses were electrical energy, maintenance and renewal of track and cars, and rates and taxes. The gross profit totalled £190,043, against £178,124 for 1903.

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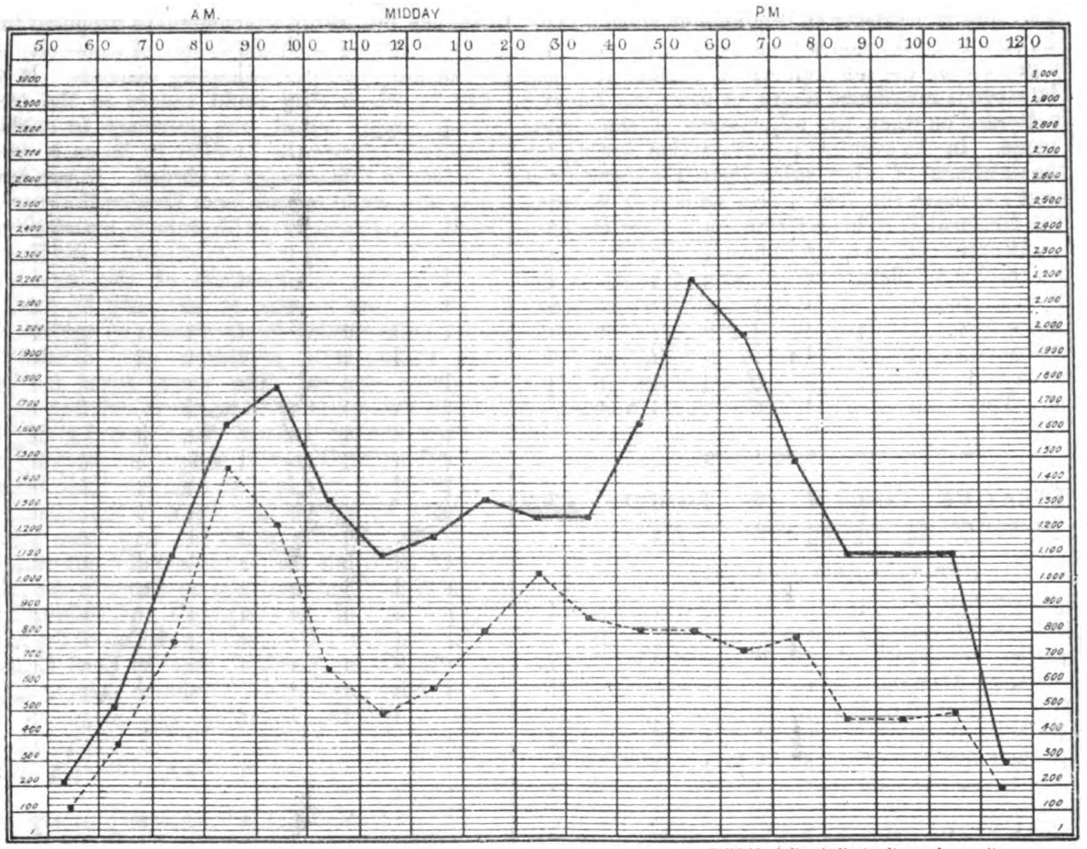
After deducting interest and sinking fund there remains a balance of £81,326, out of which £54,217 is placed to depreciation, renewal, and reserve, while the rates are relieved to the extent of £27,109. We noted at the time the report of the manager upon the question of a universal 1d. fare. It was shown that the general fares in Liverpool are lower than provided under statute for workmen, and that the charge per passenger mile is the lowest in the country. The Corporation, therefore, decided to make no changes in the scale, except to adopt 1½d. stages. The social, athletic, and thrift society in connection with the tramway employés is also in a flourishing condition. A




Solid black line indicates licensed capacity
Broken .. .. .. actual passengers carried

Diagram showing the Licensed Capacity of the Liverpool Cars over a typical route in midwinter on the inward journey, and the number of Passengers actually carried.

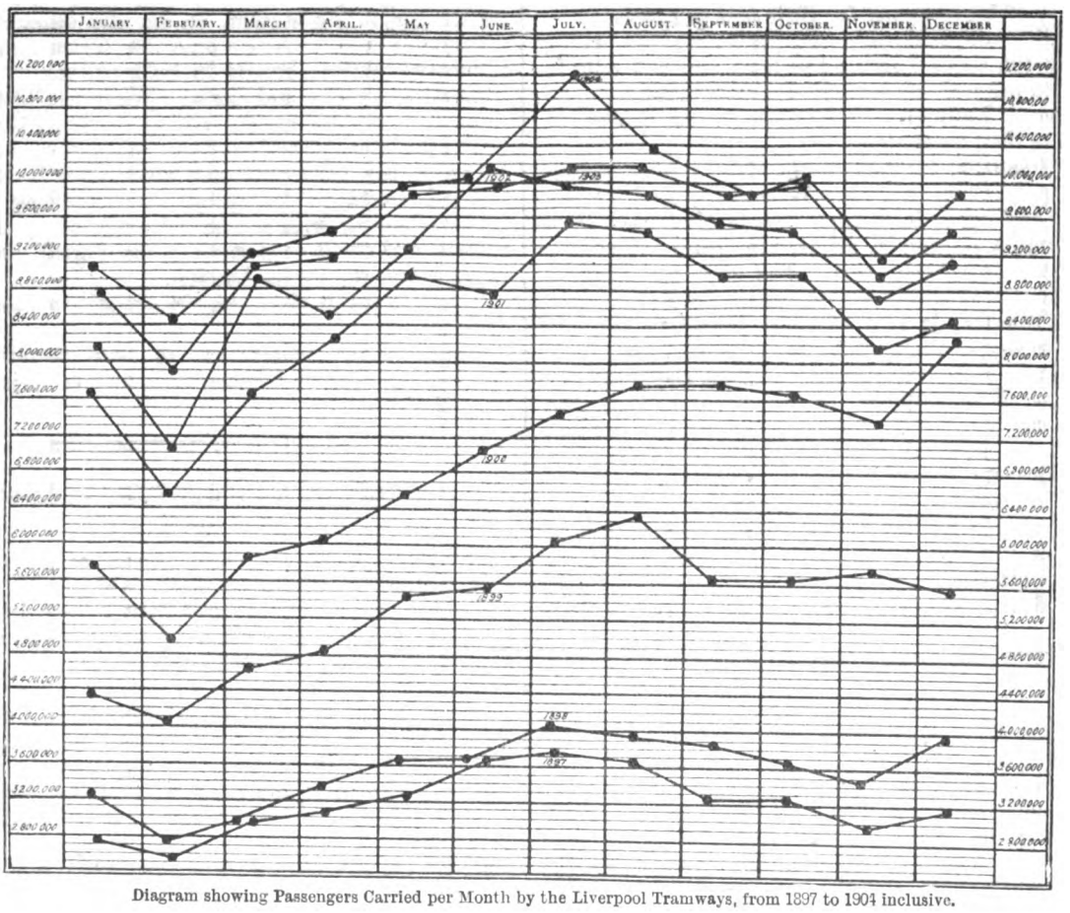



Diagram showing Passengers Carried per Month by the Liverpool Tramways, from 1897 to 1904 inclusive.

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steady decrease is shown in the amount of lost property, yet the articles in 1904, which were of the usual cosmopolitan order, exceeded 10,000.

A joint report on the subject of wheels presented to the Tramways Committee in July last by the engineers and general manager states that the wheels of the German cars, which were the first to be used by the Corporation, were steel-tyred, and the wheels of the American cars, which followed, were chilled cast iron. The steel tyres were found to "spread" in running, became loose and out of gauge, and were ultimately abandoned in favour of the chilled wheel, which was giving much better results on the American cars. The British manufacturers commenced the production of special steel tyres for tramcars about 1900, when their experimental use in competition with chilled wheels began. These experiments were carefully watched, and in May, 1902, a number of selected tyres were placed in service in Liverpool, and later it was considered desirable to buy tyres of all the representative makers. Fifty-two of the cars are now fitted with steel-tyred wheels, none of which have yet worn out, and therefore final figures cannot be quoted. Very divergent results have, however, been obtained, the mileage per unit of wear varying to the extent of 50 per cent., indicating the importance of selecting tyres of suitable composition. As a result of the experiments carried out for the last two years, a steel-tyred wheel is now being assembled and finished at Lambeth-road works which will cost 50 per cent. less than the price at which such wheels can at present be brought, and which it is believed will afford a life considerably in advance of the average of these wheels, which may be estimated at 60,000 miles, the average mileage of chilled wheels in Liverpool being 35,000. Since the date of this report over 100 cars have been fitted with the new wheel, which is giving satisfactory results. The stock of cars aggregates 494, composed of half a dozen types of single-deck, double-deck, and top-covered varieties. The number of top-covered cars in service is 317, and this figure is to be brought up to 350. As showing the effect of the top cover, it is pointed out that the average maximum number of cars in service for 1904 was 398 as against 407 for 1903, while the passengers carried increased by 3,585,429. Although 123 people fell in front of the cars or were knocked down, the lifeguard operated very satisfactorily, only three cases of fracture occurring. Altogether there were six fatalities in connection with the trams, which, in proportion to the passengers, gives a ratio of 1 in 19,440,441, whereas on railways, according to the most recent Board of Trade returns, the relation is 1 in 1,030,917.

A map graphically illustrating the entire system and several interesting traffic curves accompany the report. We reproduce two of the latter, from the first of which will be seen the licensed capacity of the cars running over a typical route on the inward journey during each hour of a traffic day and the number of passengers actually carried. This curve is for mid-winter, and, taken in conjunction with the diagram for outward traffic which also appears in the series, it shows that the service provided is capable of dealing with the demand at any part of the day. In the case of the "inwards" diagram the line representing the passengers actually carried approximates most nearly to the line indicative of the maximum capacity between eight and nine in the morning, and the disparity is greatest between five and six, when the cars are entering the city preparatory to taking the passengers home. In the "outwards" diagram these conditions are naturally reversed. The second of the illustrations which we reproduce shows at a glance the progress of the system since it was taken over by the Corporation. The consistently upward tendency of the curves reflects the progressive policy which has placed, and will doubtless keep, the Liverpool Corporation in the front rank of electric tramway undertakers.

## THE MARCONI PATENTS.

The United States Circuit Court has given its decision in the case of Marconi *v.* De Forest, and the result appears to be a sweeping victory for the former. From cable advices received, the following important claims in the Marconi patent have been declared by the Court to be valid, and to have been infringed by De Forest:

"3. The combination, in an apparatus for communicating electrical signals, of a spark producer at the transmitting station, an earth connection to one end of the spark producer, an insulated conductor connected to the other end, an imperfect electrical contact at the receiving station, an earth connection to one end of the contact, an insulated conductor connected to the other end, and a circuit through the contact, substantially as and for the purpose described.

"5. The combination, in an apparatus for communicating electrical signals, of a spark producer at the transmitting station, an earth connection to one end of the spark producer, an insulated conductor connected to the other end, an imperfect electrical contact at the receiving station, choking coils connected to each end of the contact, an earth connection to one end of the imperfect contact, an insulated conductor connected to the other end, and a circuit through the coils and contact, substantially as and for the purpose described."

These claims relate to what are essential details in all wireless telegraph systems, and appear to cover the use of an aerial conductor with one end earthed. The full text of the judgment is not yet to hand, but the decision is given on such broad grounds as to veto the commercial operation of any other system in the States during the term of the primary Marconi patent.

## HUDDERSFIELD ELECTRICITY ACCOUNTS.

The accounts of the Huddersfield Corporation electricity department for the year ended Dec. 31, 1904, show a total expenditure to that date of £175,972. Appended are abstracts of the revenue account and general balance-sheet.

REVENUE ACCOUNT.

| Dr. Expenditure. | £ | s. | d. |
|---|---|---|---|
| Coal and other fuel | 1,962 | 4 | 0 |
| Oil, water, and engine-room stores | 310 | 13 | 10 |
| Wages at generating station | 1,279 | 18 | 7 |
| Repairs and maintenance of buildings | 351 | 15 | 8 |
| Repairs and maintenance of boilers | 393 | 11 | 8 |
| Repairs and maintenance of engines | 428 | 11 | 5 |
| Repairs and maintenance of condensing plant | 291 | 10 | 2 |
| Repairs and maintenance of dynamos, etc. | 1,835 | 12 | 1 |
| Repairs and maintenance of transformers, etc. | 463 | 18 | 8 |
| Repairs and renewals of primary mains | 1,475 | 10 | 8 |
| Repairs and renewals of secondary mains | 223 | 14 | 10 |
| Attending and repairs to public lamps | 232 | 13 | 7 |
| Rents, rates, and taxes | 1,175 | 6 | 5 |
| Management expenses, salaries, etc. | 939 | 19 | 0 |
| General establishment charges | 678 | 19 | 8 |
| | 12,044 | 0 | 3 |
| Bad debts | 52 | 3 | 0 |
| Balance carried to net revenue account | 13,410 | 1 | 8 |
| | £25,506 | 4 | 11 |

*Note.*—Included in the revenue items are capital charges for mains, motors, transformers, and the additions to works, amounting to £3,297. 15s. 10d., which the committee have charged direct to revenue as a form of special depreciation.

| Cr. Income. | £ | s. | d. |
|---|---|---|---|
| By sale of current per meter | 24,787 | 5 | 8 |
| Rental of meters | 1,400 | 19 | 4 |
| Hire of motors and other apparatus | 447 | 4 | 0 |
| Sales and repairs of lamps | 88 | 8 | 3 |
| | 26,723 | 17 | 3 |
| Less discounts and allowances | 1,217 | 12 | 4 |
| | £25,506 | 4 | 11 |

GENERAL BALANCE-SHEET.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Mortgage debt, less repaid | 137,708 | 16 | 10 |
| Floating liabilities, sundry creditors, etc. | 8,917 | 3 | 3 |
| Depreciation and contingencies account | 9,743 | 0 | 1 |
| Consolidated loans fund | 38,990 | 0 | 8 |
| | £195,359 | 0 | 10 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Amount expended in works, etc. | 175,972 | 16 | 8 |
| Steam motor wagon | 459 | 7 | 6 |
| Stores on hand | 333 | 14 | 1 |
| Sundry debtors for current supplied | 12,195 | 15 | 8 |
| Cash due from treasurer and in hand | 6,397 | 6 | 11 |
| | £195,359 | 0 | 10 |

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THE
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### TO CORRESPONDENTS.

*All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

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## ELECTRIC LIGHTING BILL, 1905.

The Government Bill which has been introduced by Mr. Bonar Law in the House of Commons is in certain respects similar to the Bill which was not passed last year owing to want of time. For instance, it contains much the same clauses for dealing with the purchase by local authorities of generating stations which are outside their areas, but which are used by a company as undertaker for the supply within their areas. Joint purchase of a large undertaking by several local authorities is also provided for, as was the case in the measure which failed to become law last year. The same provisions are also included in this year's measure to deal with the combination of a number of local authorities who may form a joint board for the supply of electricity over a large district. The vexed question of stand-by supply is again dealt with in a satisfactory way, as will be seen from the details of the Bill which appear elsewhere in this issue. The most radical difference, however, between this year's Bill and the one introduced last year lies in Clause 3, respecting the supply of electricity in bulk. It provides that the Board of Trade may by provisional order authorise any company or person to supply electricity in bulk to any authorised undertaker. If the magnitude of the proposed scheme or exceptional circumstances warrant it, the matter may still be dealt with by private Bill. There are, however, before the Select Committee of the House of Lords this year a number of Bills which, in our opinion, could have been more economically dealt with by the Board of Trade This change of procedure, if it becomes law, will save power distribution companies the extremely heavy costs which they now have to incur in committee, and will tend towards a freedom of trading in electrical energy which must ultimately prove to the advantage of all users of the same. We do not suggest that a large scheme like the Administrative County of London and District Electric Power Bill could possibly be dealt with under the proposed new procedure. It will, however, be applicable to a large number of cases where a supply in bulk between undertakers in adjacent areas is to the advantage of both. The Bill contains, under Clause 6, the terms under which the Board of Trade may dispense with the consent of the local authority to the granting of an electric lighting provisional order. The first clause of this section still leaves the local authority the veto if they are already authorised to supply electricity. This prevents competition between private and municipal enterprise, and should go far towards removing municipal opposition to the Bill. The second proviso is to the effect that when mains are to be laid in streets outside the undertaker's area of supply, the Board of Trade must make a special report and state the grounds on which they decide to dispense with the consent of the local authority interested. The wording of these clauses, in our opinion, protects those most concerned—*i.e.*, the consumers—and prevents the obstructive policy of a local authority from interfering with the development of electrical distribution. The Bill, if passed, will provide means for overcoming many proved deficiencies in the older legislation dealing with the supply of electricity. It will cheapen the cost of procedure, and hence tend to the more rapid extension of the industry. We trust that this year the Government will not allow their Supply of Electricity Bill to be massacred with the other measures which annually fail to become law owing to want of time.

## INTERNATIONAL COURTESIES.

An Englishman is never at his best till after dinner. To give a feast to a friend is his delight, and he is never

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so happy as when a valued friend from another land becomes his guest. That was the condition of some thirty or forty Englishmen on Saturday last when they met at the Café Royal to entertain Mr. T. Commerford Martin, of New York, a gentleman whose kindly deeds on the other side have won him a warm corner in the hearts of all who have the pleasure of his acquaintance. The chair was occupied by Kaye Gray, the immediate past-president of the Institution, supported by his successor and the leading lights of the electric firmament. These gentlemen all came to show the high appreciation they had for the guest of the evening, and in some measure to indicate how high they valued his unceasing efforts to make their stay in the States last year and the Institution's trip to St. Louis so very successful. Mr. Martin is by birth an Englishman, by accident of residence and all that makes life dear an American, he having become a naturalised citizen of that country. Mr. Gray, at the conclusion of the dinner, gave the toast of "The King," which was loyally honoured, as was that of "The President" (Teddy the Second). *The* toast of the evening was next, and Mr. Gray and Prof. Ayrton told in simple, vivid, and eloquent words how greatly they were indebted to Mr. Martin during the sojourn in the States. Mr. Martin, in an exceedingly able speech, enthralled his audience by his earnestness in reciprocating good wishes. We are not reporting speeches, yet there was one especially good tale that must come in. Mr. Martin referred to a talk with Ingersoll, in which Martin mentioned the might and majesty of Britain, whose "drum beats are always with us." "Yes," said Ingersoll, "and so are their 'dead beats.'" Mr. Martin hoped these international visits would continue, and that, while competition led to keenness, the joining of hand to hand would bring about the heartiest good-fellowship between the kindred citizens. Colonel Crompton and Prof. Perry toasted the sister societies, to which Mr. Siemens replied. After a hearty vote of thanks to Messrs. Wetzler and Webb, who organised and did all the heavy work attached to such a meeting, the gathering broke up, after thanking the chairman, with a feeling of satisfaction that we had on this side shown in some slight degree how deeply impressed we were at the kindness showered by Mr. Martin upon those of us who had ever been brought into contact with him. May such kindly feelings never cease to flourish!

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### DUNDEE POWER SUPPLY.

SIR,—With reference to the publishing of my report on motive power charges in your issue for last week, in the first introduction I notice that you have used the word "minimum" price at 2½d. per unit, whereas this should have been maximum price at 2½d. I may say that the Dundee Town Council have adopted the system mentioned for the ensuing year, and the registration of the motors has been commenced.—Yours, etc.,

H. RICHARDSON, General Manager.

Dundee, April 12, 1905.

## MANCHESTER SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

On Tuesday last a paper on "Labour-Saving Formulæ in Dynamo Design" was read by Mr. Julius Frith and discussed.

Mr. H. W. WILSON criticised some points in the data for turbo-generator design, principally as to the safety of 15,000ft. per minute peripheral speed with smooth-core generators; and was reassured by Mr. FRITH that with No. 19 piano steel binding wire the factor of safety was 10.

Mr. S. L. PEARCE corroborated some of Mr. Frith's formulæ and details from actual experience. On the Metropolitan Supply Company they had experienced trouble with slot-wound turbo-machines, but now that these are smooth-core, with piano wire binding, their peripheral speed of 15,000ft. per minute is safe.

The other business of the meeting consisted in passing votes of thanks, one being to Mr. C. D. Taite for his services in the chair during the past session. This was proposed and seconded by Mr. S. L. PEARCE and Mr. E. W. COWAN respectively; and Mr. T. L. MILLER with Dr. BOWMAN dealt similarly with the acknowledgment to Mr. P. A. Ramage of his work as hon. secretary and treasurer. Mr. RAMAGE, in reply, prophesied that if the work of the section increased in the next 12 months as it had done in the past year, it would be necessary to engage a secretary with nothing else to do. The membership had increased from 549 to 764 (about 40 per cent.) in the interval mentioned.

The voting for next session's officers resulted as follows: chairman—S. L. Pearce; vice-chairman—T. L. Miller; hon. secretary and treasurer—P. A. Ramage; committee—L. Andrews, Dr. Bowman, A. A. Day, M. B. Field, A. Eckstein, A. H. Gibbings, Dr. E Hopkinson, A. B. Holmes, M. B. Mountain, G. F. Metzger, Dr. Rhodes, Dr. Schuster.

This concluded the business of the session.

## HECKMONDWIKE ELECTRICITY SUPPLY.

On Saturday last there was an official opening of the extensions of the electricity works at Heckmondwike, which have been carried out under the direction of Mr. G. H. Carter, the consulting and resident electrical engineer to the District Council. The original scheme for the lighting supply in Heckmondwike was carried out to the designs of Mr. W. C. C. Hawtayne. The works were opened on Dec. 1, 1901, when there were 39 consumers with 2,804 lamps connected to the mains. In the beginning of 1902 the Council were called upon to make provision to give a supply of electrical energy to the tramways which the British Electric Traction Company were about to construct in the Spen Valley. The Council instructed Mr. Geo. H. Carter to draw up a scheme for the supply to the tramway company, and also to deal with the increasing lighting load. This scheme included the addition of a boiler of the Babcock and Wilcox type evaporating 12,000lb. of water per hour. In the engine-room a 150-kw. set was added, the engine being of the Howden type and the dynamo supplied by Messrs. Dick, Kerr, and Co. A steam-driven surface-condensing plant, with Edwardes air-pump, capable of dealing with 10,000lb. of steam per hour was also added. In connection with the above, two tanks were fixed immediately under the air-pump delivery pipe, the delivery pipe being fitted with two lever valves, enabling the discharge water to be delivered into these tanks alternately, so that at any time a test of steam consumption can be made of any particular engine, the whole of the above and the necessary pipework being supplied by Messrs. Thornton and Crebbin, of Bradford. In connection with this condensing plant a cooling tower of the Worthington type with forced draught was placed in one corner of the engine-room. The forced-draught fan was a variable-speed one, and was driven by a Royce double-commutator motor.

In connection with the tramway supply a Highfield booster and a Chloride battery were installed, the combination being capable of giving a discharge to the line of 400 amperes as a maximum. The Tudor battery was at this time rearranged, the regulating cells being done away with and the battery being increased 40 per cent., the object being to enable the cells to be used on the Highfield system. The switchboard was also extended by the addition of five panels, and a new feeder was laid down for lighting and a large line feeder and return for the traction work. These extensions were all carried out in 1902. In the

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spring of the following year the boiler-house plant had again to be increased, and this time a Stirling boiler, equipped with a superheater and chain-grate stoker, was added. Automatic stokers were also then fitted to the existing Babcock and Wilcox boiler. A 300-kw. steam set, again of the Howden-Dick-Kerr type, was added, and one more lighting feeder. In the spring of last year a second Stirling boiler, also capable of evaporating 20,000lb. of water per hour, was added. Another 300-kw. steam set was installed, this time the engine being of the Willans and Robinson type, and the generators by Dick, Kerr, and Co. The switchboard was again increased in order to provide for three new feeders. Two of these were of the triple-concentric type, and one a plain concentric cable, each conductor being half a square inch in sectional area.

Since the original scheme the street-lighting has been considerably extended, the number of converted gas-posts now being 189. The demand on the station has steadily increased, as the table given herewith will show, the number of 8-c.p. lamps now connected being 20,467, and 2,271 applied for but not connected—making 22,738, which equals a kilowatt demand of 682. Assuming 50 per cent. of these lamps to be burning at one time, the demand on the station would be 341 kw., to which must be added supply given to the tramway company—namely, 400 kw.—making a total demand of 741 kw., the capacity of the plant being 900 kw. During the time the station has been working numerous additions have been made to the network in the town, which have been carried out by the Council's own men.

Herewith is given a comparative list of figures to show the progress since the commencement of supply, when there were 39 consumers with an equivalent of 2,804 8-c.p. lamps connected.

| Date..... March 31, | 1902. | 1903. | 1904. | 1905. |
|---|---|---|---|---|
| Equiv. 8-c.p. lamps connected... | 5,739 | 7,701 | 11,700 | 20,467 |
| Number of consumers ..... | 50 | 94 | 135 | 192 |
| Motors—number and h.p,..... | 1—6 | 10—36 | 36—116 | 57—331 |
| Maximum load on station—kw. | 99 | 116 | 425 | 541 |
| Units generated..... | 37,081 | 100,434 | 334,774 | 512,080 |
| Total units sold ..... | 24,598 | 73,631 | 257,054 | 419,685 |
| Station efficiency, per cent..... | 73·2 | 87·9 | 90·2 | 91·3 |
| Works costs per units sold ..... | 1·49d. | ·87d. | ·83d. | ·60d. |
| Total costs per unit sold... ... | 1·93 | 2·06 | 1·22 | ·895 |
| Capacity of plant—kw..... | 150 | 300 | 600 | 900 |
| Financial result ..... | -£675 | -£287 | +£581 | — |

The Heckmondwike Urban District Council and its electrical engineer, Mr. G. H. Carter, are to be congratulated on the continued progress which has called for these repeated extensions. Mr. H. C. Carter is the chief assistant electrical engineer.

## FORTHCOMING EVENTS.

FRIDAY, APRIL 14.

**Institution of Mechanical Engineers.**—At 8 p.m., address by the President. Conclusion of the discussion on the "Steam-Engine Research Report," and reply by Prof. Capper.

**Royal Institution.**—At 9 p.m., "The Law of Pressure of Gases below Atmosphere," by Lord Rayleigh.

**Compatriots' Club.**—At 5.30 p.m., "The Revenue Aspect of Mr. Chamberlain's Proposals," by Sir O. J. Follett.

**Physical Society.** — "Ellipsoidal Lenses," by Mr. R. J. Sowter; "The Determination of the Moment of Inertia of the Magnets used in the Measurement of the Horizontal Component of the Earth's Field," by Dr. W. Watson; and a series of lecture experiments illustrating the properties of the gaseous ions produced by radium and other sources, by Dr. W. Watson.

**North-East Coast Institution.**—At 7 p.m., re-election of officers; "Boiler Furnaces and the Effect of Oil on their Ultimate Strength," by Mr. D. B. Morison, vice-president.

TUESDAY, APRIL 18.

**Institution of Civil Engineers.**—At 8 p.m., annual general meeting.

WEDNESDAY, APRIL 19.

**Chemical Society.**—At 5.30 p.m., general meeting.

**Royal Meteorological Society.**—At 7.30 p.m., general meeting.

**Manchester and North of England Horological Society.**—At 7 p.m., "Electric Clocks," by Mr. F. Hope-Jones (Municipal School of Technology, Manchester.)

RAILWAY SUPPLIES.—We have received from the Western Electric Company, of Chicago, a copy of their railway catalogue of electrical supplies for 1905.

## UNSOLVED PROBLEMS IN ELECTRICAL ENGINEERING.*

BY COLONEL R E. B. CROMPTON, C B, M I C E.

The electrical problems which form my subject divide themselves into two groups—those set for us by Nature herself, and which chiefly concern the scientific investigator, and those which have presented themselves to us engineers since we began to use electrical energy for man's service. Engineers are only concerned with Nature's problems so far as their investigation comes into his work when he is called upon to provide means to protect our works from damage due to her display of her electrical forces.

The problems of lightning discharges have from the very first interested us, and in these later days of large power schemes the importance of protecting our works against lightning stroke has become increasingly evident. For a long time we thought that the damage caused by lightning was confined to systems of overhead conductors, as its effect on these was at once evident, in some cases by complete destruction of parts of our circuits, in others by the breakdown of our insulation, but during our recent developments of large power schemes, employing systems of conductors to carry the energy into districts where the use of overhead conductors is inadmissible, the influence of lightning discharges, or of earth strokes connected with them, on our underground systems, has been undoubtedly the cause of many failures and interruptions to service, the investigation of which forms a problem of the first magnitude. The problem has been insufficiently investigated, but it appears probable that many of the mysterious perforations of the insulation of our underground cables are commenced by static charges due to condenser effects produced on a gigantic scale in the system.

I have been slowly gathering evidence during the last few years, and find that most of the engineers who have studied this question are in agreement with me, that our present methods of detecting or guarding against the effects of frequent and hitherto unnoticed static discharges are altogether inadequate to protect our works, and that we have here presented a question of extreme difficulty and importance. No doubt in our temperate climate these effects are not so often manifested, nor are they so important, as in the more extreme climates of America, or in the parts of India where I have had personal experience of them. It is probable that they do occur in this country, and that damage to our underground systems of mains, hitherto unexplained, are due in many cases to these atmospheric or earth discharges, but only those who, like myself, have stood in a power-house in the Himalayas and witnessed the almost continual series of discharges which follow one another so rapidly that they resemble a continuous cannonade, are able to fully realise how liable our works are to become a link in the distribution of Nature's gigantic electrical display of power.

During a recent conversation with Prof. Elihu Thomson in America we discussed this question, and he reminded me of the undoubted fact that lightning strokes as they pass through the air very frequently follow one another over nearly, if not the same, identical air path. He seems to think—but this requires confirmation—that the dielectric strength of the air at this point is reduced or partly broken down by the passage of a powerful lightning stroke, which facilitates the passage of subsequent strokes at the same point. Are we to conclude that corresponding conditions of weakened path are set up below the earth's surface, and consequently affect us by affording paths for disruptive discharge through our underground mains?

Closely allied with the investigation of these interesting phenomena are the hitherto unexplained causes of ball lightning, which appear extremely difficult to understand. We have such consistent accounts given by truthful and competent observers of balls of fire moving slowly in the air or rolling along the ground, sometimes attended with slight noise or explosion, in others by violent disruptive effects, that we cannot refuse to believe that ball lightning is a reality. I am aware that it has been asserted that

* The "James Forrest" lecture, 1905, delivered before the Institution of Civil Engineers.

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they do not really exist, but are merely persistent effects on the retina produced by a previous brilliant discharge; but as Planté in his researches has distinctly stated that he was able to reproduce ball lightning effects on a small scale when experimenting with direct currents of high E.M.F. obtained from his accumulators, there can be no doubt that Nature does produce these phenomena for which at present we have no explanation to offer.

Those of us who were at St. Louis last summer witnessed the remarkable luminosity surrounding the electrical conductors carrying currents at the extremely high pressure of 100,000 volts. It appeared under those conditions of electrical stress as if the air itself became luminous, and I suggest that this may throw some light on the phenomena of ball lightning.

I cannot omit from this lecture any mention of the problems of terrestrial magnetism, as they certainly affect electrical engineering works, but our knowledge of the sources of terrestrial magnetism, and of the disturbing influences of what are known as magnetic storms, is so vague, and the hypotheses are based on such scant knowledge that I am compelled to touch on the matter very lightly. We do not know with any certainty where the magneto-motive force which produces the earth's field originates—that is to say, whether its source is within the earth itself or is situated externally to it. Quite recently it has been definitely shown that the sun has a magnetic field, for the solar corona has a very definite polar structure; but even if we agree that the sun is, like the earth, a gigantic dynamo, the magnetic effects in both cases being possibly due to their rotation on their axes, the magnetic moment of the sun must be far too small to enable it to be of itself the cause of the earth's magnetism.

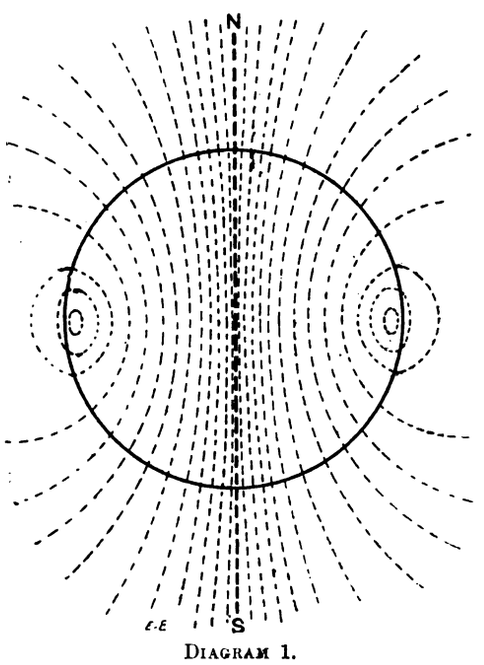


DIAGRAM 1.

There appear to be three hypotheses of the cause of terrestrial magnetism, the first being that the crust of the earth has at some time, probably shortly after solidification, become a permament magnet owing to the circulation of electric currents which possibly may have been produced by thermal causes. The second being that the cause was originally, and may still be, connected with the earth's rotation, which has gradually accumulated its magnetic field much as is the case with an ordinary self-exciting dynamo. The third hypothesis being that the sun itself is the power station for the whole solar system, and that each of the planets is merely a distributing station for the energy generated in the sun. It can, however, be shown that the direct magnetic effect of the external field produced by the sun must be small, although we know that changes taking place in the sun are unquestionably associated with the appearance of the magnetic storms which are of such importance to the navigator and the telegraphist.

The problem is undoubtedly unsolved, but great light may be thrown on it if the magnetic surveys of the inhabited portions of the globe, and especially those near the polar regions, could be completed. The diagram No. 1 shows that if we consider the earth approximately represented as a magnet with north and south poles, the lines through the equatorial zone of the earth must be directed towards the poles and recurve back from the polar areas to complete their magnetic circuit across the equator, but we have reason to believe that the earth's magnetic field is not symmetrical and differs widely from that shown in my diagram. I think that we in England may congratulate ourselves on the excellent work of our magnetic observatories at Kew and elsewhere in observing and recording variations of the earth's magnetic field over a period of years quite unbroken until the observations were interrupted by the stray magnetic field caused by neighbouring electric tramways. A new observatory is now in course of construction near the border, on the Duke of Buccleuch's estate, at which this valuable series of observations will be continued without risk of future interruption. You all know that the magnetometer observations are self-recorded on a paper strip. As Maxwell says, "On that recording paper the never resting heart of the earth traces in telegraphic symbols the record of its pulsations, and the slow but mighty work of the changes which warn us not to suppose that the inner history of our planet is ended." Surely from this long record, and from corresponding records that are being carried on in other parts of the globe, materials will be supplied to us to answer partly or wholly the problem which I have just put before you.

Another problem which is only now commencing to pass outside the domain of the physicist into that of the engineer is that of the etheric transmission of power. The development of electric wave telegraphy is an excellent instance of the various stages of the solving of an electrical problem. In this case Maxwell and Hertz settled the first stage and formulated the laws of the transmission of etheric waves. Branly supplied an important element when he invented the coherer. Marconi's enthusiasm, skill, and perseverance, aided by Fleming and other numerous competent co-workers, has carried the third stage to its present development.

We may consider that the etheric transmission of signals up to a given distance, and notably for the purposes of signalling to and between ships at sea, is practically solved, although there are many secondary problems arising out of it. No doubt the first and most important of these is the production of wave trains sufficiently powerful and of the right character to yield the best results. Fleming has particularly devoted himself to this subject, and the value of his inventions has been fully acknowledged by Marconi.

Taking the economical question first. Fleming has shown that in all probability the method that we have arrived at at our present stage of development to communicate waves to the ether by the oscillating discharge of condensers only extends over probably over 1 per cent. of the time available—in fact, that we only have a series of intermittent waves with long vacant spaces intervening. What we require is a better method of originating a continuous train of waves rather than these intermittent ones, and here we can formulate our problem, which may be solved by the mechanical engineer, or probably by the electro-chemical engineer. None of us have as yet succeeded in constructing an alternator with a frequency approaching 1,000,000 per second; but who can say that recent developments in extremely high-speed turbo-generators of the De Laval type may not furnish us with a good start in obtaining such frequency by mechanical means. Again, turning to the possibilities within reach of the electro-chemist, very promising attempts have already been made by Lodge and others to produce electrical oscillations from condensers charged by a Cooper Hewitt mercury vapour lamp. Duddell has shown by his investigation of the singing arc that herein lies a method of producing a continuous series of discharges, although in this case the frequency obtained is not sufficient for our purpose. At any rate, the solution of this problem of continuous operation by means of Hertzian waves appears to be extremely hopeful, and at any rate it is one of first importance.

One problem connected with electric wave telegraphy

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requires mention, although I believe it has been already nearly, if not completely, solved by Fleming. I refer to the noise caused by the signalling spark used in wireless telegraphy, especially on board ship. The loud cracking discharge of this spark has the two-fold disadvantage of being a nuisance to anyone in the neighbourhood of the apparatus and of entirely defeating secrecy, as the message can be read by anyone conversant with the Morse alphabet. Fleming has caused the discharge to be produced in cast-iron vessels filled with nitrogen or carbolic acid under pressure, and by this means has practically succeeded in silencing the spark, even when large powers are employed.

As to the etheric transmission of power on a large scale as foreshadowed by Tesla, it is difficult to speak with any certainty, or even hopefulness. It is evident that the consequences which would follow on the etheric transmission of considerable amounts of power would be so startling, from every point of view, that they would revolutionise our ideas socially and politically, and would profoundly affect all our present conditions of life.

I now come to the second group of problems connected with the development of electrical machinery in the form that it is now taking, and with which I have personally been most in contact during the past 25 years. It is 30 years ago since we were introduced to the dynamo. We owe to Faraday, Paccinotti, Varley, Wheatstone, and Siemens the early stages of dynamo development. To those who produced our present materials, the permeable iron and steel we use for our magnet cores, the electrolytic copper we use for our conductors, we owe the second stage. We have since passed through a long series of developments of design, at first determined experimentally, and afterwards modified by practical use. The progress of our design has been marked by constant alteration following on new discoveries of systems of generating and utilising electrical energy, but throughout the considerable changes of the many systems that have been tested and which still survive, I find that underlying the whole of our progress up to the present we meet with the one mean group of problems which form the central feature of all our designs, those relating to the designs and construction of the most efficient magnetic field, and which for convenience I hereafter call the problem of "core and coil."

The electromagnet bears the same relation to electrical machinery that the cylinder, piston, and crank bear to the steam-engine. Wherever we wish to translate mechanical into electrical energy, or electrical back into mechanical energy, we are compelled to use the "core and coil," and I hope you will bear with me if I spend some of our time in discussing how much we may yet develop our future knowledge of this important matter.

Take the core first. Although in a few instances, in fact, only for measuring purposes, we use coreless electromagnetic devices, in most cases we find it necessary that a considerable part of the path of the magnetic field should lie within the metal which possesses the highest permeability for magnetic lines of force. This, up to the present, has confined us to iron in its purest form, which, when cast or produced by methods where it has been at one time in a molten condition, the engineers have preferred to call steel. In the early days of Faraday and those who followed him, it was observed that the best results were obtained when pure forge iron, such as that obtained from Swedish bars, was used for our magnet cores; but later on, in order to cheapen and facilitate construction, we commenced using cores which could be cast into the desired form. So long as these were of cast iron the permeability was low, and results therefore poor. Later on the steel-founder was able to make for us castings of high permeability; but when we began to develop the use of alternating machinery, or whenever the cores were subjected to alternating electrical stresses, we met with the difficulty that eddy currents were set up within the cores, followed by heating, and in addition we observed for the first time the losses due to hysteresis. When we first formulated our requirements for core material they were exceedingly simple. We only stipulated that it must be permeable, easily cast, forged, or worked into the shapes in which we required to use it, of sufficient mechanical strength, and easily cut or shaped up by machine tools. These requirements were easily met by the addition of small percentages of nickel and aluminium, as the use of these alloys produced cores with extreme permeability; but when, as I have just mentioned, it became of extreme importance to minimise eddy currents, we found it necessary to mechanically subdivide our cores either by slotting or sawing the solid castings or by forming our magnet arms of thin wrought-iron plates, which are held in position by being cast into cast-iron or cast-steel yokes. But at this stage we encountered an annoying difficulty, which still exists and has been the cause of much disappointment and loss to steelfounders and dynamo builders. I refer to the difficulty in producing steel castings for magnets, yokes, and frames sufficiently free from blow-holes or porosity to ensure that the magnet core portions are of equal density of mass, and, therefore, of sufficiently equal magnetic moment.

This porosity of steel castings will continue to exist so long as they are poured from steel or ingot iron comparatively free from carbon, silicon, and other materials which are present in cast iron, and thereby lower its melting-point. The purer material is so viscous that it does not run smoothly into our moulds, and consequently entraps the gases to form the blow-holes and irregularity of mass that I complain of. This difficulty is a real one, and may possibly be met by further development of Barrett's discovery that the addition of silicon in suitable proportions to cast iron renders the whole very fusible, so that complicated and difficult castings free from porosity can be made from it, but, in addition, he has shown that we have the great gain from it, as it reduces hysteresis. It is probable that the silicon acts by reducing the combined carbon that is in the iron in the form of carbide, so that the pure iron is left with a structural formation calculated to give high permeability, as it will be in the form of a sponge or network, which will give great freedom for molecular movement; moreover, at first sight we might think that pure iron would have the disadvantage of reducing resistivity, which would facilitate the formation of eddy currents, yet in practice this is not so, as although the iron has lessened resistivity, the cross-section of the filaments of the pure iron sponge are small, and therefore the mass as a whole has considerable resistance to these eddy currents. Barrett's discoveries, therefore, point in the direction from which we may hope to obtain considerable improvement in our magnet cores. We may therefore reformulate our requirements for these cores as follows: maximum of homogeneity, permeability, low hysteric coefficient, high resistance as a mass to eddy currents; of course all this combined with sufficient mechanical strength to resist the mechanical stresses due to centrifugal forces when the core forms part of the revolving mass or to the stresses set up by magnetic attraction when they form part of the frame of a stator or magnetic ring of large dimensions. In the other class of cores, particularly those subjected to alternating electrical stresses, such as the cores of transformers, we cannot hope to obtain sufficient freedom from the losses due to eddy currents by means other than minute subdivision—that is to say, by lamination, or in some cases by forming the cores of a bundle of individual wires. Great progress has been made in the production of such laminated material, and a great part of our constructive work lies in the organisation of the labour necessary to fit together the large number of sheets or stampings which go to form this class of cores. Where such cores are used for revolving armatures we meet with the secondary problem of securing satisfactory balance of the rotating mass, and it is not easy to obtain this, as any turning or cutting process applied to the edges of the thin sheets has a tendency to bring them into electrical conducting contact at the edges and ends facilitating the eddy currents. The same difficulties occur in smoothing out of the tunnels or slots of our armatures, and a satisfactory means of carrying this out cheaply and efficiently has yet to be found.

Although I am limited by time from discusing this great core question as fully as I could wish, I cannot close it without referring to the interesting discoveries of Dr. Heusler of magnetic non-iron alloys. Dr. Hadfield has produced for Dr. Fleming rings formed of an alloy of

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aluminium, copper, and manganese which is nearly as magnetic as a low grade of cast iron, although it contains no iron at all. It is possible that the whole secret of magnetism is locked up in these rings; at any rate, the discovery is of extreme importance, and may have wide-reaching influences on the question of our cores.

*(To be continued.)*

## TRADE NOTICES AND NOVELTIES

### The "Velix" Watertight Electric Bell.

The accompanying illustration of the "Velix" completely-enclosed watertight electric bell, which is one-half full size, shows a useful accessory which Messrs. Siemens Bros. have put on the market. It is designed under the Hill patent, and is specially suitable for working in mines, chemical factories, powder mills, or other places where damp and explosive gases

The Velix Watertight Electric Bell.

make the ordinary electric bell either unsatisfactory in working or absolutely dangerous. The bell as designed can be worked under water. As will be seen, the whole mechanism is self-contained within the gong, which is made in the form of a hermetically sealed case. The leads enter this through a stuffing box. If desired, lead-covered wire can be used for this purpose, and the lead sweated to the case.

### Voltage Regulators.

The large variation of candle-power of an incandescent lamp with a small variation of voltage makes the satisfactory working of these lamps very dependent on the regulator of the pressure

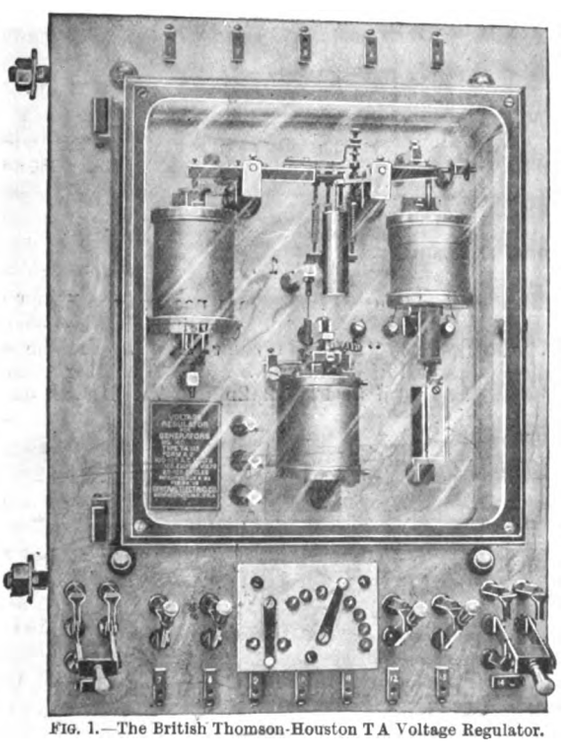

FIG. 1.—The British Thomson-Houston T A Voltage Regulator.

supply. The automatic regulation of voltage has been gone into by a large number of firms, but the latest devices for this purpose are brought to our notice by the British Thomson-Houston Company. This firm, in their pamphlet No. 178, which is just issued, describe their voltage regulator, which we illustrate herewith, and which is designed for controlling either alternating or continuous current generators. As will be seen from the diagram of connections (Fig. 2), the voltage of the alternating-current generator is automatically maintained at a constant value by varying the exciter voltage. This regulation is accomplished by rapidly opening and closing a shunt circuit across the exciter field rheostat. The rheostat shunt circuit is opened and closed by a differentially wound relay. The current for operating this relay is taken from the exciter 'bus bars, and is controlled by the floating main contacts. The current for operating the continuous-current control magnet is also taken from the exciter 'bus bars. The relay and the continuous-current control magnet constitute the continuous-current portion of the regulator, and maintain, not a constant, but a steady exciter voltage. The alternating-current

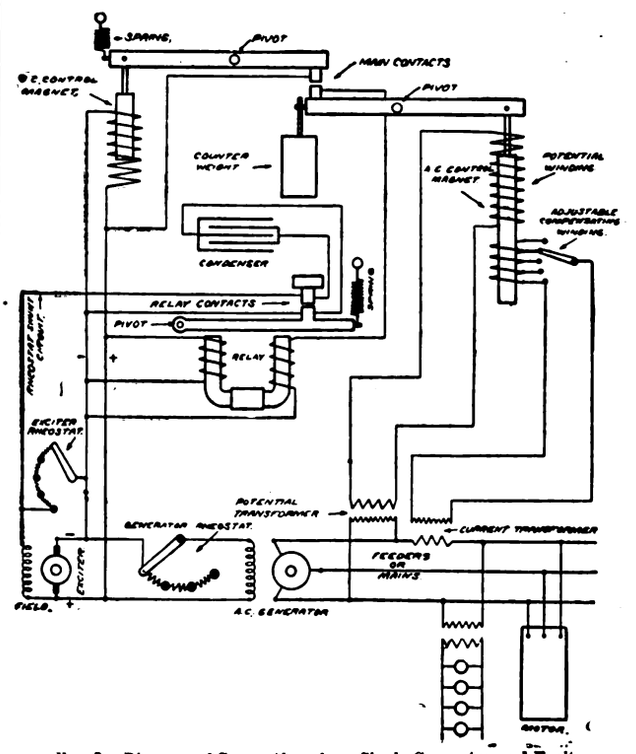


FIG. 2.—Diagram of Connections for a Single Generator and Exciter.

portion of the regulator consists of a magnet having a potential winding connected, by means of a potential transformer, to the 'bus bars or the circuit to be regulated. This magnet also has an adjustable compensating winding, which is connected in series with the secondary of a current transformer usually inserted in the principal lighting circuit. The core of this magnet is attached to a pivoted lever carrying a counterweight, which is balanced by the attraction of the magnet. If a load is thrown on the generator the voltage will tend to drop, the alternating-current magnet will weaken and destroy the balance of the core and lever, and cause the main contacts to close; this in turn will close the relay contacts and entirely short-circuit the exciter field rheostat, thus increasing the exciter voltage until the original balance of the alternating-current magnet core and lever is restored and the alternating-current voltage maintained at the required value. In some cases the exciter voltage will vary from 70 to 125 volts from no load to full load. This is especially true if the load is partly inductive and the regulator is adjusted to compensate for the line loss. It will be seen that an adjustable compensating winding is provided, so that the apparatus can be adjusted to suit local conditions. When once the regulator is adjusted to maintain a constant voltage at a given centre of distribution it requires no further adjustment, and will automatically raise or lower the station voltage as required. It is independent of the temperature rise in the alternator and also of the power factor of the load. Some interesting charts are given in this pamphlet to show what these regulators have done in the way of reducing variations in voltage.

### Catalogues Received.

THE BRITISH THOMSON-HOUSTON COMPANY have forwarded us their pamphlet No. 179, which deals with generating and sub-station switchgear. In this a large number of recently-installed switchboards are described and illustrated. The details of these various boards show how far the company have gone in the way of standardising their switchgears, and also in the development of the same for dealing with large powers. The switchboards made by the company on the remote-control principle for the District Railway Company's station at Lots-road, mark a distinct step forward in the design of such apparatus. These boards were described in our columns in the early part of the year.

CECIL HODGES AND CO. send us a large picture postcard with illustrations of the switch fuses manufactured by them on the

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one side. On the other the sector voltmeter of the type now standardised for central-station work appears. These post-cards make an excellent reminder of what a firm is doing.

LUNDELL MOTORS.—Messrs. J. H. Holmes and Co. have published a new edition of their catalogue describing the Lundell patent continuous-current motors, and also those of the Castle type. We notice in the design of these motors that certain modifications have been made, and the illustrations show some new departures in the coupling of such motors to their work. One type of gearing, in which a worm and wheel is used, is especially adaptable in those cases where high-speed reduction is a necessity. The last part of the list deals with smaller motors for driving fans and to the adaptation of large motors for induced-draught apparatus.

THE EDISON AND SWAN COMPANY have just issued two new leaflets, dealing respectively with the "Triton" extension box and the "Clincher" wall plug. The first-mentioned accessory is specially designed for those installations where the looping-in of wires is insisted upon as a means of avoiding joints. The box also affords a ready means of testing without interfering with the fittings or the insulation wire. If desired, this box can be provided with an iron cover. The wall plug supplied under the name of the "Clincher" is so designed as to give a secure hold in a wall with a minimum amount of damage to the same.

MESSRS. FERRANTI LIMITED's list of moving-coil instruments for continuous currents illustrates a type of meter which is 11in. in diameter. These instruments have a small coil moving in a permanent magnet field. In order to completely shield the instrument from stray magnetic fields, the cases are made of cast iron. The instruments are provided with either front or back terminals as desired.

FANS.—Cyclone fans for induced draught are the subject of a pamphlet recently issued by Messrs. Matthews and Yates, Limited, Swinton, Manchester. Some useful notes are included, with illustrations showing the various ways of installing the fans.

ACCESSORIES.—Messrs. Davies, Kent, and Stewart, Limited, 17, Berners-street, Oxford-street, W., have sent us a comprehensive catalogue of the electrical accessories which they supply.

MEASURING INSTRUMENTS.—The latest list issued by Messrs. Ernest F. Moy, Limited, London, deals with measuring instruments of the sector and illuminated dial types for continuous current.

## PERSONAL.

Mr. B. Pontifex has severed his connection with Messrs. G. N. Haden and Sons, of Trowbridge, Wilts.

The Carlisle City Council have increased the salary of the deputy electrical engineer, Mr. G. G. Scurfield, from £150 to £175 per annum.

The Bermondsey Council have appointed Mr. W. E. J. Heenan, at present borough electrical engineer of Southend, electrical engineer at their electricity works.

Mr. W. J. Vincent, shift engineer at the Portsmouth Corporation tramways power station at Fratton, has been the recipient of a handsome marble clock, presented on the occasion of his marriage by the staff of the station.

We learn that Mr. F. A. Glover, managing director of Messrs. F. A. Glover and Co., Limited, electrical and mechanical engineers, Vine-street, Clerkenwell-road, London, E.C., is to be married on Thursday, April 20. He is giving the whole of the staff and employés a holiday on that day, therefore the offices and works will be closed.

In consequence of the resignation of Mr. W. J. Hosgood, resident engineer and locomotive superintendent, Port Talbot Railway and Docks Company, the following appointments have been made: Mr. W. Cleaver to be engineer and Mr. A. H. Hertz to be locomotive superintendent.

## APPOINTMENTS VACANT.

**Assistant Lecturer in Engineering,** Swindon Education Committee. Salary, £150 per annum. Applications by April 29. See advertisement in last issue.

**Agents** for switchboards, transformers, instruments. See advertisement in last issue.

**Pupil,** L. H. King, Council Offices, Whitby, Yorkshire. See advertisement in last issue.

**Assistant Foreman for Overhead Line,** Tramways Department, Blackburn Corporation. Wages, 30s. a week. See advertisement.

**Men** to take charge of motor pumps, Canterbury Corporation. Wages, 22s. 6d. per week of 56 hours. See advertisement.

**Assistant Electrical Instructors** in machine drawing and construction and in electric machine testing, City and Guilds Central Technical College. £150 per annum. See advertisement.

**Jointer,** Elland Urban District Council. See advertisement.

**Canvasser,** National Electric Supply Company, Limited, Preston, Lancs. See advertisement.

**Premium Pupil.** See advertisement.

**Junior Assistant.** £1 per week. See advertisement.

## ELECTRICALLY-DRIVEN LIFTS.*

BY F. O. HUNT.

*(Concluded from page 492.)*

*Brakes.*—In the early days of electrically-driven lifts brakes were exclusively a mechanical matter, and are so still in many cases where hand-rope control is adopted. When either system

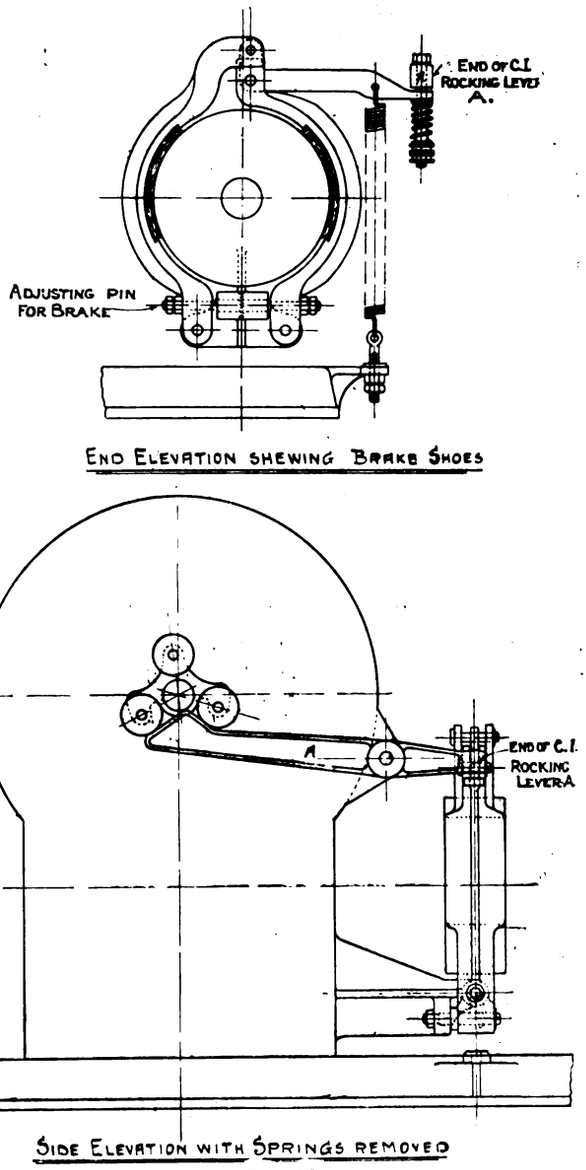


FIG. 12.

of electrical control is used, it becomes necessary to lift off the mechanical brake magnetically, thus ensuring that when current is "off" the brake is "on," and *vice versâ*. An example of a brake for mechanical lifting is shown in Fig. 12. Magnetically-lifted brakes are shown in Figs. 2, 2D, and 7A. In the design

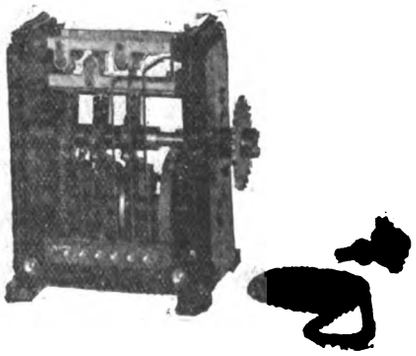

FIG. 13E.

of magnetically-lifted brakes there appears to be still room for improvement in the direction of arranging the link-work so that the solenoid has a considerably greater mechanical advantage at the beginning of its travel than at the end, thus com-

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, March 20.

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pensating for the unfortunately inherent property of the solenoid that its pull is weakest where it is desirable that the greatest force should be available.

The toggle has been a favourite motion with most of the makers, and yet in this respect it is about as bad as anything can be.

The supplementing or replacement of the mechanical brake by a retarding device depending on electromagnetic action, due to the motor being used as a dynamo, is a development which is growing in favour, and undoubtedly further changes in the same direction may be expected in the near future. The facts that such a device can be made much more even in its action, and is capable of much finer adjustment than any brake depending on an erratic coefficient of solid friction, are strong points in its favour. Where only mechanical braking has been used, the writer has seen the end of the motor shaft twisted off by the action of the momentum of the armature combined with an excessively severe application of the brake. This latter circumstance is always liable to occur owing to the anxiety of the maker of the hoisting gear to reduce the error in stopping at floors to a minimum. The ideal brake evidently should be such that the armature will be caused to dissipate the whole of its own kinetic energy in the same time that the mechanical brake is performing a similar office for the mechanical parts of the system, thus relieving the motor shaft from all twisting stresses no matter how quickly the stopping may be done. The limit of negative acceleration imposed by the safety and comfort of the passenger could then be easily reached without undue stresses upon the winding machinery. Where push-button systems are in use the range of error in the stopping point becomes rather an important matter. Fig. 9c is of interest as showing one maker's method of causing the cage to adjust itself to the floor by automatic reversal of the motor if over travel takes place beyond a predetermined limit. Some makers provide two additional buttons in the cage to enable the user to adjust its position with regard to the floor. What really is required in such a case is a method of varying the braking effect according to the load in the cage. This problem is complicated by the fact that it is usual to overbalance the lift to the extent of approximately half the load. Thus the same amount of work is required from the motor when lifting the cage with full load and when lowering it empty, so that the change of tension in the hoisting ropes is not available as a means of varying the amount of the braking forces. A method which to some extent meets this difficulty has been developed by the Otis Elevator Company, but the writer is unfortunately unable to give details of the apparatus.

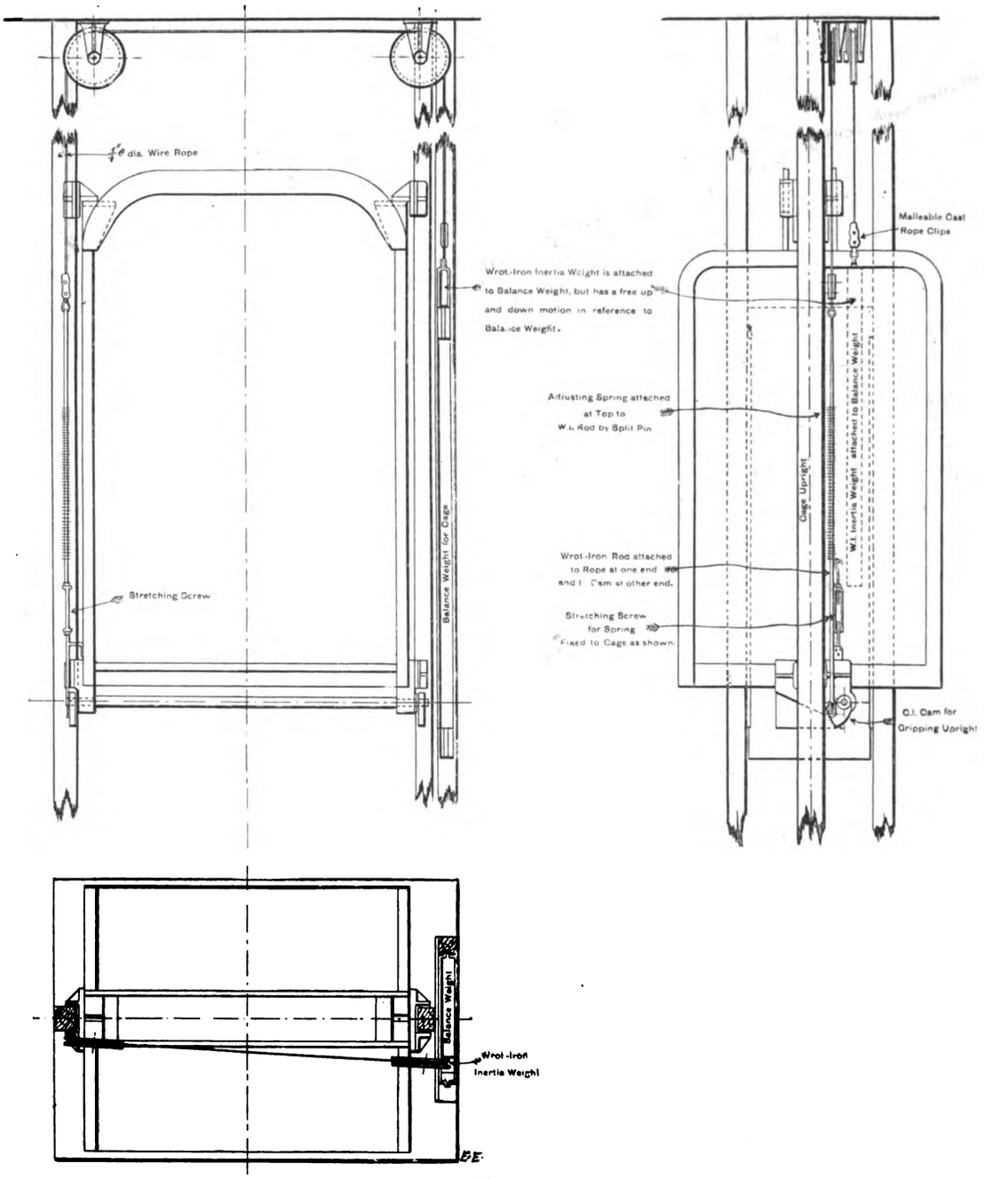


FIG. 14

*Safety Devices.*—These naturally fall more especially on the mechanical side of the work, but in the matter of preventing the cage from exceeding its proper limits of travel at either end of its range of motion, co-operation between the two designers is again necessary. Here, again, considerable difference of opinion and practice prevails. Fig. 13E represents one form of limit switch specially designed for its work, but too often the limits are controlled by ordinary hand switches with a makeshift lever attachment.

There are two guiding principles which, in the writer's opinion, should be kept well to the front in deciding these matters. They are: (1) that the mechanism between the safety device and that which it is intended to protect should be as small in amount and as simple as possible; (2) that, as far as can be foreseen, a defective piece of apparatus should cause the safety gear to act. The latter is simply a paraphase of the principle

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adopted in railway signalling, where a defective signal is taken to be a signal at danger.

The prevalent practice of working limit switches by means of sprocket chains, and that of putting an excess-speed preventer on the motor or gear, both seem to be contravention of rule No. 1. Fig. 14, although not in any way an electrical matter, is inserted as an illustration of a neat way of making a safety device depend directly on the thing to be guarded. The pull of the small weight on the auxiliary wire cord is balanced by the tension of the spring attached to the cage. Any abnormal increase in the downward speed of the cage involves an increased pull to accelerate the hanging weight, and the consequent extension of the spring applies the safety clutches beneath the cage. Door contacts and electrical-controlled locks are devices where the second principle requires to be especially kept in view.

It will be noticed that in all directions the necessity for improved co-relation of the various parts has resulted in an increase in the use of electrical apparatus for duties formerly fulfilled mechanically.

The illustrations have been lettered according to the names of the makers supplying them—as follows: Number only, Messrs. Pickerings, Limited; (A) the Otis Elevator Company, Limited; (B) Messrs. R. Waygood and Co., Limited; (C) Messrs. J. Richmond and Co.; (D) Messrs. A. Smith and Stevens; (E) the Electrical Company, Limited; (G) Messrs. Geipel and Lange. Information was also supplied by Messrs. Laurence, Scott, and Co. and the Auto-Controller and Switch Company.

In conclusion, the writer wishes to express his great indebtedness to the above-named firms for their kindness in answering many questions, and for the loan of illustrating blocks and photographs; and to Mr. Sant, of Messrs. Pickerings, Limited, for kindly criticisms and suggestions in the initial stages of the paper.

## HANLEY ELECTRICITY ACCOUNTS.

The accounts of the Hanley Corporation electricity department for the year ended Dec. 31, 1904, show a total expenditure on capital account to that date of £87,790. Abstracts of the revenue account and general balance-sheet are appended, together with the statement of electricity generated, sold, etc.

REVENUE ACCOUNT.

| Dr. Expenditure. | £. | s. | d. |
|---|---|---|---|
| Generation of electricity | 4,894 | 15 | 6 |
| Distribution of electricity | 790 | 7 | 9 |
| Attending and repairs to public lamps | 386 | 16 | 0 |
| Rents, rates, and taxes | 1,087 | 6 | 0 |
| Management expenses, salaries, etc. | 1,187 | 6 | 7 |
| Special charges, insurance, etc. | 38 | 6 | 9 |
| Total expenditure | 8,384 | 18 | 7 |
| Amount carried to net revenue account | 6,892 | 15 | 1 |
| | £15,277 | 13 | 8 |

| Cr. Receipts. | £ | s. | d. |
|---|---|---|---|
| By sale of current per meter | 12,161 | 10 | 8 |
| Public lighting | 2,405 | 13 | 10 |
| Rental of meters, etc. | 333 | 12 | 5 |
| Sale and repairs of other apparatus | 368 | 4 | 1 |
| Received from accident insurance company | 8 | 12 | 8 |
| | £15,277 | 13 | 8 |

GENERAL BALANCE-SHEET.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 75,009 | 0 | 0 |
| Overdraft on account of loans sanctioned | 12,781 | 8 | 10 |
| Sundry creditors | 554 | 12 | 4 |
| Sinking fund account | 17,750 | 15 | 3 |
| Balance | 6,983 | 0 | 11 |
| | £113,078 | 17 | 4 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended on works | 87,790 | 8 | 10 |
| Stores on hand | 375 | 1 | 9 |
| Sinking fund account | 17,750 | 15 | 3 |
| Sundry debtors for current supplied | 5,571 | 19 | 4 |
| Other debtors | 168 | 3 | 9 |
| Reserve fund—balance at bank | 124 | 0 | 2 |
| Loans repaid | 1,084 | 6 | 1 |
| Amount carried to net revenue account | 204 | 2 | 2 |
| | £113,078 | 17 | 4 |

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

| | | |
|---|---|---|
| Quantity generated in B.T.U. | | 997,933 |
| Quantity sold { Public lamps | 182,470 | 844,272 |
| Quantity sold { Private consumers by meter | 661,802 | |
| Quantity sold on works | | 23,500 |
| Total quantity accounted for | | 867,772 |
| Quantity not accounted for | | 130,161 |
| Total maximum supply demanded (kilowatts) | | 795 |

Number of public lamps, 358.

## SUPPLY OF ELECTRICITY BILL.

The text of the Government Bill (presented by Mr. Bonar Law and supported by the Solicitor-General) to amend the Acts relating to electric lighting has just been published. The measure consists of 15 clauses and a schedule, and is intended more especially to regulate such matters as the compulsory acquisition of land for generating stations, the breaking up of streets outside the area of supply, supply in bulk, revision of maximum prices, and the certification of meters. There are also provisions as to the rights of local authorities to purchase, and as to the exercise of electric lighting powers by authorities jointly. As this measure affects all electrical undertakers, we reproduce herewith the most important clauses in full.

*Clause* 1.—*Compulsory Acquisition of Land for Generating Stations*—(1) The Board of Trade may by provisional order authorise any local authority, company, or person who are authorised by the same or any previous provisional order or by Act of Parliament to supply electricity in any area, to acquire compulsorily, or to use for the purpose of a generating station, any land specified in the order, whether situated within or without the area of supply, and in the case of a local authority, whether situated within or without their district.

(2) For the purpose of the acquisition of land authorised to be taken compulsorily under any such provisional order, the provisions of the Lands Clauses Acts which relate to the purchase and taking of lands otherwise than by agreement, and to the entry upon lands by the promoters of the undertaking, are, subject to the modifications set out in the schedule to this Act, incorporated with the Electric Lighting Acts, as well as the provisions of those Acts already so incorporated by the Electric Lighting Act, 1882.

(3) Rules made by the Board of Trade under Section 5 of the Electric Lighting Act, 1882, shall provide for proper notice being given of an application for a provisional order by which it is proposed to acquire compulsorily, or use land for the purpose of a generating station to owners, lessees, and occupiers of land, and also for public notice being given of the proposal by advertisement.

(4) The incorporation of the provisions contained in the schedule to the Electric Lighting (Clauses) Act, 1899, with a provisional order authorising the compulsory acquisition or use of land specified in the order for the purpose of a generating station shall not have the effect of incorporating Section 81 of that schedule with so much of that order as authorises such acquisition or use.

*Clause* 2.—*Breaking-up Streets, etc., Outside Area of Supply*—For the purpose of enabling electricity to be brought into the area of supply from a generating station situated outside that area, the Board of Trade may by provisional order apply to any roads, railways, or tramways situated outside that area the provisions of the Electric Lighting Acts which authorise, or enable the Board of Trade to authorise, the breaking up of any road, railway, or tramway so far as those provisions do not already so apply.

*Clause* 3.—*Supply in Bulk*—The Board of Trade, unless they are of opinion that, by reason of the character or magnitude of the proposed undertaking, the matter ought to be dealt with by private Bill may by provisional order: (*a*) authorise any company or person to supply electricity in bulk to any local authority, company, or person authorised to supply electricity in any area for the purpose of distribution by that local authority, company, or person within that area; and (*b*) provide for any supply so authorised being compulsory; and (*c*) define what are to be the limits of supply for the purpose of the provisions of the Gasworks Clauses Act, 1847, incorporated in the Electric Lighting Act, 1882, in the case of a company or person so supplying electricity in bulk; and (*d*) make such other provisions as appear to them necessary for adapting the Electric Lighting Acts to any case where a company or person are authorised to supply electricity in bulk in any area; and (*e*) authorise any local authority to supply electricity in bulk to any other local authority.

*Clause* 4.—*Provisions as to right of Local Authority to Purchase*—(1) The Board of Trade may by a provisional order authorising a company or person to supply electricity in bulk only exclude the application of the power of purchase given by Section 2 of the Electric Lighting Act, 1888, as respects the whole or any part of the undertaking authorised by the order, but before doing so shall cause notice to be given to any local authorities who would have the right to purchase under the said section, and shall consider any objection made by any of those authorities.

(2) Where any generating station, mains, or other works of a company used solely for supplying electricity within the district of a local authority are situated outside the district of that local authority, the generating station, mains, and other

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works so used shall for the purposes of the provisions of the Electric Lighting Acts, and any provisional order conferring on local authorities power to purchase undertakings, be deemed to be situated within the district of that local authority, and where any generating station, mains, and other works are used solely for supplying electricity within the districts of two or more local authorities, but are not situated within any of those districts, the Board of Trade may on the application of all or any of those authorities by provisional order make such adaptations in the provision as the circumstances of the case may require. Provided that this sub-section shall not, without the consent of the company to which they belong, apply to any generating station, mains, or other works authorised by a special Act before the passing of this Act.

(3) Any local authority having power under the Electric Lghting Acts or any provisional order to purchase so much of the undertaking of a company as is within the district of that local authority may, with the consent of and upon such terms and conditions as may be approved by the Board of Trade, and with the consent of the company, transfer their rights of purchase to any other local authority having power to purchase so much of the same undertaking as is within the district of that last-mentioned local authority, and the deed of transfer may contain such consequential provisions as may be necessary for giving effect to the transfer.

*Clause* 5.—Deals with the exercise of electric lighting powers by authorities jointly, for which the consent of the Local Government Board has to be obtained.

*Clause* 6.—*Provision as to Consents of Local Authorities to Grant of Provisional Order*—(1) The Board of Trade shall, on considering whether any provisional order should or should not be granted, take into consideration the views of the local authorities affected on the subject, but whether the consent of any local authority is or is not given, may, notwithstanding anything in Section 1 of the Electric Lighting Act, 1888, grant the order or not at their discretion. Provided that (*a*) this sub-section shall not apply to any provisional order authorising a company or person to supply electricity so far as the order relates to any district in which the local authority is authorised to supply electricity; and (*b*) a provisional order authorising the breaking up of roads outside the area of supply, shall not be granted by the Board of Trade except with the consent of the local authority in whose district the road is situate, unless the Board of Trade, in any case in which the consent of any such local authority is refused, are of opinion that, having regard to all the circumstances of the case, such consent ought to be dispensed with, and in that case they shall make a special report stating the grounds upon which they have dispensed with such consent.

(2) The notice required by Section 4 of the Electric Lighting Act, 1882, to be given to a local authority on or before *the first day of July*, need not be given to the local authority of a district in which it is not intended to take power to distribute electricity.

*Clause* 7.—Makes five years the ordinary period for the revision of the maximum price on the demand of a reasonable number of consumers.

*Clause* 8.—Makes alteration in the 1899 Act respecting the certification of meters, and provides that "a meter shall be certified to be a correct meter within the meaning of any Act or provisional order relating to the supply of electricity passed or confirmed before the commencement of this Act, if it is capable of ascertaining the value of the supply within such limits of error as may, as respects meters of the class to which the meter belongs, be allowed by the Board of Trade."

*Clause* 9.—Deals with the dates for the making up of accounts of municipal undertakers. The dates selected are either March 31 or June 30, but these may be varied to meet special objections.

*Clause* 10.—*Supply of Electricity to Premises having Separate Supply*—Notwithstanding anything in the Electric Lighting Acts or in any Act of Parliament or provisional order authorising an undertaking, a person shall not be entitled to demand or to continue to receive from undertakers authorised to supply electricity in any area a supply of electricity for any premises having a separate supply, unless he has agreed with the undertakers to pay to them such minimum annual sum as will give them a reasonable return on the capital expenditure, and will cover other standing charges incurred by them in order to meet the possible maximum demand for those premises; the sum to be so paid shall be determined in default of agreement by arbitration under the Electric Lighting Act, 1882.

*Clause* 11.—Provides that undertakers may give or take a supply in bulk to or from any company or person.

*Clause* 12.—Protects gas undertakers from compulsory purchase of their land.

*Clause* 13.—Defines the terms used in the Bill.

*Clause* 14.—Makes the Bill applicable to Scotland and Ireland.

*Clause* 15.—Reads: (1) this Act may be cited as the Electric Lighting Act, 1905; (2) this Act and the Electric Lighting Acts shall be construed together as one Act, and may be cited as the Electric Lighting Acts, 1882 to 1905.

# LEGAL INTELLIGENCE.

## LYLES v. MAYOR AND CORPORATION OF SOUTHEND.

While the plaintiff was travelling on the outside of a car on Aug. 9, 1902, the connecting rod passing along the overhead wire broke and fell upon him, causing him severe injuries, and on March 31, 1903, he brought an action, claiming damages for injury "owing to the defective condition of the defendants' rolling stock." The defendants pleaded that if the injury complained of by the plaintiff had been caused through the act, neglect, or default of any of the defendants or their agents or servants, the same was done in pursuance or execution or intended execution of the provisions contained in the provisional order known as the Southend-on-Sea and District Light Railway Order, 1899 and of the defendants' public duty and authority, by virtue of which the defendants were working the tramways, and that the claim in the action was barred by reason of Section 1 of the Public Authorities Protection Act, 1893. That Act is entitled "An Act to generalise and amend certain statutory provisions for the protection of persons acting in the execution of statutory and other public duties." Section 1 is as follows: "Where after the commencement of this Act any action, prosecution, or other proceeding is commenced in the United Kingdom against any person for any act done in pursuance or execution or intended execution of any Act of Parliament, or of any public duty or authority or in respect of any alleged neglect or default in the execution of any such Act, duty, or authority the following provisions shall have effect, *inter alia*: (*a*) the action, prosecution, or proceeding shall not lie or be instituted unless it is commenced within six months next after the act, neglect, or default complained of, or, in case of a continuance of injury or damage, within six months next after the ceasing thereof." The question as to whether the defendants were exempted by that section from liability came on for trial as a point of law before Mr. Justice Bigham, who decided it in favour of the defendants. From that decision the plaintiff appealed.

After their Lordships had reviewed the case at great length, the appeal was dismissed.

## DAMAGES FOR COLLISION.

At Carlisle County Court last week John William Briggs sued the Carlisle Electric Tramways Company for £15. 15s., damages to his horse and trap caused by a collision with one of the company's cars. The approach of a tramcar made his horse restive, and the driver held up his hand and shouted to the motorman of the car to stop. The car still came on and the collision occurred. The motorman, in his evidence, said he could not see a hand at night at a distance of 20 yards, but he pulled up immediately he heard the shout. The Judge awarded the plaintiff £13. 13s., saying that the motorman did not stop as soon as he might have done.

## LIABILITY OF TELEPHONE SUBSCRIBERS.

At West Bromwich County Court the National Telephone Company sued Mr. H. J. Meredith, ironmonger, of High-street, Smethwick, to recover £5, the value of an instrument destroyed by fire.

**Mr. S. Vernon**, who appeared for the plaintiffs, explained that defendant, as a subscriber to the company, was supplied with an instrument under a contract. One of the conditions of the contract which defendant had signed was that the subscriber should be responsible for any damage to the company's apparatus whilst on his premises, and that in the event of it being destroyed by fire, or otherwise, the subscriber would pay £5 for each set of instruments as compensation

Judgment for the full amount claimed and costs.

## OBSTRUCTION.

Henry Sunderland was summoned at the Bradford City Court for wilfully obstructing a Corporation car.

**Mr. C. H. Bird**, assistant solicitor in the town clerk's department, said the seriousness of the offence would be realised when it was recalled that an accident recently occurred at that point. It was a very dangerous thing for the cars to have to stop there. The driver of the car rang his bell, and requested the defendant to move out of the way, but the cart was kept on the lines for five minutes.

The driver of the car said the man could easily have got out of the road either by crossing or turning up a side street.

The defence was that the driver of the cart was within his rights in retaining his position, and the case was dismissed.

# COMPANIES' MEETINGS AND REPORTS

## BROMLEY ELECTRIC LIGHT AND POWER.

The annual meeting of this Company (whose report we published in our issue of 31st ult.) was held at the Royal Bell Hotel, Bromley, last week, Mr. J. C. Wigham presiding.

The **Chairman** remarked that there had been a fairly uniform increase in the number of lamps. The directors held most strongly that an electric light company should put by the most substantial amounts it could afford for renewals in the time to come. They had, therefore, recommended that £300 more than that put by last year should be placed to the renewal reserve fund account, and they intended to keep on increasing this amount in the future.

A little discussion followed, and then the report was unanimously adopted.

Mr. E. Charrington and Mr. J. C. Wigham were re-elected directors.

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## CALCUTTA TRAMWAYS.

The annual meeting of this Company was held on Tuesday under the presidency of Mr. E. C. Morgan, chairman of the Company.

In moving the adoption of the report and statement of accounts (of which we gave particulars last week), the **Chairman** said that the extensions to the power-house, station, plant, and buildings had been mainly in connection with the further power that would be required for the extensions in contemplation. Owing to the rapid extension of traffic, large additions had been made in the number of motor and trailer cars. That was an item on which further expenditure would shortly be needed. The proportion of expenses to income had been almost the same as in 1903—about 50 per cent.—which he thought the shareholders would agree was not unsatisfactory. The number of additional miles run, compared with the previous year, was comparatively small, being only about 8,000, but the running had been more scientifically adjusted. Consequently the earnings had increased by about ¾d. per mile. On the other hand, the running of thick services at the busy hours had naturally required the employment of more motormen, conductors, and other members of the staff, so that the expenses were also higher by ½d. per mile; but there had been an actual gain of ¼d. a car mile. Since the beginning of this year an agreement had been signed with the Howrah Municipality for the construction of a system of lines in that important district. It would probably be some little time before the necessary preliminaries were completed, but no time would be lost when the formalities had been complied with. They were also just completing an agreement with the municipality of Barnagore to construct a line into that northern suburb. Negotiations were well advanced for the extension of the lines to the south through Alipore to Behala.

The report was adopted.

## POTTERIES ELECTRIC TRACTION.

The annual meeting of this Company was held on Tuesday, Mr. G. F. M. Cornwallis-West presiding. Particulars of the report appeared in our last week's issue.

The **Chairman** remarked that, in spite of the dulness of trade, the results showed an advance on any previous year since the initiation of the Company. The increased items of expenditure were unavoidable, due to increased rates and insurance as well as to the running of an increased car mileage for the year—2,279,588 as compared with 2,081,964—an increase of 179,624 car miles. There had, however, been a distinct economy in working. The total expenses per car mile were 5·59d. as against 5·64d., and the expenses to receipts were reduced from 59 per cent. to 58 per cent. The receipts from parcels had increased. This traffic is engaging the attention of other tramway undertakers, and it is not improbable that a combination will be formed whereby the different owners will be able to act as each other's agents in the districts they respectively serve.

In all probability during the year some further capital will be required in connection with the construction of some of the light railways authorised by the Potteries Light Railways Extensions Order of 1902. An extension of time for this purpose has been granted by the Board of Trade, and after the successful completion of negotiations with the local authorities concerned, the Company has agreed to construct during this year short lengths of line at Handford, Sneyd Green, and Adderley Green, which they have every reason to believe will be remunerative.

The report was adopted.

## BABCOCK AND WILCOX.

The ordinary general meeting of this Company (whose report we published last week) was held on Tuesday at the Cannon-street Hotel, Mr. John Dewrance presiding.

The **Chairman**, reviewing the position, said that he regarded the profit for the year as abnormal, and hoped the shareholders would not put the onus on the directors if they failed to present such a favourable report again. Their business was an industrial concern, and while they had had an exceptionally good period of trade, they must be prepared to meet the effect of very heavy competition from other industrial concerns of a similar nature. Internal-combustion engines and various types of boilers were constantly being brought out. He considered the great results attained were largely due to the exertions of the management and staff. As some of the reserve fund, to which the directors proposed to add £175,000, formed part of their working capital, they had under consideration a proposal to transfer a considerable amount to the capital account. A scheme would be submitted to the shareholders at an extraordinary general meeting, to be called later, when he hoped they would accept the proposal.

**Sir William Arrol, M P.**, seconded the motion, which was carried unanimously.

## ANGLO-ARGENTINE TRAMWAYS.

The annual meeting of this Company (whose report we published last week) was held at Winchester House on Tuesday, Mr. J. B. Concanon presiding.

The **Chairman**, in moving the adoption of the report, said the Company had started the present year with £60,000 invested in first-class Stock Exchange securities, and it was the Board's intention to go on adding to both the reserve and the renewal funds. They had also inaugurated what was rather an innovation—a share redemption fund. Although the concession was for a long period, it had been deemed prudent to provide a sum sufficient to redeem the preference and the ordinary shares at the end of the concession. The item of £15,000 for paving might have been fairly charged to capital account, but the Board's policy had been, so far as possible, to restrict the capital outlay, and to provide for the cost of work of this class out of revenue. It was estimated that for this year and 1906 the amount which would be expended on paving would reach about £10,000 per annum. The Company took over the City of Buenos Ayres Tramways Company's system on Jan. 1 last, and the work of the electrification of the lines was begun almost at once, and was proceeding satisfactorily. A contract had been entered into whereby they would pay £650,000 in ordinary shares when the electrification of the city system was completed, and arrangements had been made for £400,000 of these shares to be offered to the ordinary shareholders of this Company at par, the contractors retaining the balance to dispose of as they thought fit. He also mentioned that the Board contemplated making an issue of a further £100,000 of share capital for the purposes of this Company.

The report was adopted.

## WINDSOR ELECTRICAL INSTALLATION.

The annual meeting of this Company was held at the registered offices last week, Mr. H. L. Prior, chairman, presiding.

The **Chairman** outlined the progress for the year, which is shown by the following figures: The number of lamps and motors installed on Dec. 31, 1903, was equivalent to 27,886 of 8 c.p. During the year 3,139 were added, bringing the total to 31,025 at the end of the year 1904, of which 2,362 represent the motor power. The revenue for the year from the lighting department was £11.484. 10s. 1d., and the total net profit, after providing £1,101. 12s. 8d. for interest on loans, was £4,485. 12s. 3d. The directors recommended that the sum of £1,000 be taken from the net profit and added to the depreciation, renewal and reserve fund, bringing that fund up to a total of £9,070. The balance available for distribution amongst the shareholders was £3,135. 12s. 3d., and the directors recommended that £200 be transferred from the dividend equalisation account to the net revenue, and that a dividend at the rate of 4½ per cent., less income tax, be declared, making a total dividend for the year of 7 per cent. The directors thought it desirable to apply for a provisional order for the area of Old Windsor and Clewer, but should there be any serious opposition, the question of going on with it may have to be considered. The Company's investment in the Slough and Datchet Company is £14,000, and the first dividend of 3 per cent. on this investment has been included in the net profit.

The report was unanimously adopted, as was a resolution authorising an increase of capital by the creation of £50,000 cumulative preference shares bearing 5 per cent. interest. It was only intended to raise £20,000 for the present.

## KIDDERMINSTER ELECTRIC LIGHTING AND TRACTION.

Mr. W. L. Madgen presided last week at the seventh ordinary general meeting of this Company, held in London.

In moving the adoption of the report and accounts, the **Chairman** explained that the Company had obtained an order authorising the construction of a light railway from Kidderminster to Bewdley similar to the line which ran between Kidderminster and Stourport. Unfortunately that line had to go through what was known as the Bull Ring at Kidderminster, and under the conditions prevailing the Company could not convey passengers through that section of the line. That meant a transference of the passengers from one car to another. The objection to that was fully realised by the Company, and every effort was made to induce the local council to give permission to take cars over that portion of the track with passengers, both in the interests of the public as well as in the interests of the Company. The Council, however, refused, and the Company had now given them notice that they did not intend to ask for an extension of the Board of Trade order. The costs incurred in the promotion of the scheme would be dealt with carefully. Recently the Company had made a satisfactory arrangement with the British Electric Traction Company by which the latter had taken over 27,500 of 4½ per cent. debenture stock at par. That had enabled them to settle certain liabilities, and had left them in easy financial circumstances. The Great Western Railway had commenced to run motorcars between Kidderminster and Stourport, but they did not apprehend that their traffic would be affected by such competition, if competition it could be called.

The report and accounts were adopted.

## INDO-EUROPEAN TELEGRAPH.

The report for the year ended Dec. 31 states that the agreements between the Postmaster-General, the Imperial German Post Office, and the Company for the leasing of land wires in this country and submarine cables between Lowestoft and the German coast, referred to in the last report of the directors, have been finally concluded. The retirement trust fund, constituted with the consent of the shareholders, has been duly established, and the amounts voted by the shareholders have been handed over to the trustees. The Company's revenue for the year from all sources amounts to £141,401, as compared with £139,094 for 1903, showing an increase of £2,306. The expenses are on commercial and general account, £47,876; and on maintenance account, £24,054—total, £71,930, as against £68,894 for 1903, an increase of £3,036. The revenue account shows a balance of £69,471, which is carried to profit and loss account, 1904. Bringing forward the balance of £16,356 from 1903, and deducting income tax paid and the interim dividend of £10,625, there remains an available balance of £71,267. The directors now propose to declare a dividend for the six months ended Dec. 31, 1904, of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent. for the year, and a bonus of 20s. per share, both tax free. They also propose to add £15,000 to the equalisation of dividends fund, and to hand over a further sum of £5,000 to the trustees of the retirement trust fund, carrying forward £19,392.

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## FOLKESTONE ELECTRICITY SUPPLY.

The half-yearly meeting of this Company was held last week, Alderman Spurgen, the chairman, presiding.

The directors recommended a dividend at the rate of 7 per cent. for the half-year, making 5½ per cent. for the year. There was an increase of 10,110 lamps during the year, and that was the second best increase of any year of the Company's working. They now had 1,351 consumers, of whom 435 were taking the current by means of slot meters. A profit had been made out of the Hythe undertaking.

The report was adopted.

## BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS.

At the annual meeting of this Company in London on the 6th inst. the **Chairman** said that the receipts last year showed an increase of £6,558 over the previous year. There had again been difficulty owing to the unreasonable demand of the employés, but this had been disposed of. The capital account showed an increase of £17,441, mostly due to the purchase of 15 new cars and to work done on the Nunez extension. They had provisionally applied for further extensions, representing about 4½ miles.

The report was adopted, and a dividend making a total of 4 per cent. for the 12 months was declared on the ordinary shares.

## URBAN ELECTRIC SUPPLY.

The annual meeting of the Urban Electric Supply Company, Limited, was held on the 6th inst. at the Westminster Palace Hotel.

**Mr. J. C. Wigham** presided, who said that the profits had increased from £13,822 to £21,020. The number of lamps connected had increased from 140,000 to 215,000, and a further 25,000 had been connected, or were awaiting connection, since the beginning of the current year. This year's revenue should show a proportionate improvement. The net profit was £19,437. Debenture and loan interest absorbed £5,101, and a loss of £134 occurred in realising a parcel of Consols. The amount required to pay the 5 per cent. guaranteed dividend on the preference and ordinary shares was £19,914, and the balance of £5,712 had been paid by Messrs. Edmundson under their contract. The capital expenditure had increased from £586,000 last year to £822,000. This had been incurred in the completion of their various stations. The capital expenditure in future, now that the works were fairly started, would be on a very much smaller scale. In regard to the legal difficulty as to the Company's right to supply to two districts of Weybridge and Walton from their Weybridge works, the Company's Bill in Parliament passed the third reading in the House of Commons on Wednesday night, and he did not think that the opposition would be carried on before the House of Lords.

The report was adopted.

## KALGOORLIE ELECTRIC TRAMWAYS.

The report for the six months ended Dec. 31 states that the profits (subject only to London expenses) are at the rate of £18,388 per annum, and this notwithstanding the facts that neither the Boulder line nor the racecourse extensions, nor the duplication of the Federal road (the main connection between Kalgoorlie and Boulder), were completed until a few weeks ago. It has been somewhat difficult to apportion the receipts and expenditure as between capital and revenue, and the course has been adopted of crediting all receipts and debiting all expenses to capital prior to June 30. In addition to the sum of £9,755, transferred from operating account to credit of capital account, the sum of £4,359, being the balance at credit of profit and loss account at Dec. 31, has been transferred to credit of capital account.

## CUBA SUBMARINE TELEGRAPH.

The report for the half-year ended Dec. 31 last, to be presented at the meeting on the 19th inst., states that the total receipts of the six months have been £13,815, while expenses amounted to £8,368, leaving a balance of £5,446, to which has to be added £4,647 brought forward from last account, giving a total of £10,093 to be dealt with. The directors recommend a dividend at the rate of 5 per cent. per annum on the ordinary shares, carrying forward £3 093. The new cable contracted for with Hooper's Telegraph and Indiarubber Works was duly laid between Cienfuegos and Santiago de Cuba, and was taken over on Feb. 18 in perfect condition. The Cape Cruz Santiago cable has since been repaired, and is now in good working order. The Cuban Government having refused payment of the subsidy for the coast cables, the Company's agent in Havana has been instructed to appeal to the courts against the President's decision. The claim against the United States Government for payment of the cost of repairing the damage done to the cables during the Spanish-American war is still unsettled.

## BARCELONA TRAMWAYS.

The report for the year 1904 states that the traffic receipts show an increase over 1903 of £15,400, and the working expenses an increase of £1,333. The balance at credit of revenue account for 1904, after adding £3,940 received from the Enschenche Company, and the £1,501 from the previous account, is £46,232. Of this sum the interest and sinking funds of the debentures and of the debenture stock have absorbed £16,600; interest on loans, £723; and the dividend on preferred shares, £5,000. The directors have placed a further sum of £10,000 to renewal fund, raising it to £17,000, and they recommend a dividend on the ordinary shares at the rate of 6 per cent. per annum (12s. per share), free of tax, and that the sum of £2,527 be carried forward to next account.

## BRITISH ALUMINIUM.

The annual report of this Company states that the profit for the year 1904 is £55,411. 3s. 11d. From this has to be deducted the debit balance of £3,837. 17s. 10d. brought forward from 1903, and debenture stock interest £15,000, leaving £36,573. 6s. 1d. Out of this £3,949. 10s. 9d. has to be set aside for the redemption, with interest, of the deferred commission warrants issued in 1901, leaving an available balance of £32,623. 15s. 4d. One-fourth of this amount will be applied in accordance with the debenture stock supplemental trust deed in redeeming and cancelling £8,000 of the debenture stock, and out of the balance the Board proposes to apply £10,169 in payment of arrears of dividend on the A preference shares, £11,983 in payment of a dividend of 6 per cent. on the A preference shares for the two years 1903-1904, £1,500 in payment of a dividend at the rate of 7 per cent. on the 7 per cent. preference shares, and £700 in payment of a dividend of 7 per cent. for the year 1904 upon the ordinary shares, leaving a balance of £114. 16s. 5d. to be carried forward. The Company's interest in the Loch Leven power scheme has been transferred to the Loch Leven Water and Electric Power Company, as that company must carry out the works under the terms of the Loch Leven Water Power Act. To provide for the cost 50,000 shares of £10 each, part of its capital, will be issued. These will all be subscribed by this Company, which will thus own the whole of the issued capital of the Loch Leven Water and Electric Power Company.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Govan.**—The Council require annual stores. Tenders by 25th inst.

**Portsmouth.**—The Council require annual stores for tramways. Tenders by May 1.

**Edinburgh.**—The Corporation invite tenders for water-tube boilers. Tenders by May 8. See advertisement.

**Dublin.**—The Port and Docks Board invite tenders for an electric generating station. Tenders by May 15.

**Wallasey.**—The Council require annual supply of stores for their electricity works. Tenders by 27th inst.

**Cartagena.**—The Public Works Department, Madrid, require tenders for electrification of the local tramways.

**Erith (Kent).**—The Urban District Council invite tenders for the wiring of their car depôt and workshops. Tenders by April 17.

**Kingston-upon-Hull.**—The Council invite tenders for air-space telephone cable. Tenders by 17th inst. See advertisement last issue.

**Swindon.**—The Corporation invite tenders for the supply of electric motors for a period of three years. Tenders by April 17. See advertisement.

**Stockport.**—The Gas and Electricity Committee invite tenders for the supply of one 500-kw. steam generator. Tenders by April 26. See advertisement.

**Bournemouth.**—The Town Council invite tenders for steel poles, overhead line, section boxes, etc., for the tramways. Tenders by 10 a.m. on April 20.

**Woolwich.**—The Guardians invite tenders for wiring the union infirmary and nurses' home for electricity, and supplying fittings. Tenders by 4 p.m. on 19th inst.

**Liria.**—The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

**French West Africa.**—The Governor-General of French West Africa, at Dakar, requires tenders for the erection and equipment of a central station at that place. Tenders by May 15.

**Devonport.**—The Electricity Department invite tenders for the supply of one surface condenser with electrically-driven pumps. Tenders by April 18. See advertisement in last issue.

**Fulham.**—The Council invite tenders for condenser piping, sump and river work, steel roof and bunker work, and coal-conveying apparatus. Tenders by 25th inst. See advertisement.

**Bilbao.**—The Public Works Department at Madrid require tenders for the concession of an electric tramway in Bilbao, from the Calle de Hurtado de Amézaga to Plaza Circular. Tenders by April 24.

**Laventhem (Belgium).**—The Municipality require tenders for erection of central station, laying of mains, etc. Particulars (3s. 4d.) may be obtained from the Secretary of the Mayor of that place.

**Glasgow.**—The Corporation invite tenders for the supply of (1) main cables, (2) electricity meters, and (3) carbons for a period of 12 months from 31st prox. Tenders by April 17. See advertisement in last issue.

**Antwerp.**—Tenders will shortly be invited by the Belgian State Railways for the installation of electric light in their local railway station. Specification No. 619 may be obtained from the Government Railways Office, Brussels.

**Bristol.**—The Docks Committee invite tenders for the construction, delivery, erecting in place, fitting, testing, and maintenance for 12 months after completion of two electric goods lifts and one electric passenger lift. Tenders by May 1.

**Wimbledon.**—The Urban District Council invite tenders for the supply and erection of a 1,000-kw. steam-driven turbo-alternator, with condensing plant, high-tension switchgear, and pipework. Tenders by April 28. See advertisement in last issue.

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**New Ferry (Cheshire).**—The Lower Bebington Urban District Council invite tenders for the work of electric installation for fire brigade alarm in New Ferry, and also for supply of street lanterns for incandescent lighting. Tenders by April 24.

**Glasgow.**—The Trustees of the Clyde Navigation invite tenders for electric power generating and lighting plant for Clydebank Dock. Specifications, etc., may be obtained from Mr. T. R. Mackenzie, 16, Robertson-street, Glasgow. Tenders by April 17.

**Batley.**—The Corporation invite tenders for tramway extensions—viz.: (Contract No. 14) permanent-way construction and paving; (15) overhead equipment, steel poles, etc.; (16) feeder cables, conduits, and accessories. Tenders to the Town Clerk by April 17.

**Cardiff.**—The Corporation invite tenders for the following plant for their power station on the extra high-tension system: extra high-tension three-phase main switchboard for power station; switchboards for sub-stations; motor-generators; rotary converters, etc. Tenders by April 17.

**Switzerland.**—M. R. Vontobel, of Winterthour, and M. Charles Probst, of Lucerne, have obtained a concession for the construction of a narrow-gauge electric railway from Meiringen to Gletsch. The total cost of the enterprise is estimated at £241,600; £19,600 is to be expended on rolling-stock.

**Wigan.**—The Corporation invite tenders for steam dynamo and accessories; steam and water piping, ejector condenser, and motor-driven centrifugal pump; paper and lead-covered cables; dry-core telephone cables; paper and lead-covered cables (twin service), and vulcanised rubber cables. Tenders by 17th inst. See advertisement last issue.

## RESULTS OF TENDERS.

**Battersea.**—The Council have ordered from Parsons and Co. a spare armature for No. 6 machine at £573.

**Leith.**—The Corporation have placed the contract for a traction switchboard with Ferranti Limited, Hollinwood, Lancashire.

**Bury.**—The Corporation have, we understand, accepted the tender of Wilson and Stockhall, Bury, at £82. 10s. each, for six tops to tramcars.

**Lowestoft.**—The Town Council have accepted the tender of Babcock and Wilcox, at £1,337, for providing the new boiler, with superheater, brickwork, settings, and accessories.

**Salford.**—The Corporation have awarded R. J. Nicholson and Co., of Manchester, the contract for the electric lighting of the Seedley Schools, together with the supply of the necessary fittings.

**Halifax.**—The Town Council have accepted the tender of E. Allen and Co., Sheffield, at £730, for the supply and erection of two 20in. belt conveyors for the proposed coal siding and coal stores at the electricity works.

**Ashton-under-Lyne.**—The Electricity Committee have accepted the tender of G. R. Mather and Son, Albion Foundry, Wellingborough, for the supply and delivery of a deep-well pump for their electricity works.

**Swindon.**—The Council have accepted the following tenders for the electricity works: Siemens Bros., at £46. 8s. 6d. each, rewinding armatures of motor-generator; Bennis Stoker Company, Bolton, £127. 10s., new boiler; W. and T. Avery, £70, 10-ton weighbridge, 12ft. by 8ft.

**Fulham.**—The following tenders have been received:

Condensing plant.

| | 28in. vacuum. | 26in. vacuum. |
|---|---|---|
| Schwarz and Co. | £2,145 0 0 | — |
| Balcke and Co. | 1,948 19 6 | — |
| Ashwell and Nesbit | 1,940 15 0 | £1 880 15 0 |
| Summers and Scott | 1,720 0 0 | 1,430 0 0 |
| Thornton and Co. | 1,709 0 0 | 1,625 0 0 |
| Wheeler Condenser Company | 1,681 0 0 | 1,395 0 0 |
| Storey and Sons | 1,655 15 0 | 1,330 12 0 |
| Cole, Marchent, and Morley | 1,579 10 0 | 1,214 10 0 |
| Belliss and Morcom | 1,472 0 0 | 1,392 0 0 |
| Carrick Wardale | 1,544 0 0 | — |
| Bertrams Limited | 1 505 0 0 | 1,251 10 0 |
| Scott and Co. | 1,481 0 0 | 1,256 0 0 |
| Musgrave and Co. | 1,481 0 0 | — |
| Mirlees-Watson Company | 1,475 0 0 | 1.145 0 0 |
| Masson and Scott | 1,470 0 0 | 1,205 0 0 |
| Bailey and Co. | — | 1,450 0 0 |
| Richardson, Westgarth, and Co. | 1,436 0 0 | 1,185 0 0 |
| Coombe, Barbour, and Co. | 1,405 0 0 | 1,355 0 0 |
| Mather and Platt | 1,388 0 0 | — |
| Worthington Pump Company | 1,383 0 0 | *1,119 10 0 |
| W. H. Allen, Son, and Co. | — | 1,192 0 0 |

* Accepted.

Economisers.

| | |
|---|---|
| Goodbrand and Co. | £2,751 10 0 |
| Clay Cross Company | 2,665 0 0 |
| Lowcock and Co. | 2,665 0 0 |
| H. Windsor and Co. | 2,650 0 0 |
| Green and Son (accepted) | 2,640 0 0 |
| Danks and Co. | 2,640 0 0 |
| Stirling Boiler Company | 2,158 0 0 |
| Carter and Sons | 2,105 0 0 |

Stokers.

| | |
|---|---|
| Erith Engineering Company | 1,669 0 0 |
| Rowlands and Co. | 1,221 0 0 |
| Danks and Co. | 1,190 0 0 |
| Underfeed Stoker Company | 1 083 0 0 |
| Ditto (alternative—accepted) | 875 0 0 |

The accepted tenders appeared in our last issue.

**Yarmouth.**—The Council have accepted the following tenders: Willans and Robinson, at £2 358, for engines, with Mather and Platt alternator; Babcock and Wilcox, £1.500, boiler; G. and J. Weir, £1,400, condensing plant; British Insulated and Helsby Cables, £911. 17s. 10d., extension cable.

**Bradford.**—The Electricity Committee have decided to recommend the acceptance of the tender of the British Westinghouse Company for the generators, and that of the General Electric Company for the switchgear in connection with the adoption of the three-phase system. The tenders total £10,000.

**Condensing Plant.**—The Worthington Pump Company, Limited, Queen Victoria-street, London, E.C., record the following condensing business secured during the last month: one complete condensing set, to deal with 20,000lb. of steam, for the Fulham Electric Light Station; three combined condensing sets, each to deal with 10,000lb. of steam per hour, for Messrs. Lever Bros., Port Sunlight; one condensing set, being a repeat order, for the Malta Dockyard; one condensing set for the Leeds Forge Company, and an experimental set for the Heriot-Watt College, Edinburgh; one complete condensing set for Milan Electric Light Station; one winch condenser, for marine service, for the North-Eastern Marine Company; one horizontal jet condensing set, for use with Ratean turbine, for the Hucknall Torkard Colliery; one barometric condensing set for South Wales; three oil separators, each to deal with 20,000lb. of steam, for the Belfast Tramways, this being a repeat order; one separator for Pekin Electric Light Station, and number of other separators for various jobs; two cooling towers for Bradford Mills; one large water-softening plant for a Durham Colliery.

# BUSINESS NOTES.

## TRACTION.

**Southend.**—During March 278,548 passengers were carried on the tramways, the fares amounting to £1,071.

**West Cumberland Tramways.**—This Bill, which seeks a further extension of time, has passed the House of Lords.

**Exeter.**—The tramways' takings for the third day amounted to over £39, and the number of passengers carried was 9,545.

**Scarborough.**—The company have ordered five new cars for the coming summer season. They will then have 22 running.

**Bury.**—The Corporation have decided to provide covered cars, and have just placed an order for six of these covers with Messrs. Wilson and Stockall, the well-known ambulance makers, of Bury.

**Rangoon.**—The construction of this electric tramway is reported to be proceeding apace, and it is probable that Messrs. Darwood and Co. will complete the undertaking in the course of the present year.

**Sweden.**—The *Journal de St. Pétersbourg* states that the Swedish State Railways Department are about to submit a project to the Riksdag for the purchase of the waterfalls near the principal lines.

**Tynemouth.**—The Tynemouth District Electric Traction Company were successful last week in their appeal to the Northumberland Quarter Sessions, securing a reduction of the assessment of their undertaking from £1,800 to £1,367.

**Bournemouth.**—At a meeting of the Town Council last week the borough surveyor submitted alternative proposals for the linking of the lines connecting the Bournemouth and Poole tramways. The plans were approved, and the surveyor instructed to proceed with the work.

**Metropolitan Electric Tramways.**—The revenue account for 1904 shows a surplus of £32,283. Allowing for preference interest and repayment to British Electric Traction Company of balance due to them for advance made in January, 1903, £3,854 is left, which amount is carried forward.

**Switzerland.**—The *Feuille Féderale Suisse* publishes a decree granting a company, headed by M. Francesco Balli, mayor of Locarno, a concession for the construction and working of an electric tramway from Locarno to Lake Maggiore and Minusio. The tramway will eventually be carried to Gordola.

**Kirkcaldy.**—At the monthly meeting of the Town Council on Monday a minute of the Tramway Committee was submitted making certain recommendations regarding the tramways, including one that no extension be made at present either in the Links district or to Dysart. Eventually the recommendation was approved.

**Heywood.**—As the result of a conversation between members of the Heywood and Bury Corporations it is reported that terms may now be agreed for the working of the former's trams by Bury. The Tramway Committee of the latter authority view the suggested arrangement with favour, and the decision of the Heywood Council is awaited.

**Hastings.**—Terms have been agreed between the Corporation and the company, under which the Upper Church-road line will be abandoned, and other outstanding points of a minor character have also been settled. The proposed feeder system for supplying the energy to operate the cars has been approved by the Corporation.

**Leeds.**—It is reported that terms will probably be arranged shortly between the Corporation and the Calverley Urban District Council for linking up the two towns. The Urban District Council obtained a tramway order 12 months ago. The extension to Rodney is being rapidly pushed forward, and a portion of it will be opened in a few days.

**York.**—The secretary of the company writes to the local Press stating that the company were quite prepared, and indeed anxious, to undertake the electrification of the system themselves, but that, as the parties failed to come to terms, the Corporation are placing obstacles in their way by refusing their consent to the work of reconstruction.

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**Dundee.**—The Town Council last week again considered the question of running Sunday cars, against which the citizens decided by a *plébiscite* two years ago. Mr. Brownlee moved that they be given three months' trial, and, on a division, 14 voted for and 14 against. Lord Provost Barrie gave his casting vote against Sunday cars, which were therefore vetoed.

**Edinburgh.**—At a meeting of the Linlithgow District Committee plans were submitted of the proposed Edinburgh and Queensferry tramways, as also a notice that application was intended to be made by the National Electric Construction Company for a provisional order for the construction of the tramways. The meeting unanimously agreed to lodge objections to the granting of the order.

**Spain.**—The *Gaceta* publishes a decree authorising the Société des Tramways de Grenade et de Murcie to substitute electric for animal traction on the tramway from Murcia to Alcantarilla and Espinardo. No higher tender having been received for a concession for an electric tramway between Azcoitia and Zumaya, in the province of Guipúzcoa, than that of Don Dionisio Sorseta Garcia, the concession has been granted to that gentleman.

**Rochdale.**—The reconstruction of the section between Sudden and the Heywood boundary has been completed. The other routes are being pressed forward with all expedition. It has been decided to defer the question of issuing contract tickets. Including the parcels traffic the receipts on the electrically-equipped sections during March amounted to £1,941. 4s. 7d., against £1,602. 19s. 11d. in February, and £1,718. 18s. 4d. in January.

**Swansea.**—At a meeting of the Tramways Committee, the suggestion of the company that the Corporation should supply them with power at ½d. per unit till the whole system was completed, and then institute the agreed scale, was not favoured by the committee, and it is probable that the point will be submitted to the Board of Trade for arbitration. It has been decided to make urgent representations to the Harbour Trust to complete the North Dock bridge in order that the extension may be opened at an early date.

**Chile.**—The *Chilian Times* reports the passage of a Bill through the Senate granting permission for the construction of an electric railway, which, starting from the port of Valparaiso, will pass through the Casablanca and Curacavi Valleys and communicate with Santiago by the west, having a branch line connecting the Curacavi Valley with the town of Nelipilla. The length from Valparaiso to Santiago will be about 89 miles. All the materials, implements, and machinery imported for the construction and exploitation of this line are to be free of customs duties.

**Municipalisation in the States.**—Chicago having decided upon the municipalisation of the tramways, requested the Glasgow Corporation to lend assistance by placing an expert at their disposal in the work of transferring the system from private to public ownership. Glasgow has given an affirmative reply, at which Judge Dunne, the newly-elected mayor, has expressed his gratification. He says that he believes scores of American cities will follow the example of Chicago. It is reported that Judge Dunne intends to make visits to several eastern cities, including New York, in order to begin agitations for the purchase of the local tramways by the various corporations.

**Llanelly.**—The purchase of the tramways has been completed. Mr. Howell, solicitor, and Mr. David Evans, representing the vendor company, attended at the offices of the London agents (Messrs. T. D. Jones and Co.), where they met the representatives of the new company, and an assignment having been executed, the amount of purchase money and all claims was paid in accordance with the arrangement. News of the completion of the purchase was received in Llanelly on Friday night with general satisfaction. It is expected that the present antiquated service will before long be replaced by an electric system, for which application is to be made to the Light Railway Commissioners, as the order granted by them has lapsed.

**Leicester.**—As a car was going underneath the Great Central Railway bridge into Dun's-lane on Monday, the trolley left the wire and got fast in the overhead work. The pull broke the wire at a point which was just outside the bridge and on a curve. The wire fell first on the car and then on the ground, but by the automatic device fitted to the Leicester system the electric current was cut off immediately it touched the ground. A few sparks were emitted by the wire when it touched the car, and also when it struck the ground, but there was no danger to anyone. The officials at the power station were at once telephoned to, and in a very short time the repair van was on the spot, and within half an hour the cars were running again.

**Central London Railway.**—A fire occurred at Notting Hill Gate Station at a quarter to six on Tuesday evening. It appears that the fire broke out in the sub-station, the wires in the distributing box fusing. A quantity of smoke rolled out into the station, tunnels, and lifts, creating some consternation among the passengers. The smoke found an outlet into the street through the air shafts. A constable promptly summoned the fire brigade, and in the meantime the station staff, thoroughly equipped in cases of fire, got a hydrant to work, and also employed sand to smother the outbreak. It was found necessary to cut off the current throughout the entire line, and for an hour and a half no trains were running. The distributing box being constructed entirely of stonework prevented the fire from spreading to other parts of the station.

**Stalybridge, etc., Board.**—The Stalybridge, Hyde, Mossley, and Dukinfield Joint Board has approved the following resolution of the Tramway Committee: "That a communication be forwarded to the Oldham, Ashton, and Hyde Electricity Company, Limited, asking for an appointment to meet representatives from the Board to consider whether it would be possible to arrange for running powers between Newton-street and the Market-place, Hyde; that a sub-committee, consisting of the chairman and deputy-chairman of this committee, the chairman of the Board, and Messrs. Oldham and Kenny, be appointed to meet the representatives of the company; and that as an alternative arrangement, a loop with movable points at each end be laid about the centre of George-street." Further cars have been ordered from the British Westinghouse Company.

**Ashton.**—The example of Manchester in instituting an elaborate goods service seems likely to be followed by their neighbours at Ashton. The Corporation has a scheme under consideration, drawn up by the tramways manager (Mr. A. Covaney), by which it is sought to develop and increase the earning capacity of the tramways of the borough, and possibly obtain inter-running with other authorities in time to come. For a long time it has been thought that a still greater use might be found for the tramways than simply carrying passengers, and ways and means have been devised for increasing their earning capacity by the carriage of coal, cotton, and merchandise. No definite arrangements have, however, been made, and investigations are being carried on by the Tramway Committee with a view to evolving a practical scheme. It is in the carriage of coal that the manager sees prospects of a profitable return on the outlay which would be necessary to carry out the scheme satisfactorily.

**Croydon.**—The Corporation's Bill for power to construct certain tramways, to run a service of motor omnibuses, and to supply electricity in bulk outside the district came before a committee of the House of Commons in the early part of the week. The committee, in giving their decision, said it was only in the case of thoroughly well-considered and thought-out schemes that such powers could be given, and as in this case they did not consider that the scheme had been well thought out, they must strike out the omnibus clause. The clause giving the Corporation power to supply electric light in bulk outside their area was agreed to. Interesting statistics have been compiled regarding the tramways, which since the electrification have been worked under lease from the Corporation by the British Electric Traction Company, Limited. During the last three years of the old horse cars 10,000,000 passengers were carried, but during the three years of the electrified system 40,000,000 have been carried. In the last 12 months the population of Croydon, about 145,000, has been carried almost 100 times over.

**South Shields.**—At the meeting of the Town Council, the consideration of tenders in connection with the electric tramways was proceeded with. After proposals to delete three routes had been rejected, Councillor Grant moved that the tender of Messrs. Hurst, Nelson, and Co., Limited, for 10 electric cars at £5,307 be accepted. Councillor J. W. Henderson seconded, and remarked that the portion of the trucks which was of American manufacture was only 8 per cent. of the total value. Councillor R. D. Barlow was strongly opposed to the Corporation adopting the Brill truck, and maintained that they could obtain equally as good a truck of British manufacture. The British manufacturers, he complained, had not had a chance of tendering for the cars, because it was specified that the trucks were to be of the Brill type, which meant that they were to be made in America. He thought the British manufacturers should be treated fairly, and in support of the British-made truck he quoted several instances to show that they were being adopted in connection with important systems throughout the country. He moved that the subject be referred back to committee, and this was carried.

**Aberdare.**—The Urban District Council's Bill for tramway and other purposes was proceeded with by a Select Committee of the House of Commons last week. Mr. Noble, addressing the committee on behalf of the Taff Vale Railway Company, submitted that the way in which the railway company was affected by the scheme entitled them to peculiar consideration. If the scheme did not prove a financial success, not only would the railway company be injured by losing their traffic, but would have to contribute to the loss on the scheme out of the increased rates. The evidence clearly showed that there could be no steady demand for tramway accommodation during the whole of the day, and he suggested that the 10-minute service on which the promoters relied could not be justified. After making proper deductions, he estimated a loss on the trams of £1,790 for 30 years. He called attention to the decrease in the output of coal since 1894, showing that the rateable value of the district was not likely to increase. He asked the committee to say that the Bill should not be proceeded with. Mr. Wedderburn, replying for the promoters, contended that the case as to competition set up by the Taff Vale Railway Company had broken down. The Powell Duffryn Company, Lord Bute, and the Cwmaman Coal Company paid one-third of the rates, whereas the Taff Vale Company paid an extremely small amount. He met the declaration that the district was decaying by pointing to the statement before the Royal Commission that there was enough coal in the district to last for 80 years, and to another calculation that the supply would last for at least 100 years. The great majority of the people strongly desired the tramways. Having regard to the present satisfactory position of Aberdare, he submitted that the tramways would not throw an undue burden on the rates. Striking a margin between the estimates presented, he put the loss on the tramways at £446 a year. The Chairman announced that the committee found the preamble of the Bill proved except in respect of the tramways.

**Belfast.**—At a meeting of the Tramways Committee on Monday a report by Mr. Nance, the general manager, on the question of fares was considered. Ultimately it was decided to allow the publication of the report before coming to any conclusion, in order that the question might be fully discussed, and that the committee might thus have the advantage of ascertaining the views of the citizens generally. The report, which is a lengthy document, states, that in his opinion, there are four systems of fare which are applicable to the special conditions of the Belfast tramway system: (*a*) universal 1d. fare; (*b*) the present scale of fares; (*c*) 1d. from Castle Junction out; (*d*) ½d. fares. He proceeds to consider these seriatim, dwelling at greatest length upon the first, which he favours most. No other fare would be taken on the tramcars except a 1d. fare, with the exception of the children's ½d. fares, which would be available on

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the same conditions as at present. He points out that the machinery of collecting and accounting for the receipts of the undertaking would by this system be simplicity itself, and it would also be extremely easy for citizens and visitors to understand. In support of the system, he instances the case of Hull, with a population of 250,000, where ever since the tramways were first worked by the Corporation six years ago a universal 1d. fare has been adopted, with very favourable results. Mr. Nance believes that by this system a balance of £45,000 in relief of rates can be reached in the second year of working under normal conditions. As to maintaining the present scale of fares, Mr. Nance gives as a primary objection the fact that the citizens have expected a material reduction, and will be disappointed if it is not granted. The present fares would, he believes, leave an annual sum available for the relief of rates of £25,000 within two years. As to the third system, this would result in a great part, if not all, of the 2d. fares being turned into 1d. fares, and Mr. Nance does not believe much of this loss would come back. There would also have to be a number of overlapping stages—so lengthened that he doubts if it would be possible to make both ends meet. In fact, if stages are to be retained at all, he considers it would be far better to retain the present stages. As to the fourth system, he is of opinion that the adoption of ½d. fares would mean that the undertaking would be worked at a considerable loss. He therefore sums up strongly in favour of a universal 1d. fare.

**London County Council.**—The most important matter in the Highways section of the agenda for Tuesday's meeting referred to the Council's northern system, leased to the North Metropolitan Tramways Company. The Highways Committee have from time to time submitted to the Council reports dealing with the reconstruction for electrical traction of this division, and they have now prepared a further report, in which they state that it appears to them to be so important for the whole question to be dealt with at once, that they are submitting for the Council's consideration the proposed terms of an agreement with the company (who work the lines under a lease which expires in 1910) for the surrender to the Council upon agreed terms as from April 1 next of the remaining portion of their lease. Some time ago the committee came to the conclusion that the difficulties in the way of arranging for the reconstruction of the tramways under the provisions of the lease were so serious as to indicate that the only satisfactory manner in which this work could be carried out efficiently and expeditiously would be for the Council itself to obtain possession of the lines. Negotiations were accordingly opened with the company, which have resulted in certain terms being arranged. The company has expressed its willingness to sell its interest in the lease to the Council as from April 1 next for £120,000. Further, the Council agree at the same date to purchase from the company for £315,000 the company's rolling-stock, horses, and plant. If the transfer of the tramways to the Council is arranged as proposed, it is hoped that it will be possible to make the necessary arrangements to proceed immediately after the acquisition with the electrification of the lines. Even if the sacrifice of the profits secured to the Council under the lease entailed some financial loss (which, however, the committee do not think in the long run would be the case) they are still of opinion that the course now proposed would be justified to secure to North London the benefit of electric tramways four years sooner than would otherwise be possible. No estimate has yet been made of the expenditure involved in the scheme for electrifying the northern tramways; but approximately it will be £3,000,000 for tramway works, and £1,000,000 to £1,500,000 for street widenings, or a total of £4,500,000, which will in all probability be expended at the rate of about £1,000,000 a year. About one-half of the lines will, as at present proposed, be reconstructed on the underground conduit system and the other half on the overhead trolley system. It is estimated that the annual mileage run on the northern lines will be 21,024,000, and that the profit on working, at 5d. a car mile (which the committee do not consider an excessive figure), would amount to £438,000 a year. If provision for renewals be made at the rate of 1d. per car mile, £87,600 would have to be deducted from the estimated profit, leaving a balance of £350,400. The interest and repayment charges which would have to be made amount to £252,500 a year, leaving a balance of £87,000. These figures exclude the question of street widenings. The Council are also to be entitled to purchase in 1910 the portion of the tramways not included in the company's lease. As the amount involved exceeds £5,000, consideration of the matter was adjourned for a week in accordance with the standing order. The tramways in Camberwell New-road and Church-street, Camberwell, have been linked up, and a short junction line has also been constructed from Camberwell New-road to the authorised tramways in Denmark-hill. Through services have been instituted between Greenwich and certain of the London termini, *via* Camberwell New-road, materially assisting in the relief of the traffic along congested routes. The undertaking of the Woolwich and South-East London Tramway Company will be taken over by the Council on May 31. The Council have voted the £26,000 (referred to in our last week's issue) for diversion of mains along the Wandsworth and Battersea routes, and have decided to call for tenders for the construction of the tramway in Archway-road, Highgate. Mr. J. W. Benn addressed to the Press the other day a spirited reply to the letter of Sir Joseph Dimsdale against trams along the Embankment. Mr. Benn, after dealing with the various statements made by Sir Joseph, deprecates the expression of hostile opinions pending the report of the London Traffic Commission. The Council have come to an arrangement with the Middlesex County Council under which the Council will construct, at their own expense, a line of three furlongs in the Islington area to link up the Archway-road and Archway Tavern trams of the Middlesex Council. The line will be leased to the lessee company for three years, at a rental of £1,500 for the first, £2,000 for the second, and £2,500 for the third year. The company will pay to the Middlesex County Council a percentage on the takings of this line as they are to do with the lines in the county of Middlesex. When this line is completed cars will run from the Archway Tavern to Whetstone direct. A general meeting of the London, Deptford, and Greenwich Tramway Company was held last week, when the Chairman stated that, owing to the expense involved, the company decided not to appeal to the House of Lords in respect of the additional sum of £22,773 provisionally awarded them by the arbitrator on the transfer of their undertaking to the Council, but disallowed by the Court of Appeal. The liquidation of the company will take about 12 months.

## LIGHTING AND GENERAL.

**Grimsby.**—The Council have decided to borrow £3,000 for electric lighting purposes.

**Islington.**—The report mentioned in our last issue will again come before the Council to-night.

**Walsall.**—The Electricity Committee are about to expend £1,350 in providing an additional supply of current for the centre of the town.

**Swansea.**—The Sub-Electric Lighting Committee have insured the electric light works in the County Fire Office for the sum of £30,000.

**Sale of Plant.**—Particulars of a sale of an electrical engineer's stock in-trade by Messrs. Scottorn and Smedley appear in another column.

**"Eltradion."**—Under this title the Electrical Trades Union have published No. 1 of their official organ. It appears to be in favour of the London County Council Wiring Bill.

**Burnley.**—The Council have decided to purchase a new steam generator of 500 kw. for the electricity works, and to apply for sanction to the borrowing of £6,015 to meet the cost.

**Direct United States Cable Co.**—An interim dividend of 3s. per share, tax free (being at the rate of 3 per cent. per annum), for the quarter ended March 31 is payable on the 25th inst.

**Elland.**—The total output from Feb. 1 to 28 was 8,832 units, being a decrease of 3,094 units on the previous month, and an increase of 5 889 units on the corresponding period of last year. A new cable is to be laid.

**Calendars.**—We have received a belated calendar issued by Messrs. Parmiter, Hope, and Co., Hulme Electrical Works, Manchester, 74, York-street, Glasgow, makers of switchboards, arc and incandescent lamps, and accessories.

**Battersea.**—It has been decided to connect up the network of electric mains in the neighbourhoods of Albert Bridge-road, Bridge-road, Bridge-road West, Bolingbroke-road, Church-road, Park-road, Northcote-road, Morella-road, Rusham-road, Sudbrooke-road, and Old Park-avenue, so as to secure more efficiency in the supply of electrical energy, at an estimated cost of £800.

**New Issues.**—We note the following new issues: The County of Durham Electrical Power, 30,000 preference shares of £5 each and £40,000 ordinary shares of £5; the Montreal Light, Heat, and Power Company, 7,500 shares of 100dol. each—750,000dol.—in certificates of five and ten shares each; Yorkshire (West Riding) Electric Tramways Company, Limited, £275,000 4½ per cent. first debenture stock (part of a total authorised issue of £400,000). Full particulars appeared in our last issue.

**Widnes and Runcorn Transporter Scheme.**—A special generating station has been built on the Widnes side of the Mersey to supply the power for the transporter in course of erection for the company, of which Sir John Brunner, M.P., and Sir Henry Seton-Kerr, M.P., are the chairman and vice-chairman respectively. The contractors for the various works are: Arrol's Bridge Company, Glasgow; St. Helens Cable Company; Messrs. Holme and King, Liverpool. The engineers are Messrs. John J. Webster, Westminster, and John T. Wood, Liverpool. Mr. C. H. Chase is the resident engineer.

**Eastbourne.**—At an interview of the representatives of the Town Council and the Eastbourne Gas Company with the Hon. T. H. W. Pelham at the Board of Trade on Wednesday, the extension of the electric lighting system to Willingdon was discussed. It resulted in the Corporation agreeing to leave the question of the insertion of the Northumberland clause in the new order and also in the old order to the Board of Trade, and to abide by their decision. The gas company consented to this course, but reserved their right to prosecute the matter before the House of Lords Committee.

**Opening of Streets.**—At the Court of Common Council on Thursday a letter was read from the Metropolitan Paving Committee stating that they had decided to convene a conference of representatives of the City Corporation, the Westminster City Council, and the Metropolitan Borough Councils, to be held at the Westminster City Hall, Charing Cross-road, on Friday, May 19, at 5 p.m., to consider the question of the opening of streets by public companies and others, and asking the Corporation to appoint two representatives, with the town clerk and engineer, to attend such conference. The matter was referred to the Streets Committee, with power to appoint two representatives.

**Stock Exchange.**—The Stock Exchange Committee have ordered the undermentioned securities to be quoted in the official list: Baker-street and Waterloo Railway Company—Speyer Bros.' scrip certificates to bearer (partly paid) for £500,000 4 per cent. perpetual debenture stock; and Folkestone Electricity Supply Company's 10,000 5 per cent. cumulative preference shares of £5 each fully paid, Nos. 1 to 10,000. Applications have been made to the committee to allow the following securities to be quoted in the official list: Sao Paulo Tramways, Light, and Power Company's 70,000 shares of 100dol. each, and 5 500,000dol. 5 per cent. 30-year gold bonds of 500dol. each; and South Metropolitan Electric Light and Power Company's further issue of 85,368 7 per cent. cumulative preference shares of £1 each, fully paid, and 4½ per cent. first debenture stock.

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**Acton.**—The electricity works have closely approached completion. The arc lamps in the street have been lighted temporarily. A good many house connections have been made, and current is being supplied experimentally.

**County of London Electric Supply Co.**—We are informed that the Holborn and Finsbury electrical exhibition, which closed its doors on Wednesday last week, was visited by nearly 50,000 people during the short run of its existence.

**Thornhill.**—The Yorkshire Electric Power Company have offered to instal 160 20-c.p. lamps on 80 trolley poles at a total cost of £192 per annum, or £2. 8s. per lamp-post. Trial lamps are to be erected at Savile Town and at Thornhill Lees.

**Windsor**—The Windsor Electric Lighting Company have declared a dividend of 7 per cent. Last year it was 8 per cent. The public street-lighting has been doubled without any appreciable extra charge, and there is a decreased charge to private consumers.

**Electric Lighting of Ferry Steamers.**—An estimate for lighting the East Indian Railway ferry steamers "Tara" and "Lakshmi" with electricity has been sanctioned at a cost of about Rs.20,000. An indent for the plant will shortly be sent forward.—*Indian Engineering.*

**Anglo-American Telegraph Co.**—The directors have resolved, after placing £5,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ended March 31 of 15s. per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock, less income tax.

**Power Bills.**—At the last meeting of the Essex County Council Alderman Russell, in reference to the opposition of the Council to the Electric Power Bills, moved that the opposition should be withdrawn, since they would cheapen the supply of electricity generally. The motion was lost.

**Hessle.**—The application of the Urban District Council to the Board of Trade for a provisional order for electric lighting has not yet been sanctioned, but the part referring to Soulcoates rural district having been withdrawn, the Council are sanguine as to obtaining the order for Hessle.

**Blaydon.**—The Urban District Council have sealed an agreement with the County of Durham Electrical Power Distribution Company, Limited, as to the electric lighting of the district, and the transfer to the company of the undertaking authorised by the Blaydon Electric Lighting Order, 1902.

**Large Bell.**—Not everything is made in Germany. We have just seen at the offices of Messrs. Fuller, McLeod, and Co., Norfolk House, Laurence Pountney-hill, E.C., an enormous electric bell, the disc of which has a diameter of 19½in., which is destined for railway track signalling at Berlin. It is worked by 12 dry cells in series.

**Stourport.**—A memorial, which was very numerously signed by tradesmen and residents, urging the Council to take such steps as would secure electric light for the district, has been referred to the General Purposes Committee for consideration. It suggested that the Council should ask the Kidderminster Electric Lighting Company to apply for a provisional order.

**Morley.**—Mr. J. E. Ellis, electrical engineer, in his last report states that the output from the electricity works during the month ending Feb. 28 was 15,149 units, and that the actual units sold to customers was 9,964, this being a decrease of 716 units in the output, and an increase of 1,150 units sold to customers the same period last year. The total number of lamps connected to date was 12,301.

**Poole.**—The Rural District Council have granted permission to the National Telephone Company to erect poles on the roadsides running through Talbot Village and Wallis Down, and also on two short sections of the Council's roads at Canford, in connection with the company's extension of their system to Wimborne. The County Council had already given their sanction in regard to their roads.

**Ulster Telephones.**—The work of connecting Londonderry, Coleraine, and Ballymoney with Belfast by telephone has been almost completed by the General Post Office, who have had charge of the undertaking, and they expect to open the system to the public on May 1. The price to be charged for a three minutes' conversation will be 2d. between Belfast and Londonderry, and 6d. for the other towns mentioned.

**Removal.**—Mr. George W. Green, A.M.I.C.E., M.I.E.E., has removed from 92, Victoria-street, S.W., to Crown Works, Guildford-street, Lambeth, S.E. The telephone number is changed into 7,733 Central; the telegraphic address remaining as before—viz., "Filicoid, London." The Harris Patent Feed-Water Filter, Limited, have removed to 82, Victoria-street, London, S.W. (telephone No. 876 Westminster).

**Transfer of Business.**—We are advised that the transfer of the business of the British Schuckert Electric Company, Limited, to Messrs. Siemens Bros. and Co., Limited, London, is now complete, and that Mr. Arthur Jacob, M.I.E.E., late general manager, has entered the service of the latter company. Further communications should be addressed York Mansions, York-street, Westminster, London, S.W.

**Norwich.**—The National Telephone Company have just reorganised and remodelled their exchange. The visual system of signalling and the central battery system have been introduced. The formal opening was made the occasion of a largely attended function, at which the directorate of the company was represented by Sir Cuthbert Quilter, M.P., and Mr. W. E. L. Gaine attended in his capacity of general manager.

**New Firm.**—The partnership heretofore subsisting between Edgar Arthur Braddick and Arthur Driffell Poulter, carrying on business as printers' and electrical engineers, at 18 and 19, Whitefriars-street, Fleet-street, London, and 43, Great Guildford-street, Southwark, under the style or firm of Braddick and Poulter, having been dissolved by mutual consent, Mr. E. A. Braddick has resumed business on his own account at 9, Gough-square, Fleet-street, E.C.

**Gillingham.**—Electric light is to be substituted for gas in various parts of the borough, and a canvass will be made prior to laying down private and public lighting cables opposite Kingswood-villas. The engineer in his last report shows that the equivalent of 40 8-c.p lamps had been connected to the mains since the last meeting, making a total of 14,169 8-c.p. lamps with 229 consumers connected, and that an application had been received for 25 8-c.p. lamps.

**Dunfermline.**—At the last meeting of the Electric Lighting Committee the reports of Mr. W. B. Sayers, Glasgow, and Mr. Alexander Waddell, gas manager, Dunfermline, on the question of an electric supply scheme for the burgh were submitted. Discussion was deferred. An opinion on the two reports was expressed by Mr. N. H. Cohen, London. It was stated that within a week or 10 days a commencement would be made with the laying of the cables from the generating station of the Fife Power Company at Townhill to Dunfermline and district.

**Middleton.**—In moving the adoption of the minutes of the Electricity Committee at the last Council meeting, Alderman Lord said the supply of energy for traction purposes had been below the average during the past month. This was accounted for to some extent by the fact that the Middleton Electric Traction Company had not used so much as usual, and the supply to the Manchester Corporation trams had also not been so great as usual. The electricity supplied for lighting purposes had likewise been less than was customary so far as the demand was concerned.

**Salisbury.**—During last week an electrical exhibition promoted by the Salisbury Electric Light and Supply Company was held at the County Hall, Salisbury, and was largely patronised. The exhibition was opened by the Earl of Pembroke, the light being switched on by Lady Muriel Herbert. Amongst those present were the Mayor and Mayoress (Mr. and Mrs. J. K. Dowden), Mr. W. M. Hammick (chairman of the Salisbury Electric Light and Supply Company), Miss Hammick, Mr. and Mrs. A. R Malden, and Mr. A. B. Randall (resident engineer).

**Mussoorie Electrical Supply Scheme.**—*Indian Engineering* says the undertaking for the electric lighting and water-supply scheme will be carried out practically on the sole responsibility of the sanitary engineer to Government, U.P. This is hardly fair to the Municipal Board, which have to provide the funds and make payments on the certificate of the sanitary engineer. Even their own engineer will be subject to the sanitary engineer, and the electrical engineer to the Government of India will not, it is said, be referred to under any circumstances in the matter.

**Worthing.**—The number of units generated from March, 1902, to March, 1903, was 288,550, and from March, 1903, to March, 1904, 357,682, showing an increase of 27 per cent.; and from March, 1904, to March, 1905, 476 249 units, representing an increase of 29 per cent. The gross income in the first two years was £3 864 and £5,020, showing an increase of 29 per cent.; and in the last year £6,450, showing an increase of 28 per cent. The Town Council have increased the salary of the resident electrical engineer (Mr. Porter) from £300 to £350 a year, and the salary of the assistant engineer from £120 to £130 a year.

**London Gazette.**—The partnership between Harry William Sutton and George Aaron Benton, carrying on business as electrical engineers at 8, The Exchange, Muswell Hill, London, N., has been dissolved by mutual consent. A receiving order has been made out on debtor's petition in the estate of Harry Thorpe, electrician and engineer, 11, Bartholomew-villas, Kentish Town-road, London. The first meeting will be held at Bankruptcy-buildings, Carey-street, London, on April 19 at 11 a.m. The last day for receiving proofs in the estate of Charles Aubrey Smith, electrician, 23, King-street, Regent-street, London, is April 20.

**Electrical Driving of Textile Mills.**—The worsted spinning mills of Messrs. Thomas Burnley and Sons, Limited, Gomersal, have recently been completely equipped with electric motors, and the whole mill is now driven electrically. The electrical energy is being purchased from the Yorkshire Electric Power Company, and therefore the boilers and main engines of the mill will no longer be required. The advantages of electrical driving of textile mills are well known and fully appreciated in other parts of the world, and now that the Yorkshire millowners can obtain a cheap supply of electricity "on tap" from the power company, Messrs. Burnley's example will, doubtless, be followed by others.

**Lowestoft.**—A balance-sheet of the electric lighting undertaking has been prepared by Mr. Charles F. Spencer, A.S.A.A., A.C.I.S. The accounts for the year ended Sept. 30, 1904, show an expenditure on revenue account of £7,597, and an income of £9,929, leaving a credit balance of £2,332. Interest on loans and sinking fund absorb £3,816, so that the deficiency for the year was £1,471. The capital account shows that the amount raised by loans to September was £61,220, of which £60,639 has been expended. The contributions to the sinking fund during the four years (£4,042) and the surplus of £4,037 appear in the accounts as "surplus of assets over liabilities," the total under this head being £8,0.0.

**Beckenham.**—The question of letting motors on hire is to stand over until the results of the experiments with the time switches have been determined. The claim of the British Insulated Wire Company's right to a percentage upon the meters supplied under the Westinghouse meter contract has been allowed. Revised charges for house services are under consideration by a sub-committee who are negotiating with the British Insulated Company on another matter for report. The matter of the arbitration *re* South Metropolitan Electric Light and Power Company is being urged forward. The South-Eastern and Chatham Railway Companies have promised to give attention to the

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Council's request to the establishment of public telephone call offices at Beckenham Junction, Kent House, Penge, and Clock House railway stations.

**Water Power.**—Good progress has been made with the canal from the Spey, which is to provide the power to actuate the two turbine wheels to drive the dynamos which will provide electric light for Gordon Castle and Fochabers. The work is in the hands of Messrs. Drake and Gorham. The wiring of Gordon Castle is being proceeded with, and Fochabers has secured electric light at the cost of 5s. per 16 c p. lamp per annum, without having to bear any further share in the cost of the installation. The canal from the Spey will be about a mile long, and will act as a dam during its whole length, there being but about 1½ft. fall upon it. The body of water which it will contain will be about 12ft. broad and 4ft. deep.—The Swedish State Railways Department propose to buy a waterfall at a cost of 4,000,000 crowns for the purpose of producing electric power.

**Partick.**—The Town Council have adopted a report in which the Electric Lighting and Destructor Committee stated that they had agreed that considerable extensions of plant were necessary. Altogether about £13,000 was required, but £4,000 of this was to pay for material used according to contracts given out during last year. There had been a breakdown of the large engine in February last, and if this breakdown had occurred in December they would have been under the necessity of cutting down the supply of electricity. Their plant was practically all in use, and the committee now recommended the duplication of the large engine. There had been an increase of nearly 80 per cent. in the demand for current, and so it was absolutely necessary that they should have sufficient plant. Last year their profit had been £405, and their estimate for next year was at least £880 after providing for the new plant.

**Nelson Telephones.**—At the last Town Council meeting the town clerk read the following letter from the secretary of the Nelson and District Manufacturers' Association: "In consequence of a report made to me by several members of the association as to the inefficiency of the telephone service at Nelson, more particularly with regard to the trunk service, I asked the members to take careful note of the day, hour, and minute of every trunk call made, and the time at which the connection was effected during the month of December. From the report received I find that the average time taken in getting 349 trunk call connections was 23¾ minutes. This is very unsatisfactory, and I am desired to ask you to bring the matter before the notice of the Town Council, and ascertain whether the Council will be prepared to co-operate with this association in endeavouring to secure more satisfactory service." At a meeting of the General Purposes Committee it was resolved to agree with the complaint, and a sub-committee, consisting of the Mayor, Alderman Reed, and Councillor Smith, was appointed.

**Telephone Exchange Fire.**—During the evidence at the resumed inquest held on the 11th inst. into the two fires which broke out simultaneously in the premises of the National Telephone Company at Mansion House-chambers, 11, Queen Victoria-street, and 1 and 2, Oxford-court, Cannon-street, on the morning of Tuesday, Feb. 28, Mr. C. B. Clay, the metropolitan superintendent of the Telephone Company, gave evidence, and said the accident was attributable to the carelessness of a workman in allowing the cable to come into touch with the live rail. He did not consider that there was even any danger of subscribers who might have been using their instruments at the time receiving a current of 500 volts, because the wires would not carry it. It appears that both offices are of a somewhat antiquated construction, and had no heat coils, although part of one of the cables in question communicated with the Gerrard-street exchange. The accident did not affect that exchange, because there the heat coils blew and protected the apparatus. Heat coils were not in use when the other exchanges were fitted, as heavy currents were extremely rare, and they were not modernised because the company were going to close them.

**Paddington.**—At the last Borough Council meeting the General Purposes Committee recommended that the solicitor be instructed to prepare an agreement between the Council and the Metropolitan Electric Supply Company on lines as follows: "Borough Council not to insist upon compliance with Clause 21 of provisional order, provided that the company should establish and maintain at Willesden a sufficient generating station for Paddington, separate and capable of being completely severed from other generating stations and plant of the company. That the Borough Council shall have the same rights of purchase of such generating station and plant as they would have under the Act of 1888 and the provisional order in the case of generating station and plant within the borough, but that they should be at liberty to purchase the company's Paddington undertaking without the obligation to purchase Willesden plant or station. That the site at Amberley-road be retained by the company with or without plant, and the Borough Council shall be at liberty at time of purchase of undertaking to purchase site with such plant. That the Borough Council may purchase either site with plant, or both at their option. That in the event of Willesden site not being purchased, the Borough Council are not to buy outside mains. That in the event of the company obtaining powers to supply the whole of the borough, the above conditions shall apply to the added portion. That the obligation of the company under Act and orders shall be deemed to apply to Amberley-road and Willesden sites, subject to the above conditions." The solicitor had informed the committee that if the Council were satisfied that there was no engineering or other difficulties in the option proposed to be given to the company, he saw no legal objection to the heads of agreement, but was of opinion that the agreement, if executed, must be scheduled to an Act of Parliament. An amendment was carried that the matter be referred back that they might obtain expert advice, but as the clock struck one before it could be put as the substantive motion it was not carried technically, and the whole matter was adjourned.

## PROVISIONAL PATENTS, 1905.

MARCH 31.

3855A **Improvements in apparatus for use in starting, stopping, and reversing electric motors.** Ernest Sherwood Woollard Moore and William Brabiner Bennitt, Prince's-chambers, Wolverhampton. (Date applied for under Patents Rule 9, Feb. 24, 1905.)

APRIL 3.

6954. **Improvements in electrical prepayment meters.** Chamberlain and Hookham, Limited, and Sydney Holmwood Holden, 4, New Bartholomew-street, Birmingham.

6958. **Improvements in and relating to safety devices for overhead wires for electric traction and other purposes.** Henry Ridley Burnett, Roman House, Abbey-road, Barrow-in-Furness.

6989. **An electrical time cut-off for motors and the like.** George Moore and Joseph Henry Hirst, 2, Belvoir-street, Hull.

6994. **Improvements in and connected with separators for the plates of batteries and the like.** William Frederick Newcomen, 48, Pulteney-road, South Woodford, Essex.

7004. **Improvements in electric furnaces.** Alleyne Reynolds, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

7006. **Improvements relating to the generation of electricity by means of earth cells.** Emil Jahr, 73, Cheapside, London. (Complete specification.)

7008. **Improvements in safety circuit closers.** Leon Ottinger, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

7010. **Improvements in and relating to methods of receiving electrical impulses.** Daniel Watts Troy, 18, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, April 8, 1904, being date of application in United States.) (Complete specification.)

7019. **Improvements in or relating to electrical contact breakers.** George Bowron, 111, Hatton-garden, London.

7020. **Improvements in or relating to electrodes for electrolysers used in the manufacture of bleaching liquors.** Richard Kother, 111, Hatton-garden, London. (Complete specification.)

7035. **Improvements in and relating to electrical conductors.** John Frederick Dake, 70, Chancery-lane, London.

7036. **Improvements relating to electrically-propelled vehicles.** August Weiss, 322, High Holborn, London.

7048. **Improvements in electric temperature controlling devices.** James Esten de Jersey, 28, New Bridge-street, London.

APRIL 4.

7068. **An improved holder or carrier for the shades of electric lamps** Joseph Andrews and Joseph Andrews, jun., 77, Colmore-row, Birmingham.

7075. **Electrically-controlled device for operating valves of internal combustion engines.** James Alexander Main, 65, Chancery-lane, London.

7082. **Electrical alarm mat.** John Skinner, 44, St. Mary's-street, Southampton.

7095. **Improvements in arc lamps** John Morrecraft Wellington and Walter Francis Daniell, 88, Chancery-lane, London.

7101. **Apparatus for absorbing gases by a liquid under the action of the silent electric discharge.** Alexandre de Hemptinne, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

7105. **Improvements in electrical cables.** W. T. Henley's Telegraph Works Company, Limited, and Henry Savage, 53, Chancery-lane, London.

7111. **Improvements in or connected with magneto-electric generators.** Louis Alexandre Gianoli and Raoul André Perrin, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, April 14, 1904, being date of application in France.) (Complete specification.)

7121. **New or improved means of attaching the globes of electric arc lamps** Henry Baggett and the New Century Arc Light Company, Limited, Norfolk House, Norfolk street, London.

7124. **An improved telephone system.** William Phillips Thompson, 6, Lord-street, Liverpool. (A/S Elektrisk Bureau, Norway.)

7133. **Improved electric regenerative battery.** William Holloway Fellows, Edward Thomas Pickup, and William Tice, 173, Fleet street, London.

7148. **Improvements in and relating to electric motor control systems applicable for electrically-propelled trams or vehicles.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

7149. **Improvements in and relating to electric motor control systems applicable for electrically-propelled trams or vehicles.** The British Thomson-Houston Company, Limited, 83 Cannon-street, London. (General Electric Company, United States.)

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**7136. Improvements in the electric lighting of trains.** Henry Leitner and Richard Norman Lucas, 4, South-street, Finsbury, London.

**7150. Improvements in and relating to systems of electric motor control applicable for electrically-propelled trams or vehicles.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

APRIL 5.

**7159. Improvements in telephone apparatus.** Bernhard Ehrlich and Max Konrad, 6, Bank-street, Manchester. (Complete specification.)

**7176. Improved method of operating the points of overhead trolley wires, and also of the rails for electric tramways.** John Greenwood and Son, Windsor Bridge Works, Salford, Lancs.

**7197. An electric current reversing switch, lamp socket, and plug combined.** Herbert Rhodes Edward Perkins and Joe Blakey, 23, Spencer-street, Park Grove, Barnsley. (Complete specification.)

**7211. Improvements in or relating to electric clocks.** Henri Alfred Campiche, 111, Hatton-garden, London. (Complete specification.)

**7448. Improvements in electromagnetic or eddy-current brakes and electromagnetic clutches.** David King Morris and George Auslow Lister, The University, Birmingham.

**7498. Improvements in air-insulated telephone and telegraph cables.** Emanuel Jensen, 321, High Holborn, London. (Date applied for under Patents Act, 1901, April 9, 1904, being date of application in Denmark.) (Complete specification.)

**7566. Improvements in telephone transmitters.** Harry Merton Gail, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published April 27.*

1904.

**5213. Controlling electric motors.** Geipel, Lange, and Mascord.

**5214. Controlling electric motors.** Geipel and Lange.

**8693. Electric arc lamps.** Ganz und Co. Eisengiesserei und Maschinenfabriks Akt.-Ges. (Date applied for under International Convention, May 9, 1903.)

**8694. Alternating-current arc lamps.** Ganz und Co. Eisengiesserei und Maschinenfabriks Akt.-Ges. (Date applied for under International Convention, July 24, 1903.)

**10836. Registering apparatus for gas, electricity, water, or other fluids.** Henderson and Higgin.

**11077. Railway or tramway signalling systems.** British Thomson-Houston Company, Limited. (General Electric Company.)

**11141. Winding of armatures of dynamo-electric machines.** Ker and Paterson, Cooper, and Co., Limited.

**11156. Manufacture of electric cables.** Beaver and Claremont.

**11363. Apparatus for use in the distribution of alternating current.** Berry.

**12313. Electrical timing devices for fire brigade competitions, military drills, race meetings, and the like.** Nichols and Brown.

**12467. Electrically-driven fans.** Veritys, Limited, and Walker.

**12741. Electric ignition apparatus for internal combustion motors.** Du Cros. (Soc. Anom. des Anciens Etablissements Panhard et Levassor.)

**12840. Electrical train describer or indicator.** Wells.

**13136. Electrically-heated gauffer moulds and other similar apparatus.** Boult. (Soc. Dubois et Emery.)

**13173. Apparatus for providing air, light, and telephonic communication for use at fires.** Merryweather.

1905.

**257. Electric arc lamp electrodes.** British Thomson-Houston Company, Limited. (General Electric Company.)

**2474. Process for neutralising static electricity.** Chapman.

**2939. Electric incandescence lamp fittings.** Suter.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ⅝-¾ |
| Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 7/16-17/32 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | – | 5½-6 xd |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | – | 5¼-6 |
| —— 4½ per cent. Mortgage Debentures | 100 | – | 101-104 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 99-101 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | – | 2¾-3¼ |
| —— 4 per cent. Mortgage Debenture Stock | 100 | – | 91-93 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,751 | 2 | – | ½-¾ |
| —— Non. Cum., 6 per cent. Pref. | 2 | – | 1½-2 |
| —— 4½ per cent. 1st Debenture Stock | 100 | – | 92-95 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | – | 79-82 |
| Callender's Cable, Debentures | 100 | – | 107-109 |
| —— Ordinary | 5 | – | 11-11½ |
| —— 5 per cent. Pref. | 5 | – | 5¼-5⅜ |
| Crompton and Co. | 3 | – | 2⅛-2⅜ |
| —— 5 per cent. Debentures | 100 | – | 96-98 |
| Edison and Swan United, "A" Shares, 1-99,261 | 5 | – | 1-1¼ |
| —— "A" Shares, 01-017,139 | 5 | – | 1⅜-2⅛ |
| —— 5 per cent. Debentures | 100 | – | 84-89 xd |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 80-85 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | – | 1½-1⅝ |
| —— 7 per cent. Cumulative Pref. | 2 | – | 2⅛-2⅜ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | – | 97-99 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | – | 9¾-10 |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | – | 97-101 xd |
| W. T. Henley's Telegraph Works, Ordinary | 5 | – | 11½-12½ |
| —— 4½ per cent. Preference | 5 | – | 5⅜-5⅝ |
| —— 4½ per cent. Debentures | 100 | – | 109-111 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | – | 16-17 |
| —— 4 per cent. Debentures | 100 | – | 100-103 xd |
| Parker, Thos., Limited, Ordinary | 10 | – | 10-10¼ |
| Telegraph Construction and Maintenance | 12 | – | 26 38 |
| —— 5 per cent. Bonds | 100 | – | 103-105 |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary | 10 | – | 11⅜-12½ xd |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | – | 9⅜-10½ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | – | 11-12 |
| —— 4½ per cent. Debenture Stock, Red. | 100 | – | 105-107 |
| Bromley (Kent) Electric Light and Power Co. | 5 | .. | 5½-5⅝ |
| —— 4½ per cent. 1st Debenture Stock, Red. | 100 | – | 103-106 |
| Brompton and Kensington, Ordinary | 5 | – | 9½-10¼ xd |
| —— 7 per cent. Preference | 5 | – | 9½-10⅛ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 | 5 | – | 9 9⅛ |
| —— Nos. 60,001-80,000 | 5 | – | 6⅞ 7⅛ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | – | 12½-13½ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 105-108 |
| Charing Cross and Strand, 70,001-80,000 | 5 | – | 7⅛-8½ |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5⅜-5⅝ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 5-5¼ |
| —— 40,001-80,000 | 5 | .. | 5-5⅛ |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | – | 105 107 |
| Chelsea Electricity Supply | 5 | – | 6¼-7 |
| —— 4½ per cent. Debentures | 100 | – | 109-111 |
| City of London, Ordinary | 10 | – | 11-12 |
| —— 6 per cent. Cumulative Pref. | 10 | – | 13½-14 |
| —— 5 per cent. Debenture Stock | 100 | – | 123-127 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | – | 103-106 |
| County of London Electric Supply, Ordinary | 10 | – | 9-9¼ xd |
| —— 6 per cent. Cum. Pref. | 10 | – | 12-12½ xd |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 104-106 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. | 100 | .. | 110-113 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | – | 6-6½ |
| —— 6 per cent. Cum. Pref. | 5 | – | 6½ 6⅝ |
| —— 4½ per cent. First Mort. Deb. | 100 | – | 106-108 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 2½-2⅝ |
| —— 5 per cent. Debenture Stock, Red. | 100 | – | 86-91 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | – | 5½-6 |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | – | 101-104 |
| Havana Electricity, Limited, 1-15,000 | 10 | – | 9½-10⅛ |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | – | 7⅜-7½ |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 101-103 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 | 1 | – | 11/16-13/16 |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | – | 12-13 |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red | 100 | – | 101-103 xd |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅜-10½ |
| London Electric, Ordinary | 5 | – | 2¼-2⅜ |
| —— 6 per cent. Pref. | 5 | – | 5¼-5⅜ |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | – | 99-101 |
| Metropolitan Ordinary | 10 | – | 17½-18½ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | – | 109-114 |
| —— 4½ per cent. Cum. Pref. | 5 | .. | 5⅜-5⅞ |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | – | 97-99 |
| Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb. | 100 | – | 99-101 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | – | 98-101 |
| —— Preference | 4 | – | 100-102 |
| Notting Hill Electric Lighting | 10 | – | 14½-15½ |
| —— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.) | 100 | – | 100-102 xd |
| Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,310 | 5 | – | 6¼-6½ |
| —— 4 per cent. Debenture Stock | 100 | – | 98-100 |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures | 100 | – | 98-100 xd |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 | – | 2⅜-3½ |
| —— 4 per cent. Debenture Stock | 100 | – | 79-83 |
| South London, Ordinary | | – | 3⅜-4½ |
| South Metropolitan Electric Light and Power Co., Ord. | 1 | .. | ⅞-1 |
| —— 7 per cent. Cum. Pref. | 1 | .. | 1⅛-1 7/16 |
| —— 4½ per cent. 1st Mort. Deb. | 100 | .. | 105 108 xd |
| —— Ditto, June, 1904 | | .. | |
| St. James's and Pall Mall, Ordinary, 101-80,080 | 5 | – | 13½-14½ |
| —— 7 per cent. Pref. | 5 | – | 8¼-8⅜ |
| —— 5½ per cent. Deb. | 100 | – | 98-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | – | 4 15/16-5 1/16xd |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5-5½ xd |
| Westminster, Ordinary | 5 | – | 12-13 |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | – | 6-6½ |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 | 5 | – | 5⅜-6 |
| —— Ord. | 5 | .. | 8 11/16-8 15/16 |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | – | 140-143 |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 105-107 |
| Barcelona Tramways, Limited, Ord., 1-20,000 | 10 | .. | 12-12½ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 | 10 | .. | 9½-10 |
| —— 5 per cent. Deb., Red., 1-500 | 100 | .. | 99-102 |
| —— 4½ per cent. Red. Deb. Stock | 100 | .. | 96-100 |
| Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606 | 1 | .. | 13/16-15/16 |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 | 1 | .. | 15/16-1 1/16 |
| Belfast Street Tramways, Ord., 1-26,600 | 10 | .. | 10¼-11¼ xd |
| Blackpool and Fleetwood Tramroad | 10 | – | 13⅜-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | – | 1-1⅛ |
| —— 5 per cent. Cum. Pref., Nos. 1 75,000 | 5 | – | 3⅜-4½ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 91-98 |
| British Columbia Electric Railway Co., Ord. Def. | 100 | – | 104-107 |
| —— Ord Pref. | 100 | – | 100-103 |
| —— Non. Cum. 5 per cent. Pref. | 10 | – | 10-10¼ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each | 40 | – | 105-107 p c |
| —— 4½ per cent. Vancouver Power Deb. | 100 | – | 99-102 |
| British Electric Traction Ord. 1-300,000 & 60,001-80,000 | 10 | – | 9-9⅛ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | – | 10⅜-11⅛ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | – | 120-122 xd |
| —— 4½ per cent. 2nd Deb. Stock | 100 | | 98-100 |

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| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| | £ | | £ |
| Buenos Ayres and Belgrano Tram. Ord., 1-100,000 | 5 | – | 3¾-4 |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | | 5⅜ 5¾ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | – | 5⅜-5¾ |
| —— 5 per cent. Deb. Stock, Red. | 100 | – | 107-109 |
| —— Prov. Cert., all paid | 100 | – | 103-106 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | – | 97-99 |
| Calcutta Tramways, Limited, 1-102,268 | 5 | .. | 8½-8¾ |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | .. | 106-108 |
| Cape Electric Tramways Nos. 1-480,000 | 1 | – | 1⅛-1⅜ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | – | 4⅞-5¼ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | – | 101-104 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | | 103-105 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | | 9½-10 |
| —— 5 per cent. Cum. Pref. | 10 | – | 11-12 |
| —— 4 per cent. Debentures | 100 | – | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-50,000 | 10 | – | 13½-14½ |
| —— 5 per cent. Pref., Nos. within 1-50,000 | 10 | – | 15½-16½ |
| —— 5½ per cent. Mort. Debs., 1-3,000, Red. | 100 | – | 94-97 |
| Imperial Tramways Ordinary | all | – | 18-19 |
| —— 5 per cent. Cum. Pref. | all | – | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 | | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000 | 5 | | 2¾-3¼ |
| —— 4 per cent. Debenture Stock | 100 | – | 85-90 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | – | 8-8¼ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | – | 10-10¼ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | – | 99-102 |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 | .. | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016. | 1 | .. | 13/32-15/32 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | .. | 1-1 1/16 |
| —— 4½ per cent. Deb. Stock, Red. | 100 | .. | 105-107 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000 | $1,000 | .. | 106-110 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 | .. | 101-104 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 | .. | 103-105 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000 | 5 | – | ¼-1½ |

| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| | £ | | £ |
| Oldham, Ashton, and Hyde Tramway, Ordinary | 10 | | 12½ |
| —— 6 per cent Cum. Pref. | 10 | – | 9⅜-9¾ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk. | 100 | – | 105-108 |
| Potteries Electric Traction, Ordinary 20,001-40,00 | 10 | – | 9½-10 |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | – | 9½-10 |
| —— 4½ per cent. Debenture Stock | 100 | – | 103-107 |
| South Lancashire Electric Traction and Power Company | | | |
| —— £250,000 Ordinary | 1 | | 1 |
| —— £101,152 5 per cent. Preference | 1 | | |
| —— £597,170 4½ per cent. Debenture Stock | 100 p.c. | – | 100 p.c. |
| **Electric Railways.—** | | | |
| Central London, Ordinary | 100 | – | 92-94 |
| —— 4 per cent. Pref. | 100 | – | 101-103 |
| —— ,, deferred | 100 | – | 82-85 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | – | 111-113 |
| City and South London, Consolidated Ordinary | 100 | – | 44-45 |
| —— 4 per cent. Debenture Stock | 100 | – | 109-111 |
| —— 5 per cent. Pref. Stock '91 | 100 | – | 120-123 |
| —— ,, ,, ,, '96 | 100 | – | 118-121 |
| —— ,, ,, ,, '01 | 100 | – | 115-118 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | – | 10-10½ |
| —— Ordinary, 1-50,000 | 10 | – | 3¾-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | – | – | 99-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | – | – | 99¼-100½ |
| Waterloo and City, Ordinary | 100 | – | 92-94 |
| **Telephones.—** | | | |
| National Telephone, Preferred | 100 | – | 109-110 |
| —— Deferred Stock | 100 | – | 101-103 |
| —— 6 per cent. Cum. First Pref. | 10 | – | 12¼-13¼ |
| —— 6 per cent. Cum. Second Pref. | 10 | – | 11¼-12¼ |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | – | 5¼-5⅜ |
| —— 5¼ per cent. Deb. Stock, Red. | 100 | – | 100-102 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 104-106 |
| —— 4 per cent. Prov. Cert. | – | .. | 103¼-105½ |
| Oriental Telephone and Electric Company | 1 | – | 1¼-1⅜ |
| —— 6 per cent. Cum. Pref. | 1 | .. | 1 3/16-1 5/16 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905. | 1904. | Week. | Current year. | 1904. | 1903 | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Passenger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | April 8 | 1,124 | 1,206 | – 82 | + 5,516A | 19¼ | 19¼ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·14 |
| Ayr Corporation | ,, 8 | 203 | 276 | – 73 | + 600 | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 336,049 | 1·03 | 10·11 | 1,770 | 5 0 |
| Barking Corporation | ,, 1 | 48 | 41 | + 7 | + 306 | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 9 | 1,004 | 1,059 | – 55 | — | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,319,701 | 1·158 | 9·98 | 2,383b | 6·1 |
| Birmingham Corporation | ,, 8 | 362 | 319 | + 43 | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | — | — | — | — | — | 6¼ | 6¼ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 5 | 874 | 1,302 | – 428 | — | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10 94 | — | 4·59 |
| Blackpool Corporation | ,, 6 | 412 | 1,445 | –1,033 | — | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 8 | 244 | 631 | – 387 | — | 16½ | 16½ | Dec. 31 | 32,021 | 2,253,984 | 600,757 | 3·34 | 12·75 | 2,001 | 7 05 |
| Bolton Corporation | ,, 9 | 1,820 | 1,810 | + 10 | — | 38 | 38 | March 31 | 94,151 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·89 |
| Bournemouth Corporation | ,, 5 | 997 | 1,554 | – 557 | + 2,830 | 10·15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | Mar. 25 | 3,939 | 3,620 | + 319 | +31,365 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | April 9 | 810 | 974 | – 164 | — h | 9 | 7½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 7 | 4,596 | 4,782 | –1,185 | — | 51½ | 51½ | Dec. 31g | 253,150 | 44,391,439 | 6,033,528 | — | — | — | — |
| Burnley Corporation | ,, 8 | 1,127 | 971 | + 156 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 9 | 301 | 363 | – 62 | — | 8½ | — | March 31j | 11,574 | 2,556,134 | 282,378 | 1·08 | 9·84 | 1,570 | 7·57 |
| Cardiff Corporation | ,, 8 | 1,837 | 2,194 | – 297 | – 514 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 8 | 177 | 231 | – 54 | – 381 | — | — | Dec. 31g | 9,987 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 8 | 7,158 | 6,672 | + 486 | + 2,161A | 6 | 6 | ,, 31 | 362,471 | 44,933,938 | 1,292,674a | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 9 | 2,804 | 2,822 | – 18 | – 2,555h | 6½ | 6⅝ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Colchester Corporation | ,, 5 | 171 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. T. and L. Company | Mar. 30 | 417 | 397 | + 20 | — | — | — | ,, 31g | 26,657 | 6,353,323 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | April 7 | 238 | 252 | – 14 | — | 7·23 | 7·23 | March 31g | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 8 | 177 | 246 | – 69 | — | 4½ | 4½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0 91 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | Mar. 31 | 100 | 100 | — | + 324 | 7 | 6⅔ | Dec. 31g | 6,234 | 588,905 | 107,164 | 3·88 | 14·09 | 952 | 7·39 |
| Dublin U. T., electric cars | April 7 | 3,805 | 4,018 | – 213 | } — | 47 | 46 | ,, 31g | 134,643 | — | 3,429,356 | — | — | — | — h |
| Dublin S. District, Electric | ,, 7 | 812 | 918 | – 106 | | | | | | | | | | | |
| Dundee City Tramways | ,, 5 | 826 | 861 | – 35 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 8 | 750 | 833 | – 83 | — | 10·77 | 10·75 | March 31 | 34,312 | 12,950,269 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 8 | 15,184 | 14,045 | +1,139 | +31,087A | 143 | 123 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Gloucester Corporation | ,, 5 | 256 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 5 | 2,638 | 3,003 | – 345 | — | 33 | 30½ | March 31 | 68,283 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,059 | 8·77 |
| Huddersfield Corporation | ,, 8 | 1,223 | 1,546 | – 323 | — | 35 | 35 | ,, 31 | 65,545 | 11,893,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | ,, 8 | 2,091 | 2,215 | – 118 | — | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | — | — | — | — | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | ,, 5 | 116 | 186 | – 70 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 5 | 241 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 8 | 5,476 | 6,185 | – 709 | — | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | ,, 8 | 1,954 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | ,, 1 | 10,955 | 9,913 | +1,022 | + 5,704 | 103 | 103 | Dec. 31g | 531,434 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | ,, 9 | 1,499 | 1,776 | – 277 | – 1,029h | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — s |
| London County Council | ,, 1 | 13,251 | 10,864 | +2,387 | — | 46½ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | ,, 6 | 103 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 8 | 11 982 | 12,127 | – 145 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 8 | 123 | 107 | + 16 | — | 2¾ | — | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newcastle-on-Tyne Corptn. | ,, 8 | 3,636 | 3,794 | – 189 | — | 45 | 38½ | ,, 25 | 135,027 | 39,715,120 | 4,059,807 | 1·1 | 10·94 | 4,111b | — |
| Newport (Mon.) Corporation | — | — | — | — | — | 15 | — | — | — | — | — | — | — | — | — |
| Oldham Corporation | ,, 9 | 1 452 | 1,188 | + 263 | + 695 | 34¾ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 8 | 1,606 | 2,464 | – 858 | — | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·16 | 12·39 | — | — |
| Reading Corporation | Mar. 30 | 562 | 569 | – 7 | — | — | — | — | — | — | — | — | — | — | — |
| Rochdale Corporation | April 8 | 487 | 128 | + 359 | — | 4½ | 4½ | 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 6 | 422 | 619 | – 197 | — | — | — | ,, 31 | 20,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·68 |
| Salford Corporation | ,, 10 | 3,865 | 3,771 | + 94 | — | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 8 | 73 | — | — | — | 7¾ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 9 | 4,631 | 4,886 | – 255 | – 945 | 34½ | — | ,, 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 5 | 870 | 1,057 | – 187 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 5 | 266 | 388 | – 122 | — | 6¼ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | Mar. 31 | 487 | 573 | – 86 | + 8,814 | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 20 | 1,144 | 1,064 | + 80 | + 1 676 | 19 54 | 18·48 | ,, 31 | 62,506 | 14,848,958 | 1,433.463 | 1·01 | 10·46 | — | 6·02 |
| Swindon Corporation | April 5 | 195 | — | — | — | 3¾ | — | — | — | — | — | — | — | — | — |
| Wallasey U.D.C. | ,, 8 | 671 | 789 | – 117 | — | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·50 |
| Warrington Corporation | ,, 6 | 319 | 352 | – 33 | — | 7½ | — | — | — | — | — | — | — | — | — |
| West Ham Corporation | ,, 6 | 1,187 | 807 | + 380 | — | 8·62 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 5 | 722 | 705 | + 17 | — | 7½ | — | ,, 31g | 20,878 | 4,263,066 | 417,335 | — | 12·006 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. s Train mile.
Per mile of single track. g Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. A Half-year's figures.
Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**The Institution.**—We have received a copy of the Institution *Journal*, dated April, which contains the following papers, with discussions: "The Combination of Dust Destructors and Electricity Works Economically Considered," by W. P. Adams; "Fuel Economy in Steam-Power Plants," by W. H. Booth and J. B. Kershaw; "Compensated Alternate-Current Generators," by Miles Walker (Manchester); "High-Tension Switchgear," by L. Andrews (Manchester); "Armature Reaction in Alternators," by J. B Henderson and J. S. Nicholson (Glasgow); "Condensing Arrangements in Central Stations," by J. D. Bailie (Leeds); and "The Magnetic Properties of some Alloys of Iron and Silicon," by Thos. Baker.

**Pyrotechnics.**—During the thunderstorm on Sunday afternoon St. Mathias's Church, Richmond-hill, was severely damaged by what is described as a fireball. Following a vivid flash of lightning, there descended from the clouds, according to several spectators, a huge ball of fire, which exploded with a loud report near the church steeple. A hole was torn in the roof, through which a brilliant glare appeared, while outside pedestrians are reported to have been almost thrown to the ground. The church is illuminated by electricity, and the glass doors of the switch-boards were blown outwards and broken to pieces. On examination it was found that several of the electric light wires had fused. The Lightning Research Committee should be able to get some useful data from this occurrence as to ball lightning.

**Eddy-Current Brakes.**—A paper on "The Eddy-Current Brake for Motor Testing" was presented at a meeting last week of the Birmingham Local Section by Messrs. D. K. Morris and G. A. Lister. The authors pointed out that the eddy-current brake had many advantages over the band or rope brake for motor testing. Among these were sensitiveness, combined with convenience of adjustment to exact balance, uniformity of load and constancy after final temperature conditions have been reached. The heat produced in the energy-absorbing element is not conducted to the bearings. The brake also gives a retarding torque only. The brake was described in detail, and, in conclusion, the authors claimed that, besides being the most convenient and compact for ordinary motor testing, it compared favourably, when correctly designed, with mechanical water-cooled brakes on all points except that of initial cost.

**The American Institute.**—The nominee for the presidency of the American Institute of Electrical Engineers is Dr. Schuyler Skaats Wheeler, who was born at New York in 1860. He was educated at Columbia University, and his early experience in the electrical field was in the direction of electric lighting and central-station work. In 1886 he went into the manufacturing field, first as electrician to the Herzog Teleseme Company, subsequently becoming connected with the C. and C. Electric Motor Company. Mr. F. B. Crocker was associated with the latter concern, but after a time the two severed their connection with that company, and organised the Crocker-Wheeler Company. Dr. Wheeler has had a varied experience of electrical matters, and as he is credited with a true engineering mind, as well as great executive and business ability, his election is regarded as practically certain.

**The Telephone Transfer.**—A discussion arose in the House of Commons on Tuesday evening with reference to the constitution of the Select Committee which is to consider the agreement between the Postmaster-General and the National Telephone Company. Lord Stanley, replying to a question, stated that he hoped the matter would be treated as non-controversial, and that the motion to appoint the committee would be agreed to as soon as possible. Certain objections as to the constitution of the committee had been made, and these objections had been met, so he did not think it necessary to appoint a day for debating the subject in the House. In reply to another question, his lordship added that what he had promised was that the House should have an opportunity of considering the agreement before it became effective, and he thought that Parliament would be in a more favourable position to arrive at a conclusion if they had the report of a Select Committee before them.

**Obituary.**—Mr. John Verity, who died at Hailey, Oxon, on the 6th inst., at the age of 41, took a prominent part in the development of electrical industry in this country. In the early days he turned his attention to adapting electric light to domestic use. Joining hands with Mr. Edison, whose personal friendship he enjoyed, his efforts culminated in the great display of incandescent lighting at the Crystal Palace Exhibition of 1882, which did so much to popularise electric lighting in this country. In conjunction with the late Sir James Pender and Sir George Elliot he founded the Metropolitan Electric Supply Company, which came into such prominence in connection with the proceedings of the St. Marylebone Borough Council's electric lighting scheme. As chairman of Verity's, Limited, he was a large employer of labour in Birmingham and Manchester. Mr. Verity was high sheriff for the county of London in 1901, and was a justice of the peace for the county of Warwick. He married in 1897 the eldest daughter of Mr. Henry Lubbock, of Newberries, Herts, who, with four children, survive him.

**Electro-Therapeutics.**—An inquest was held on Saturday last upon the Hon. Mrs. Monck, who met her death at Charing Cross Hospital while under electrical treatment. It is tolerably clear from the medical evidence that this was entirely a coincidence, and that death was in no wise attributable to the treatment. Deceased was suffering from gout in the arm and underwent several electric light baths. These, apparently, did not have much effect, so she was treated with high-frequency current, which she thought was beneficial. On the last occasion that deceased was under this treatment the physician observed perspiration break out on the patient's face and immediately stopped the current. Death occurred shortly afterwards. A *post-mortem* examination showed that deceased was suffering from Bright's disease, death being due to rupture of a cerebral artery. Two physicians corroborated the hospital surgeon's view that death occurred quite irrespective of the electrical treatment, and an ordinary verdict was returned. It is as well that the Press has given due publicity to the medical evidence, as a section of the community are apt to be prejudiced against electricity through coincidences of this kind. Even the coroner, though he had no difficulty, after the evidence, in accepting an open verdict, appeared inclined at first to regard electricity as some kind of occult medium.

**Trolley Contact Spring.**—The Illinois Circuit Court recently gave its decision in the case of the General Electric Company *v.* the Morgan-Gardner Electric Company. The plaintiffs are the proprietors of the Anderson patent, No. 412,155, for a trolley contact spring, the validity of which has been vindicated in preceding suits. The particular feature alleged to be infringed was that covered by Claim 8 of the patent, which calls for the combination of a trolley frame and wheel with metallic conducting brushes between the hubs of the wheel and the frame The specification provides for brushes connected at their

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base with the cross bar of the trolley frame at each side. The first diagram in the specification shows the brush connected at its base with the inside of the cross bar; the third diagram shows the brushes carried through the frame, so that the base of the brush rests on the outside of the frame. The defendants' device is identical with that of the plaintiff's patent, except that the base of the brush spring is made fast to the outside of the frame in a countersunk channel, and then carried inside the frame and extended to its position between the end of the hub and the frame. It will be noted that the claim does not attempt to restrict the manner of resting the brush spring. It only provides that the combination shall operate substantially as described. The defendants' device operates in a substantially similar manner. The Court decided that defendants' device was a palpable infringement, and therefore gave judgment for the plaintiffs.

**A New Society.**—For some considerable time past there has been a strong feeling on the part of the electrical engineers in the Post Office service that the great developments in every branch of telegraph and telephone engineering, and the increasing responsibilities of their position, justified the formation of an organisation which would enable them, by the exchange of opinions on matters of interest, to keep abreast of the rapid progress in various directions, and also to remain in touch with their colleagues, scattered, as they are, over the whole of the British Isles. A conference, attended by over 100 engineers, including the majority of the officers stationed within the metropolitan area, and also delegates from England, Wales, Scotland, and Ireland (the latter representing a staff of more than 200 engineers), was held in London on the 8th inst., when after a lengthy discussion it was unanimously resolved to form an organisation under the title of "The Society of Post Office Engineers." It was decided that the administration of the affairs of the society should be vested in the hands of a president, vice-president, treasurer, secretary, and a council of eight members. The following election of officers took place: president, Mr. D. H. Kennedy (London); vice-president, Mr. P. Jarvis (Sunderland); treasurer, Mr. J. M. Crawford (London); secretary, Mr. J. W. Atkinson (London). Arrangements were made for the election of the council at an early date, and a sub-committee, comprising the officers and five other engineers, was appointed to draft the rules of the society on lines indicated by the conference. It is anticipated that by means of lectures and papers the society will materially promote the interests of its members.

**New Publications.**—We have received the April number of the *Electric Club Journal* (Pittsburg), which contains articles on "Single-Phase Line Construction," by Theodore Varney"; "Electro-Pneumatic System of Train Control," by P. C. McNulty, jun.; "How to Remember the Wire Table," by Chas. F. Scott; "Protective Apparatus," by N. J. Neall; "Engineering Shorthand," by Geo. A. Wardlaw; "One Side of Construction Work," by W. H. Rumpp; a continuation of the series on "Factory Testing of Electrical Machinery," by R. E Workman; and "Taping," by C. Stephens. There is also an address delivered at the annual banquet of the Westinghouse apprentices by Mr. D. O. Hales, an apprentice from New Zealand. Mr. Hales, who has spent some years in an American workshop, contrasts the apprenticeship system of that country with that obtaining in England. On applying to an English electrical firm he was informed that they would take him for a three years' course in return for a premium of £300. In the States a large company not only provided him with the course without premium, but paid him while doing so. Mr. Hales thus summarised the advantages of the Westinghouse apprenticeship course: "First, I have had the chance of being a unit in a great organisation, and of observing some of the details of that organisation; second, I have come into personal contact with men who have distinguished themselves in engineering and scientific work; and I have worked with the working-man as a working-man." Mr. Hales considers the last of these a great factor, as when the apprentice becomes an engineer or manager he will be able to understand his men's character and environment much better.

**Motor Controllers.** — The Illinois Circuit Court recently gave its decision in the case of the Thomson-Houston Company *v.* the Morgan-Gardner Electric Company. Patent No. 393,323, granted in 1888 to George Herbert Condict for a system of control for electric railway motors, vests in the plaintiffs, who alleged that Claims 10, 21, 22, 27, 29, and 31 had been infringed. Claim 10 calls for a reversing switch, arranged in the same case with the controlling switch and "combined with a locking device which is operated by the controlling switch so that when current is flowing through the motors the reversing switch cannot be moved," but which can be moved when the current is substantially cut off, and which is operated simultaneously with the controlling switch and by the same handle. Claims 21 to 31 relate to a controller wherein "the regulation of the introduction of electric current to motors is effected by means of the combined use of both the rheostatic or dead resistance coils and live resistance coils, so adjusted as to avoid the loss of energy and the danger arising from sparking or short-circuiting during changes of circuit connection, and also by means of placing the manipulation of the current under the control of one handle or its equivalent device." The validity of the patent had been sustained in previous suits. Defendants not only denied infringement, but contended that the plaintiffs had been guilty of laches and were seeking to destroy competition. The defendants' device consisted of a controller and reverser in one case, governed by a single handle. The motors are protected from injury during change of current by the introduction of auxiliary resistance, and dead resistance and live resistance coils are used in combination. The Court held that any difference between the devices of the two parties was merely one of detail, the principle being substantially the same in both cases. The questions of laches and monopoly could not properly be raised in the suit. Plaintiffs would be granted the interim injunction asked for.

**Electrically-Heated Carbon Tube Furnaces.**—At the Faraday Society last week Messrs. R. S. Hutton and W. H. Patterson contributed a paper on this subject. The authors observed that this type of furnace seemed to be the most readily available for the very highest temperatures, and they had been able to get satisfactory results with a very simple type of construction. The important points to bear in mind are the end connections (which must be kept cool), protection of the tube from contact with air, and heat insulation. Two types of furnace were described as follows: Graphite tube furnace: this is bored from a solid rod of Acheson graphite and screwed into graphite plates which form the end connections, the latter being clamped to copper holders. The central thinner portion of the tube is surrounded with carborundum or other heat insulator, and the material to be heated is placed in small carbon boats. In a 1·5cm. tube (internal), 320 amperes at 9·6 volts melt platinum in 16½ minutes. Agglomerated carbon tube furnaces: these are more suitable than the former type when much experimental work has to be done, and the tubes can be readily obtained. The ends of the tubes (which are too hard to be worked) are coppered electrolytically and soldered to

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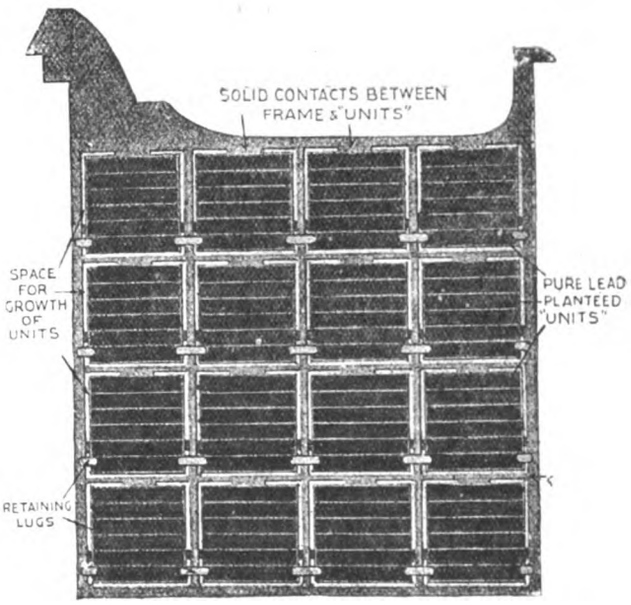
copper tube extensions, provided with water-jackets to keep the joint cool. Into these the current is led by copper clamps, and glass tubes for the passage of gases, etc., are connected by means of rubber stoppers. Carborundum kept in place with an external asbestos tube serves as the jacketing material, as before. Tube furnaces up to 67mm. internal diameter have been successfully made. It is hoped to use these in a vertical position, so that large crucibles may thereby be heated. In such a tube 850 amperes at 13 volts melt nickel in 12 minutes and platinum in 20½ minutes. In a special tube furnace for experiments in atmospheres of pure gases (free from carbon monoxide), the furnace proper is surrounded by an outer jacketed carbon tube, also provided with water-cooled copper extensions, and the joint between the two is gas-tight. Hydrogen is passed through the space between the tubes. In a later paper full details as to current and temperature measurements will be published.

**An Electrical Rolling Road.**—After some three years of experiment, an electrically-driven "rolling road" has been put into operation at Cleveland, Ohio, for the purpose of conveying loaded wagons up a steep incline. The "road" consists of a moving platform, 8ft. wide, which revolves around sheaves at either end. Its length is 420ft., and the elevation attained is 65ft. The promoters selected this as the most difficult site in order to thoroughly test the device. Four 40-h.p. compound-wound motors, operating under a single controller, are used to work the mechanism. It was essential that the motors should act in complete unison, as a slight variation in starting or stopping them, or in the speed, would be liable to distort the platform. The motors, which are arranged one at each end, with the other two between equidistant to each other, revolve at 850 revolutions per minute, and are provided with a 17 to 1 reduction gear. Each carries a sprocket chain 36ft. long, running over wheels at each end, and these in turn engage a large chain running the entire length of the platform. This is accomplished by placing teeth on the outer side of the motor chains, which engage the endless chain both above and below, so evenning up the pressure on the platform. The endless chain is placed in the middle of the belt, so that the power exerted is distributed evenly. The small chains, by engaging above and below at the same time, actuate a large portion of the entire length of the platform continually. Owing to the great weight of the platform—106 tons—it was at first thought that it would be almost impossible to operate it, but when it is considered that the returning half is descending the grade underneath the ascending half, it will be seen that the power required is only that needed to overcome friction and to raise the wagons. The motors may be worked in series or parallel, and are operated similarly to street car motors. The "road," which is described in the *Western Electrician*, is not kept in continual motion, as it is necessary to stop it for the vehicles to be driven on and off. It has been found that the contrivance is of great value in economising time in the district served. In view of the frequent stopping and starting of the roadway, we doubt if it has much advantage over an electric lift.

**Arc Lamp Improvements.**—An interesting discussion took place at a recent Chicago meeting of the American Institute of Electrical Engineers as the result of a paper by Mr. George A. Eastman upon numerous tests made by him to determine the most suitable size of carbons to be used with arc lamps of 5 and 3·5 amperes capacity. The author's tests have served to emphasise the conclusion that smaller carbons than are now common should be used. Mr. Eastman favours $\frac{5}{16}$in. carbons for lamps of five amperes and less. By the use of such carbons, as compared with ½in. carbons, he found that the efficiency is increased in the five-ampere lamp from 2·5 watts per mean spherical candle-power to 1·8 watts, while on the 3·5-ampere lamp such a reduction increases the efficiency from 3·4 watts with the ½in. carbons to 2·2 watts with the $\frac{5}{16}$in. carbons. With the smaller carbons it is impossible for the crater to wander from one side of the lamp to the other, as it does in the ordinary enclosed arc, due to the fact that there is not room on the carbon tips for much wandering at the crater. This makes the light of the smaller carbons very much steadier. In the ordinary arc lamp the light at any given point varies between maximum and minimum values in the ratio of at least 1 to 3, because of the wandering of the arc between the blunt carbon ends. Another important gain by the use of smaller carbons is in the colour of the arc. The light is much nearer the sunlight in quality with the smaller than with the larger carbons, because with the latter the arc has a violet tint. The author found that any outlay occasioned by increased cost of trimming or higher price of the smaller carbons was more than counterbalanced by their higher efficiency. Mr. V. R. Lansingh described recent attempts to correct the natural distribution of light around an arc lamp so as to better adapt it to street-lighting where it is desired that the greatest amount of light shall be thrown about 15deg. below the horizontal, instead of 40deg. as in the ordinary direct-current arc lamp. He had found that the best combination of clear and opal globes for outdoor lighting was provided by an opal inner and a clear outer globe. As far as the ordinary types of globes were concerned, the illumination at great distances away from the arc, as in street-lighting, was much better with this combination than with clear inner and outer globes. The best results were obtained with a new type of Holophane bell shade of rather peculiar design.

**Accumulator Plates.** — A type of accumulator termed the "Unit" has been designed by the National Battery Company, of Buffalo, N.Y., having for its object the prevention of abnormal chemical deposits on the positive plate.




These deposits often lead to distortion of the plate. The Unit accumulator, which is described in the *Western Electrician*, is specially designed for high charge and discharge rates, combining long life and high efficiency, and is constructed in such a way that the units are firmly attached to a rigid frame, thus insuring full contact between the two during the entire life of the plate. Both sides of the accumulator are uniform, and in addition its mechanical structure is strong, holding the active material closely to it.

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The accompanying illustration shows one of the plates. Sufficient space is left on all sides of the unit to allow for the natural growth of the plate. This does away with buckling. In the construction of the positive plate no attempt has been made to prevent the natural growth of the active material portions. The units, or active portions, are hung in a rigid lead frame, with ample space at the bottom and at the two sides of each unit to allow for expansion without straining or distorting the supporting frame. The pasted type of negative has been adopted, and a grid developed in which the natural molecular shrinkage of the active material has been provided for and utilised so that the contact is maintained as the shrinkage progresses, owing to the fact that the active material enclosed in the contact portions is drawn more tightly around the grid projections or pins. A negative plate which loses its contact by shrinkage will cease to give its full capacity as this physical change takes place.

**Electromagnetic Clutch.**—A new type of electromagnetic clutch for machine-tool drive has been devised by the Williams Electric Machine Company, of Akron, Ohio, of which a description appears in the *Western Electrician*. The mechanism operates on the principle of the friction disc, the disc being clamped by magnetic action induced by the energising coil concentric with the shaft, as shown in the accompanying

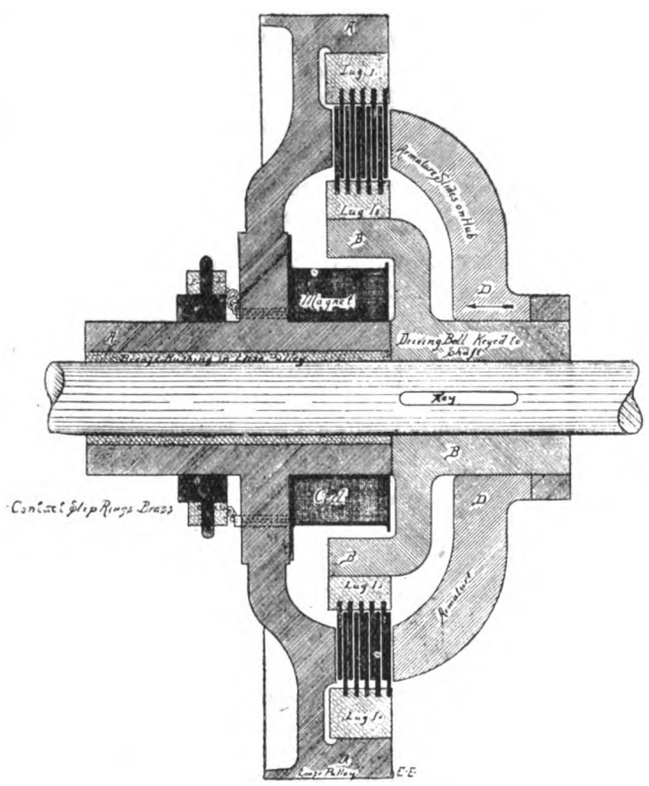


diagram. The magnet coil is energised through the contact slip-rings, and is enclosed in an oil and waterproof case, so that the clutches can be run in oil if required. Interleaved driving discs are mounted through their respective key lugs—one-half on the driving member, B, and one-half on the driven member, A. As the driving discs are loosely fitted to these key lugs, the armature, D, when magnetised by the action of the coil, slides on the hub, B, and presses against the driving discs and brings their surfaces into close contact. This action also reduces the reluctance of the magnetic circuit, and automatically increases the disc clamping effect, which in turn increases the transmitting power of the clutch. The multiple interleaved discs introduce into the magnetic circuit a number of minute air-gaps in series. On cutting off the current from the energising coil the release of the clamping effect on the discs causes these air-gaps to open, and the rotative action of the discs on the driving member accentuating this condition, the objectionable residual effect is entirely overcome. The gripping power of the clutch may be increased to practically any point desired by simply decreasing the resistance in series with the magnet coil, and thereby allowing more current to flow through it. The current needed to energise the magnet coil is quite small.

**Electric Railway Tests.**—The work of the St. Louis Electric Railway Test Commission is approaching completion, tests having been carried out respecting the alternating-current losses in rails, the efficiency of various methods of braking and accelerating both city and inter-urban cars, the energy consumption in cars with different kinds of service, and the resistance offered by the air to the motion of cars at high speeds. A feature of interest is provided by the special dynamometer car designed for the purpose of measuring directly the head and rear air-pressures and the side and roof resistances of car bodies. An ordinary car body is located upon a flat steel car frame by means of rails screwed to the floor of the frame, enabling the car body to move freely along same. A special steel vestibule and a standard vestibule are provided with this car. Under the side sills of the dynamometer body are mounted eight Chapman double-ball bearings, and these carry four axles of $3\frac{7}{16}$in. diameter, 9ft. long. Upon the axles are specially chilled wheels 12in. in diameter with ground treads. The rails are also ground where they come into contact with the wheels. By this method of mounting there is, for practical purposes, no friction between the body and the flat car floor. The body is restrained from excessive motion by various effective safety devices. The pressure of the air upon the body is measured by means of scale beams, which are supplied with dash-pots, and the weighing mechanism consists of the regular beam with weights and poise. A spring balance with dial is employed to render easier the manipulation of the machine. For the purpose of separating the head and rear resistances from the total the vestibule is independent of the body, but is carried therefrom by means of a link suspension. In order to guide the vestibule and to transmit the pressure to the weighing device, a steel-trussed oak frame, attached to the vestibule, projects into the car a distance of 8ft., and is guided on all sides by small Chapman bearings. To secure stability of the vestibule and body, each of these is held against the scales by counterweights, the forces of which are transmitted through bell cranks and levers, all equipped with knife-edged contacts. In order to gain exact results two independent plans are employed. The test track, over 25,000ft. in length, is divided into sections of 1,000ft. each. The instant of passing each section is indicated on the graphical record of a General Electric ammeter, which is also used for the current record. This ammeter records upon a strip of paper at regular intervals of five seconds each. Upon this record is superimposed the time of passing each of the sections, this being accomplished by closing a switch for an instant as each of the sections are passed. Thus the time of passing through a section is accurately recorded. The second speed device consists of a small dynamo carried upon the truck frame and geared to the car axle. It has permanently magnetised field poles, but these also carry exciting coils, through which the field current of the recording ammeter is also passed. The E.M.F. generated by the dynamo is read upon a specially arranged voltmeter, the readings being directly proportional to the speed. The tests will continue until sufficient data are available to determine the air resistance to the motion with different shapes of car front at all speeds up to 70 miles an hour.

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**The Tantalum Lamp.**—Some tests on tantalum lamps are described in the *Electrical World* of New York by Messrs. A. E Kennelly and S. E. Whiting. Ten lamps were obtained from Messrs. Siemens and Halske, all of which had frosted globes, and were understood to be of 110 volts and 22 c.p. Figs. 1 and 2 indicate the behaviour of one of these lamps in regard to resistance, current, power, luminous intensity, luminous efficiency, and specific consumption. The corresponding data are indicated also, in dotted lines, for an Edison carbon-filament lamp nominally of 120 volts, 16 c p, and 3 1 watts per candle, in a frosted globe. This particular lamp was taken at random from a number of similar lamps which had been in service about 50 hours. The tantalum filament had an initial resistance of about 55 ohms at the normal room temperature and lowest voltage. It rose rapidly at first, and afterwards more slowly as the terminal voltage increased. The highest resistance observed was 316 8 ohms at 143·3 volts. The resistance was still rising at this point, as shown by the curve. Whereas, therefore, the carbon filament falls,

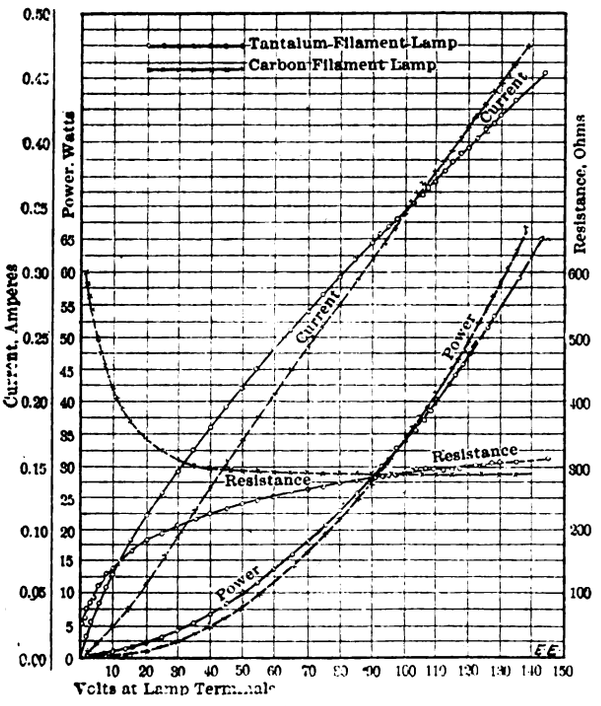



FIG. 1.

under operation, to about half its cold resistance, the tantalum filament rises, under operation, to about 5½ times its cold resistance. On this account the initial rush of energy into the tantalum filament must be about 10 times as great as in the carbon filament. The time allowed for the tantalum filament to reach its working temperature is, by inference, materially less than for the carbon filament. It would be interesting to investigate, from this standpoint, the possible influence of frequent turning on and off upon the lifetime of the tantalum filament. Under operative conditions the carbon filament has sensibly constant resistance for the working range of voltages. The tantalum filament increases in resistance about one-fifth of 1 per cent. per volt increase of terminal pressure, in the neighbourhood of its normal working voltage. On this account, a given percentage increase of voltage on the tantalum lamp will not produce the full corresponding increase in current strength. Thus, an increase of terminal voltage of 5 per cent. would increase the current only about 3¾ per cent. Such a property is valuable, since it tends to regulate automatically the current strength passing through the lamp under variations of line voltage. The effect in these tantalum filaments is not, however, very marked at their normal working point, and not so great as the curve shows it would be at a much lower pressure, say at 20 volts. Here an increase in voltage of 5 per cent. would cause an increase in current of only 2¾ per cent. The curve of current strength in the carbon filament is not far from a straight line through the origin. The corresponding curve in the tantalum filament starts rapidly, but droops considerably owing to the increase of resistance.

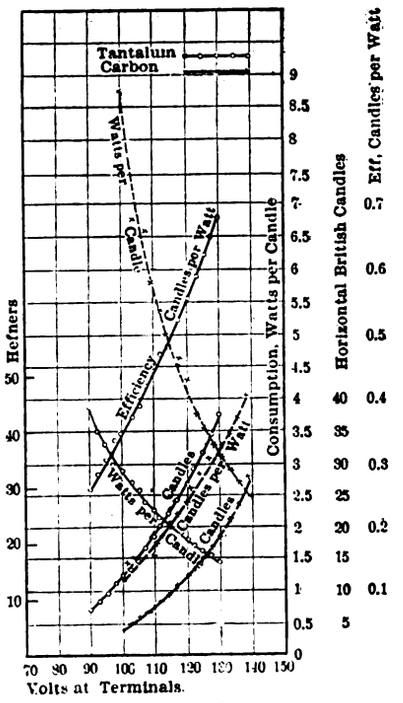
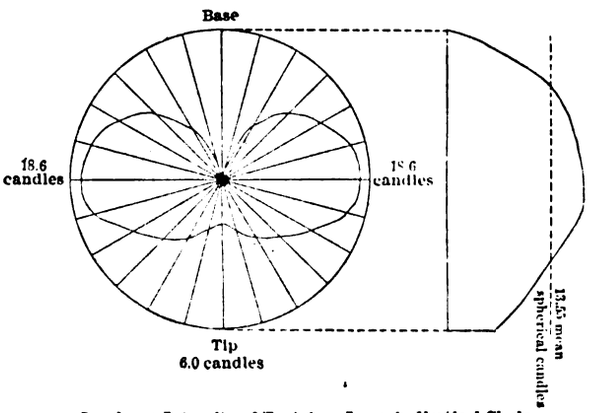



FIG. 2.

The slope of the current is greater finally in the carbon filament than in the tantalum by about one-third. This is due to the self-regulating property referred to under resistance. The tantalum lamp became appreciably luminous at a terminal E.M.F. of 9·5 volts, or about 9 per cent. of its normal working voltage. The carbon filament became luminous at 24 volts, or about 20 per cent. of its normal voltage. The curves of Fig. 2 show that the horizontal candle-power of the tantalum lamp is markedly greater than that of the carbon lamp. The luminous efficiency, or candles per watt, of the tantalum lamp is also markedly greater than that of the carbon lamp tested, frosted globes being used in each case. Thus at 110 volts the tantalum




Luminous Intensity of Tantalum Lamp in Vertical Circle.

lamp consumed 2·2 watts per candle, while at 120 volts, the normal for the carbon lamp, the latter consumed 4·3 watts per candle. The normal efficiency of the frosted tantalum lamp was, therefore, nearly double that of the frosted carbon lamp. No information is at present available as to the relative lives of the two types, but it will be seen that the general results greatly favour the new lamp.

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## ARMATURE WINDINGS OF THE CLOSED-CIRCUIT TYPE.

BY WM. CRAMP.

(*Concluded from page 511.*)

CLOSED-CIRCUIT WINDINGS FOR ALTERNATORS.

**General Connections.**

It is immediately apparent that if a bipolar Gramme ring be tapped at two points at opposite extremities of a diameter, and the tappings be connected each to a separate slip-ring, that a single-phase alternating current may be taken from the slip-rings. Similarly, if two more tappings at right angles to the first two be connected to two more rings, another single-phase current differing in phase a quarter period from the former may be collected. In this way a two-phase armature is obtained.

Three tappings at 120 deg. connected to three slip-rings will give a three-phase current, and generally $n$ tappings on the winding $\frac{360 \text{ deg.}}{n}$ apart are necessary for an $n$-phase current.

This is the foundation of all rotary converters which usually have the armature winding connected down on one side to a commutator, and on the other to the requisite number of slip-rings.

The principle just explained may be applied to all those windings which have already been discussed for direct-current machines. In the general case of multiple-circuit windings, we have only to reckon the distance from the centre of one north pole to the centre of the next as 360 deg. and apply the rule given above. Of course, each slip-ring in this case will have one connection to the winding per pair of poles, so that the armature remains *multiple-circuit* from the point of view of the *alternator*, just as much as for the direct-current machine.

Similarly, a double or, generally, a multiple winding on a multiple-circuit armature may be tapped to yield an alternate current. *A tapping must be made to each slip-ring for each winding per pair of poles.* It is not uncommon to make these slip-ring connections to the commutator instead of to the actual coil, but the principle is the same. Sometimes it is not possible to give to each phase exactly the same number of inductors; but it is disadvantageous to do otherwise. Fig. 13, for instance, which has 62 inductors, would be very difficult to connect to three slip-rings; each ring would have to be connected to four points on the armature since it is four-pole and double-wound, and these connections should be regularly spaced; but in that part of the armature lying between a pair of north poles there are only $15\frac{1}{2}$ inductors in each winding, consequently we should have either to make a connection to the centre of the inductor, which is practically impossible, or have the three phases slightly out of balance. Fig. 11, for similar reasons, is difficult for three-phase, but easy enough for two-phase connections.

It will be remembered that Fig. 11 is the drum winding developed from the ring of Fig. 10. If, then, we arrange for the slip-rings in Fig. 10, we can transfer the connections afterwards to Fig. 11. Considering one phase alone, it is obvious that when the alternating electromotive force is a maximum, the connection to the slip-ring must be made to the section under the brush. Consequently for the first slip-ring of one phase we shall need connections to the pair of spirals $C^1$ and D, and to those diametrically opposite, E and F; and for the other ring of the same phase we shall need connections to G and H and K and L. So that for a single-phase current alone we require eight connections, four to each slip-ring. Of course, had there been a single winding and a four-pole multiple-circuit machine, four connections per phase (two per slip-ring) would have sufficed. Passing to the connections for the other phase, it is clear that these must be made midway between the connections of the first pair of slip-rings; so that to one ring of the second phase will be joined $A^1$ and B, M and N, to the second ring of the same phase P and Q, R and S. These tappings might easily have been made from the commutator.

In the corresponding drum we commence by selecting such an inductor as A (Fig. 11) to represent A in Fig. 10, and we remember that one spiral of the ring armature is represented by two inductors on the drum, so that we simply have to count round from A; and where connections have been decided upon for the ring, there will they be marked on the drum. Assuming that the slip-rings are to be put at the opposite end of the armature to the commutator, we obtain $C^1$ and D, E and F, for the connections to one ring, and G and H, K and L, for the other ring of the same phase. The letters $A^1$ and B, P and Q, R and S, E and F, correspond to the same letters in Fig. 10.

Since there are in all four equally spaced slip-rings, and to each ring there are four connections in pairs, it follows that having chosen any two neighbouring inductors not in the same winding for the first two connections, the correct places for the others are spaced with a number-pitch of 8 reckoned continually forward.

We then get this rule for connecting slip-rings to a multiple-circuit drum.

If $r$ be the number of rings, $w$ the total number of inductors, $m$ the number of windings, $p$ the number of poles, choose any $m$ neighbouring inductors, one in each winding, to be connected to the first ring. Then the other connections to that ring are taken with a number-pitch of $\frac{2w}{p}$ from these.

The connections to the next of the $r$ rings will be made from each winding at a number-pitch $= \frac{2w}{rp}$ from the corresponding connection of the first ring, and so forth for each slip-ring. Thus, in Fig. 11, if connections $A^1$ and B are decided upon for the first connection to the first ring of a two-phase machine, the next connections to the same ring will occur at a pitch $\frac{2w}{p} = \frac{2 \times 64}{4} = 32$ from $A^1$ B. This will be found to give the connections N and M. Similarly, the first connections to the second ring will occur at a number-pitch $\frac{2w}{rp} = \frac{2 \times 64}{4 \times 4} = 8$ from $A^1$ and B.

It must be remembered that a two-phase machine requires four slip-rings, and therefore might be more correctly styled a "quarter-phase" machine.

The slip-rings are in a multiple-circuit winding connected to each winding at each pair of poles. This is seen from the example just taken (Fig. 10) to be absolutely necessary, since because the winding is closed, there must always be at least two circuits on the alternate-current side; while, on account of the connection of the winding in the multiple-circuit type, there will be as many pairs of circuits as pairs of poles

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for each winding. This is exactly in accordance with what has been already explained for the direct-current forms of these armatures, and therefore we need not dwell longer on it here.

**Ratio of Electromotive Forces in Direct and Alternate Current Armatures.**

The maximum electromotive force which can occur between any two slip-rings is the same as that which exists between the brushes for a similar continuous-current winding when they are properly set. This naturally is the peak of the alternate-current wave, and its ratio to the root mean square value of the wave is 1 : 0·707 : consequently any armature giving, when arranged for continuous current, 200 volts will for alternate-current work as a single-phaser give 141 volts. This ratio is quite independent of the number of windings or their connection, and therefore holds equally for multiple and for two-circuit windings.

**Connection of Slip-Rings to Two-Circuit Windings.**

The same reasoning applies to the case of two-circuit armatures, modified only in virtue of the fact that for each winding there are never more than two paths through the armature, and consequently there is never more than one connection per ring per winding. As an example, we may take Fig. 14, in which, for a single-phase current, connections would have to be made to two such inductors as 18 and 4, and they might be arranged at E and F as shown in the figure: the potential difference between the two positions varying, as the armature rotates, between a maximum and zero. This armature, having 18 inductors, is not easily arranged for two-phase connections; but by dividing the inductors in *order of their connection* into three equal groups (which may easily be done from Fig. 16) we arrive at three connections, such as E, M, and L, which would be the tappings necessary for a three-phase current. It is thus seen that, if from this armature we wish to take *either* single-phase *or* three-phase current, we need four tappings and four slip-rings. In multiple-wound two-circuit armatures one tapping per ring per winding is required; so that if we were to use the armature of Fig. 22 for single-phase work we should connect one slip-ring to A and $A^1$ and the other to B and $B^1$, since the inductors connected to either of these pairs lie one in each winding. No difficulty can occur in finding connections on these two-circuit armatures if we set out the inductors as in Fig. 16 for each special case.

**Frequency given by these Windings.**

Although the multiple-circuit winding remains a multiple-circuit for alternate-current work and the two-circuit remains two-circuit, yet this does not interfere with the fact that any section of the winding lying between two slip-rings undergoes in every revolution as many periods as there are pairs of poles to the machine. Thus, whether the armature is multiple or two circuit, the frequency is the same, provided that the speed and number of poles is the same. The frequency is given by $f = \frac{n p}{2}$, where $n$ = revolutions per *second* of the armature, $p$ the number of poles.

**Conclusion.**

Although throughout this exposition of the laws governing the usual forms of modern closed-circuit armature windings many points have been passed over which might have been enlarged upon, yet we feel certain that if, instead of making a blind use of winding tables, the designer refers his difficulties with multiple-circuit windings to a corresponding ring diagram, and his troubles with two-circuit windings to our corresponding development (like Fig. 16), a more complete understanding and increased self-confidence is likely to result. It is surely far better to remember how to derive formulæ and check the result, than to depend upon having a particular set of tables always in the right pocket.

## THE POWER PLANT OF A MODERN RAILWAY TERMINUS.

### The Terminal Railroad Association of St. Louis Union Station.

**To the casual observer the design and equipment of a railway terminus power station presents problems of no greater difficulty than are ordinarily encountered in the usual power plant. Upon closer examination, however, there is found to be a marked difference. In the one, a single definite service is contemplated, one subject to large fluctuations and rapid increase; while in the other, multifarious needs of widely diverse character must be provided for. Furthermore, interruptions of service must be diligently guarded against, for they so seriously interfere with the operative functions of the establishment as to render valuable almost any reasonable preventive. Not long ago an exemplary power plant was placed in operation in St. Louis, U.S.A., for serving the entire terminus properties of the Terminal Railroad Association, which controls transcontinental as well as other traffic centering in St. Louis. Only in 1902 was the enlargement of the terminus decided upon, but within the short time preceding the opening of the exposition it was to a great extent remodelled, and now ranks among the largest of the world. The magnitude of the undertaking can only be appreciated by a careful study of the service conditions and the present equipment, which are briefly outlined in the following, although but one branch of this subject—the power station—has been selected for full treatment.**

**The present terminus comprises a long principal building containing the station proper and executive offices; a hotel fronting on Market-street; a 32-track five-arch train shed extending for a distance of 880ft. to the rear; a number of express, baggage, and mail buildings; signal towers situated in the middle of the train yard, controlling the two groups of throat tracks; and a power-house placed at one side of the property. A short distance from this site are situated engine-houses, transfer tables, and a coaling station. The reconstruction work comprised the enlargement of the train shed; the rearrangement of old and erection of new baggage, express, and mail buildings; the construction of a new power-house; the building of a baggage transfer subway and of main branch subways connecting the power-house with the main and the several subsidiary buildings; the provision of an underground baggage transfer system, operated by 39 hydraulic elevators; and a Gray telautograph system for transmitting and recording train signals. The power for the above hydraulic elevators, and also that for the operation of the pneumatic system for transferring baggage checks between the main building and the railway, is supplied entirely from the power-house.**

SERVICE.

**The extreme diversity of service rendered by the present power-house equipment may be appreciated from the following enumeration, from which it will be seen that the operation of the entire terminus is largely dependent upon that of the power plant, from the heaviest power supply down to the small amount of current required for the signal and telautograph systems.**

**_Electric Lighting._—Arc and incandescent, alternating current = 1,100 primary pressure: main station building; train shed; mail building; five express buildings; coaling station; three engine-houses; three switch-houses.**

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*Electric Power.*—Alternating current, 1,150 volts, main distribution system; direct current, 500 volts elevator, and fan motors; direct current, 50 volts, signal systems, train lighting; main station building; three electric elevators, direct current; ventilating fans for hotel and station; exhausters for ventilation; dish-washing machinery.

*Switch and Signal System.*—Motor-generators.

*Train Lighting, Battery Charging.*—Motor-generators.

*Telautograph System.*—Motor-generators.

*Mail Building.*—Two elevators.

*Express Buildings.*—Sixteen elevators.

*Power-House.*—Coal crusher, coal elevator, and conveyor.

*Sixteenth Street Shops.*—Various motors.

*Three Engine-Houses.*—Various motors.

*Four Transfer Tables.*

*Coaling Station.*—Coal crusher; coal elevators and conveyor; ash and cinder elevator; green sand elevator and conveyor; dry sand elevator and conveyor; car puller.

*Compressed Air.*—Switch and signal system; car cleaning; air suction, 76-tube pneumatic check transfer system.

*Steam.*—High pressure for power-house machinery, 150lb.; car heating in yards, 60lb.; steam to kitchen; occasional building heating; exhaust steam for building heating.

*Water.*—General water supply; fire protection system; high-pressure system for 39 4,000lb. baggage elevators.

## Equipment.

If there is one feature of the power equipment which may be termed characteristic, it is that of duplication of important functions. This has not been carried to the extent of extreme complication, but rather to a point where in the light of past experience the advantages derived have been found to give the greatest insurance against breakdowns with least complication. Thus the generators, exciters, rotaries, air-compressing systems, pumps, and heaters, are installed in duplicate or multiple. Shut-downs from piping failures are insured against by sectioning, and duplicate feed piping is provided. Further, automatic or semi-automatic systems and labour-saving devices are largely used in order to reduce to a minimum the work of the staff and the cost of operation. Thus lubrication is accomplished by gravity systems; coal is fed to the boiler furnaces by mechanical stokers with gravity fuel feed; and both coal and ashes are handled by power-driven machinery. The selection of the machinery and the general design of the plant was influenced by the special, rather than the general, requirements of the installation. For example, the plant was equipped with non-condensing engines, not only because no condensing water was available, but also on account of the fact that the exhaust steam would be highly convenient for heating purposes in the buildings, doing away with the necessity for live steam except in the coldest weather. For the same reason steam-driven auxiliaries are largely used, the exhaust steam being either returned to the feed-water heater or in part to the steam heating system.

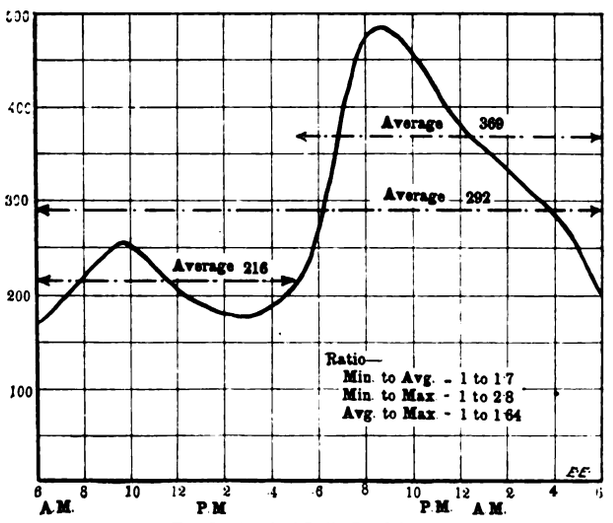


FIG. 1.—Typical Daily Load Curve.

## Electrical Equipment.

Owing to the necessity for variable speed motor drives in the electric elevators a direct-current supply was preferable, but the main distribution system for lighting and general power covers so large an area that polyphase alternating current was adopted for the main current supply of the station, and in this manner the lowest possible distribution loss for the system as a whole secured. The direct-current supply is furnished through the medium of rotary converters controlled from the main switchboard, while the alternating-current load is handled by individual feeders directly at generator potential—viz., 1,100 volts. In spite of the diversified service, the composite electrical load upon the plant resembles very closely that of the usual central station, with the exception of a higher all-day average in comparison with the peaks. This is shown by the load curve (Fig. 1) for July 5, 1904.

## Compressed-Air Service.

An idea of the importance of this section may be gained by the following facts relating to the signal system. For controlling the various switch movements 503 air-cylinders are required, each taking from ·06 to 1·5 cubic feet of free air per stroke. Each train entering the station occasions from three to thirty or more switch movements, averaging 15. During July the train movements averaged 496 trains per day, totalling 2,193 cars, but during the rush hours a maximum of 158 trains per hour was observed, which is equivalent to one every 23 seconds. Compressed air is also largely used for cleaning car cushions, for which purpose outlets are provided at numerous points where hoses may be attached.

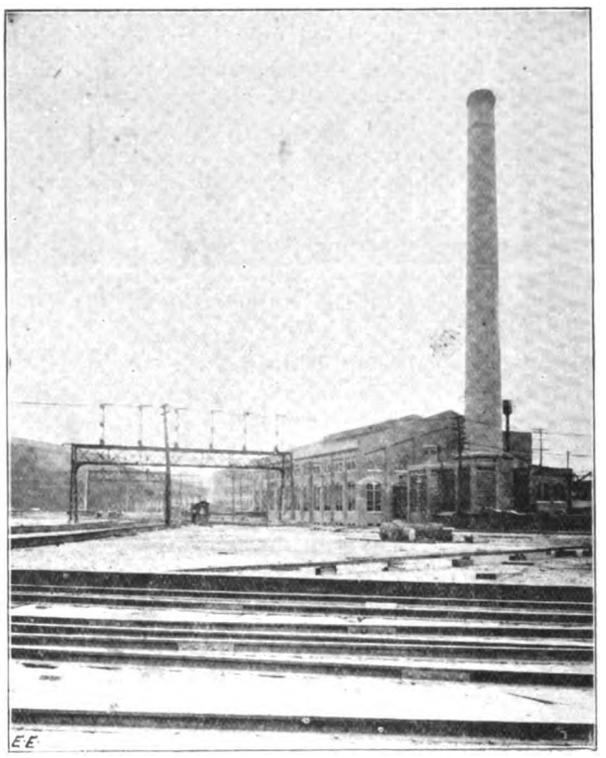

FIG. 2.—General View of Power Station.

## Power-House Building and Distribution Tunnels.

The accompanying illustration (Fig. 2) gives a general view of the power-house. From this building a subway extends to the left, where it turns at right angles, continuing down the centre of the train shed, with other branches to the express buildings. This main tunnel aggregates 700ft. in length, is 12ft. in width, 9ft. in height, and of concrete construction, with steel roof beams. The power-house building has been rendered fireproof throughout by the use of concrete-steel construction, tile roof, steel roof trusses, and concrete-steel coal and ash bins. For all supported flooring, reinforced concrete arches are used, and solid floors are surfaced with concrete. At the rear end of

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the boiler-room is situated a small pump-house addition, containing heaters, feed pumps, and fire pumps, and outside the building, opposite the coal elevator, is an elevated ash-storage bunker, placed directly over the spur track paralleling the building wall, so that coal may be unloaded and ash loaded from one position of the hopper car.

some vacant space for extensions. The generating units alone occupy less than 19 per cent., including liberal passageways, or 1·35 square feet per electrical horse-power.

### Details of Boiler-Room Equipment.

The accompanying illustration of the boiler-house (Fig. 8)

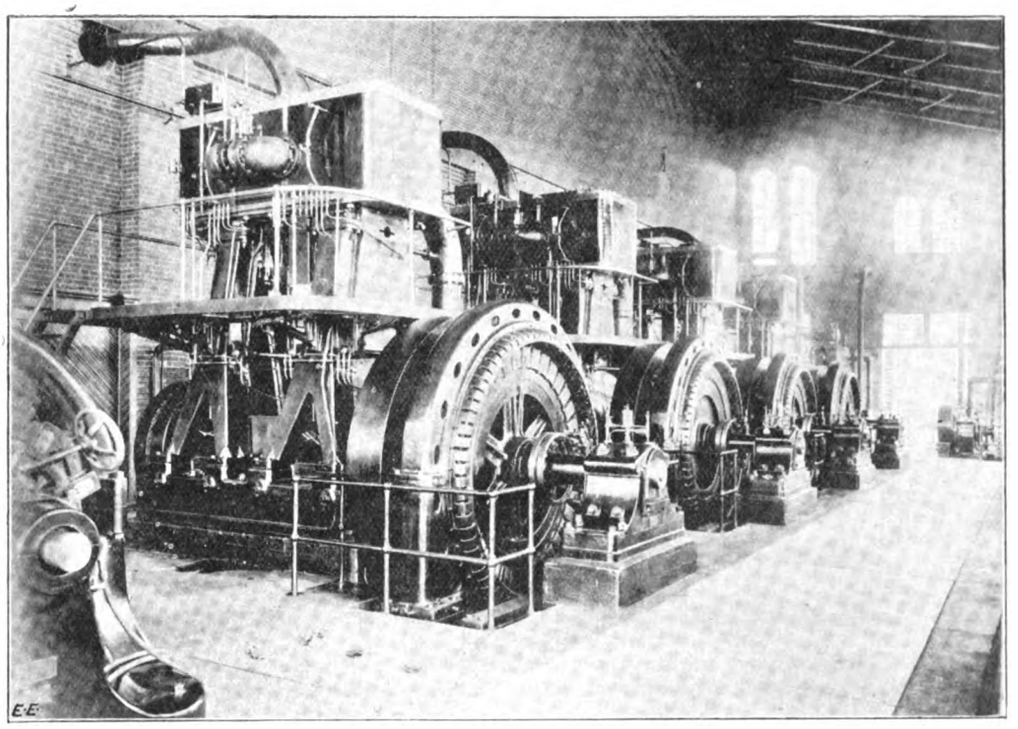

Fig. 3.—Front View of Main Power-Generating Units.

The power-house occupies a total of 13,660 square feet inside the walls, of which 53 per cent. is devoted to the boiler plant and 34 per cent. to the electric power machinery, the remainder, 13 per cent., being occupied by the compressors. This is equivalent to 1·8 square feet per electrical horse-power for the electric power equipment and 2·62 square feet per boiler horse-power for the boiler plant. The 34 per cent. includes the floor space necessary for generating and exciter units, rotaries, switchboards, and

shows the general arrangement. The two Babcock and Wilcox boilers in each battery are suspended from a structural framework free from the setting. At the front independent supporting columns are not used, the drums being hung from gusset plates riveted to the longitudinal girder supporting the side wall of the coal bunker. The stokers are of the well-known Roney inclined rocking-grate type with coking arches, which assist in gasifying the green fuel, thus preventing smoke. They are operated by two small

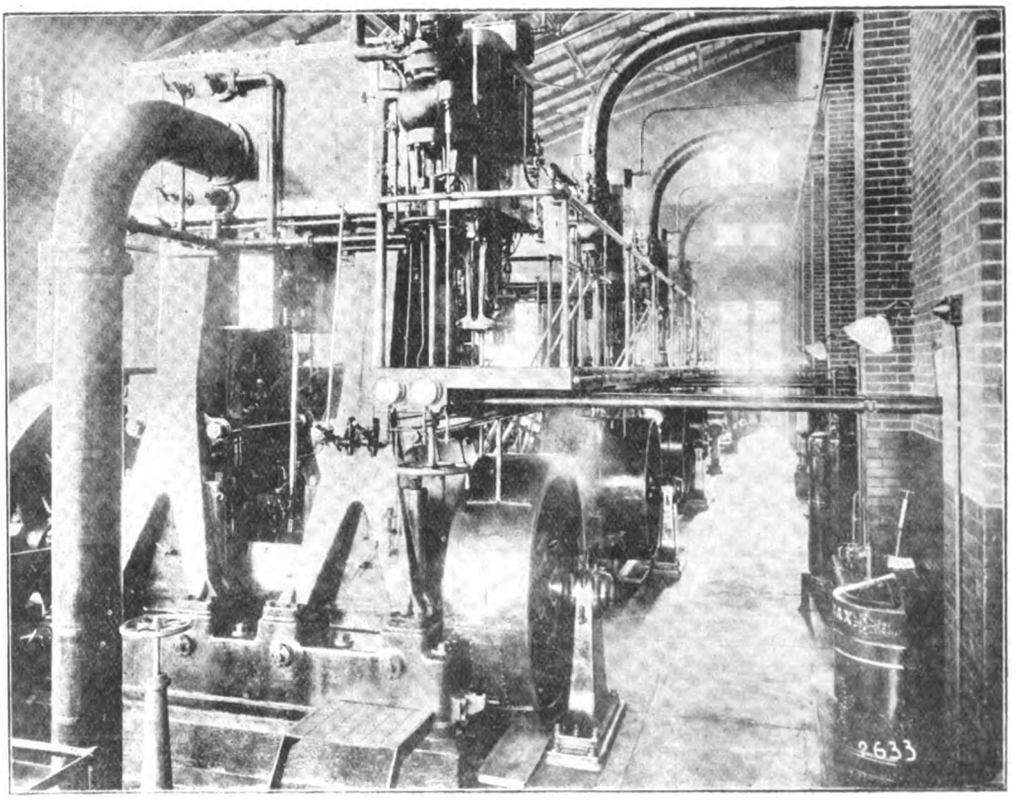


Fig. 4.—Rear View of Main Power-Generating Units.

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"Standard" engines, each of which normally works half of the stoker equipment, although couplings are provided in the line shaft so that their connections may be interchanged if necessary. Coal is fed by gravity from the bunkers above, being conveyed by shoots (as shown) to the hoppers. These shoots may be swung back when the boilers are to

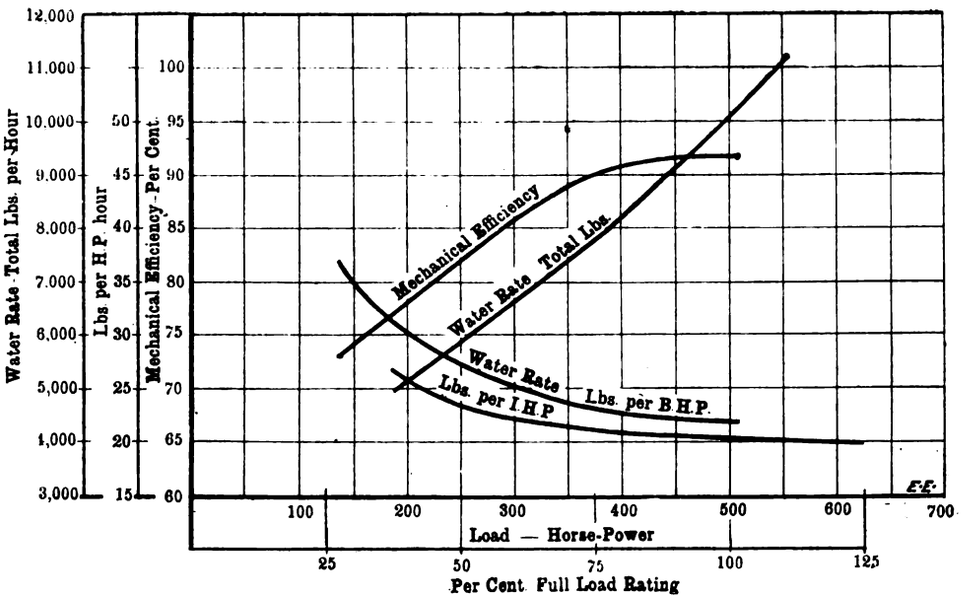


FIG. 5.—Performance of a 500-h.p. Westinghouse Marine Type Compound Engine (non-condensing).

be cleaned, at which time the gates at the top are used to shut off the coal supply. Ordinarily they are left open. A single vertical conveyor handles both ash and coal, which is distributed by a deflecting gate at the top, the ashes gravitating to the ash bunker outside and the coal to the belt conveyor traversing the length of the coal bunkers. Ashes drawn from the stoker pit are conveniently transferred by means of Koppel cars to a hopper in the floor communicating with the elevator boot, and covered by a cast-iron grating. Coal may be delivered from the hopper cars either through the crusher or not, as is desired, and provision is also made for receiving coal from wagons. In order to manipulate one or several trucks standing upon the siding without the assistance of a locomotive, a steam-driven winch is used, placed, as shown in Fig. 9, at the end of the boiler-room. A cable from this winch extends for some distance into the yard and round a pulley, doubling back along the building wall for such a distance as may be necessary to pick up the car in question. A considerable saving in the quantity of water required for boiler cleaning is made by returning the dirty water to a sump well through floor gutters. After settling, the water is skimmed while overflowing into a tank, from which it is again pumped to the boilers. By this means the entire row of 10 boilers may be washed with one change of water.

*Piping.*—Two steam mains extend the entire length of the boiler-room, one a 12in. header and the other a 6in. auxiliary. The main header is sectionalised by valves between each battery and at the centre, while the auxiliary is sectionalised only at the latter point. The mains are tied together at both ends and also near the centre. Main engines, exciter engines, air-compressors, and hydraulic pumps are ordinarily supplied from the main header; but in cases of accident one exciter, one compressor, and the hydraulic pumps may be driven from the auxiliary main. Combination globe-check valves in the boiler risers prevent back flow of steam in case of accident to any one boiler. The entire pipe system is suspended from the roof trusses, long runs being anchored at the centre; and in the case of branches, necessary lateral flexibility is secured by 6in. lengths of screwed pipe at the junction with the mains (see Fig. 9). The auxiliary main is fed by 2in. connections with its checks and valves tapped directly into each boiler header. This practically debars the possibility of steam supply being entirely shut off from the high-pressure system. Water-pockets are purposely formed at the ends of each steam main, which are drained by a steam loop and Holly gravity return system. This system also drains all valve pockets, engine throttles, and the entire high-pressure system of piping, the drips being automatically returned to the boilers by the differential pressure of the system. All important valves may be operated from iron galleries supported from the roof, as shown. These are 24in. wide, and are constructed of flat iron bars set on edge with 1in. spacing. Iron ladders and stairways of equally substantial construction are also used throughout the boiler-room. Steam due to boilers blowing off is prevented from escaping into the boiler-room by a conical discharge main connected to the several safety valves. This main varies from 4in. to 12in. in diameter, and runs the entire length

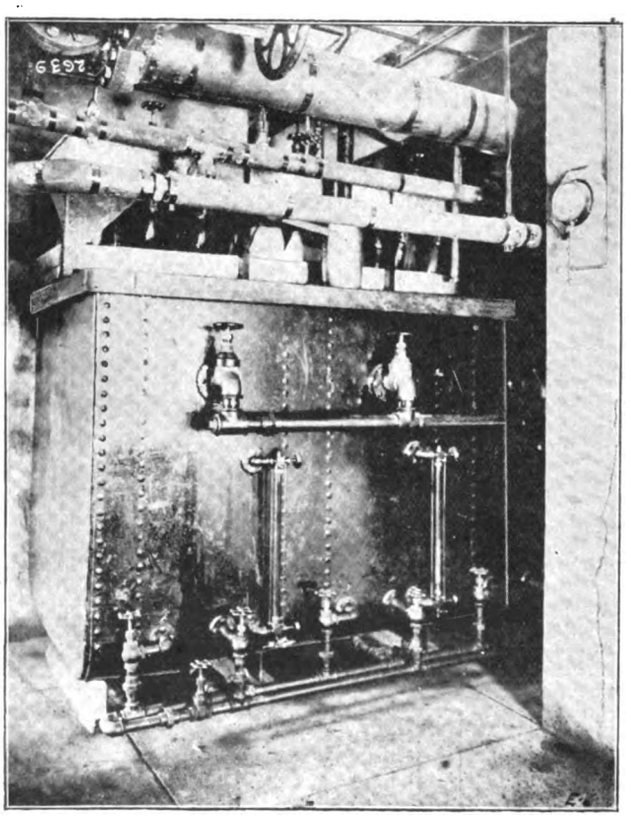

FIG. 6.—Oil Filters.

of the boiler-room, paralleling the other mains as shown in Fig. 9.

Unusual precautions have been taken in ensuring against interruptions of feed water. Two duplicate 6in. feed mains extend along the roof of the ash tunnel parallel with the boiler fronts. At each battery two 2½in. risers form a loop from main to main, with branches to the boiler drums.

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This arrangement, shown in Fig. 8, enables the feed for either boiler to be drawn from either main. The main exhaust line, a 16in., 18in., 20in. conical main, rests directly upon the engine-room basement floor, and discharges into the heating system at one end through a 20in. Cochrane separator, which removes the greater part of the oil from the steam used for heating purposes, and into the feed-water heaters at the other. This exhaust system, likewise the feed piping and heaters, are covered with magnabestos insulation. During cold weather the exhaust steam may be supplemented by live steam from two sources, a branch from the end of the main header, and an extension of the pump line, which latter may either be supplied from the main or the auxiliary steam line.

### Details of Engine-Room Equipment.

The main power generating units are well illustrated in the accompanying illustration (Figs. 3 and 4). Four units are at present installed, each of 500 h.p. normal capacity, and a blank steam connection has been provided for a fifth unit should it be found necessary to instal one in the future. The engines are of a type specially developed by the Westinghouse Machine Company for power station work—a medium power, high speed, compact, and efficient engine, and one well suited to this particular service. The general data of the engines are as follows: over-all dimensions—length 10ft. 2in., height 13ft. 10in., width 6ft. 6in.; cylinders—high pressure 17in. diameter, low pressure 27in. diameter, stroke 24in.; revolutions per

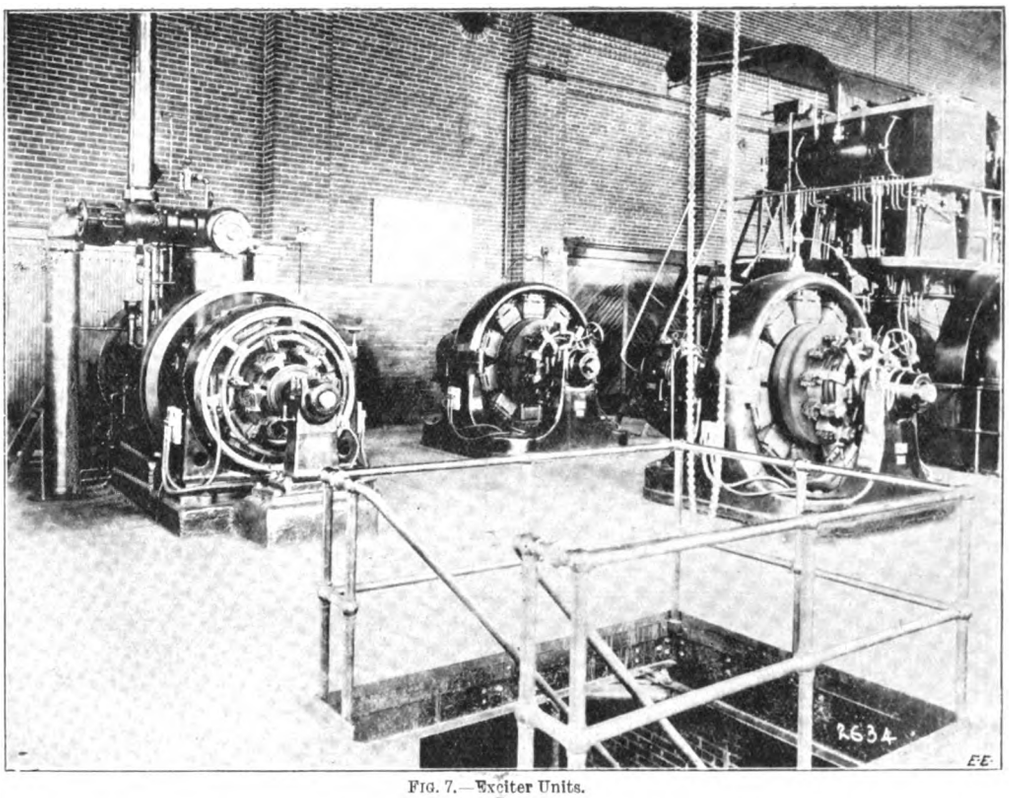


FIG. 7.—Exciter Units.

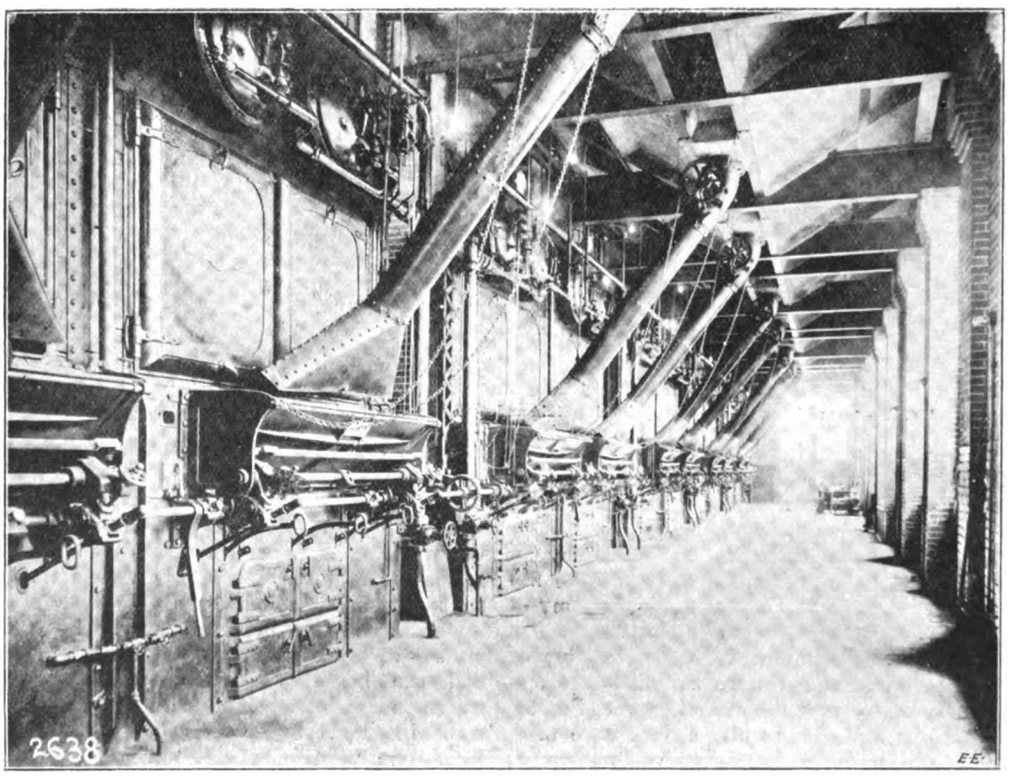


FIG. 8.—View of Boiler House, showing Stokers.

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minute, 200; piston speed, 800; volumetric ratio, cylinders, 1 to 2½; shaft diameter at bearings—crank 7·5in., generator 9in.; projected area of main bearings—crank 67·5 square inches, generator 189 square inches; ratio connecting rod to crank, 5 to 1; normal capacity, 500 h.p.; maximum capacity, 750 h.p.; weight of engine 75,000lb., with flywheel 90,000lb.; weight of unit, 100,000lb.; weight per rated indicated horse-power—engine 180lb., unit 200lb.; weight of unit per square foot of footing, 266lb.; floor space required—engine 82 square feet, unit 245 square feet; horse-power per square foot—engine 6·1, unit 2·04; steam pressure, 150lb; exhaust pressure, atmosphere; capacity of generator, 350 kw.

ABSTRACT OF EFFICIENCY TEST OF 500-H.P. ENGINE.—17 and 27 by 24 Marine Type Compound. The Westinghouse Machine Company, builders. Tested by Sargent and Lundy.

| | | | | |
|---|---|---|---|---|
| Brake horse-power | 136·1 | 267·3 | 391·5 | 508·0 |
| Indicated horse-power | 186·7 | 321·5 | 432·5 | 553·6 |
| Per cent. rated capacity | 37·4 | 64·5 | 86·6 | 110·6 |
| Mechanical efficiency | 73·0 | 83·25 | 90·5 | 91·8 |
| Water rate, total* | 4980· | 6985· | 8775· | 11130· |
| Steam per b.h.p. hour | 36·60 | 26·20 | 22·90 | 21·80 |
| Steam per i.h.p. hour | 26·63 | 21·70 | 20·70 | 20·01 |

Moisture, 1·3 per cent; steam pressure, 150lb.; reheater, none; jackets, none; valves, high-pressure balanced piston type, low-pressure double-ported bell slide; revolutions per minute, 200; cut-off high-pressure, variable; cut-off, low-pressure, constant; cranks, 90deg. * Non-condensing.

not over 16·7lb. per indicated horse-power. A few features of construction are of interest.

It will be observed that the continuous bed-plate is not used for the entire unit, but that engine, generator, and outboard bearings are supported by separate concrete piers built up from the common foundation. The bed-plate, which is of the heavy box type, is designed so that the three crank pits may serve as oil-wells to collect all oil drips, which are then conveyed by pipes to a filter and returned to the oil reservoir. Each bearing may be adjusted from the outside of the bed-plate by the wedge bolts shown in the illustration. By removing the cap and easing off the bearing wedge, the lower shell may be slid out on top of the shaft for inspection. A coupling on the crankshaft placed between the two cranks permits of the removal of the shaft without dismantling the engine.

All of the four engines are inter-connected by a cast-iron gallery, which also surrounds three sides of each of the units at a height convenient for getting at the throttle and lubricators. Each engine may thus be controlled from this gallery or from the floor, as may be most convenient. The exhaust pipe of the engine is fitted with a pedestal valve, shown at the left side of Fig. 4, so that the engine may be operated from one position. A small by-pass upon the main throttle valve provides for warming up the engine previous to starting, and a similar by-pass around this

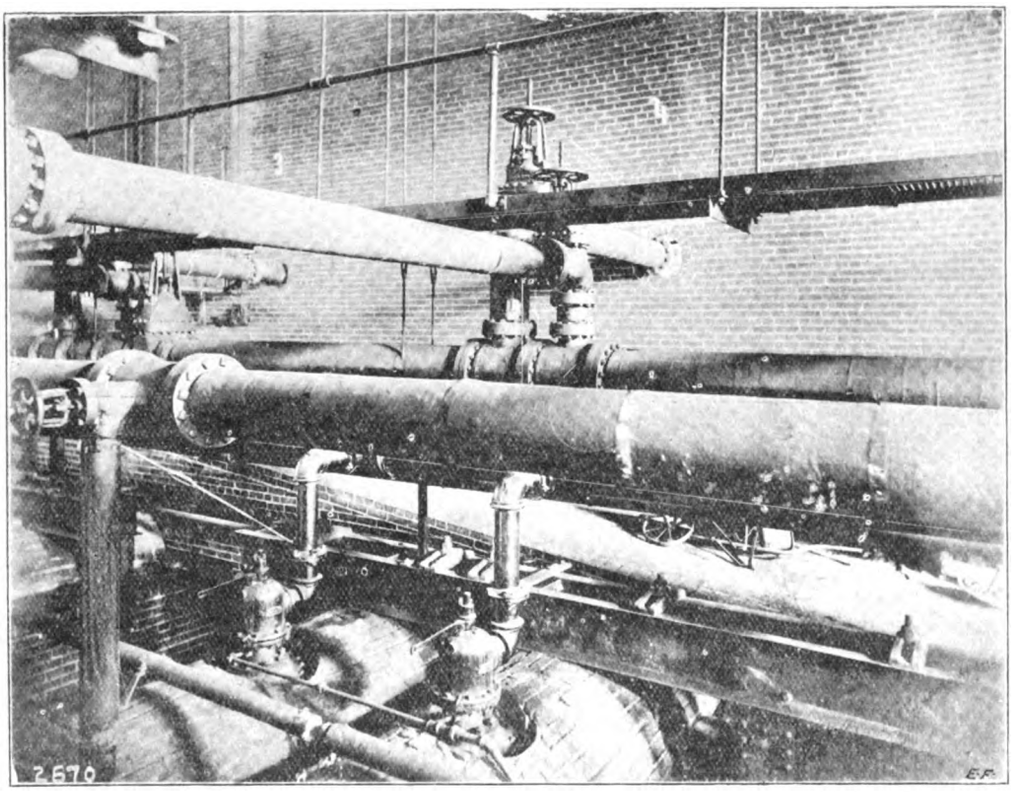

FIG. 9.— team Piping above Boilers, showing Main and Auxiliary Steam Line and Safety Valve Discharge Line.

The engines are capable of sustaining a continuous overload of 25 per cent. with a maximum of 750 h.p., or 50 per cent. for short periods. They were, of course, designed for non-condensing operation, having a cylinder ratio of only 1 to 2½. The speed is controlled by an automatic inertia shaft governor mounted within the flywheel at the throttle side of the engine. An economy of 20lb. of steam per indicated horse-power at full load has been obtained during tests conducted upon an engine of this size and type before leaving the works. These results are shown in the accompanying tables and curves (Fig. 5) It is of interest to note that the results shown have been obtained without infinitesimal clearances, valve arrangement, automatic low-pressure cut-offs, steam-jackets, receivers, or any of the refinements that are generally supposed to be responsible for economic performances. As a matter of information only, a series of condensing trials were run. Although obviously out of its element, the engine showed a steam consumption of 16·2lb. at a load of 430 i.h.p., and at all loads ranging from 300 h.p. to 550 h.p., pedestal valve into the exhaust main allows the drip and condensed steam to be carried off while the engine is idle without manipulating the large exhaust valve.

*Oiling System.*—One of the features of the power plant is the complete manner in which the lubrication of the machinery is taken care of by automatic means. In the case of the engine oil, a simple gravity head is depended upon to insure a constant supply. Two 500-gallon tanks are situated upon an elevated gallery in the boiler-room, and the height of oil in them is indicated by a gauge glass connection, shown on the engine-room wall in Fig. 3. Oil is elevated to these tanks from the filter in the basement by a small duplex pump (in duplicate), and after passing through a small cone filter of perforated metal, is delivered to a 2½in. brass oil main passing along the engine-room with branches to each engine. One of these is shown in the upper left-hand corner of Fig. 3. After reaching a small cast-iron reservoir on top of each engine, the oil descends to a main supplying the several manifolds, from which it is distributed to the various

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parts of the engine through sight-feed cups. As the oil head upon the system is constant at about 15ft., an adjustment of all the feeds once made is permanent, and a single valve in the feed pipe controls the entire system at each engine. The oil filter referred to above is shown in Fig. 6. It consists of a boiler iron tank divided into three compartments by baffle plates, these compartments being partly filled with water. Oil from the engine is first filtered through small canvas bags, 27 in number, and in passing around the baffles the remaining impurities are removed and deposited in the bottom, from which they may be drawn off at outlets provided in each compartment, as shown. A live steam connection to each compartment is used only during cold weather to maintain the mobility of the oil by heating it to any desired temperature. Cylinder oil is handled in a somewhat similar manner, except that it is under boiler pressure. A steel tank of 75 gallons capacity, and situated in the basement, is filled with cylinder oil through a funnel in the floor above, covered by a cast-iron floor grating. City water pressure introduced into this tank elevates the oil to a riveted steel tank on the engine-room floor, shown between the two pilasters in Fig 4, a check valve preventing the return when the water pressure is turned off. This tank is filled approximately once a week, and when full boiler pressure is turned on which forces the oil into a 1in. main running along the edge of the engine platform, with branches at each engine serving the throttle, receiver, cylinders, and glands. Steam pressure is taken directly from the main steam header through a pipe loop, carried up to the height of the roof trusses in the boiler-room and back to the oil-tank. This pipe loop is continually filled with condensed steam, and the differential pressure between boiler and throttle, combined with the static head due to the water column of approximately 20ft., ensures a good supply of oil to all parts of the engine. The automatic system does not, however, interfere with the usual methods of lubrication, as hand pumps are provided at each engine on both floor and gallery for the same purpose. The pressure tank may also be filled by hand if necessary, and the oil may be drawn off from this point through a convenient spigot. A 2½in. pipe connects with the oil filter, so that if desirable the cylinder oil may be purified in the same manner as the engine oil.

*Gauge Board.*—Another excellent feature of the engine-room is the gauge board, which is of uniform size with, and installed as part of, the electric switchboard. Upon this gauge board may be observed the operation of the several functions of the mechanical equipment as follows: boiler pressure, steam and exhaust heating, hydraulic supply and return, city water, and compressed air. All the above are indicating gauges. There are two recording gauges on the air pressure, for general uses and for the signal system. At present these services are combined, but provision has been made for separating them in case of mutual interference.

*Air-Compressors.*—The two compressors, which are of the compound two-stage type with a large intermediate receiver, deliver compressed air through independent mains to a condenser house near by. Here are installed two large air-storage tanks, automatically drained at the bottom, which finally distribute to four sets of condensers, where the air is cooled and the moisture precipitated before it is utilised in the switching system. These condensers consist of 38 vertical 2in. pipes in parallel between receiving and discharge headers. Each of the compressors has capacity to handle 2,000 cubic feet of free air per minute.

*Hydraulic Elevator System.*—The pumping machinery necessary for supplying the elevators is placed in the basement beneath the switchboards. Each of the pumps is of the duplex pressure pattern of 120 gallons capacity, and is automatically controlled by Mason regulators. One thousand gallons per hour will ordinarily be required for operating the 39 elevators. The hydraulic system is designed to stand 750lb. pressure per square inch, and either oil or water may be used. For the former, a storage tank of 14,000 gallons capacity is installed in an underground chamber connecting with the tunnel. All of the hydraulic piping is constructed with forged bends. A 6in. line conveys the high-pressure oil to the elevators, and an 8in. line returns it to the storage tank.

*Distribution.*—In the main tunnel a section, 3ft. 6in. in width, is reserved for the distributing piping and electric conduits, but only about 10 per cent. of the tunnel area is actually used. A typical section of the distributing system comprises the following: 20in. low-pressure steam for heating, 8in. heating return, 6in. steam for car heating, 4in. steam for kitchen, 6in. hydraulic supply, 8in. hydraulic return, 3in. compressed air, 27 tile cable ducts (laid in and covered with cement), telephone and signal wires. The various runs of piping in the tunnel are supported by flexible roller hangers of simple design. These consist of a short length of iron pipe hung from the roof beams by two eyebolts, and covered by a loosely-fitting pipe roller, upon which the distributing main rests. All of the pipe mains are usually anchored at approximately the middle point of straight runs. In one case, however, the length of the run has made necessary the use of a specially-designed expansion joint, which combines its principal function with that of an anchor.

### Details of Electrical Equipment.

A very complete switchboard controls the electrical system. It comprises several sections devoted to the main generators, exciters (Fig. 7), rotary converters, power and lighting feeders, and arc system. Each panel controls a single machine or feeder, which arrangement results in great simplicity, ease of operation, and absence of danger from confusion. Westinghouse type D oil switches are used on all the high-tension circuits, and small series and shunt transformers are placed in the meter circuits in order to avoid the application of high-tension current directly on the meters. The arc circuits are controlled entirely by plug switches. The generators are synchronised with the aid of a Westinghouse synchroscope mounted upon a swinging panel at the end of the board, or by the usual synchronising lamps. In breaking the generator fields the current is first shunted through an iron resistance until it has been reduced to a harmless nature, when it may be opened by the switch. The majority of the instruments are of the Westinghouse long scale, round dial type, but where confusion would be liable to result between alternating-current and direct-current meters, dissimilar designs are used.

### Operation.

The regular operating force of the power station consists of an engineer-in-chief, an assistant engineer, two engine-room and two boiler-room attendants. It is good evidence of the value of the several automatic and labour-saving appliances used in the plant that this small force of men is capable of successfully handling an equipment of such comprehensive character, where continuity of service is an item of such extreme importance. At the appointed time for transferring the power supply of the terminus from the old power-house to the new one above described, no hitch or interruption occurred, the two sets of switches being simply opened and closed respectively.

The establishment of the power plant, as well as the power reconstruction work at the terminus, has been entirely carried out by Messrs. Westinghouse, Church, Kerr, and Co., who have also acted as consulting engineers for the Terminal Railroad Association on this particular work.

## TEMPERATURE CURVES AND THE RATING OF ELECTRICAL MACHINERY.*

BY RUD. GOLDSCHMIDT, ASSOCIATE MEMBER.

*(Concluded from page 455.)*

Below an example is given to show the application of the rules just formulated. We intentionally adhere to the simple case of a field coil, only just referring to the subject of machine parts, in which we have to deal with the separate heating of copper and iron, and in which, especially before the final temperature is reached, the copper may be quite hot, whilst the iron is still cool—a subject which it is intended to deal with more fully in a separate paper. In principle there is no difference whatever in calculating the

* Paper read before the Institution of Electrical Engineers.

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temperatures of field coils or armatures, induction motor stators and rotors, or transformers.

*Example.*—A continuous-current generator has a current density in the field of 1·35 amperes per mm.², corresponding to an initial increase of 0·55deg. per minute. The field coil is dimensioned so that at normal watts the temperature rise is $t\,f = 45$deg. C. = 81deg. F., total ideal heating time $T_i = \frac{45}{0·55} = 82$ minutes = 1 36 hours.

The machine is to be submitted to the following test:

(1) 4 hours normal watts.
(2) 1½ hours 56 per cent. higher watts (25 per cent. overload in current).
(3) ½ hour 125 per cent. higher watts (50 per cent. overload in current).
(4) 2 hours normal watts.
(5) 4 hours shut down.
(6) 2 hours ½ × normal watts.

What is the temperature rise $t_1$ . . . $t_6$ at the end of the different periods?

(1) $T_1 = 4$ hours normal watts.
$t\,f_1 = 45$deg. C.

$$T_1 = 4 \text{ hours} = \frac{4}{1·36} = 3 \times T_i.$$

From Table V. we find at end of period (1) the final temperature $t_1 = 0\,95 \times t\,f_1 = 0\,95 \times 45 = 43$deg. C.

(2) $t_2 = 1\frac{1}{2}$ hours 56 per cent. higher watts.
New $t\,f_2 = 1·56 \times 45 = 70$deg. C.
Initial temperature $t_1 = 43$deg. C.

Total change of rise 70 − 43 = 27deg. C. $t_2 = 1\frac{1}{2}$ hours $= \frac{1·5}{1·36} = 1·1 \times T_i$.

From Table V. we find that at $1·1 \times T_i$, $0·65 \times 27 = 17$deg. C. is reached. Temperature at the end of the second period is $t_2 = 43 + 17 = 60$deg. C.

(3) $t_3 = 0·5$ hours at 2·25 × normal watts.
New $t\,f_3 = 2·25 \times 45 = 102$deg. C.
Initial temperature $t_2 = 60$deg. C.

Total range of rise 102 − 60 = 42deg. C. ½ hour $= \frac{0·5}{1·36} = 0\,37 \times T_i$.

From Table V. we see that at $0·37\,T_i$ $0·28 \times 42 = 12$deg. C. is reached. The temperature at the end of the third period $t_3 = 60 + 12 = 72$deg. C.

(4) $t_4 = 2$ hours at normal load.
New $t\,f_4 = t\,f_1 = 45$deg. C.
Initial temperature $t_3 = 73$deg. C.

Total range of drop 73 − 45 = 28deg. C. $t_4 = 2$ hours $= \frac{2}{1·36} = 1·47 \times T_i$.

By Table V., in 1·47 times $T_i$ − $0·73 \times 28 = 20$deg. C. of cooling down. Temperature at the end of the fourth period, $t_4 = 73 - 20 = 53$deg. C.

(5) $t_5 = 4$ hours shut down.
New $t\,f_5 = 0$.
Starting temperature $t_4 = 53$deg. C.
Total range of drop 53 − 0 = 53deg. C.

The cooling when the machine is shut down is in the ratio of 2 to 3 worse than with the machine revolving. Thus our ideal heating or cooling time, $T_i$, goes up in this ratio, say to $T_i^1$. $T_i^1 = \frac{3}{2} \times 1·36 = 2·04$ hours. $t_5 = 4$ hours $= \frac{4}{2\,04} = 1·96 \times T_i$.

By Table V., in 1·96 times $T_i^1 = 0·83 \times 53$deg. C. = 44deg. C. are cooled down, and the temperature at the end of the fifth period is $t_5 = 53 - 44 = 9$deg. C.

(5) $t_6 = 2$ hours ½ normal watts.
With this reduced excitation the motor has to run faster, and in consequence the ventilation is improved, say 20 per cent.

$$\text{New } t\,f_6 = \frac{0·5 \times 45}{1·2} = \frac{22·5}{1·2} = 19\text{deg. C.}$$

Initial temperature, $t_5 = 9$deg. C.
Total range of rise, 19 − 9 = 10deg. C.

$$\text{New } T_i^{11} = \frac{1\,36}{1·2} = 1·13 \text{ hours.}$$

$$T_6 = 2 \text{ hours} = \frac{2}{1·13} \times T_i^{11} = 1\,78 \times T_i^{11}.$$

By Table V., in 1 78 times $T_i^{11}$, $0·8 \times 10 = 8$deg. C. are reached. The temperature at the end of the sixth period is $t_6 = 9 + 8 = 17$deg. C.

## IV.—Crane Rating.

These investigations are of great importance in the design of machines which are only on full load for a few hours, such as lighting transformers, and machines which require an overload for an hour or two. In such cases the time during which the load is on can generally be determined with tolerable exactitude, and for dealing with this problem our next examples give full information. This kind of rating is often called the "short-time rating," from which we have to distinguish machines which are designed for intermittent use for short periods of application and interruption (of a few minutes), briefly called "crane rating." This latter kind of machine is quite distinct from a machine designed for short periods of use and long interruption, which we dealt with in the first part of our study.

The characteristic qualities of crane rating are as follows: (1) The load has a more or less regular periodic character. This distinguishes crane rating from the short-time rating. (2) The time of use and the time of interruption is so short that during the former the temperature obtained does not come anywhere near the final temperature, and during the time of interruption the apparatus does not cool down to anywhere near the air temperature. In fact, after some hours' run the maximum and minimum temperature attained must remain within a few degrees per cent. of the average temperature.

We will first assume that the cooling conditions when the machine is shut down are the same as when the machine is running, and study the question of crane rating on our field coil, the data for which are:

Current density 1·35 amperes per mm².
Final temperature for continuous run, 50deg. C.

As we found from the current density, the initial rise is 0·55deg. per minute, and the ideal heating time $T_i = \frac{50}{0\,55} = 90$ minutes = 1½ hours. If we submit the coil to a crane load, consisting of periods of three minutes' heating and seven minutes being shut down, the total period lasting 10 minutes, then in order to obtain the average temperature curve round which the actual temperature fluctuates, we have only to consider that a heating time of three minutes is followed by a cooling time of seven minutes. Since during these short spaces of time the temperature increase or fall in the unit of time can be considered constant, the seven minutes' cooling is as effective as a three minutes' cooling with $\frac{7}{3}$ times increased intensity. To find the final average temperature we have only to multiply the final temperature for continuous run, 50deg. C. by $\frac{3}{10}$, and so obtain $\frac{3}{10} \times 50 = 15$deg. C.

Considering that three minutes is 3/90 = 3·3 per cent. of the ideal heating time, and that in the short times of three and seven minutes the time and temperature (taken as percentages) are practically proportionate to one another, the positive temperature fluctuation during three minutes (see Table V.) is 0·033 × total range of temperature = 0·033 × (50deg. − 15deg.) = 0 033 × 35deg. C. = 1·15deg. C. The negative fluctuation during seven minutes is 0·077 × total range of drop = 0·077 × (15deg. − 0) = 1·15deg. C. Consequently the final temperature is 15deg. C. $\pm \frac{1·15\text{deg. C.}}{2}$

The average initial rise is $\frac{3}{10} \times 0·55 = 0·165$deg. C. per minute, so that the ideal heating time is $\frac{15}{0·165} = 90$ minutes, the same as with continuous rating. Thus the crane motor requires the same time for heating up as the machine

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designed for continuous rating. The final temperature is directly proportional to the ratio,

$$\frac{\text{time of use}}{\text{time, full period}}$$

under the assumption that when the machine is shut down the ventilation is the same as when it is running.

As stated above, the cooling is much worse while the machine is shut down, because we considered that a reduction of the ventilation of the field coil in the ratio of two-thirds would occur. Taking this into account, we have three minutes' heating, three minutes' cooling with full intensity, seven minutes' cooling with two-thirds of full intensity, which is equivalent to

$\frac{2}{3} \times 7 = 4{\cdot}7$ cooling with full intensity.

Total equivalent time of cooling with full intensity $4{\cdot}7 + 3 = 7{\cdot}7$ minutes.

Final temperature $\frac{3}{7{\cdot}7} \times 50 = 0{\cdot}39 \times 50 = 19{\cdot}5$deg. C.

The ventilation of the *armature* is, at full speed, three to five times better than when it is stationary, so here we have three minutes' heating, three minutes' cooling with full intensity, seven minutes' cooling with, say, one-quarter of full intensity, equivalent to $\frac{1}{4} \times 7 = 1{\cdot}8$ minutes' cooling with full intensity. Total equivalent time of cooling with full intensity $= 3 + 1{\cdot}8 = 4{\cdot}8$ minutes.

Final temperature $\frac{3}{4{\cdot}8} \times 50 = 0{\cdot}63 \times 50 = 31$deg. C.

If an ordinary continuous rating motor is to be used as a crane motor, the losses in the badly-ventilated parts (field coils) can be increased considerably more than in the well-ventilated ones (armature). This only holds good if the machine is to be designed for actual crane-working conditions, the time of working and stopping being definitely given.

Usually a crane motor has to stand a one hour's test on full load, independently of what it has to do in actual practice. It is naturally very much simpler to carry out a test of this kind than a test in which the motor has to be alternately switched on and off. It is even an easier test than a continuous rating test. This is the chief reason why we adhere to the one hour's test, and long experience in actual practice has proved that in nearly every case a motor which stands this test with a moderate temperature rise is large enough for crane work. One disadvantage, however, is seriously felt—namely, that the time of test is the same for small as well as for large machines—and still more that the time is the same for open and totally enclosed ones.

Applying the formula for $T_i$, we find that for a 2-h.p. motor the ideal heating time of the field is about one hour, and of the armature six hours, therefore in one hour 63 per cent. and 80 per cent. respectively of the final temperature is reached (Table V.). In the case of a 50-h.p. motor, the ideal heating time of the field is, say, 12 hours, that of the armature 75 hours, and thus the field has in one hour attained 56 per cent. and the armature 75 per cent. of the final temperature.

Now, under a certain condition of crane work, given by the load factor $= \frac{\text{time of working}}{\text{total period}}$, the machine reaches a temperature which is quite in proportion to that which we have called the final temperature, and which would be obtained if the machine ran continuously with its crane brake horse-power. Taking the ventilation, with the machine at rest, to be two-thirds in the case of the field, and a quarter in the case of the armature, of that when the machine is at full speed, the one hour's test corresponds:

| | | | | | | |
|---|---|---|---|---|---|---|
| In the field of the 2-h.p. motor to a load factor of | | | | | 60 | per cent. |
| ,, armature | ,, | 2 | ,, | ,, | 50 | ,, |
| ,, field | ,, | 50 | ,, | ,, | 47 | ,, |
| ,, armature | ,, | 50 | ,, | ,, | 42 | ,, |

In the case of totally-enclosed machines, taking the ventilation when the machine is at rest as 0·8 for the field, and for the armature half of that of the machine when at full speed, the one hour's test would mean approximately

| | | | | | | |
|---|---|---|---|---|---|---|
| In the field of the 2-h.p. motor a load factor of | | | | | 38 | per cent. |
| ,, armature | ,, | 2 | ,, | ,, | 38 | ,, |
| ,, field | ,, | 50 | ,, | ,, | 31 | ,, |
| ,, armature | ,, | 50 | ,, | ,, | 31 | ,, |

Thus we see that the one hour's test is more severe on small and open machines than on large and totally-enclosed ones. Considering a one hour's crane test to be correct (load factor, say, 50 per cent.) for small open-type machines, the time of test ought to be:

| | |
|---|---|
| For large open-type machines, say | 1½ hours. |
| For small totally-enclosed machines | 1½ ,, |
| For large ,, ,, | 2 ,, |

Naturally, a difference would also come in for different speeds and different percentages of cotton in the field coils, but we cannot consider this question on the present occasion.

Our investigation as to the meaning of the one hour's crane test shows that its simplicity involves a very great inequality, having a different value for every single machine. It would be desirable, therefore, to find a test which would give accuracy as well as simplicity. A test with the exact conditions given, for instance, with a period of three minutes' running and seven minutes' stopping is, however, somewhat troublesome.

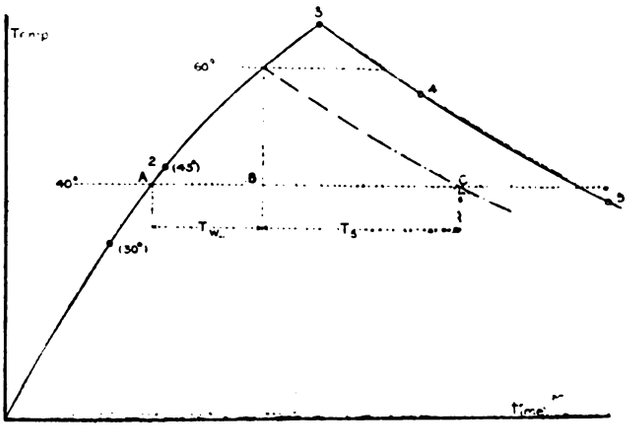


FIG. 20.

Now, within rather wide limits, the temperature curve can be considered a straight line, and in consequence the temperature is only dependent on the load factor. Therefore we could replace the three minutes' running and the seven minutes' stopping by saying nine minutes' running and 21 minutes' stopping respectively, which would require less attention than the shorter period. We could extend the length of the period a little further still for large machines, and shorten it a little for small machines. This "crane test with extended periods" certainly gives more exactness than the one hour's test, and enables us to make the expression "crane rating" more definite, and to allow for different load factors. The following is suggested as a simple method of crane-motor testing. The final temperature of a crane motor depends (1) on the load (brake horse-power; (2) on the load factor, $\frac{\text{time of working}}{\text{total period}}$.

With an ordinary machine for continuous rating we have only to consider two figures—viz, the load and the temperature rise. In the case of the crane machines a third is added—viz., the load factor. Having to deal with three figures, instead of asking, "What will be the final temperature at a given load and load factor?" we can reverse the question, and ask, "For how many minutes out of 10 can the motor give a certain output if the temperature rise is not to exceed 50deg. C.?"

The answer to the latter question can be very easily supplied by a test. When a crane motor has reached its final temperature, the temperature increase (during the working period, *a b*, Fig. 20) is exactly equal to the temperature drop during the stopping period, *c d*. If, therefore, we take the temperature curve of the motor on full load up to a little more than 50deg. C, or to 60deg. C., and carefully observe the time, T *w*, required for the rise from 40deg. to 60deg. C. (Fig. 21), then if we shut down the machine and observe the time required for cooling down from 60deg. to 40deg. C., T *s*, the load factor is given by the ratio—

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$$\frac{\text{Heating time}}{\text{Heating + cooling time}} = \frac{t\,w}{\mathrm{T}\,w + \mathrm{T}\,s} = \frac{\mathrm{A\,B}}{\mathrm{A\,C}} \text{ (Fig. 21).}$$

It is very easy to take this test for all stationary parts to which a thermometer can be left attached during the working period. For the armature one could stop, say, half-hour after starting, take the temperature at that moment (point 1, Fig. 22), and easily judge in what time the 40deg. rise will be approximately reached. At the end of the period stop again, take the actual temperature, which need not necessarily be exactly 40deg. C. (point 2, Fig. 22), run on again for some time until 60deg., or a little more, are reached (point 3, Fig. 22), and then finally stop to observe the cooling of the armature (points 4 and 5).

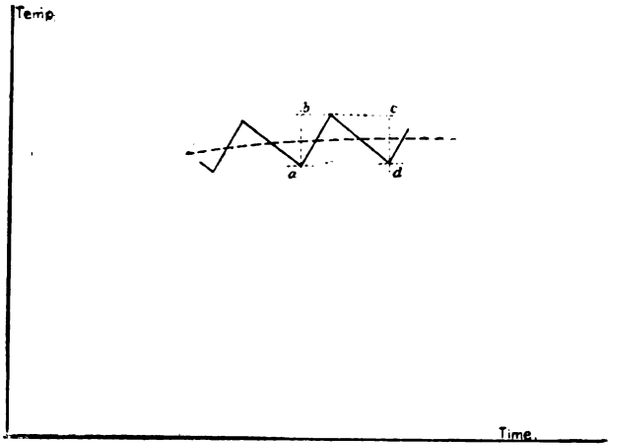


FIG. 21.

If point 3 does not coincide with 60deg. C., we transfer the cooling curve horizontally until it passes the 60deg. point (dotted curve, Fig. 22), and draw the horizontal line, A C, through the 40deg. point, then $\frac{\mathrm{A\,B}}{\mathrm{A\,C}}$ is the load factor.

If the temperatures are taken with a thermometer, the latter should have a very small mercury bulb so that it records the temperature of the armature as quickly as possible.

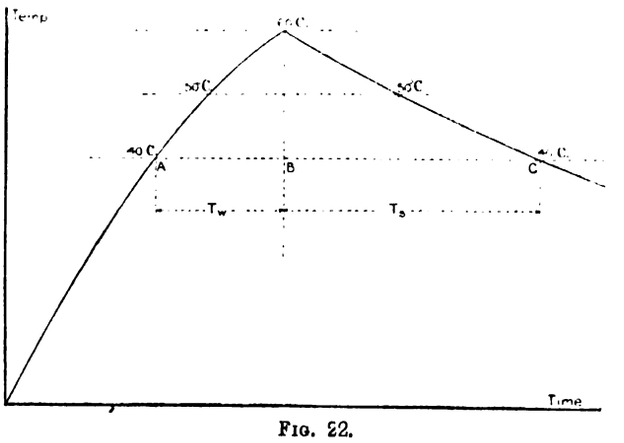


FIG. 22.

It will be found that in these investigations I have preferred approximate methods to exact mathematical ones, the former enabling us to keep in closer touch with the real physical phenomena, and being more easily adaptable to any irregular case; on the other hand, they are precise enough for practical purposes. For investigations on a more mathematical basis, I refer to the excellent article of E. Olschläger "On Intermittent Rating" (*Elektrotechnische Zeitschrift*, p. 1,058, 1900).

## GLASGOW SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The monthly meeting of the above section was held at 207, Bath-street, Glasgow, on Tuesday, 11th inst; Prof. Baily being in the chair. The chairman announced that the committee of the section had nominated the following gentlemen as office bearers for next session: Mr. J. M. Munro, chairman; Mr. F. A. Newington, vice-chairman; Mr. E. G. Tidd, secretary and treasurer; and Messrs. Lackie, Goslin, Stothert, Macfee, Sam Mavor, Stewart, Blackwood Murray, Stevenson, and Lowson as members of committee. These nominations are likely to be all confirmed at next meeting. The chairman then called on Mr. W. W. Lackie to reply to the discussion on his paper on "Earthing."

Mr. LACKIE said that if he were to adopt Mr. Munro's suggestion and give a list of the local electric fires, with the names of the contractors whose work was involved, it would certainly lead to an over-heated discussion which he had hardly the temerity to face. If dampness, whether in plaster, stone, or wood, were the only earth, then a further metallic earth connection should be made. He was glad that Mr. Munro agreed with him that each new earth would pass current equal to some pressure divided by its resistance, and that the current which was limited in amount would divide itself inversely as the resistance of each earth. The time taken to make the insulation test at Port Dundas electricity works each week was half an hour. The positive or negative main was earthed through a resistance and the current taken on the middle wire of the feeder before and after the earth was made. Mr. Newington did not see the use of insulating the earth-wire. Mr. Lackie had heard of one or two fires due to the earth-wire being left bare, and it appeared to him a little inconsistent to have a bare wire running for some length across a basement when such a wire would be called upon at certain times to carry considerable current. Insulating the earth-wire had also the advantage that it was readily distinguishable for earth connection from telephone and bell wires. Mr. Newington and other speakers had pointed out that although an installation carried out according to Mr. Lackie's ideas would be all right at first, a plumber or bellhanger's pipes would be pretty sure to be subsequently run in such a way as to bring them into contact with the metallic sheathing of the electrical conductors One of Mr. Lackie's main contentions had been that in the event of such a contingency there was absolutely no means of testing, with the existing wiring practice, the real state of affairs, whereas if the tubing were known to have been originally clear of all other metal work it could be tested after the plumber had finished his work to ascertain whether his pipes were in contact with the cable sheathing or not. All insurance companies insisted on metal sheathing being kept clear of gas-pipes, and there was no electrical difference between sheathing being in contact with a gas-pipe and its being in contact with an iron beam or girder with which a gas-pipe is in contact. Mr. Mavor was wrong in assuming that Mr. Lackie was coming round to the idea that it was not safe to run electrical conductors without an earth protection. Formerly they had laid their lead-sheathed cables in Glasgow in iron troughs; now they were definitely convinced that this was quite a mistake. Trouble had been experienced with arcing and fusion between the lead sheathing and the iron troughs when the lead got alive by accident. Two alternatives presented themselves—viz, either to use metallic-sheathed cables and put them inside a non-metallic box, or to get a non-metallic sheathed cable and put it inside an iron box, in both cases running the box up solid with compound. They had now got a non-metallic sheathed cable which they ran up in wooden boxes with no metallic sheath or earth protection, and it was proving most satisfactory. The current returning by the tramway rail was not the same as that which flows when an earth took place on an electric lighting or power installation. In the case of tramways it was a fixed current, and would divide up in proportion to the conductivity of each path, but the tramway rails need not necessarily be the earth, but are an earth of their own. The London County Council had put down an insulated positive and negative, and he believed other tramway companies and corporations would do the same if they could afford to do so. He did not understand Mr. Mavor's contention that the real trouble arises, not between one of the conductors and the earth, but between two conductors when the flash takes place inside the metal box or other place where a fault occurred. The trouble undoubtedly

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did occur with one conductor only coming in contact with the metal sheathing, and also the current leaving the metal sheathing and other metal work, and the great difference of potential was practically between the point at which the fault occurred and the earth proper. Mr. Lackie was in agreement with the Board of Trade regulations, and Mr. Mavor said that so far as these regulations were concerned the requirements of the paper were very proper. Mr. Lackie agreed that Simplex tubing of the light gauge ought to be abolished and only proper screwed tubing used. The rules of the American Institute of Electrical Engineers state that the iron tubing used for protecting conductors shall be of a certain gauge corresponding to our gas barrel. The cost of a resistance such as Mr. McWhirter expected the speaker would require to carry 70 amperes with a pressure of 200 volts would be more like £25 or £30 than £500, but where a consumer got into the habit of inserting larger fuses in faulty circuits, no system of earthing would avail for such a consumer's wiring. With regard to break-down in lead-covered wire, such faults did not occur in larger cables. Small stranded wires in being tinned became hard and brassy. The possibility of using the electricity supply for working electric bells had been mentioned. The risk of shock, however, from bell pushes, which were not as a rule very highly insulated, was a drawback. He was of opinion that by keeping what Mr. Maxwell had called their fourth conductor insulated throughout its run the work of the outside testing department would be greatly lessened, for if this one conductor were right the other three would be bound to be right, and there would be 99 per cent. fewer complaints. He did not agree with Mr. Mordey in thinking that the rise of voltage to 200 and 250 had been brought about in the interests of the undertakers rather than for the benefit of the consumers. Mr. Lackie was certain that if the Glasgow Corporation had stuck to the old 100-volt supply, their capital expenditure on mains alone would have been half a million more than it is to-day, and this would in its turn have affected the price of the current to the consumers. In reply to Mr. Mackenzie's contention in favour of a concentric system, Mr. Lackie expressed the opinion that if a concentric system were universally used they would probably have, when a fault occurred, enormous rushes of current that would not only melt soft gas-pipes but iron pipes also. Mr. Lackie maintained that his suggestion would help rather than hinder the electric lighting industry, because while it would not add materially to the cost of installation work, it would help to eliminate fire risk, which, slight though it was, was undoubtedly an impediment.

The CHAIRMAN then called upon Mr. Harold Watson, of the Holland House Electrical Manufacturing Company, Glasgow, to read a paper on "Fittings."

Mr. WATSON'S paper was a short one, and dealt with the subject more from the points of view of the architect and the artist than the electrical engineer. At the outset the author briefly sketched the evolution of electric fittings, starting from the beautiful designs of oil lamp in use among the Greeks, referring to the various developments that took place with the introduction of gas as an illuminant, and then going on to deal more particularly with the changes that took place with the increased use of electrical energy for lighting. The author showed that manufacturers were gradually realising the possibilities of electricity in the design of fittings, and were freeing themselves of the earlier imitation of gas fittings. The present stage of progress might aptly be called that of the renaissance of the hand candle-stick. He was sure that although from use and wont the eye was pleased with a brilliant cluster of lights in the centre of a drawing-room or recreation-room, diffused light from lamps not actually seen, in combination with recessed lights carefully placed, would probably receive more general attention in the future. The lecture was illustrated throughout with sketches, and a model of a counter-weight fitting of the author's own invention was shown. In this fitting a chain arrangement took the place of twin flexible for bearing the strain of the counter-weight and lamp fitting. In describing this model, the author spoke strongly of the dangers and disadvantages of using twin flexible for counter-weight fittings.

A discussion followed. Mr. H. A. MAVOR (Glasgow), the first speaker, said that after the work done by Mr. Benson, the most important development in the design of fittings had been in connection with the work of Mr. McIntosh, a Glasgow man. What Mr. Watson had said about the probable development along the lines of reflected light was very interesting, although the speaker in his personal experience had found great difficulty in keeping the reflecting surface clean. The method adopted by Prof. Barr in his laboratory in the Glasgow University was worthy of mention. It consisted in utilising the cross beams in the ceiling for the diffusion of the light by putting the incandescent lamps in rows on one side of these beams, so that the lamps themselves were not visible to the eye looking in the direction of the front of the room. Mr. Mavor also described the fitting he found most suitable for use in his drawing office. It consisted of a tubular arrangement with a weight at the upper end and an incandescent lamp and shade at the lower end. In the middle of the tube was a ball, which acted as a swivel, and by means of which the lamp could be conveniently placed at any angle.

Mr. J. M. MUNRO (Glasgow), in a lengthy speech, regretted that the technical vocabulary in connection with their industry was so ill chosen. The word "fitting" might mean almost anything. Switches, for instance, were often called fittings. The word "installation" was just as unfortunate. With regard to the paper before them, the author could have added greatly to the interest if he had been less anxious to avoid all appearance of self-advertisement. The speaker thought that all electrical connections ought to be made, if at all possible, by screwed joints in preference to made joints, and he was of opinion also that makers should adopt standard methods of suspension.

Mr. J. D. MACKENZIE (Glasgow) said he did not agree with Mr. Munro with regard to screwed connections for making joints. Screws had a nasty habit of working loose, and there was nothing better than a good soldered joint. The speaker thought the word "electrolier" was as inadequate as some of the other words to which Mr. Munro had referred.

Mr. TIDD (Glasgow) described a method whereby he was easily able to take down his electric fittings. This consisted of an arrangement of hooks upon which the fittings themselves were hung, the wires in the fitting being connected to the conductors by means of bayonet lampholders.

The CHAIRMAN also spoke.

Mr. WATSON, in reply, said that there was still much to be done in illumination by means of reflected light. Designers of fittings were often electricians nowadays, and they understood what was wanted in a fitting from the wiring contractors' point of view. Mr. Watson thought that Mr. Mackenzie was right with regard to screwed joints being less desirable than soldered ones. He was of opinion, however, that fittings should be sent out by the maker wired and ready for erection, and that all jointing should be done in the workshop. He regretted that more had not been said with regard to the use of flexible, because he thought that the use of flexible was a question that required serious consideration.

## FORTHCOMING EVENTS.

THURSDAY, APRIL 27.

**Institution of Electrical Engineers.**—At 8 p.m., discussion of Mr. B J. Arnold's address to the joint meeting at St. Louis "On the Problem of the Alternate-Current Motor applied to Traction," and Mr. F. Creedy's paper "The Alternate-Current Series Motor."

## PERSONAL.

The Carlisle Town Council have increased the salary of the deputy electrical engineer (Mr. Scurfield) from £150 to £175 per annum, and have resolved to make a telephonic connection between his house and the electricity station.

The Southampton Town Council have decided to appoint Mr. Street, the borough electrical engineer, general manager of the tramways department for a period of 12 months, in addition to his present duties

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## UNSOLVED PROBLEMS.

The James Forrest lecture which was delivered by Colonel R. E. Crompton, C.B., before the Institution of Civil Engineers last week, forms an excellent *résumé* of the present state of progress in electrical engineering. The lecture, supposed to be devoted to unsolved problems, contained many descriptions of problems which had been actually solved within recent times. The solution of these, however incomplete it may be in certain cases, argued well for the final solving of the other problems which Colonel Crompton brought to the notice of his audience. In fact, in a number of instances he was able to predict with considerable assurance the direction in which we should look for progress towards the final overcoming of the difficult problems involved. These he divided into two groups—*i.e.*, those set for us by Nature herself, and which chiefly concern scientific investigators, and those which present themselves to engineers making use of electrical energy for man's service. The first class of problem still has to be considered by engineers in order to avoid interference with his works. For instance, the explanation of ball lightning has yet to be given. This was pointed out by Colonel Crompton at the beginning of last week, and a new record as to the phenomena in question was obtained on Sunday last at Richmond. In this instance a church was struck, and a number of observers state that they saw what appeared to be a huge ball of fire descending from the clouds. This exploded with a loud report near the church steeple. The explosion of the fire-ball was described by a military officer as resembling the explosion of a shell from a siege gun. This account agrees with others described in the lecture, and yet our scientific investigators are unable to give any reasonable explanation of a discharge of electricity resulting in a ball of fire moving so slowly as to be readily followed by the eye. In this subject, as in the phenomena connected with terrestrial magnetism, much remains to be done before a true explanation of the known phenomena can be given. While electrical engineers have hindered to a certain extent the work in magnetic observatories, they have only done so in the interest of the general public. Thus the introduction of electric tramways with earth returns has resulted in the moving of magnetic observatories into secluded spots where the variations in the earth's field can be watched and recorded without interference. It was when Colonel Crompton turned to the electrical engineering problem of the day that he excited the keenest attention. This is so from the fact that he has personally been responsible for the solution of so many difficulties. Thus in the early days he had to deal with pioneering work in the design of dynamos, in the construction of light and power distribution systems, and the many accessories connected therewith. The lecture, as will be seen from our columns, contains the description of how many of these problems have been solved. For instance, the insulation troubles in the early dynamos seemed almost insuperable, and even now it is no easy matter to ensure that the insulation shall be able to resist both moisture and heat while retaining its mechanical properties. Still, this problem has practically been solved for machines of ordinary size and speed. The introduction of the steam-turbine as the prime mover for large generating units exaggerates the mechanical difficulties of insulation owing to the enormous centrifugal forces involved. This problem is now being considered by most of our large manufacturers, and the experience obtained from the various machines running at high speeds will soon determine what general lines are likely to lead to success. The detailed improvements in storage batteries, although

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many, still leave a great deal to be done before the storage of electricity is sufficiently cheap and simple as to render the power factor of the load of as little importance to the electrical engineer as it is to the gas undertaking. The great problem, however, which is before us at the present time is the electrification of our railways. As to this, Colonel Crompton, speaking before an institution whose members have been responsible for the great railway systems of the country, was comparatively modest in his claims. He was sure that electric traction could supersede the present steam haulage on our railways at the schedule speeds which are now in use. He was not so certain as to the raising of these schedule speeds to a considerable extent by electric haulage, as he thought that the locomotive designers would meet the competition by improvements which would enable steam locomotives to run also at higher schedules and safely. The problem is one on which experience is being accumulated at a rapid rate, and with the introduction of the single-phase motor a great step has been made towards the economic electrification of main lines. Many other problems are given in the lecture as awaiting solution, and the young electrical engineer cannot do better than read the 1905 James Forrest lecture when looking for an outlet for his energy.

## SINGLE-PHASE RAILWAY MOTORS.

Dr. Behn-Eschenburg in an article in the *Schweizerische Elektrotechnische Zeitschrift* deals with recent work of the Maschinenfabrik Oerlikon in connection with single-phase motors, and gives some interesting test results. Curves are given of a 35-h.p. (continuous rating) motor used (1) as a direct-current motor at 200 volts; (2) as a plain series alternating motor at 200 volts and 22 ⁓; (3) as a repulsion motor at 230 volts, 44 ⁓; and (4) as a compensated series motor, with additional short-circuited brushes (Latour's method) at 250 volts, 44 ⁓.

The motor is a six-polar one, but has no salient poles, the windings on both rotor and stator being similar to a direct-current armature winding, and the rotor winding being connected to an ordinary commutator without the interposition of any high-resistance connections. The stator winding is divided into two similar parts with their magnetic axes half a pole-pitch apart. One of these parts is the exciting winding proper and the other is the compensating winding to counteract the field set up by the armature current. For cases (3) and (4) the two parts of the stator winding were combined into a single regular winding. The slots on both stator and rotor are half closed. For cases (1), (2), and (3) six sets of brushes were used and for (4) 12 sets. Each brush was 8mm. wide, and in cases (1) and (2) the brushes were set on the neutral line. The air-gap of the motor is 1mm. a side.

The temperature rise in all four cases was found to be about the same, and in no case exceeded 45deg. C. after four hours at full load. The sparklessness and the state of the commutator at the end of each run were also found to be equally satisfactory in all four cases. Even at speeds above 1,000 revolutions, or below 500 revolutions, the machine was sparkless in cases (1) and (2), but in cases (3) and (4) special devices for counteracting the voltage induced in the short-circuited section would be required at these speeds. In case (2) this short-circuit voltage can easily be kept within the required limit, even with large overloads, by proportioning the iron sections so that they become saturated before the maximum safe field strength is exceeded. In cases (3) and (4), however, the higher periodicity, necessitated by power-factor considerations, involves a higher induced short-circuit voltage at starting and at speeds much below or much above synchronism, though at, or about, synchronism this voltage practically disappears. The tests show that the short-circuit induced voltage per section at starting was 2·6 volts with 200 amperes 22 ⁓ in case (2), and 4·5 volts at 130 amperes 44 ⁓ in cases (3) and (4). In the case of the repulsion motor (3) the brushes were short-circuited together and set at an angle of 18 (electrical) degrees, or one-tenth of a pole-pitch from the magnetic axis, as this position was found to give about the correct current in the rotor, as indicated by armature and commutator heating at 35 h.p., 1,000 revolutions, and by the power factor approaching its maximum value.

The following table shows the behaviour of the motor under the different conditions as read off the curves accompanying the article:

| Motor tested as | H.P. | Revs. | Volts. | Amps. | ⁓ | Efficiency | Cos $\phi$. |
|---|---|---|---|---|---|---|---|
| 1. Direct-current series motor.. | 35 | 1,000 | 187 | 160 | — | 85 % | — |
| 2. Series alternating motor ... | 35 | 1,000 | 182 | 182 | 22 | 81·5 % | 95 % |
| 3. Repulsion motor | 35 | 880 | 225 | 156 | 44 | 83 % | 90 % |
| 4. Latour motor.. | 35 | 880 | 255 | 128 | 44 | 81 % | 100 % |

The weight of the motor complete without gear is 1,000 kg.

The article concludes with a short description, together with photographs and some test results, of a 200-h.p. single-phase geared railway motor. This is a plain series motor, with eight salient poles, working at 260 volts, 600 amperes, 15 ⁓, at 650 revolutions normal and 1,000 revolutions maximum. The ampere-turns per unit of armature periphery and the number of commutator segments were kept as high as possible, the width of the latter at the surface being 4·8 mm. The armature diameter is 750mm., length of armature core parallel to the shaft 290mm., diameter of commutator 580mm, and over-all diameter of outer frame 1,245mm. A special device for reducing the sparking voltage is employed, but is not described. No special compensating winding for reducing the armature distortion is employed, but the design is such as to reduce this to a minimum. Commutation was found to be equally good over the whole range of speed from 0 to 1,100 revolutions. The induced voltage per section is only two volts when the torque is 200 kilogram-metres, and only increases some 12 per cent. when the torque increases to 350 kilogram-metres, owing to the dimensioning of the iron circuits. The curves given show that at 200 h.p. the input is 263 volts, 600 amperes, 680 revolutions, the efficiency being 92 per cent., and the power factor 95 per cent. The weight of the motor complete with three bearings is 3,000 kg.

## UNSOLVED PROBLEMS IN ELECTRICAL ENGINEERING.*

BY COLONEL R. E. B. CROMPTON, C.B., M.I.C.E.

*(Continued from page 527.)*

From the first we found that the most convenient method of forming our existing coil or helix was by winding up into a coil on the core itself, or on a separate frame slipped on to it, copper wire of circular cross-section, and covered with a fibrous insulating material such as cotton or silk thread. This method of coil winding has held up to the present date, chiefly on account of its convenience and of the very perfect and economical methods of covering the wire with silk and cotton thread, or in some cases with spiral paper strip, which have been from time to time introduced, but in all these cases the mass of the wound coil is largely made up of insulating material, as, on account of the circular section of the copper itself, there is much wasted space. Moreover, on account of the low heat conductivity of the mass of insulation and the waste spaces entrapping air, the heat-conducting properties of the coil as a whole is very low. The recent series of experiments that have been carried out for the Standards Committee by the National Physical Laboratory have shown very clearly that with coils of this class the temperature at the hottest part of the coil is frequently 35deg. F. in excess of its mean temperature, and as in this case the maximum temperature of the coil is the

* The "James Forrest" lecture, 1905, delivered before the Institution of Civil Engineers.

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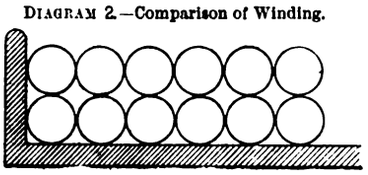
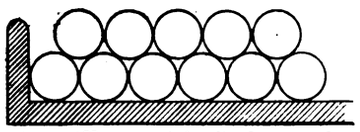
governing factor, it is evident that if we can so increase the heat conductivity so as to materially reduce this difference between the maximum and mean temperatures, so can we improve the coil both in the cost of its production and in its economical working.

I have prepared diagram 2 showing winding in three forms, the first showing the relation of copper to insulation and wasted space when cylindrical cotton or paper covered wires are wound on to short formers provided with flanges of the full depth of the winding; the second, which is also a usual form and allows of a more solidly wound coil—*i.e.*, when the ends of the winding are stepped back—the alternate layers fitting in to some extent between the depressions of the first layer. But for the third case I have shown an ideal winding of a coil to produce the same results as to the required magnetic field and to give sufficient cooling surface to get rid of the heat, but using less copper and having greater heat conductivity due to the continuity of the copper from the inside to the outside of the coil. This ideal winding you will see consists of thin copper strip wound on its edge into correct position by suitable machinery, each turn being insulated from the adjacent turn by a thin film of insulating material applied to it at the time it is being wound. This ideal form of coil winding has already been occasionally used in practice for the larger coils required for certain transformers and for the magnets of large generators and

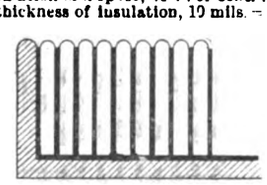
DIAGRAM 2.—Comparison of Winding.



Case I.—Ampere turns, 120; current density, 1; area of copper, 54·5 per cent.; area of insulation and space, 45·5 per cent.; diameter of wire, 100 mils. = 1in.; thickness of insulation, 10 mils. = ·01in.



Case II.—Ampere turns, 120; current density, 1; area of copper, 58·6 per cent.; area of insulation and space, 41·4 per cent.; diameter of wire, 100 mils. = 1in.; thickness of insulation, 10 mils. = ·01in.



Case III.—Ampere turns, 121; current density, 1·15; area of copper, 68·9 per cent.; area of insulation and space, 31·1 per cent.; total space occupied, 59·34 per cent.; thickness of insulation, 10 mils. ·01in.

motors, and it will be seen that we gain greatly in reducing bulk of the winding, weight, and cost of copper, and as the magnet arms are shorter we gain greatly in the size and cost of the framework of the machine, but in order to apply it generally to the smaller class of apparatus we still require a combination of rolling, winding, and insulating machinery which will take the rough copper strip and at one operation reduce it to the correct cross-section, winding it into place, and apply the coating of insulating material. In my diagram I have not taken advantage of the reduced thickness of insulating material although I might have done so, but even as shown the reduction in size, weight, and cost are very noteworthy. And it is the constructional problem which I here set and formulate for your consideration.

We now come to insulating problems. As I have already said, up to the present we have been content with the older method of fibrous insulation, sometimes untreated, but in other cases impregnated with an insulating varnish or enamel. In order to render our coils non-hygroscopic, so that we can maintain sufficient insulation in moist atmosphere, we have already introduced vacuum machinery to remove the moisture after they are wound, and afterwards we inject our waterproofing and insulating varnishes under pressure to fill up as far as possible the interstices, at all events in the outer layers of winding, at the same time we slightly increase the heat-conducting qualities of the coil as a mass. But, unfortunately, it is difficult by such impregnation to make the coils waterproof to a satisfactory extent, for the fact that when these coils are at work they are alternately heated and cooled of itself tends to aid the re-entrance of moisture, at all events in this climate.

Quite recently in connection with this winding question another difficulty has been observed by Highfield and others—*i.e.*, the formation of ozone, and, finally, of nitric acid inside the coils, which has in many cases destroyed the fibrous material used for insulation. All this points to the desirability of dispensing with fibrous material and of replacing it by an insulating material which will have sufficient dielectric strength, will stand the action of nitric acid, and facilitate heat conductivity. A good deal has been recently done in this direction, and notable advances have been made towards increasing the temperature up to which such insulating compounds can be worked without notable decrease of their dielectric strength, so that although a few years ago we considered a temperature of 100deg. C. or 212deg. F. as quite the outside temperature at which coils could be satisfactorily worked for lengthened periods, we are now slowly coming to the opinion that it is desirable that we should work them at far higher temperatures, and that it is quite reasonable to hope that our chemists will furnish us with suitable insulating materials for impregnation, or coating our conductors, and which will stand continuously temperatures up to at least 200deg. C. or 390deg F. If we are successful in obtaining the two requirements which I have mentioned—*i.e.*, the reduction in the sizes of our coils, as shown in the third case of my diagram, and in obtaining the higher temperatures at which we can work them without endangering the durability of our plant—we shall benefit greatly, both contractors and users, by reducing the bulk, weight, and cost of our machinery without in any way impairing its efficiency.

The recent introduction of high-speed turbo-generators has called attention to the difficulties of designing both the cores and the winding of the revolving fields so that they can successfully withstand the severe mechanical stresses to which they are exposed at these extreme speeds. Much ingenuity has already been exercised in attempting to reconcile the antagonistic requirements of great mechanical strength to resist centrifugal forces combined with minute sub-division of the score to prevent a free path for the eddy currents. It will be seen that here the difficulties of the designer are very great, and the problem of overcoming them is yet in its early stages.

Although we are all agreed that the development of electrical storage is desirable from every point of view, we engineers are still divided into two camps—those who believe in storage in its present stage of development, and those who hold the contrary opinion, that until we have at command a form of electrical storage differing widely from that furnished by the lead-couple accumulator of Planté, we had better leave storage severely alone, and trust to careful design and the parallelising of our generating apparatus or to similar precautions to obtain sufficient regularity of supply to our users.

I have from the first held strongly to the former view, as I have all along considered that in the lead-couple accumulator we have a most valuable means of obtaining sufficient storage for our purposes, and that we had far better address our energies to encouraging the development and improved manufacture of the storage that we have, rather than to sit with our hands before us awaiting the invention of something which, after all, we may never obtain.

It may surprise many of you to hear how great have been the improvements in the lead-couple accumulator during the 15 years or so that it has been in practical use. These developments have been steady, continuous, and have been very lately discussed; but the fact remains that the accumulator, as we now have it, has taken rank as a part of our electrical plant which is well understood, and from the use of which many of us are obtaining great economical benefit.

The causes of this improvement are two-fold. Our early troubles arose partly from difficulties in the manufacture of

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the plates in the accumulator cells; means were adopted to hasten the formation of these plates during their manufacture, for which we paid somewhat dearly by their shortened life. Another and very important cause of our early troubles was that for a long time we continued to use the cells themselves as a means of regulating our electrical pressures. This introduced conditions extremely unfavourable to the regulating cells of our batteries of accumulators, but since, owing to the discoveries of Chamen, Highfield, and others, we have obtained regulation by means of automatic motor-generators, to which the name of boosters has been generally given. This difficulty has been largely removed, so that the life of a battery is no longer confined to the short life of its regulating cells, but is that of the life of the whole mass of cells that are all working under equal conditions.

The heavy cost of upkeep of the early accumulators was due to the fact that the active material on which storage capacity depends, became detached from the plates and fell to the bottom of the cells in the form of an inert mud, which required to be removed at frequent intervals of time, and was a great source of loss and annoyance.

The value of recent improvements may be gauged by the fact that the formation of deposit in the bottom of the cells from this detached active material has been reduced to one-quarter of its quantity during the last five years, and we may safely say that the durability and cost of upkeep of these accumulators has been reduced in the same proportion.

These improvements have been noticed by those who have closely studied this question, and has been followed by a great increase in the use of storage, especially where the demand on the electrical energy has been intermittent, or has been confined to short hours, such as in towns or villages, where the demand up to the present has been principally for domestic purposes during hours when artificial light is required; so that at present my view is that we can design far the most economical plant for supplying electrical energy for these cases by combining the most economical generating plant that we know of, which is the combination of the internal-combustion engine with a suction gas plant worked for long hours, and thereby charging storage sufficient to deal with the bulk of the load, but supplying the short hours of peak load from steam plant specially designed to work for short hours at a maximum efficiency.

The storage problem which has been insufficiently developed, but to which much attention is now being directed, is that of portable storage. We require a box of power, as it was first termed by Lord Kelvin when the Faure accumulator was brought over to this country. I must remind you that Lord Kelvin was not alone in thinking that we had already within our reach the power of storing considerable amounts of power in boxes of reasonable size and weight, which could be transported from the point at which they were charged to the point at which the power was to be utilised. After long years of disappointing delay we do see this realised in the very considerable number of private carriages driven by electrical means which we now see in the streets of London and Paris.

Here, again, we have been told that the lead-couple accumulator is hopeless, and that we must wait for something lighter and stronger, such as Edison has been working on for some years past, but again practice has shown that we are far from obtaining anything to take the place of the lead couple, and if we are to argue from the progress that I have already indicated as already having taken place in the fixed batteries we use in connection with our distribution systems, it is reasonable to suppose that similar progress will be made in the portable accumulators, and that a few years hence we shall see great developments. It is probable that these developments will rather take the form of a better organisation of methods of using, of obtaining facilities for recharging and repairing the accumulators we already have, but this is more the province of the commercial organiser than of the engineer himself.

It is quite certain that an enormous impulse would be given to the production of electrically-driven vehicles when the boxes of accumulators and the means of charging them are sufficiently standardised. I am glad to say that the matter has been already taken up by the Standards Committee which is supported by this institution, and in this respect the outlook is distinctly hopeful.

The railway problem, which is of the highest interest and importance to my audience, would occupy not one but a series of lectures. I must confine my remarks to pointing out that one solution of the problem seems already within our reach—namely, that of the utilisation of single-phase alternating currents for long-distance transmission which only requires two insulated wires and two contacts. The engineering and mechanical secondary problems still unsolved are easy ones. We have the choice between the type of series motors as made by Finzi in Italy, and that of the Winter and Eichberg compensated repulsion motors made by the Allgemeine Company. The difference between these two types lies principally in the size of the transforming apparatus which must be carried on the train. In the first instance this must be equal in capacity to the total output of the motor equipment, whereas with the repulsion motor the transformer need only have a capacity of one-tenth the rated capacity of the motors. Our future choice lies between these two or similar systems or modifications of them.

As regards the problem of the third rail, its difficulty and dangers, and of substituting the overhead work necessary for these single-phase motors, it is a mere draughtsman's question, and is quite certain to be satisfactorily dealt with. I think we can even now answer two questions. The first is: Can electric traction supersede the present steam haulage at the schedule speeds which are at present in use on our railways? To this question we electrical men say that, although there are many secondary problems arising out of it, they are all easily solvable, and we have no doubt whatever that we can answer the question in the affirmative. The second railway question is: Can we, by the introduction of electric haulage, raise to a notable degree the present schedule speeds, and from this cause alone become very formidable competitors to long-distance steam haulage? Although there are many electrical engineers who would answer this question in the affirmative with as much confidence as they answer the first one, yet, personally, I am not quite so sure. I see that, spurred by our electrical competition, the designers of the steam locomotive are likely to make further efforts, and I feel sure that if we electrical men can work to schedule speeds of 100 miles an hour, the steam locomotive also can be improved so as to work at the same speed with equal safety.

As to long-distance goods traffic, I do not think we are likely to attack this problem for years to come. None of the engineers who I have met, either in England or America, seem to think that electricity is ever likely to replace steam for this work—of course I mean in our present knowledge of the generation and supply of electrical energy.

Our railway problems would be greatly assisted by the solution of another mechanical problem closely connected with it, or with the driving of any machinery, such as rolling-mills, where the starting torque is very great and very variable, whereas the source of energy for driving is constant. You are all familiar with the attempts to deal with this matter mechanically on the motorcar or motor-omnibus by the change speed gear, but I believe and hope that the real solution is an electrical one. Ward Leonard has worked it out by the introduction of a motor-dynamo having a variable field, but up to the present all the devices have been heavy and costly; still the problem of producing by electrical means a change of speed and torque gear will be of the utmost value in aiding the work of the mechanical engineer, whether in railway works, rolling-mills, cranes, hoists, or in the propelling mechanism of the steam, petrol, or electrical vehicles which are now beginning to be used so largely on our roads.

Probably the branch of electrical engineering which has already made its greatest advances has been that of perfecting our measuring instruments. This is a matter on which I could dwell with loving interest, but time prevents me from dwelling on it at any length. The instruments that we have already at command for measuring direct currents are already so accurate, and so low priced, that they are commencing to be used for many purposes

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quite outside the field of electrical engineering proper. By combining them either with a thermal couple, such as copper constantan, iron constantan, or with a platinum rodium or similar alloys, they become the most accurate and convenient methods of measuring temperature from the minute changes necessary in measuring lunar radiation up to extremely high temperatures close to the melting point of platinum. The standard methods of checking these coil instruments by means of the potentiometer are already very perfect, but when we come to the measuring of alternating energy, although the instruments for measuring separately the current and pressures are satisfactory, yet no completely satisfactory method at all approaching the accuracy and simplicity of the direct-current methods for measuring power are as yet available in this case. This is due to the difficulty of measuring current and pressure simultaneously and under such conditions that no corrections have to be made for the difference in phase between the two, wherein lies the all-important power factor. Probably the solution of this problem lies in the further perfecting and simplification of electrostatic means of measuring alternating pressures. Much is to be hoped for from the further development of the beautiful spherical electrostatic instruments devised by Price.

The problems of the further utilisation of electrical energy for the purposes of our daily life are of extreme interest. The first strong impetus given to the discovery of improved means of generating electricity arose from the desire for electric light. First came the arc light, followed by the incandescent lamp, and both have been perfected up to a certain point. By the invention of the enclosed arc we have greatly reduced the cost of labour of recarboning our lamps, and have so far increased their utility by perfecting smaller details of manufacture, and the carbon filaments of our smaller lamps have also reached better efficiency and regularity of light-giving power than was at first the case. Still, as at present produced, they fall short of what is desired in point of efficiency; but there is, nevertheless, room for hope and material benefit in this respect. For years past many minds have been attempting to solve the problem of obtaining increased light from an incandescent filament or wire. The successive appearance of the Nernst, the Auer, von Welsbach, the osmium, and, finally, the tantalum lamp indicate the more or less successful efforts that have been made and which seem likely to yield satisfactory results.

The development of this tantalum lamp has been a striking instance of the way a problem of this kind ought to be attacked. The search for a suitable wire was set about in a thoroughly systematic manner. Tantalum was tried, as it was one of a group of metals that from their known atomic values would be likely to give the desired results. It was then hardly known in its metallic form, so that during the search it was necessary to devise means for obtaining it in sufficient quantity, to draw and toughen the wire, and to mount it in a suitable manner. The result has been a lamp which, although not perfect, does yield many of the results that were expected from it, and the enquiry will very probably lead to notable additions to our knowledge of this part of the lighting problem.

Quite recently we have witnessed the introduction of lamps yielding strange coloured lights, on the one hand the blue of the Cooper Hewitt mercury vapour lamp, and at the other end of the scale the orange-flame carbon arc lamp. An investigation into this question of the colours which are best suited to obtain clear visual definition by artificial light is sorely needed. Such an investigation was begun 10 years ago by Langley in America, Blondel in France, and by Barr and Phillips in this country, but of late years little further has been heard on this extremely important subject. The revival or reintroduction of these modern lamps show that the problem is an important one. More than 12 years ago Langley defined the brightness of light as the intensity of retinal absorption, and probably this is what most of us believe it to be. He pointed out that the effect of lights of different colour on the retina varied with the individuals and with the age of individuals, so that the greatest visual intensity is obtained with younger men when the light is rich in yellow rays, with the older men when the light is richer in the green and violet. Now that we have at command electric lamps that can give us colours of both kinds, it will be interesting to notice how far Langley's ideas are corroborated now that we have such full opportunities for investigating them on a larger scale. We are told that the Cooper Hewitt lamp gives excellent definition and does not fatigue the eye when exposed to the trying work of reading fine scales, or wherever high definition is of first importance, and has to be obtained by the aid of artificial light.

*(To be concluded.)*

## TRADE NOTICES AND NOVELTIES.

### The Lahmeyer High-Tension Oil Fuse.

The essential features of the high-tension oil fuses of the Lahmeyer Electrical Company, of 109-111, New Oxford-street, W.C., are apparent from the illustrations herewith. The fuses

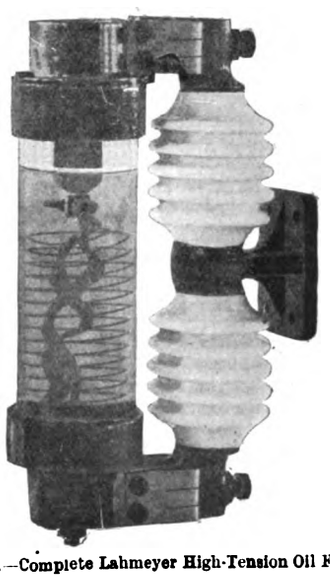

FIG. 1.—Complete Lahmeyer High-Tension Oil Fuse.

are standardised for 12,000 volts and up to 120 amperes in capacity. The complete fuse is shown in Fig. 1. The fuse wire is not immersed in oil, but is contained in the metallic fusing chamber (Fig. 2). This is lined with insulation, and the lower part just enters the oil. The lower end of the fuse is connected by a flexible copper connection to the lower contact of the fuse carrier. This fuse chamber may be compared

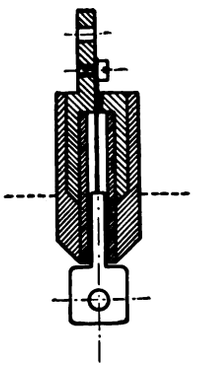

FIG. 2.—Fusing Chamber with Fuse Wire.

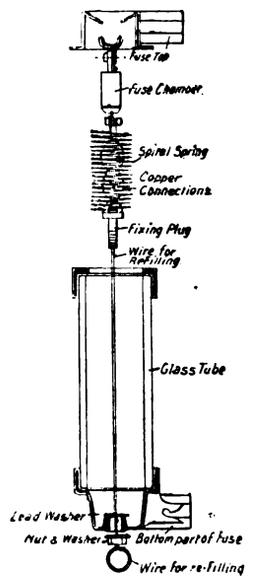


FIG. 3.—Details of Fuse, showing method of replacing.

to a gun with its muzzle placed under oil. The fuse, when it blows, causes a rapid increase of the gaseous pressure inside this chamber, which discharges downwards into the oil. This forces the lower terminal of the fuse into the oil, and also the heated gases are promptly cooled by passing into the same. The interruption of the circuit is thus instantaneous, and it does not

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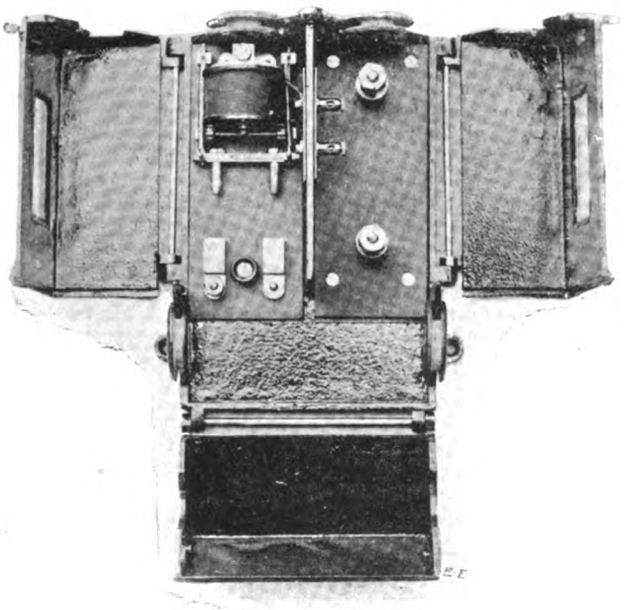
depend on the mechanical action of the spring, which is solely used to keep the fuse wire in tension. The fact that the fuse wire is clear of the oil makes the fusing current a definite quantity. Fig. 3 shows the details of the fuse carrier and the method of replacing the fuse wire.

### Earthing Device for Metallic Conduits.

Mr. A. J. Beaumont, of 78, Bishopsthorpe-road, York, sends us particulars of apparatus he has devised for cutting off the supply to any installation should there be any leakage to earth through either the metallic covering of the conductors or the frames of motors, etc. This we illustrate herewith. It consists of an automatic main switch, which is held in its closed position by a catch. The switch is pulled open by the springs seen at either side of the coil as soon as the catch is tripped by a small current passing round the solenoid. The metallic tubing in the installation on the lead sheathing of the cable is connected to form a continuous circuit, and then earthed through the solenoid in question. If, then, any current passes



The Beaumont Automatic Main Switch in off position.

from any conductor to the tubing, the solenoid trips the main switch and cuts off the supply of current. It will be seen that this makes it necessary for the metallic tubes to be kept from contact with any earthed conductors in the walls, such as water-pipes or girders. Mr. Beaumont tells us that he frequently finds the resistance to earth of such a system of conduits to be over 2,000 ohms. In large buildings it is advisable to have a separate earthing device between the feeding tubes and the distributing tubes, and to have a larger one on the mains to protect the feeding tubes. This larger cut-out would require one or two amperes to cause it to act, while the distributing boards would be protected by the ¼-ampere cut-outs. The cut-outs can, of course, be arranged to act with any desired currents to earth. The apparatus can also be actuated by a heat coil instead of by a solenoid. The efficacy of the device as a protection against fire depends on the continuity of the metallic tubing or cable sheath.

### Catalogues Received.

N.S. Accumulators.—The new catalogue of the N.S. Electric Storage Company contains particulars of further developments in the manufacture of lead storage cells by the firm in question. There is a great field for storage batteries to be used on motor-cars for ignition purposes. For this purpose and also for train lighting the portable accumulators manufactured by the Horton Kirby firm have exceptional advantages. The construction of the cell is in such a form that it is physically impossible for the active material to become detached from the plates. In this N.S. cell the electrodes are made up of alternate layers of pellets composed respectively of oxide of lead and sponge lead. They are divided the one from the other by a porous diaphragm, and are packed in so that a permanent connection is obtained between the pellets and the conductors. In the list before us these cells are described in a range of sizes varying in capacity from 20 ampere-hours up to 80 for motorcar ignition work. For train-lighting purposes two sizes are made—respectively 230 and 350 per ampere hour capacity. The firm also manufacture large cells for use in central-station work.

Electrical Measuring Instruments.—Messrs. Isenthal and Co. have given great attention to the manufacture of laboratory measuring instruments and rheostats for use in technical colleges. Their 1905 list of these includes also a number of commercial instruments. Thus their pocket voltmeters are extremely useful to all motorists. Ammeters of the same type are now being supplied, which afford a ready means of testing the output of small accumulators for ignition purposes. The firm standardise a series of electromagnetic instruments for workshop purposes, and their megohmeter is a useful adjunct to the switchboard of an isolated installation. Voltmeters and ammeters of the moving-coil type are included in the list. The latter portion of the catalogue deals with instruments for the laboratory.

J. H. Holmes and Co. send us their list of installations in textile mills. We gather from the information on this that the bulk of the installations are for lighting, but in certain cases motors of a considerable aggregate horse-power have been installed. From the list of mills given there is obviously a great field for the further extension of electric driving.

The Cleveland Crane and Car Company have sent us a series of their bulletins dealing with various types of their electric cranes and hoists. The bulletin distinguished by the letter F describes an interesting electric runway manufactured by the firm. The electric motor, complete with hoisting gear, is arranged to run on the lower flanges of a continuous girder. The current is led to the motor by means of two insulated wires on the one side of the girder. Vertical spring trolleys are used to collect the current from these wires, while the motor is controlled by means of ropes from the floor level. The system affords convenient means of transporting heavy pieces of material in factories where the headroom is limited. The other types of cranes manufactured by the firm are exceedingly interesting in construction, and we notice that the three-motor type is very largely used. The full address of the firm is Wickliffe, Ohio.

Single-Phase Motors.—The Lahmeyer Electrical Company standardise a line of single-phase motors for working on 50-period circuits for output from ⅛ h.p. up to 20 h.p. The voltages for the smaller sizes up to 1¼ h.p. are 110 and 220, for larger outputs motors for 500 volts are also stocked. The motors can either be of the wire-wound slip-ring type or with squirrel-cage motors. The list forwarded to us illustrates the general design of the motors, and gives useful information as to detailed prices of the motors and their accessories.

## NOTES ON SOFTENING AND PURIFICATION OF WATER FOR STEAM RAISING.*

BY LOUIS J. LE CLAIR, ASSOC. GLASGOW TECH. COLL., A.M.I E.E.

Although methods of treating hard waters were known many years before Dr. Clark patented his process in 1841, until comparatively recent years little attention had been directed to the treatment of boiler feed water, in "softeners" for the prevention of scale formation, or in "purifiers" for the elimination of grease from condensation water.

Both scale-forming constituents and grease are most objectionable in feed water, and every effort should be made to reduce the former to a minimum and entirely eliminate the latter. Scale reduces the heat-transmitting efficiency of boiler plates, as may be seen by the curve in Fig. 1. The average loss

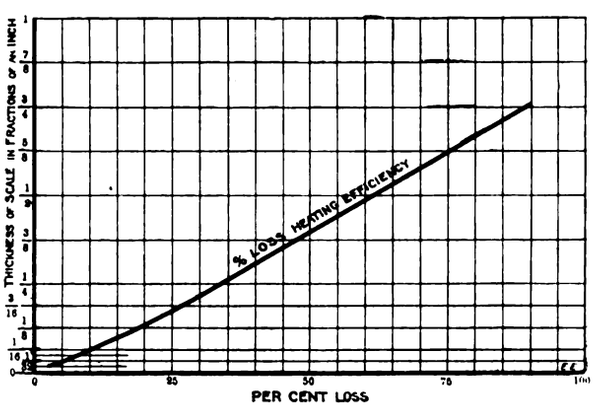



Fig. 1. Loss of Heating Efficiency due to Scale on Boiler Plates.

amounts to about 8 per cent. for each 1/16in. thickness of scale. Certain scales, however, resist the transmission more than others, sometimes nearly doubling the above figure. It is also worth remembering, with regard to water-tube boilers, that the formation of scale decreases the internal diameter, and, in consequence, the heating surface of the tubes. In boiler furnaces free from scale and soot the "thermal head" between the surface of the metal next to the fire and that next to the water

* Paper read before the Dublin Local Section of Institution of Electrical Engineers, April 13, 1905.

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is comparatively small. A coating of scale or grease increases this considerably, as may be seen from Fig. 2, which is a diagram of some of Hirsch's experiments, carried out with a clean plate and pure water, and then with coatings of oil and scale. It will be observed that at 45lb. per square foot per hour (for a flame temperature of about 1,500deg. F.), a comparison between temperatures on the fire-side when using a clean plate, then one with a layer of scale 1/5in. thick, shows the former to be about 380deg. F. and the latter 665deg. F.—an increase of 285deg. F. It might be mentioned that iron at 750deg. F. is just visible in the dark as a dull red. Table I., which is made up of extracts from Sir A. Durston's experiments on the effect of grease in boilers, again shows the great retardation of heat transmission and the heating up of boiler plates from this cause (*Proc.* Inst. Naval Architects, 1893).

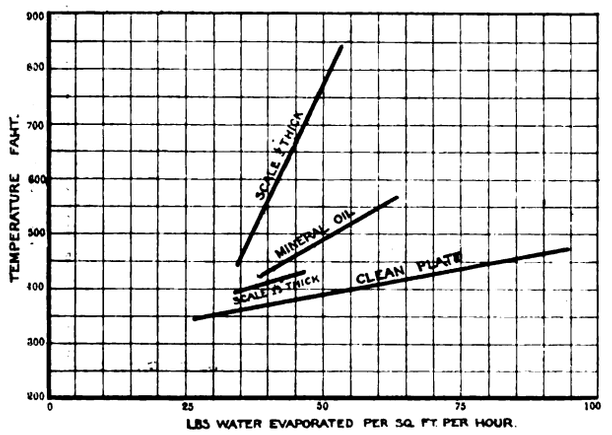



FIG. 2.—Temperature on Fire Side of Boiler Plate ¾in. thick when Evaporating Pure Water at 212deg. F. Water Side of Plates clean and coated with Scale and Oil. (Hirsch.)

TABLE I.—Showing Temperatures of Plates with Clean and Greasy Surfaces (Durston).

| Experiment. | Thickness of plate. | Thickness of grease. | Temperature of fire. | Temperature fire-side of plate | Temperature of water. | Difference. |
|---|---|---|---|---|---|---|
| | In. | In. | F°. | F°. | F°. | F°. |
| A | ¼ | — | 1,500 | 240 | 212 | 28·0 |
| B | ¼ | — | 2,200 | 280 | 212 | 68·0 |
| C | ¾ | — | over forge, full blast | 430 | 344·5 | 85·5 |
| D | ¼ | 1/32 | 1,500 | 330 | 212 | 118·0 |
| E | ¾ | 1/16 | over forge, full blast | 510 | 359 | 151·0 |
| F | ¼ | 1/16 | 2,500 | above 550 | 212 | above 338·0 |
| G | ¾ | 1/16 spread up sides | over forge full blast | 617* | 80 | 537·0 |

REMARKS.—Experiments A, B, D, and F were made with open vessel and water boiling at atmospheric pressure. C, E, and G were made in a closed vessel and under pressures corresponding to temperatures given. * This temperature was reached three minutes after placing vessel on fire.

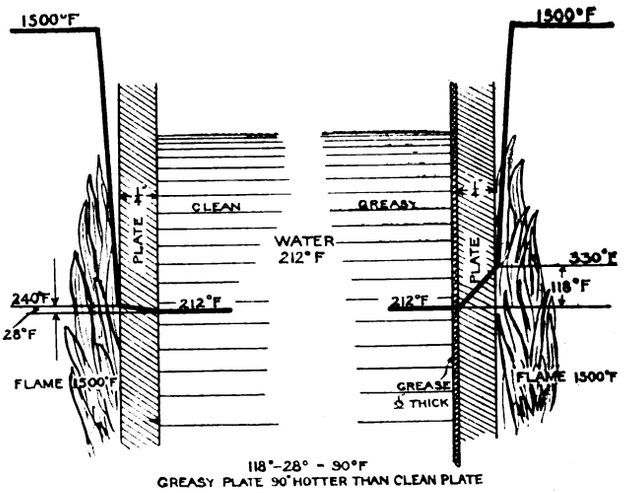
Figs. 3 and 4 show graphically the fall of temperature from the flame to the fire-side of the plate and thence to the water-side for two of the experiments in Table I. The fall from one side to the other or thermal head being with a clean plate 28deg. F., a coating of grease 1/32in. thick increases this to 118deg. F.—*i.e.*, 90deg. F. more than when using a clean plate. These two experiments were carried out with water boiling at atmospheric pressure. Had the pressure been, say, 200lb. per square inch (steam temperature 388deg. F.), and assuming the thermal heads to remain as before, then the temperature at the fire-side would have been 416deg. F. with the clean plate and 506deg. F. with the greasy plate. All these experiments show how rapidly the temperature of boiler plates increases as scale or oil is deposited on their surface. Eventually when the deposit is sufficiently thick collapse ensues, with possible loss of life. Even if the plate temperatures are barely high enough to bring about such serious results, they are quite sufficient to set up enormous varying strains each time the fire-door is opened, ultimately causing grooving and other defects to appear.

The "remedy" generally applied is to have the scale chipped off, entailing considerable expense and putting the boiler out of work for a time. "Prevention" is preferable, and can be accomplished by "softening" and "purification" in proper treatment apparatus before the feed water enters the boiler. The boiler should not be used for any other purpose than raising steam. All patent compositions for treatment of the water inside the boiler should be carefully avoided. If used, they form soluble matter and precipitates inside the boiler, and they are too often added to the water with utter disregard to the proportions necessary for proper precipitation. These compositions generally contain some of the reagents used in water-softening apparatus, and often, in addition, substances injurious to boilers. I have heard of an analysis of one such preparation showing the presence of metallic mercury.

TABLE II.—Principal "Scale-Forming" and "Non-Scale-Forming" Substances

| Scale-forming. | | Non-scale-forming. | |
|---|---|---|---|
| Substance. | Symbol. | Substance. | Symbol. |
| Calcium carbonate..... | $CaCO_3$ | Calcium nitrate..... | $Ca(NO_3)_2$ |
| Calcium sulphate ..... | $CaSO_4$ | Magnesium sulphate.. | $MgSO_4$ |
| Magnesium carbonate. | $MgCO_3$ | Magnesium nitrate ... | $Mg(NO_3)_2$ |
| Magnesium hydrate ... | $Mg(OH)_2$ | Magnesium chloride... | $MgCl_2$ |
| | | Sodium chloride ..... | $NaCl$ |
| | | Sodium sulphate ..... | $Na_2SO_4$ |
| | | Sodium nitrate ..... | $NaNO_3$ |

*Softening.*—Water is a powerful solvent, and whether taken for domestic or technical purposes from reservoirs, wells, rivers, lakes, etc., it has invariably before being collected come in contact with some part of the earth's surface, and in so doing dissolved or carried away certain substances, the amount of which may vary from practically nil to considerable quantities Rain-water, if collected in the country, may be nearly pure, whilst in some districts mineral waters are found, the salts in which are present to such an extent as to impart to them a distinct taste or smell. The salts found in waters and which chiefly concern engineers are given in Table II. These have been divided into scale-forming and non-scale-forming. Calcium and magnesium, in combination with other elements, are freely distributed in nature. The carbonates and sulphates of calcium and magnesium are the chief cause of "hardness" in water.




FIGS. 3 AND 4.—Diagram showing Fall of Temperature from Flame to Water with Clean and Greasy Plate. (See Durston's Experiments, A and D, Table I.)

The hardness of water is judged by its behaviour with soap in giving effect to the phenomenon called "lathering." Hard water, when used with soap, forms a lather with difficulty; soft water, on the contrary, readily does so. With hard water a considerable amount of soap is used before the lather is formed, and it may be observed that a scum comes on the surface. This scum is formed by the action of the soap in neutralising the salts causing hardness, or, in other words, part of the soap is used or destroyed in softening the water. As previously stated, the salts which chiefly cause hardness are those of calcium and magnesium, and the reaction between soap and one of these may be represented by the typical equation:

$$\underset{\text{Soap or sodium stearate.}}{2NaC_{18}H_{35}O_2} + \underset{\text{Calcium sulphate.}}{CaSO_4} = \underset{\text{Sodium sulphate.}}{Na_2SO_4} + \underset{\text{Calcium stearate Insol. Curdy. ppt.}}{Ca(C_{18}H_{35}O_2)_2}$$

The acid radicle of the soap combines with the calcium to form calcium stearate, a curdy precipitate, which is the scum referred to. Sodium sulphate is also formed, but as this compound does not destroy soap, no hardness is caused by its presence. As has been stated, when hard water is used for washing purposes considerably more soap is required than when soft water is used, just under 1¾lb. of soap being required per 1deg. hardness per 1,000 gallons. Thus, for instance, even when using Dublin Vartry water, which is soft, over 6lb. of soap would be required to soften 1,000 gallons of it before a lather would be formed. Other waters are sometimes used in Dublin, and I have here a sample of water from a well in the city which would destroy about 250lb. of soap per 1,000 gallons before being softened.

Many years ago Dr. Clark took advantage of the fact that waters of different hardness required different quantities of soap

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to form a lather, and he applied this in his method of estimating the hardness of water. He made a standard soap solution of such a strength that the number of cubic centimetres of it required to produce a lather, when shaken with a given volume of sample water, indicated the degree of hardness of that water. In this country a degree is considered as one grain of calcium carbonate, or its equivalent in other soap-destroying salts, in one gallon of water. In many other countries the hardness is expressed as parts of calcium carbonate in 100,000 parts of water.

Table III. gives the most common soap-destroying salts found in water, also their equivalent values relatively to calcium carbonate—*e.g*, a water containing 1·36 grains of calcium sulphate per gallon would be equivalent to 1·00 grain of calcium carbonate, or 1deg. hardness. The hardness of water may generally be reduced by prolonged boiling. The hardness which is removed in this way is called "temporary" hardness, and that remaining "permanent" hardness, the "total" hardness being the sum of the two.

TABLE III.—Principal Calcium and Magnesium Salts found in Waters.

| Salt. | Symbol. | ‡ Combining weights. |
|---|---|---|
| Calcium carbonate* | $CaCO_3$ | 100 |
| Calcium sulphate† | $CaSO_4$ | 136 |
| Calcium chloride | $CaCl_2$ | 111 |
| Calcium nitrate | $Ca(NO_3)_2$ | 164 |
| Magnesium carbonate* | $MgCO_3$ | 84 |
| Magnesium sulphate | $MgSO_4$ | 120 |
| Magnesium chloride | $MgCl_2$ | 95 |
| Magnesium nitrate | $Mg(NO_3)_2$ | 148 |

REMARKS.—* Held in solution as bicarbonate by presence of $CO_2$. † For solubilities see Fig. 5. All these salts decompose soap. ‡ The combining weights are in this case equal to the molecular weights.

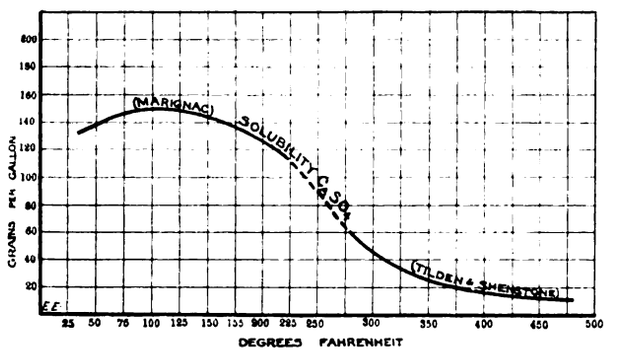


FIG. 5.—Solubility of Calcium Sulphate in Water at Different Temperatures

*Temporary Hardness.*—Temporary hardness is caused by the presence of carbonates of calcium and magnesium, held in solution in the water as bicarbonates by the presence of carbonic acid. By boiling water containing bicarbonate of calcium or magnesium the carbonic acid is driven off, and the insoluble carbonate is precipated thus :

$$\underset{\text{Calcium bicarbonate. Soluble.}}{Ca(HCO_3)_2} = \underset{\text{Calcium carbonate. Insoluble.}}{CaCO_3} + H_2O + CO$$

Where only temporary hardness exists, the water may, therefore, be treated by heating, but the process is costly unless exhaust steam can be used, in which case oil is sometimes introduced into the boiler. About 1½cwt. of coal would be required to heat up 1,000 gallons of cold feed to 212deg. F., and as prolonged boiling is afterwards necessary for complete removal of temporary hardness, it is evident that boiling would not be economical as compared with chemical treatment. With exhaust steam treatment the heating is generally insufficiently prolonged to properly precipitate the carbonates. In some systems, by a combination of heating and introduction of sodium carbonate, both the temporary and permanent hardness are treated.

Table IV. shows approximately the limits of temperature between which certain salts are precipitated by heating the water in which they are dissolved. The carbonates of calcium may also be decomposed by soap, as shown in a previous formula.

TABLE IV.—Approximate Temperatures at which Salts Dissolved in Water will be Precipitated.

| Salt. | Symbol. | Precipitating temp. F°. |
|---|---|---|
| Calcium carbonate | $CaCO_3$ | 180 – 260 |
| Calcium sulphate | $CaSO_4$ | 100 – 430 |
| Magnesium chloride | $MgCl_2$ | 212 – 270 |
| Sodium chloride | $NaCl$ | 330 – 380 |

The most successful and economic method of treating temporary hardness is by Dr. Clark's process. Nearly all patent apparatus of the present day treat the carbonates of calcium and magnesium in this way. The principle of the process lies in the fact that by adding "lime water" (calcium hydrate) to waters containing calcium or magnesium carbonates held in solution by carbonic acid, the lime water combines with the carbonic acid to form calcium carbonate :

$$\underset{\text{Bicarbonate of calcium. Soluble.}}{Ca(HCO_3)_2} + \underset{\text{Lime water. Soluble.}}{Ca(OH)_2} = \underset{\text{Calcium carbonate. Insoluble.}}{2CaCO_3} + 2H_2O$$

The reaction for magnesium carbonate is somewhat different, and may be shown thus :

$$\underset{\text{Magnesium bicarbonate. Soluble.}}{Mg(HCO_3)_2} + \underset{\text{Lime water. Soluble.}}{Ca(OH)_2} = \underset{\text{Magnesium carbonate. Slightly soluble.}}{Mg(CO_3} + \underset{\text{Calcium carbonate. Insoluble.}}{CaCO_3} + 2H_2O$$

The magnesium carbonate produced is only slightly soluble. If, however, twice the quantity of lime water shown in the above equation be added instead, then the second chemical equivalent of lime water acts thus upon the magnesium carbonate produced above :

$$\underset{\text{Slightly soluble.}}{MgCO_3} + \underset{\text{Soluble.}}{Ca(OH)_2} = \underset{\text{Insoluble.}}{CaCO_3} + \underset{\text{Magnesium hydrate. Insoluble.}}{Mg(OH)_2}$$

Magnesium hydrate is produced, and forms as a gelatinous substance which is likely to choke the filters. It is thus not always advisable to add the excess of lime water necessary for converting the magnesium carbonate.

*Permanent Hardness.*—The chief cause of permanent hardness is due to sulphates of calcium and magnesium. Calcium sulphate is soluble in water at ordinary temperatures. Fig. 5 shows that its solubility increases up to about 100deg. F., and then, contrary to general rule, decreases at higher temperatures until at ordinary boiler pressure temperatures it is considerably reduced—*e.g.*, of the calcium sulphate in solution at 100deg. F. only about 17 per cent. would remain in solution at a temperature, corresponding to a pressure of 150lb. per square inch, the remaining 83 per cent. having been precipitated to form incrustation in the boiler. The heaviest deposits obviously occur over the hottest part of the furnace. When such a boiler is cooled down, the calcium sulphate scale will be partly dissolved, and will concentrate in crevices of the scale. On heating up, it will again be deposited in these and cement the whole more firmly than before. This is further accentuated if calcium carbonate is present in the scale.

Magnesium sulphate (better known as Epsom salts) is, as indicated in Table I., a non-scale-forming salt, very soluble, and causes permanent hardness. If this salt is concentrated in a boiler in contact with calcium carbonate scale, the following reaction may take place under certain conditions of temperature:

$$\underset{\text{Calcium carbonate.}}{CaCO_3} + \underset{\text{Magnesium sulphate.}}{MgSO_4} + H_2O = \underset{\text{Calcium sulphate.}}{CaSO_4} + \underset{\text{Magnesium hydrate.}}{Mg(OH)_2} + CO_2$$

The magnesium hydrate formed unites with the calcium sulphate to form a vitreous scale, so that although magnesium sulphate is a non-scale-forming salt, it should not be allowed to concentrate in a boiler on this account.

If water containing calcium sulphate be treated with sodium carbonate, the following reaction takes place :

$$\underset{\text{Soluble.}}{CaSO_4} + \underset{\text{Soluble.}}{Na_2CO_3} = \underset{\text{Soluble.}}{Na_2SO_4} + \underset{\text{Insoluble.}}{CaCO_3}$$

The insoluble calcium carbonate is precipitated and settles down. The sodium carbonate formed remains in solution, and as it does not decompose soap, the water is softened. To prevent concentration of the sodium sulphate or other salts, it is essential that boilers be periodically "blown off." This need not be done more frequently than is usual with properly worked boilers using untreated water.

Magnesium sulphate may be precipitated by treating with lime water, the reaction which takes place being as follows :

$$\underset{\text{Soluble.}}{MgSO_4} + \underset{\text{Soluble.}}{Ca(OH)_2} = \underset{\text{Insoluble ppt.}}{(Mg(OH)_2} + \underset{\text{Partly soluble.}}{CaSO_4}$$

Calcium sulphate is undesirable, and therefore the magnesium sulphate should preferably be treated with sodium carbonate :

$$\underset{\text{Soluble.}}{MgSO_4} + \underset{\text{Soluble.}}{Na_2CO_3} = \underset{\text{Slightly soluble.}}{MgCO_3} + \underset{\text{Soluble.}}{Na_2SO_4}$$

Magnesium sulphate may also be precipitated by the addition of sodium hydrate (caustic soda) with this reaction :

$$\underset{\text{Magnesium sulphate. Soluble.}}{MgSO_4} + \underset{\text{Sodium hydrate. Soluble.}}{2NaOH} = \underset{\text{Magnesium hydrate. Insoluble.}}{Mg(OH)_2} + \underset{\text{Sodium sulphate. Soluble.}}{Na_2SO_4}$$

If, however, lime water and sodium carbonate are added to each other, sodium hydrate is produced :

$$\underset{\text{Sodium carbonate. Soluble.}}{Na_2CO_3} + \underset{\text{Calcium hydrate. Soluble.}}{Ca(OH)_2} = \underset{\text{Calcium carbonate. Insoluble.}}{CaCO_3} + \underset{\text{Sodium hydrate, Soluble.}}{2NaOH}$$

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TABLE V.—SHOWING CHIEF SALTS CAUSING TEMPORARY AND PERMANENT HARDNESS AND TREATMENT FOR REMOVAL.

| Hardness. | Cause. | Treatment. | Reaction. |
|---|---|---|---|
| Temporary | Calcium bicarbonate $Ca(HCO_3)_2$ | (1) Boiling | $Ca(HCO_3)_2 = CaCO_3 + H_2O + CO_2$* (Soluble. Insol. ppt.) |
| | | (2) Adding lime water | $Ca(HCO_3)_2 + Ca(OH)_2 = 2CaCO_3 + 2H_2O$ (Soluble. Sol. Insol. ppt.) |
| | Magnesium bicarbonate $Mg(HCO_3)_2$ | (1) Boiling | $Mg(HCO_3)_2 = MgCO_3 + H_2O + CO_2$ (Soluble. Slightly sol.) |
| | | (2) Adding lime water | $Mg(HCO_3)_2 + Ca(OH)_2 = MgCO_3 + CaCO_3 + 2H_2O$ (Soluble. Soluble. Slightly sol. Insol.) |
| | | (3) Adding further lime water | $Mg(HCO_3)_2 + 2Ca(OH)_2 = 2CaCO_3 + Mg(OH)_2 + 2H_2O$ (Soluble. Sol. Insol. Insol.) |
| Permanent | Calcium sulphate $CaSO_4$† | Adding sodium carbonate | $CaSO_4 + Na_2CO_3 = Na_2SO_4 + CaCO_3$ (Sol. Sol. Sol. Insol.) |
| | Magnesium sulphate $MgSO_4$§ | Adding sodium carbonate | $MgSO_4 + Na_2CO_3 = MgCO_3 + Na_2SO_4$‡ (Sol. Sol. Slightly sol. Sol.) |
| | Magnesium chloride $MgCl_2$§ | Adding sodium carbonate | $MgCl_2 + Na_2CO_3 = MgCO_3 + 2NaCl$ (Sol. Sol. Slightly sol. Sol.) |
| | Magnesium nitrate $Mg(NO_3)_2$ | Adding sodium carbonate | $Mg(NO_3)_2 + Na_2CO_3 = MgCO_3 + 2NaNO_3$ (Sol. Sol. Slightly sol. Sol.) |

REMARKS —* $CaCO_3$ if precipitated slowly, as in economisers, forms a hard scale; if the precipitation is rapid, as in boilers, the deposit is in the form of mud. † $CaSO_4$ forms no scale in economisers, but a hard scale in boilers (see Fig. 5). ‡ $Na_2SO_4$ does not decompose soap. § These three salts are liable to cause corrosion; if it is desired to convert the slightly soluble $MgCO_3$ to the insoluble $Mg(OH)_2$, lime water may be added with the sodium carbonate, the typical reaction then being:

$$MgSO_4 + Na_2CO_3 + Ca(OH)_2 = Mg(OH)_2 + CaCO_3 + Na_2SO_4$$
(Sol. Sol. Sol. Insol. Insol. Sol.)

As both sodium carbonate and lime water are used in treating other salts, their presence may be taken advantage of for the precipitation of the magnesium sulphate—thus:

$$MgSO_4 + Na_2CO_3 + Ca(OH)_2 = CaCO_3 + Mg(OH)_2 + Na_2SO_4$$

Chlorides and nitrates of calcium are likewise acted upon by sodium carbonate alone, or by sodium carbonate + calcium hydrate.

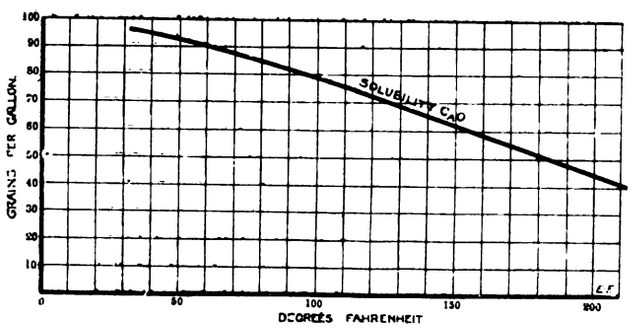


FIG. 6.—Solubility of Lime in Water at Different Temperatures. (Lunge.)

It will be observed that the salts in water which are the chief cause of temporary and permanent hardness are removed by two reagents only—viz., lime water and sodium carbonate. The lime may be added in the form of lime water, which is the clear liquid obtained by dissolving lime (CaO) in water, or by "slaking" quicklime with excess of water. Fig. 6 shows that lime is not very soluble in water, even at its maximum solubility. It can, however, be added to less water than is required to entirely dissolve it, and if the whole be kept stirred or agitated a milky fluid known as "milk of lime" is obtained, which may be used in softening water. Both lime and carbonate of soda are inexpensive and easily obtained. The latter is used in the form of "soda ash."

Table V. shows a summary of the chief causes of temporary and permanent hardness and means of removing these. It will be observed that the last three magnesium salts are acted on by sodium carbonate, producing the partly soluble magnesium carbonate. Caustic soda, if used as a reagent, produces the insoluble magnesium hydrate. The latter reagent, as previously stated, is formed by the combination of lime water and sodium carbonate.

The quantities of reagents required to treat a water can be found from the molecular weights of the hardening salts (see Table III.), and the reactions given in Table V. Thus 0·56 grains of lime are required to precipitate one grain of calcium carbonate, or, in other words, 0·56 grains of lime are required for each 1deg. of temporary hardness per gallon, or 0·081b. for each 1deg. per 1,000 gallons. With lime at 20*s.* per ton, the cost would be 0·00856d. per 1deg. per 1,000 gallons. In the same way 0·1521b. sodium carbonate would be required for each 1deg. of permanent hardness, and this at £4 per ton would amount to 0·06491. per 1deg. per 1,000 gallons. Each degree of permanent, therefore, costs over 7½ times as much to remove as each degree of temporary hardness, or 1,000 gallons with 58deg. temporary hardness costs for lime ½d., and 1,000 gallons with 7·7deg. permanent hardness costs for soda, ½d.

Most water softeners consists of the following: (1) tanks or vessels for containing the chemicals or reagents; (2) apparatus for distributing the chemicals in their proper proportions; (3) tank or vessel in which the hard water is treated; (4) filters for retaining the precipitates formed. The distributing apparatus should be automatic in regulating the supply of reagents according to any variation which may occur in the quantity of hard water requiring treatment, and should also be capable of being readily adjusted should the hardness of the water vary. The filters should also be designed for rapid and efficient cleansing with minimum delay in the working of the plant should renewals of filtering medium (which generally consists of either wood wool, sponge, cloth, or sand) be required. Some filters are made in sections, each of which can be by-passed when cleaning, thus enabling the filters to be cleaned without interrupting the work.

Below are the results of tests I have made on the hardness of three Dublin waters:

| | Vartry. | Canal. | Well. |
|---|---|---|---|
| Temporary hardness | 0·55 | 10 0 | 20 0 |
| Permanent hardness | 3·35 | 5·0 | 130 0 |
| Total hardness | 3 90 | 15·0 | 150 0 |

*Purification.*—The injurious effects of oil introduced into a boiler have already been pointed out. If the condensation water from the condenser of an engine be collected in a glass vessel and examined, it will be found to have a milky appearance, due to the presence of minute globules of emulsified oil in suspension. These globules, if allowed to enter the boiler with the feed water, to a large extent adhere to the plates. How a thin film of oil on a boiler plate should hinder heat transmission to such an extent as to become dangerous is a subject which has been the cause of much discussion. To obviate risk, the condensed steam may be run to waste and fresh feed water used. Assuming this is done in a station with an average output of 500 kw., the steam consumption being equal to about 1,000 gallons of water per hour at 6d. per 1,000 gallons, equals

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12s. per day, or over £200 per annum. This only represents about one-half the saving, as, before a comparison can be made, the cost of heating up the cold feed to the temperature of the condensed steam, say 100deg. F to 130deg. F., would have to be taken account of. As the cost of working a purifier is very small, a total saving is effected worth serious consideration.

Oil in the exhaust steam on the way to the condenser cannot be completely arrested, neither can it be separated from the condensation water by mechanical filtration. The globules of emulsified oil are of such minute dimensions that they will pass through filter paper as easily as through the finest-woven fabric. Fig. 7 shows diagrammatically a comparative ratio between the size of a mesh of fine fabric and that of a particle of emulsified oil.

The most successful method of satisfactorily eliminating oil in this condition is by chemical means. Chemicals are introduced into the condensation water. This brings about a reaction which envelopes the oil particles with a precipitate, causing them to adhere together in sufficiently large groups to render filtration easy; the resulting filtrate being perfectly clear. The reagent generally used is aluminium hydrate ($Al_2(OH)_6$), readily prepared by the interaction of sodium carbonate on aluminium sulphate:

$$Al_2(SO_4)_3 + 3Na_2CO_3 + 3H_2O = Al_2(OH)_6 + 3Na_2SO_4 + 3CO_2.$$

The sodium carbonate and aluminium sulphate are added to the condensation water, and form the aluminium hydrate precipitate which surrounds the oil particles.

Another method of purification recently tried is by electrolysis, whereby the emulsified condensation water is used as an electrolyte. Electrodes are introduced into this, the current acting upon and precipitating the oil in such a form that it can afterwards be filtered.

The essential parts of chemical purifiers are similar to those already mentioned for softeners.

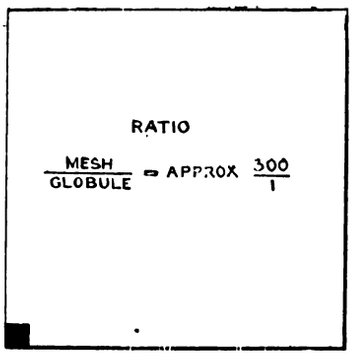


FIG. 7.—Approximate Ratio of Area of Mesh of Fine-Woven Fabric to average size of Globule of Emulsified Oil in Condensation Water.

It would scarcely be possible in this paper to describe the numerous water softeners and purifiers on the market, but anyone desirous of investigating the working of the former will find valuable information in a recent paper on the subjects by Messrs. Stromeyer and Baron (*Proceedings*, Institution of Mechanical Engineers, 1903, p. 773).

## PHYSICAL SOCIETY.

At a meeting of this society on April 14, Dr. R. T. Glazebrook, F.R.S. (vice-president), in the chair,

A paper on "*The Determination of the Moment of Inertia of the Magnets used in the Measurement of the Horizontal Component of the Earth's Field*" was read by Dr. W. WATSON. One of the constants required when determining the horizontal component of the earth's magnetic field by the ordinary method is the moment of inertia of the magnet which is used in the vibration experiment. It is usual to determine the moment of inertia of the cylindrical brass bar supplied with each instrument by calculation, then by measuring the period of the magnet alone, and when loaded with this bar to calculate the moment of inertia of the magnet. This method presupposes that the density of the inertia bar is uniform throughout. It is not easy to secure a bar of which the density is uniform throughout, and, further, it is difficult to test whether such uniformity has been secured. The author thinks that more reliable and uniform results would be obtained by determining once for all, with very great care, the moment of inertia of a standard bar and then determining the moment of inertia of the bars supplied with the different magnetometers, by comparing them with the standard bar experimentally. In the paper is described an instrument suitable for comparing the moment of inertia of bars, together with some experiments made with a view to determining the moment of inertia of a standard bar, and an investigation of the influence of the air upon the period. The bars which have been compared are as follows: (1) rolled brass; (2) cast silver; (3) rolled copper; (4) copper with 5 per cent. zinc; (5) copper with 5 per cent. phosphide of tin; (6) gunmetal; (7), (8), (9) rolled copper; and (10) a rolled brass bar with slightly rounded ends and gilt. The periods of oscillation of the bars when resting in a cradle hung by a quartz fibre were determined accurately with the instrument described. Owing to the fact that the rigidity of fused silica increases as the temperature rises, the period changes very little with temperature and the corrections for changes in temperature can be made without difficulty. With an initial amplitude less than 5deg the period is not, within the limits of accuracy of the observations, affected by the variation in amplitude. Variations in period due to the variation of the rigidity of the fibre with the load upon it were found to be negligible. In order to test the influence on the period of the air carried by the bars when swinging, a vacuum chamber was used which enclosed the whole instrument. The procedure adopted was to observe the period at atmospheric pressure, then exhaust and observe the period, and, finally, the air having been readmitted, to observe again at atmospheric pressure. The results showed an increase of moment of inertia for 76cm. increase in pressure of the order ·1 per cent. The author has investigated the effect of the air in the case of the magnets used in the Kew pattern unifilar magnetometer, and finds that it may cause an error of about 4·4 γ. The paper concludes with a comparison of Dr. Watson's bars with some belonging to the National Physical Laboratory.

Dr. C. CHREE expressed his interest in the paper, and remarked that the want of homogeneity in inertia bars was a source of serious trouble in magnetometer work. The variation in density might be as much as 5 or even 10 per cent. He favoured the adoption of a standard bar which could be swung in various magnetometers. He expressed his interest in the size of the error which may affect the value of the horizontal force due to the increased moment of inertia caused by the air. A similar error entered into pendulum observations. With regard to the rigidity of quartz fibres, he was inclined to think that there would be a change in rigidity with a change in load.

Mr. W. A. PRICE asked if the difference in magnetic permeability between air and the material of the bars was sufficient to affect the period, and also if there were any other fibres whose rigidity increased with rise of temperature.

The CHAIRMAN expressed his interest in the paper, and said that he had followed the course of the work. In attempting to get an accurate value for H it was most important to check the homogeneity of the inertia bar. The value of the moment of inertia should be known with great accuracy. Four or five years ago he suggested experiments similar to those described by Dr. Watson for measuring inertia bars, and although preliminary observations were made they were not carried far.

Dr. WATSON said he knew of no other substance but quartz which was suitable for the experiments he had performed. He had not found any variation of period due to magnetic permeability. With regard to Dr. Glazebrook's remarks, he said the measurement of the diameter of the bars was easy, but that the determination of the length was much more difficult.

Dr. W. WATSON gave an "Exhibition of a Series of Lecture Experiments illustrating the properties of the gaseous ions produced by Radium and other Sources." Many well-known experiments on the subject were shown by Dr. Watson, who pointed out the precautions which must be observed in order to ensure success at lecture demonstrations.

## LEGAL INTELLIGENCE.

### OBSTRUCTING A CAR.

At the Spelthorne Petty Sessions last week, George Fearnham, of High-street, Teddington, baker's assistant, was summoned by the London United Tramways Company for obstructing a car when driving a horse and cart at High-street, Teddington, on March 4 and on March 23.

It appeared that accused had been in the habit for a long time of deliberately placing his van so that the wheels projected over the tramline. Defendant had been spoken to by a police officer, but he refused to move his van. On the first day in question he delayed a car eight minutes, and on the 23rd he repeated such conduct in an aggravated form. On that occasion a gentleman pulled the van aside, whereupon defendant deliberately placed the van again in the position complained of, and further delayed the car.

Several witnesses corroborated the facts, one deposing to a statement by the defendant that it was allowable to stop a vehicle for 20 minutes, which he intended to do. There was quite enough room for the van to have passed the car.

Mr. ROBINSON, for the defence, said that a cart had a right to stop for loading and unloading for a reasonable time irrespective of obstructions. There had been no trouble till the trams came along. The company had agreed with the Teddington Urban District Council to widen the road, but this had not been done.

The CHAIRMAN: That has nothing to do with this case.

Mr. ROBINSON said the question was whether there was room or not.

The CHAIRMAN said they had it in evidence that there was ample room for the cars to pass.

Mr. ROBINSON: That is their opinion.

The CHAIRMAN: This van had been passed time after time.

Mr. ROBINSON: If the doors are open the tramcars can't pass.

The CHAIRMAN: Nothing should project on a cart beyond the hubs.

Mr. ROBINSON: Then every load of hay would be against the law.

The CHAIRMAN: We are not trying that now.

The Bench were unanimously of opinion that it was a case of wilful obstruction to cause annoyance. Defendant would be fined £2. 10s. on each summons, including costs. If such obstruction were again proved against him, he would be fined the full penalty with costs.

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# COMPANIES' MEETINGS AND REPORTS.

## BRUCE PEEBLES AND CO.

The annual meeting of this Company was held at the offices of the Company, Edinburgh, Mr. W. Carmichael Peebles (the chairman) presiding. Particulars of the report appeared in our issue of the 31st ult.

The CHAIRMAN, after reviewing the satisfactory position, said that the increase in trade was being maintained in the current year. Although the progress of the Company's electrical interests had overshadowed other branches the gas business had also done well, the "penny-in-the-slot" meter having proved of great value.

The report was unanimously adopted.

Mr. A. W. Tait was elected and Messrs. A. C. Peebles and Roland S. Portheim re-elected directors.

Extraordinary general meetings of the Company and also of the preference shareholders were afterwards held, at which resolutions were unanimously carried authorising the increase of the capital from £200,000 to £300,000, by the creation of a further 10,000 6 per cent. cumulative preference shares of £5 each, and 10,000 ordinary shares of £5 each. Resolutions were also passed authorising an increase of the borrowing powers of the Company from £50,000 to £100,000. It is not intended to exercise the increased borrowing power at present.

## METROPOLITAN ELECTRIC TRAMWAYS, LIMITED.

The report for the year ended Dec. 31 showed that the total revenue amounted to £113,254 including the dividends on shares held in the North Metropolitan Tramways Company and the Harrow-road and Paddington Tramways Company, and interest upon the advances made to the North Metropolitan Electric Power Supply Company. The gross traffic receipts amounted to £81,843, as compared with £66,973 for the previous year. As the lines now working by electric traction were not opened until the second half of the year, and some of them not until December, the directors consider the increase of traffic receipts satisfactory. The revenue account, after deducting all expenses chargeable to revenue, including loan and debenture interest, shows a surplus of £32,283. Deducting the full dividend on the preference shares for the year, amounting to £25,000, and providing for the repayment to the British Electric Traction Company, Limited, of the balance due to them for the advance made in January, 1903, under their guarantee of the preference share dividend, there remains an available balance of £3,854, which the directors recommend should be carried forward. The directors propose to make an issue of ordinary shares at par to the holders of all classes of shares and to the debenture stock holders on the registers of the Company on April 7, 1905, in the proportion, as nearly as practicable, of one ordinary share in respect of every 10 shares or £10 debenture stock held at that date. It is proposed to make the shares payable by instalments of 5s. on acceptance of allotment, 5s. one month later, and 10s. two months later.

At the ordinary general meeting last week Mr. EMILE GARCKE, who presided, said that during the past year the Company had carried about 9,500,000 of passengers by horse cars and about 7,500,000 by electric cars, amounting to about 17,500,000 in all. On the horse lines the average receipts were 10·8d. per car mile and on the electric line they averaged about 13·3d. per car mile, and taking the receipts per route mile on the horse lines, they were able to take about £8,000 per route mile per annum and on the electrical part of the tramways close upon £14,000 per route mile per annum. They were busily engaged in completing the conversion of the remainder of the horse lines, and the Middlesex County Council were constructing, and this Company equipping, various light railway routes, and it was hoped that about 4½ miles of light railways would be open before Whitsuntide on what was known as the Great North-road, from Highgate Archway to Finchley, thus serving a very populous district which had not hitherto been opened up by tramways. In connection with that particular route, he referred to an important arrangement which the Company had been able to effect with the London County Council. The present horse tramways in the direction of the Highgate Archway fell short of the commencement of their light railway by about half a mile this side of the Highgate Archway. It was, therefore, very important that that link should be completed, and they had been able to arrange with the London County Council to construct that piece of line, which would be leased to their Company, so that they would be able to start electric cars at the point where the present horse lines terminated. Another very important route, which would be in operation at any rate before the summer, was that leading direct to the Alexandra Palace. Two other important arrangements had been effected with the Wood Green local authorities and the authorities of Edmonton, both providing for the extension of the Company's tenure, these authorities agreeing not to exercise their rights of purchase of these lines until 1930. Referring to the reported proposal of the London County Council to purchase the unexpired term of the lease held by the North Metropolitan Tramways Company, the Chairman remarked that their Company was very largely interested, as shareholders in the North Metropolitan Tramways, but this matter had not as yet come officially before them. The matter was still under negotiation, but there would be no harm in his making a general statement as to how it affected the Company otherwise than financially. Practically, it would anticipate the normal course of events, and if the lease were continued until 1910 they would continue to receive their dividends at the rate of 3¾ per cent.; but at the end of that time the Company would receive a payment in respect to the sale of the horses and cars to the London County Council. The Bill which they promoted in the last session of Parliament for the purpose of completing the purchase of the Harrow-road and Paddington undertaking, and to carry out the conversion to electric traction, was confirmed by Parliament, and they were therefore in the position of being virtually the owners of that undertaking though they had not yet completed the purchase. So strongly did the directors feel the importance of losing no time in the electrification of the undertaking that they were very seriously contemplating the raising of some additional capital for the purpose at a very early date.

In connection with the various ambitious schemes in existence for the supply of electrical power, the CHAIRMAN stated that their Company was already very well situated for doing that particular work, and their area was not affected by the Administrative County Company's Bill. Having alluded to the proposed issue of ordinary shares, mentioned above, he concluded by moving the adoption of the report.

Sir ERNEST SPENCER, M.P. (deputy-chairman), seconded the resolution, which, after a short discussion, was unanimously carried.

The retiring directors (Mr. G. Richardson and Mr. J. Goddard) were duly re-elected, and the meeting closed with a cordial vote of thanks to the chairman and directors for their able services during the past year.

## BARCELONA TRAMWAYS.

The annual meeting was held on Monday at Winchester House, Mr. J. B. Concanon presiding.

The CHAIRMAN, in moving the adoption of the report (of which we gave particulars last week), said that the Ensanche line, for the first time since its electrification, had not only earned the full interest on this Company's large loan to that undertaking, but had also shown a surplus on working of nearly £700, which had gone in reduction of the loan itself. With regard to the outlook, the earnings this year, to the end of March, were more by £4,621 on the Barcelona system, and he thought that £4,000 of this amount would be retained as net profit. Provided that for the rest of the year there was no falling off in the receipts, and that the rate of exchange remained as it was, they should be between £6,000 and £7,000 better off at the end of 1905 than they were at Dec. 31 last. Against this, however, nearly £5,000 would have to be expended on relaying a certain portion of the system, and the directors contemplate voting a substantial sum to their colleague Mr. H. Brown for his special services to the Company. Negotiations were at present in progress with the Municipality of Barcelona for the unification of their concessions. In view of the improved financial position of the Company, the Board hoped to be able to declare an interim dividend on the ordinary shares in the autumn.

The report was unanimously adopted.

## PRIMITIVA GAS AND ELECTRIC LIGHTING OF BUENOS AYRES.

The balance of revenue account for 1904 and the interest received from the German Transatlantic Electricity Company amount to £115,386, and transfer fees to £72, making a total at the credit of profit and loss account of £115,458. Adding the balance brought forward from the previous year of £16,613 there is a grand total of £132,071. After deducting the various charges and placing £15,000 to reserve, there remains a balance of £40,469 to the credit of profit and loss. The directors recommend that a dividend of 6s. per share (free of income tax), equal to 6 per cent. for the year, be declared on the ordinary shares of the Company, which will absorb £24,000, leaving £16,469 to be carried forward to next year's account. The service and redemption at par of the whole of the authorised issue of debentures is provided for in the agreement of Aug. 12, 1903, with the Deutsch Ueberseeische Electricitäts-Gesellschaft of Berlin, the particulars of which were given in the previous report of the directors. The Company's works have been maintained in efficient repair. An additional sum of £1,500, over and above the annual minimum of £2,500 previously agreed to, has been added to reserve against discount on debentures and expenses of issue. The increase in sales of gas during the past year amounted to 4½ per cent., and there has been considerable growth in the use of cookers and stoves. The Company were affected by the workmen's strikes in Argentina.

## WYCOMBE ELECTRIC LIGHT AND POWER.

The report for the year ended Dec. 31 states that considerable progress has been made by the Company during the year, the connections having risen from 31,930 to 37,383, being an increase of 5,453 equivalent 8-c.p. lamps. The result of the year's trading, including a balance of £93. 5s. 8d. brought forward from the previous year, shows a profit to the credit of the net revenue account of £3,854. 19s. 2d., and, after paying interest on debenture and loans amounting to £2,122. 5s. 10d. (including £100 written off for bad debts), there is a surplus of £1,825. 19s. The directors recommend the payment of a dividend at the rate of 4 per cent. for the year, which will absorb £1,200, and that £500 be placed to the reserve fund for renewal of plant, leaving a balance of £125. 19s. to be carried forward to next year's account.

## APPOINTMENTS VACANT.

**Premium Pupil**, Cork. 52 guineas. See advertisement.

**Foreman** of switch and controller department. See advertisement.

**Switchboard Attendant**, Swindon Corporation electricity and tramways department. Wages 25s. per week. Applications by May 3. See advertisement.

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## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Govan.**—The Council require annual stores. Tenders by 25th inst.

**Portsmouth.**—The Council require annual stores for tramways. Tenders by May 1.

**Dublin.**—The Port and Docks Board invite tenders for an electric generating station. Tenders by May 15.

**Wallasey.**—The Council require annual supply of stores for their electricity works. Tenders by 27th inst.

**Bournemouth.**—The Town Council invite tenders for Contract No. 6—11 electric cars. Tenders by 29th inst.

**Edinburgh.**—The Corporation invite tenders for water-tube boilers. Tenders by May 8. See advertisement in last issue.

**Cataquoxes (Spain).** — The local light and power company require tenders for electrical plant. Tenders by July 1.

**Montreal.**—The Montreal Water and Power Company, 107, St. James-street, require tenders for machinery for a pumping station.

**Johannesburg.**—The time for sending in tenders for this contract (particulars of which appeared in former issues) is May 8 (London).

**Paris.**—The Government Railways, rue de Chateaudun 42, Paris, require tenders for copper strip, lighting accessories, etc. Tenders by 2.30 p.m. on April 27.

**Cork.**—The Cork Electric Tramways and Lighting Company, Limited, invite tenders for the supply of white wood casing and capping. See advertisement.

**Stockport.**—The Gas and Electricity Committee invite tenders for the supply of one 500-kw. steam generator. Tenders by April 26. See advertisement in last issue.

**Liria.**—The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

**Dax (Province of Landes, France).**—The Municipality require tenders for their concession to erect and work electric lighting for 35 years. Tenders to the Mayor by May 14.

**French West Africa.**—The Governor-General of French West Africa, at Dakar, requires tenders for the erection and equipment of a central station at that place. Tenders by May 15.

**Bilbao.**—The Public Works Department at Madrid require tenders for the concession of an electric tramway in Bilbao, from the Calle de Hurtado de Amézaga to Plaza Circular. Tenders by April 24.

**Laventhem (Belgium).**—The Municipality require tenders for erection of central station, laying of mains, etc. Particulars (3s. 4d.) may be obtained from the Secretary of the Mayor of that place.

**Bournemouth.**—Tenders are invited for the following, for the Corporation Tramways (Christchurch extension): Contract No. 5—feeder cables, troughing, excavation, etc. Tenders by April 29.

**Fulham.**—The Council invite tenders for condenser piping, sump and river work, steel roof and bunker work, and coal-conveying apparatus. Tenders by 25th inst. See advertisement in last issue.

**Wimbledon.**—The Urban District Council invite tenders for the supply and erection of a 1,000-kw. steam-driven turbo-alternator, with condensing plant, high-tension switchgear, and pipework. Tenders by April 28.

**Antwerp.**—Tenders will shortly be invited by the Belgian State Railways for the installation of electric light in their local railway station. Specification No. 619 may be obtained from the Government Railways Office, Brussels.

**Bristol.**—The Docks Committee invite tenders for the construction, delivery, erecting in place, fitting, testing, and maintenance for 12 months after completion of two electric goods lifts and one electric passenger lift. Tenders by May 1.

**New Ferry (Cheshire).**—The Lower Bebington Urban District Council invite tenders for the work of electric installation for fire brigade alarm in New Ferry, and also for supply of street lanterns for incandescent lighting. Tenders by April 24.

**London.**—The London County Council invite tenders for the supply, erection at its generating station, East Greenwich, S.E., and maintenance for a period of 10 years, of a battery of 280 accumulator cells having capacities of 645 ampere-hours at a three-hour discharge rate and of 450 ampere-hours at a one-hour discharge rate. Tenders by May 16. Full particulars in advertisement columns.

**Switzerland.**—M. R. Vontobel, of Winterthour, and M. Charles Probst, of Lucerne, have obtained a concession for the construction of a narrow-gauge electric railway from Meiringen to Gletsch. The total cost of the enterprise is estimated at £241,600; £19,600 is to be expended on rolling-stock.

**London, N.**—Tenders are invited for the road work, platelaying, and paving, etc., required for the construction for electrical traction on the overhead trolley system of the short length, equivalent to about three-fourths of a mile of single track, of authorised tramway in Archway road, Highgate, between the Archway Tavern and the Highgate Archway, in the metropolitan borough of Islington, for the London County Council. Tenders by May 8.

## RESULTS OF TENDERS.

**Rochester.**—The Town Council have accepted the tender of the National Telephone Company for fixing telephones between the various offices and the Council chamber at £24.

**Sunderland.**—The Corporation have accepted the tender of the Phœnix Dynamo Manufacturing Company, Limited, Thornbury Works, Bradford, for the supply of four 250-kw. synchronous three-phase motor-generators.

**St. Marylebone.**—The Electricity Supply Committee recommend the Council to accept the tender of the St. Helens Cable Company, Limited, for the supply, erection, and connecting up of 880 yards of 2 sq. in. and 440 yards of 1 sq. in. fire-resisting cables for £1,381.

**Hoylake.**—The order for a 250 kw. steam alternator has been placed with the British Thomson-Houston Company, Limited, at £1,407, with Browett, Lindley and Co., Limited, as sub-contractors for the engines. The delivery is to be made within 19 weeks. The alternator efficiency is given as follows: full load 92½ per cent., three-quarter load 91 per cent., half load 87½ per cent.

**Fulham.**—The Borough Council have accepted the following tenders for the supply of electrical stores for year ending March 31, 1905; W. H. Willcox and Co., asbestos goods; J. Gibb and Co., rubber goods and street-lighting (with the exception of arc lamp globes); General Electric Company, carbons; British Insulated and Helsby Cables, Limited, service boxes (with the exception of house fuse boxes).

**Hammersmith.**—On Wednesday the Electricity Committee recommended that the tender of G. and J. Weir for the feed-water pumps, at £108, be accepted. They also reported that tenders for supplying the arc lamp accessories required during the year were invited with those for the other electrical stores, but as no tender was received, the engineer had obtained a quotation from the Universal Electrical Manufacturing Company, of Peckham, and had reported that the value of the goods required will amount to about £25 during the year. The committee recommended that the goods be obtained from that company. They also submitted the following tenders:

Flues and forced draught.

| | |
|---|---|
| J. Howden and Co., Glasgow* | £1,228 0 0 |
| E. Green and Sons, Wakefield | 1,260 0 0 |
| A. Lowcock, Limited, Shrewsbury | 1,260 0 0 |
| Pollock, McNab, and Highgate, Glasgow | 1,280 0 0 |
| J. Spencer and Co., Wednesbury | 1,282 0 0 |
| Rosser and Russell, Hammersmith | 1,324 0 0 |
| Davey, Paxman, and Co., Colchester | 1,348 0 0 |

Economiser and settings.

| | |
|---|---|
| J. Howden and Co. (Green's) | 540 0 0 |
| Ditto (Lowcock) | 563 0 0 |
| Ditto (Pollock-McNab) | 893 0 0 |
| E. Green and Sons* | 500 0 0 |
| A. Lowcock, Limited | 523 0 0 |
| Pollock, McNab, and Highgate | 875 0 0 |
| J. Spencer and Co. (Green's) | 525 0 0 |
| Rosser and Russell (Green's) | 520 0 0 |
| J. Carter and Co., Stalybridge | 1,245 0 0 |

| Pipes. | | Erection. |
|---|---|---|
| Alton and Co.* | £1 393 0 0 | £119 0 0 |
| J. E. and S. Spencer | 1 324 6 0 | 153 0 0 |
| J. Wilson and Co. | 1,423 14 8 | 164 10 0 |
| E. W. Haley | 1,424 0 0 | — |
| Hill, Mason, and Co. | 1,430 0 0 | 172 0 0 |
| E. Le Bas and Co. | 1,441 0 0 | 138 0 0 |
| J. E. and S. Spencer | 1,457 16 0 | 170 0 0 |
| Rosser and Russell | 1,681 0 0 | 222 0 0 |
| Babcock and Wilcox | 1 695 0 0 | 214 0 0 |
| Stewart and Lloyds | 1,7d5 15 0 | 233 11 0 |
| Foster Bros. | 1 850 0 0 | — |
| Askham Bros. and Wilson | 2,010 0 0 | — |
| Davey, Paxman, and Co. | 2,475 0 0 | 290 0 0 |
| Worthington Pump Co. (part only) | 734 14 0 | — |
| Westwood and Wright (part only) | 350 0 0 | 115 0 0 |
| Wheeler Cond. and Eng. Co. (part only) | 845 0 0 | 95 0 0 |

High and low pressure water-valves.

| | |
|---|---|
| J. E. and S. Spencer (Fletcher and Blakeborough) | £665 9 6 |
| G. M. Marchant (own make) | 721 8 6 |
| J. E. and S. Spencer (Fletcher and Blakeborough) | 732 0 0 |
| Templer and Rance (internal screws) | 734 13 2 |
| Ditto (external screws) | 749 9 2 |
| Hill, Mason, and Co. (Templer and Rance) | 753 0 0 |
| Ditto (Hopkinson's) | 864 6 0 |
| Ditto (Fletcher's) | 637 16 0 |
| Ditto (Glenfield's) | 590 0 0 |
| Alton and Co. (Templer and Rance and Alley and McLellan)* | 763 16 0 |
| Babcock and Wilcox (Templer and Rance) | 840 12 6 |
| Rosser and Russell (Hopkinson's and Alley and McLellan and Sugden) | 855 0 6 |
| Davey, Paxman, and Co. (Templer and Rance) | 880 0 0 |
| Worthington Pump Company (Hopkinson and Co.) | 891 11 6 |

* Recommended for acceptance.

Feed-water heaters.

| | |
|---|---|
| Pollock, McNab, and Highgate | £220 0 0 |
| Baker's Patent Appliances, Limited | 330 0 0 |
| I. Storey and Co. | 360 0 0 |
| J. Wright and Co. | 445 0 0 |
| G. M. Marchant | 447 0 0 |
| J. E. and S. Spencer | 416 0 0 |
| Ditto | 456 16 0 |
| Worthington Pump Company | 468 0 0 |
| W. Boby and Co. | 486 0 0 |
| Rosser and Russell | 537 0 0 |
| Paterson Engineering Company | 575 0 0 |
| Lawrence Patent Water Softener Company | 575 0 0 |
| Sir Hiram Maxim Electrical Engineering Company | 975 0 0 |

It is recommended that one of the feed-water heaters be obtained from the Worthington Pump Company at £234 and one from W. Boby and Co. at £243.

A report on the tenders for the coal-elevator will be submitted at a future meeting of the Council.

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**Dundee.**—The contract for the construction of the Dundee and Broughty Ferry tramway has been allocated to Messrs. J. G. White and Co., London, at £80,250. This sum includes the cost of the permanent way, overhead equipment, power station, car sheds, cars, and the construction of a thoroughfare through the lands of Craigie.

**Swansea.**—The Corporation have received the following tenders for the wiring and supply of sundry fittings for an installation of electric light at the new police and fire brigade station:

| | | | |
|---|---|---|---|
| Symons and Sons | £157 | 17 | 0 |
| Neuer and Sons | 202 | 0 | 0 |
| T. A. Evans and Co. | 179 | 10 | 6 |
| Wills, English, and Co. | 290 | 0 | 0 |
| A. L. Furneaux (accepted) | 169 | 0 | 0 |
| L. Roberts | 206 | 14 | 0 |
| J. S. Brown | 220 | 15 | 0 |

All of Swansea.

**London County Council.**—The following tenders have been received (1) for the supply of electric lamps required in connection with the Council's general stores, and also the lamps for use on the tramcars:

| | | | |
|---|---|---|---|
| Mackey's Electric Lamp Company, London | £656 | 7 | 1 |
| General Electric Company, London* | 662 | 10 | 0 |
| Sunbeam Lamp Company, Gateshead-on-Tyne | 689 | 15 | 10 |
| British Thomson-Houston Company, London† | 722 | 7 | 11 |
| Sir Hiram Maxim Electrical, etc., Company, London | 735 | 10 | 5 |
| Edison and Swan United Electric Light Company, London | 988 | 15 | 0 |

† Tender not in order.

(2) The wiring and supply the fittings for an electric light installation at the Rotherhithe fire station:

| | | | |
|---|---|---|---|
| Ward Bros., 28A, Basinghall-street, E.C.* | £130 | 0 | 0 |
| Oliver, Clark, and Co., St. Mark's-road, North Kensington, W. | 135 | 0 | 0 |
| F. J. Coleby and Co., 7, Thayer-street, Manchester-square, W. | 140 | 0 | 0 |
| A. H. Marshall and Co., 270, High-road, Leytonstone, E. | 145 | 0 | 0 |
| Durell and Co., 58, Fenchurch-street, E.C. | 145 | 10 | 0 |
| Barlow and Young, 8, London-street, Fenchurch-street, E.C. | 150 | 0 | 0 |
| Tamplin and Makovski, Limited, 27, Charles-street, Haymarket, S.W. | 152 | 0 | 0 |
| National Electric Construction Company, Limited, 34, Victoria-street, S.W. | 153 | 0 | 0 |

(3) Low-tension cables, etc., for the Greenwich generating station:

| | | | |
|---|---|---|---|
| W. F. Dennis and Co., London | £2 151 | 3 | 6 |
| Johnson and Phillips, London (not to specification) | 2 214 | 13 | 1 |
| Western Electric Company, London* | 2,232 | 4 | 9 |
| British Insulated and Helsby Cables, Limited, Prescot | 2,438 | 17 | 6 |
| St. Helens Cable Company, Limited, Warrington | 2,446 | 11 | 3 |
| Siemens Bros. and Co., Limited, London | 2,465 | 3 | 7 |
| W. T. Glover and Co., Limited, Manchester | 2,523 | 11 | 9 |
| W. T. Henley's Telegraph Works Company, Limited, London | 2,553 | 10 | 0 |
| Callender's Cable and Construction Company, Limited, London | 2,595 | 1 | 0 |
| Edison and Swan United Electric Light Company, Limited, London | 2,701 | 8 | 10 |

(4) Induction motor-generators at Greenwich and the sub-stations at Streatham and Clapham;

| | | | |
|---|---|---|---|
| Bruce Peebles and Co., Edinburgh (not to specification) | £12,800 | 0 | 0 |
| Electrical Company, London | 14 364 | 0 | 0 |
| Dick, Kerr, and Co., London* | 14,747 | 10 | 0 |
| Ditto (alternative tender) | 13 660 | 0 | 0 |
| Electric Construction Company, Wolverhampton | 14,940 | 0 | 0 |
| General Electric Company, Birmingham | 15,491 | 0 | 0 |
| Brush Electrical Engineering Company, Loughborough | 15,590 | 0 | 0 |
| British Westinghouse Electric and Manufacturing Company, London | 16 329 | 0 | 0 |
| Ditto (alternative tender) | 15 917 | 0 | 0 |
| Phœnix Dynamo Manufacturing Company, Bradford | 17,187 | 0 | 0 |
| Siemens Bros. and Co., London | 17 415 | 15 | 0 |
| Ditto (alternative tender) | 15 986 | 15 | 0 |
| British Thomson-Houston Company, Rugby | 17 934 | 0 | 0 |
| British Electric Plant Company, Alloa, N.B. | 18 728 | 0 | 0 |
| Johnson and Phillips, London | 19,817 | 0 | 0 |

(5) For the supply of the general electric wiring material required for the Greenwich electricity generating station:

| | | | |
|---|---|---|---|
| Conduits and Fittings, Limited, London* | £1,407 | 0 | 0 |
| General Electric Company, Limited, London | 1 413 | 13 | 11 |
| Armorduct Manufacturing Company, Limited, London | 1,423 | 14 | 9 |
| Edison and Swan United Electric Light Company, Limited, London | 1,424 | 16 | 0 |
| W. McGeoch and Co., Limited, London | 1,480 | 0 | 9 |
| Simplex Steel Conduit Company, Limited, Birmingham | 1,697 | 11 | 11 |
| Verity's, Limited, London (incomplete) | 1,144 | 4 | 0 |

Conduits and Fittings, Limited, to be allowed to sublet to Spagnoletti and Co., London, or to such other person or firm as may be approved by the engineer under the contract, the supply of certain of the electrical fittings.

* Recommended for acceptance.

**Sports.**—The Electrical Trades Union (London District) have formed an athletic club under the title of "Eltradion," the name of the official journal of the society. They would like to arrange cricket matches with clubs connected with electrical firms. They describe their calibre as "25; weak." The secretary is Thos. Grover, 108, Hall-road, Peckham.

# BUSINESS NOTES.

## TRACTION.

**Dover.**—The work on the tramway at River is progressing rapidly.

**Blackpool.**—The new double line of tramway is expected to be running for Easter.

**Yarmouth.**—Two additional cars are to be purchased for the Corporation tramways.

**Derby.**—It is expected that the contractors will start upon the construction of the Kedleston-road and Normanton extensions at the beginning of next month.

**British Columbia Electric Railway Co.**—The directors have declared an interim dividend on the deferred ordinary stock at the rate of 6 per cent. per annum for the half-year ended Dec. 31.

**Coventry Electric Tramways Co.**—A dividend of 2 per cent. for the year 1904 is recommended by the directors in their report, and the transfer of £500 to reserve, leaving £646 to be carried forward.

**Swansea.**—A trial trip was made on the Morriston section last week. The Corporation engineer, Mr. Prusmann, expressed himself as quite satisfied with the test, which was rather a severe one.

**Cartagena.**—The Tramways de Carthagéne, a Belgian company, with offices at 80, Rue du Nord, Brussels, have obtained the permission of the Spanish Government to introduce electricity in the whole of their system.

**Bradford.**—The Board of Trade have given the Corporation sanction to construct a double line, about 1¾ miles in length, between North Bierley and Wyke, and another, about a mile in length, from Huddersfield-road to the boundary at Hipperholme.

**Isle of Wight.**—A public service of motor omnibuses for the Isle of Wight, arranged by the Isle of Wight Express Motor Syndicate, has been inaugurated at Ryde, Lady Adela Cochrane, wife of the deputy-governor of the island, driving the first car round the Canoe Lake.

**Edinburgh.**—A provisional order seeking, among other things, the construction of an electric tramway along Gilmore-place to Colinton was considered by the Town Council last week, but as no instructions were given for the order to be lodged, it will now have to stand over till November.

**Belfast.**—The Belfast United Trades and Labour Council have passed the following resolution: "That no arrangement of stages and fares on the new electric system will be satisfactory to the working classes of the city which does not include ½d. fares for stages of at least one mile in length."

**Radcliffe.**—The Urban District Council have agreed upon fares with the Bury Corporation in view of the two systems being linked up shortly. It is probable that the Electricity Committee will shortly come to a decision with reference to the purchase of another engine set, so that a fair margin of energy may be available.

**Chilian Electric Tramway and Light Co.**—The directors have received a cablegram from Santiago de Chile advising them that the profit of the lighting department of the company for the month of March, 1905, is 30,162dol., instead of 24,153dol. The total profit of the company therefore will be 104,176 dol., instead of 98,166dol., as previously stated.

**Baker-street and Waterloo Railway.**—This Bill came before the Unopposed Bill Committee of the House of Commons last week. The object of the Bill is to allow of new subways, an extension of time for the compulsory purchase of land, and the payment of interest out of capital during construction. The preamble was formally proved, and the Bill ordered to go forward.

**West Cumberland.**—The West Cumberland Tramways (Extension of Time) Bill, which has already been passed by the House of Lords, came on before the Examiners of the House of Commons for proof of compliance with the further Standing Orders. There was no opposition at this stage, and the necessary formal proofs having been given the Examiners decided that the further orders had been duly complied with. The Bill will therefore be reported for second reading.

**Halifax.**—A preliminary statement of receipts during the past year puts the takings at £74,019, or 11 53d. per car mile run, the aggregate number of car miles run being 1,540,707. In the previous year the receipts were £68 208 6s. 3d., or 11 79d. per car mile run. The present length of route open is 35½ miles, which is 2½ miles more than 12 months ago. The energy consumed was 3,009,940 units, or 1·94 units per car mile, compared with 1·87 units per car mile in the year 1903-4.

**Cardiff.**—At a meeting of the Tramways Committee last week the engineer, Mr. Ellis, reported that during March they had carried 44,180 more passengers, had run 10 985 fewer car miles, and there had been £130 less expenditure and £335 more profit, making a total increase in profit for the month over March of last year of £466. These figures were received with gratification, and it was remarked that they were justification of the recent rearrangement of the tramway service.

**Edgware-to-Hampstead Railway.**—Last week the Committee of Ways and Means considered this Bill, to which there was no opposition. The Bill authorises the construction of a deviation railway at Hampstead to join up with the Charing Cross and Hampstead Railway, and it also empowers the company to enter into agreements with the Underground Electric Railways Company for the construction of works and supply of current. There was no opposition, and the Bill was ordered to go for third reading.

**Leeds.**—The annual tramway report (of which we recently gave an outline) will come before the committee in a fortnight. The profits will approximate to £56,000. This figure has been arrived at on a similar basis to that adopted in previous years—*i.e.*, full allowance has been

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made for depreciation. A sum of £6,000 more than was estimated has been spent on renewals and the maintenance of the permanent way, in pursuance of a policy by which the whole of the system is maintained in the highest state of efficiency.

**Croydon.**—Interesting statistics have been compiled regarding the Croydon tramways, which since their electrification have been worked under lease from the Corporation by the British Electric Traction Company. During the last three years of the old horse cars 10 000 000 passengers were carried, but during the three years of the electrified system 40 000,000 have been carried. In the last 12 months the population of Croydon, about 145,000, has been carried almost 100 times over. In one year £20,000 was absorbed in wages, while the taxes paid totalled £2,120.

**Leith.**—At a meeting of the Tramways Committee last week it was decided to relay the section from the foot of Leith Walk to Pilrig at an estimated cost of £3,000. This section was relaid four years ago at a cost of several thousand pounds, and it was hoped that the heavy rails then laid would suffice for the new system now being installed. The rails were bonded for electricity, iron connections being placed between the two rails at suitable intervals. It is now found, however, that the part of the rails on the inner side of the groove is so much worn that they are quite unsuitable for the new cars.

**Rothesay.**—Before Sheriff Martin at Rothesay last week the Buteshire County Council and the Bute District Committee applied for an interim interdict against the Rothesay Tramway Company proceeding with the work of extending the line to Ettrick Bay until they had completed their agreement to purchase the greens in front of Port Bannatyne village for the extension of the roadway. For the company, it was pointed out that the owners refused to sell, and that the company had statutory powers for proceeding. The sheriff declined to grant an interim interdict, and adjourned the further claims for interdict and restoration of the roadway till the first ordinary court on May 11.

**Heckmondwike.**—On the consideration of the Urban District Council's Improvement Bill it was stated that a sum of £15 000 was needed to extend the electricity works, so as to supply energy to the tramway company. Part of the money had been spent in advance. The Council were bound to complete the agreement with the tramway company, and were anxious to do it as soon as possible. The chairman said the committee would not think of giving them powers to raise so large a sum of the capital on such evidence as was put before them. The utmost the committee would do would be to give such a sum of money as the Local Government Board might, on enquiry, approve.

**Dalkeith.**—At the monthly meeting of the Town Council the draft agreement between the Council and the Suburban Electric Tramways was considered, and it was agreed to forward the same for the approval of the directors. A clause was inserted giving the Council power to control the Sunday traffic. The other conditions proposed include a provision that the company shall within one year from the date of the passing of the provisional order substantially commence the work of laying down the tramways, and within two years have the same open for the conveyance of passengers. There is a limitation that the fares shall not exceed 1d. per mile, and that on workmen's cars the charge will not be above half that rate.

**Kirkcaldy.**—It is reported that Mr. Wemyss has decided to form a company to carry on the tramway scheme. At the enquiry in Edinburgh in connection with the tramways Mr. Wemyss stated he intended to retain the concern entirely in his own hands. The Home Office intimated that he must form a statutory company within two years, and hand over the concern to it. In view of this Mr. Wemyss has resolved to float a company with a capital of between £60,000 and £70,000, half ordinary and half preference, and £20,000 of debentures. Mr. Wemyss will retain the ordinary shares, but he intends to give the public in Scoonie and Wemyss parishes the first opportunity of taking up the preference and debenture shares. It is understood that work will be actually started by the end of the month.

**Calcutta.**—*Indian Engineering* understands that the Calcutta Tramways Company have obtained the concession for carrying a line through Cossipore northwards to Barnagore. There were several projectors in the field for this scheme, but the municipalities concerned very wisely decided to accept the terms offered by the tramways company, and in due course this very important service will bring the busy riverside areas to the north of Calcutta into close touch with the city itself. The road communications in the northern section of Calcutta are not satisfactory, there being only two wide thoroughfares—viz., Cornwallis-street and Upper Circular-road—which are both far away from the riverside, where traffic is heavy and where the want of broad roads is sorely felt by those having now to drive through narrow and crowded streets in order to get to the northern suburbs.

**East Ham.**—At the meeting of the Electric Lighting and Tramways Committee the receipt of a letter was reported from the Barking Town Council, covering the conditions upon which they were prepared to allow the East Ham authority to work the length of light railway in their district from the eastern boundary in Barking-road to a point in East-street (opposite Ripple-road), Barking, and, having considered the report of the engineer and manager, the committee recommended, subject to the following terms being agreed to by the Barking Council, that the same be approved: that the charge for current consumed be the same as that charged by the Council for its own tramways; that the payment to the Barking Council per car mileage above the minimum of 83 000 car miles per annum be at the rate of 2½d. per car mile; and that the agreement be for seven years instead of three years. The recommendation was adopted.

**Manchester.**—The Tramways Committee estimate that the income for the current year from traffic revenue will be £645 250, and from miscellaneous revenue (including Salford's user of lines, rents, etc.), £4,552, making a total of £649,802, against £638,755 for the year just ended. The latter figures are rather less than the amount that was estimated—£640,665. After meeting expenditure this year a balance, it is expected, will remain of £206,122, of which £49,560 will go for interest on loans, £38 795 for sinking fund and instalment of loans, £53,200 for the renewals fund and permanent way, and £14 525 for depreciation, leaving a surplus available for the city fund of £46,000 and £4,042 in respect of the infirmary purchase. Last year the committee gave £51 000 to the city fund—£46,000 coming out of profits and £5,000 from the contingent reserve fund. The parcels department has been left out of the account, because the committee have as yet no data to go upon. On capital account the committee purpose spending £52 500 this year. Of this sum £35,000 will be for cars and car equipments. In the year just ended the expenditure on capital account was £89 277, although the estimate was £124,000.

**Rhondda Tramways Bill.**—The Select Committee of the House of Commons presided over by Sir L. M'Iver accorded part of the Urban District Council's application for extension of time. The Bill sought to prolong the time for the purchase of land and construction of waterworks, tramways, street widenings, and other works by the Rhondda Urban District Council. The only objection to the Bill had relation to the tramways clauses on the part of a few owners of property in the district. The only means of communication at the present time is that provided by the Taff Vale Railway Company. Mr. Nicholas, clerk of the Urban District Council, explained the difficulties that had arisen in connection with the construction of the tramways already authorised, and said that an extension of time for three years was required in order to purchase land for their requirements. The population of the district proposed to be served is 155,000. In the end the committee granted an extension of one year for the compulsory acquisition of land in connection with the trams, but refused the three years' extension for the construction of the tramways themselves, as the committee considered that the time available was sufficient.

**Aberavon.**—At the meeting of the Highways Committee a report was read from Colonel Druitt, who held an enquiry on behalf of the Local Government Board into the Aberavon tramways scheme. Colonel Druitt sums up as follows: "Having examined the route of the proposed tramway, I consider it very desirable that the Great Western Railway bridge should be widened, and it is to be hoped that the company will give their consent thereto; but even if the consent is not given, I do not consider the order should be refused on that account, nor if the road in Water-street cannot be widened as approved by the Council. But in any case, if the order is granted, a clause should be inserted limiting the width of cars to 6ft., the width proposed by Mr. Seldon in his evidence for the promoters. On the questions referred to me on my appointment I find (1) that two-thirds of the length of the proposed tramways are to be laid in a district the local and road authority of which consents thereto; and (2) that the consent of the Glamorganshire County Council ought to be dispensed with and the provisional order made subject to my foregoing recommendations and to such conditions as the Board may deem advisable." It was resolved to write to the Great Western Railway pointing out the desirability of widening their bridge in Water-street.

**Ashton.**—At the monthly meeting of the Town Council the Tramways Committee reported that on March 28 the surveyor submitted an estimate of the cost of constructing the proposed siding into the L. and N. W. Railway Company's yard for coal haulage, and the manager gave details showing the approximate financial result. The committee decided before proceeding further in the matter, to write to the L. and N. W. Railway Company asking if they were prepared to bear the cost of constructing the siding into their yard, as the same would always remain on their premises and form part of their property. The L. and N. W. Railway Company replied that the company could not bear the cost of constructing a siding into their premises for the use of the Tramways Department, and the manager was instructed to write asking for a full reply to the sub-committee's communication as to what arrangements they were prepared to make in respect to siding accommodation for coal haulage by electric cars. The Works and Management Sub-Committee passed the following resolution: "That the electrical engineer and tramways manager forthwith prepare a specification, and that tenders be obtained for six single-deck cars to carry from 26 to 30 passengers, similar in general design to those used by the Oldham, Ashton, and Hyde Tramways Company, and equipped with regenerative control, and alternately with series-parallel control." The minutes were confirmed. The overhead equipment of the Scotland-street section has been completed, and the route is ready for inspection.

**London County Council.**—The proposals for coming to an early arrangement with the North Metropolitan Tramways Company were again postponed on Tuesday, as the Finance Committee had not had sufficient time to investigate same. Probably a decision will be come to at the first meeting after the Easter recess. The agenda at Tuesday's meeting also contained proposals relative to the construction of new routes and the reconstruction of existing ones, to the number of nine in all, which have already been authorised. The Highways Committee recommend the conduit system, so as to facilitate connection with other lines in South London. The agreement with the Middlesex County Council, referred to in our last week's issue, in reference to the line at Highgate, was submitted for confirmation, with an estimate of £5,513 for overhead equipment, etc. Estimates of £14 747, £1 500, and £1 407 for machinery and electric light wiring at the Greenwich generating station were also submitted. The Lambeth Borough Council have decided to withdraw their opposition to the London Southern Company's project for electrifying their No wood system. The company are prepared to undertake certain street works, whilst the County Council asked the Borough Council to contribute £40,000, subsequently reduced to £25 000, when the former authority made suggestions last year for the purchase of the company's property. A further resolution was passed, by a majority of one, that if the County Council and the company came to terms for the purchase

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of the latter's system the Borough Council would, having regard to the need of the improvement, make the reduced contribution of £25 000 towards the cost of street widenings. The County Council's tramway receipts for the week ended 8 h inst. amounted to £13 405, against £11,770 last year, the respective totals for the period from April 1 being £15,943 and £13,620.

**Weymouth.**—At a meeting of the Corporation the Electric Light Committee reported as follows upon the proposed electric tramways: "In accordance with the resolution of the Council passed on April 14, this committee obtained a report from Dr. Kennedy on the cost of construction and the possible results obtainable from the working of an electric tramway in this borough and district, a copy of which had been sent each member of the Council. In addition to Dr. Kennedy's report this committee has considered various alternative schemes—namely, (*a*) electric accumulator cars; (*b*) the trackless trolley system. The question of petrol cars has not been considered, but from enquiry the committee has discovered that only one municipality (Eastbourne) has obtained powers for them, the borrowing being for a very limited period. With regard to electric accumulator cars, this committee has heard that these cars have been tried in various places, but have all been discarded in favour of tramways on account of expense and technical trouble. The trackless trolley cars have been started in various places on the Continent, but unless the roads have been very carefully made and kept in first-rate order the result is utter failure. The principal Continental firm specialising in this matter has informed the committee, through Dr. Kennedy, that they have given up its further construction. The above reports being so very unfavourable, this committee feel that they cannot even submit them to the Council for consideration. Prof. Kennedy's report deals with tramways on the overhead trolley system. This committee has also considered the conduit system, as used in South London and also in parts of Bournemouth, and are of opinion that the excessive cost necessary for the construction of a line of this type makes it absolutely impossible for a return to be obtained on the capital invested. The committee had also considered the surface contact system as used in Wolverhampton, and cannot recommend it on account of the cost of construction and of the danger of 'live' studs being left in the roadway after the passage of the cars. In conclusion, this committee considers that an electric tramway service for Weymouth and the locality will at some time be a necessity, and are also of opinion that such service can be best obtained by an Act of Parliament, and they approve the system as outlined in Prof. Kennedy's report, but consider the Corporation should decide whether or not an Act of Parliament shall be promoted this session." It was decided to refer the whole matter to the Council in committee.

## LIGHTING AND GENERAL.

**Hackney.**—The Electric Lighting Committee propose to extend the electric lighting mains at a cost of £460.

**Apprentices.**—Particulars of an enquiry *re* apprenticing a lad to electrical engineering appear in another column.

**Isle of Man Telephone.**—An attempt is to be made to obtain telephonic communication between the Isle of Man and England.

**Wolverhampton.**—The Electrical Committee are about to extend the mains along Waterloo-road to Stafford-road at a cost of £950.

**Stirling.**—The Scottish Central Electric Power Company have issued the statutory notice of intention to lay electric mains in the district.

**Sunderland.**—An enquiry has been held into the application of the Corporation for sanction to borrow £15,000 for electric lighting purposes.

**Barking.**—During the past year 630,000 units were generated as against 487 000 for the previous 12 months, representing an increase of 30 per cent.

**Sale of Plant.**—Particulars of sale of second-hand electric generating sets by Kynoch Limited, Witton, Birmingham, appear in another column.

**Newbury.**—The Newbury Urban Electric Light and Power Company are holding an exhibition in the corn exchange in aid of the Newbury District Hospital.

**Clonmel Asylum.**—The Committee of Management have confirmed a previous resolution in favour of lighting the institution by electricity at an estimated cost of £2,925.

**Southend-on-Sea.**—The Corporation's returns just published show a great demand for electric lighting, the consumption in three years having increased from 200,000 units a year to 800,000.

**Reed's Electrical Co.**—The Reed's Electrical Company, of London, have opened a branch for the North of England at 24, Charles-street, Bradford, under the management of Mr. Chas. Pullan.

**Reading.**—Preparations are being made at the electrical exhibition buildings in Vastern-road, Reading, in anticipation of the formal opening of Reading's first electrical exhibition by the Mayor on Easter Monday.

**Mirfield.**—Electric light consumers are growing apace. The wiring of Christ Church, Battyeford, has been completed, and the Council have decided to extend the main from the bottom of Kitson-hill to the church.

**Ossett.**—The report and plans for an electric lighting station prepared by the engineer (Mr. W. Emmott) have been approved, and application will be made for power to borrow £8,400 for carrying out the necessary work.

**Middlesbrough.**—The Middlesbrough Chamber of Commerce have decided to ask the Telephone Company to reopen negotiations with the Corporation with a view to placing all the telephone wires in the borough underground.

**Loughborough.**—An electrical exhibition is being held at the town hall, the arrangements for which have been made and very successfully carried out under the supervision of Mr. W. H. Allen, the borough electrical engineer.

**New Issue.**—The Indian Electric Supply and Traction Company, Limited, are issuing 120,000 shares of £5 each at par, and £135,000 6 per cent. construction debenture stock at par. The company has been formed to establish and work electrical enterprises in India.

**Gravesend.**—An enquiry was held on Friday into the application of the Gravesend Corporation for an extension of their electricity area. The Hon. T. H. W. Pelham, after hearing evidence for and against, said he would consider the application and objections, and report later.

**Parliamentary Bills.**—The Chelsea Electricity Supply and the Walton-on-Thames Electricity Supply Bills were read a second time in the House of Lords on Friday. The West Cumberland Electric Tramways (Extension of Time) Bill was read a second time in the House of Commons on Monday.

**Islington.**—The Borough Council have decided to instal six mechanical stokers at the electric lighting works at a cost of £300 each. Overhead steel bunkers, a coal elevator and conveyor, and motors and accessories, with labour and other work, will, as anticipated in our last issue, bring the cost up to £4,500.

**Heywood.**—The Electricity and Tramways Committee in their last report state that the consumption of electricity for February, 1905, was 7,273 units, as against 6 121 units for the corresponding period of last year, showing an increase of 1,152 units. Tenders are to be obtained for the supply of 600 tons of washed slack coal for the ensuing 12 months.

**Hanley.**—The Town Council have received from the Electric Lighting Committee £1,150 to the credit of the district fund account. The price for electrical energy for private lighting is to be reduced from 6d. for the first 150 hours' use per quarter of the maximum demand supply and 3d. for all further consumption, to 6d. for the first 91 hours' use (or one hour per day) and 3d. for all further consumption.

**Electrical Plant (U.S.A.).**—The directors of the Allis-Chalmers Company, of Milwaukee, have decided to make an immediate expenditure of three million dollars on the extension of their works for the purpose of manufacturing electrical machinery of the largest type as well as steam and hydraulic turbines and gas-engines. The electrical department at Milwaukee will be operated in connection with the big plant of the Bullock Electric Company at Cincinnati, which is owned by the Allis-Chalmers Company.

**New Company.**—The Adelaide Electric Supply Company, Limited, has been registered with a capital of £300,000 in £5 shares, the object being to carry on in Australasia and elsewhere the business of electrical and general engineers, electricians, contractors, carriers of passengers and goods, manufacturers of and dealers in railway, tramway, electric, magnetic, galvanic, and other apparatus generators, etc. The first directors are J. B. Braithwaite, A. F. Parish, and R. P. Sellon, Mansion House-buildings, E.C.

**Belfast.**—Current will be supplied to the Cavehill and Whiterell Tramway Company on the following conditions under a 12 months' notice: the supply to be taken from and metered at the Fortwilliam sub-station; the company to bring their cables into the sub-station; the maximum demand to be 120 kw.; the minimum quantity to be paid for per annum to be 150 000 units; and the price to be for the first 150,000 units per annum, 2d. per unit; for the next 25,000 units per annum, 1¾d. per unit; and for the next 25,000 units per annum, 1½d. per unit.

**Paddington.**—The Borough Council on Tuesday discussed an agreement with the Metropolitan Electric Supply Company consenting to the removal of the Amberley-road generating station and the entire supply of the borough from the company's works at Willesden. The company offered, under five years' agreements with consumers, to make reductions in the price of current as follows: private house lighting, from 5½d. to 5d. per unit for the first two years, and 4¾d. in the remaining three years; trade lighting (including churches and schools) from 6d. to 4¾d. per unit the first two years, and 4½d. afterwards. An amendment in favour of taking expert and legal advice before the Council committed itself was adopted.

**London County Council.**—On Tuesday it was agreed that, with a view to relieving telephone users in the London area, the maximum rate fixed by the agreement of 1901 between the Postmaster-General and the National Telephone Company should be reduced; that Clause 4 (1) of the new agreement be amended so as to make it clear that no addition shall be made to the value of items, other than "plant" of the company's undertaking, in respect of compulsory purchase and that the Parliamentary Committee be authorised to endeavour to obtain such further modification of the proposed terms of purchase in the interests of the telephone users of London as may be desirable. The Council have sanctioned the borrowing of £8 500 for the installation of the electric light within the borough of Woolwich, to be repaid within 42 years.

**Institution Journal.**—Part 171, edited by G. C. Lloyd, secretary (E. and F. N. Spon, Limited), contains "The Combination of Dust Destructors and Electricity Works Economically Considered" (with discussion) by W. P. Adams; "Fuel Economy in Steam-Power Plants" (with discussion), by W. H. Booth and J. B. C. Kershaw; "Compensated Alternate-Current Generators" (Manchester Local Section), by Miles Walker, B.A. (with discussion); "High-Tension Switchgear" (Manchester Local Section), by L. Andrews (with discussion); "Armature Reaction in Alternators" (Glasgow Local Section), by J. B. Henderson, D.Sc., and J. S. Nicholson, B.Sc. (with discussion); "Condensing Arrangements in Central Stations" (Leeds Local Section), by J. D. Bailie; "The Magnetic Properties of some Alloys of Iron and Silicon," by T. Baker, M.Sc.

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**Stock Exchange.**—The Stock Exchange Committee have ordered the British Electric Traction Company's further issue of 5,000 6 per cent. cumulative preference shares of £10 each, fully paid, Nos. 356,438 to 361,437, to be quoted in the official list.

**Truro.**—The Electric Power and Light Committee are conferring with Mr. J. A. Purver, of Exeter, and the surveyor has been instructed to make enquiries as to what municipalities of a size similar to Truro had undertaken their own electric lighting.

**Harwich.**—The Board of Trade have given notice that they have revoked the Harwich (Corporation) Electric Lighting Order, 1892, as confirmed by the Electric Lighting Orders Confirmation (No. 2) Act, 1892, as to the whole of the area of supply, as from March 31, 1905.

**African Telegraphs.**—Mr. Merlaux Ponty, Governor of Upper Senegal, is at Paris in connection with his scheme for a new telegraph line to cross the Sahara from Algiers to Timbuctoo, and ultimately to Lake Chad. This line is estimated to cost £240,000. The route has been surveyed.

**South Wales Electrical Power Bill.**—The South Wales Electrical Power Distribution Company's Bill has passed the committee stage, and will in due course be reported for third reading. The object of the Bill is to transfer and vest in the South Wales Electrical Power Distribution Company the undertaking of the Carmarthenshire Electric Power Company and other purposes.

**Southampton.**—An enquiry has been held into an application of the Borough Council for sanction to borrow £6,950 for purposes of electric lighting made up as follows: £6,300 for excess expenditure from the previous loan for the erection and fitting of the new works; £520 for extension of mains in Oxford-street, Bernard-street, and Bridge-street; and £130 for two 10-ton coal trucks.

**Weymouth.**—A resolution recently passed by the ratepayers' association asking whether they would grant permission for any ratepayers desirous of so doing to visit the electric light works and destructor, and to name a date for such visit if granted, has been handed on to the Electric Lighting Committee with a recommendation that the members of the ratepayers' association should be allowed to view the works.

**Brighton.**—The *West Sussex Gazette* says it was arranged with the Shoreham Harbour Trustees that the Brighton Corporation should dredge down 6ft. across the canal at Southwick before laying the electric cables from the great power station there. Hard strata have been met with to prevent dredging to the full depth. Having regard to the safety of the harbour and the vessels using it, the trustees say they cannot consent to the cables being laid at a less depth.

**Warrington.**—The engineer estimates the cost of providing new condensing plant at £1,200, and the Town Council intend to apply for sanction to the borrowing of the said sum, and also, in addition to the following, £1,000 for land; £100 for shed, partition, and palings; £1,000 for four mechanical stokers and pipework; £500 for water softener; £100 for foundations, motors, and accessories; £200 for lathe, drilling machine, and accessories; and £50 for contingencies.

**New Photo-Copying Process.**—We have received from the "Blue Print" Company, of 128-30, Edmund-street, Birmingham, some samples of photo-copying done by a new process which they have protected. The feature of the process is that it reproduces in black lines on drawing-paper or on linen, and that there is no shrinkage in the copy so made. The examples sent to us are excellent, the lines being sharp and clear. The details of the process are not to hand, but information as to the same can be obtained from the firm.

**Lichfield.**—The promoters of the Shropshire and Worcestershire Electric Power Bill having agreed to insert in the Bill the clause agreed to by the Council as to the supply of energy within the city, and also an amendment incorporating therein the provisions of the promoters' Act of 1903 and the Acts incorporated therewith, the petition in opposition presented on behalf of the Corporation has been withdrawn. Messrs. Foote and Milne, Limited, have deposited with the Council a print of the provisional order for public inspection.

**Hammersmith.**—The Electricity and Lighting Committee require additional office and workshop accommodation. The premises of 18 additional consumers, representing a maximum of 352 8-c.p. lamps, have been connected to the mains, and 14 consumers disconnected. The present number of consumers taking current from the mains is 1,567. Seven new lamps are to be erected in Aldbourne-road and Askham-road. It is proposed to supply the National Electrical Manufacturers' Association with current at the proposed exhibition of electrical appliances to be held at Olympia from Sept. 25 to Oct. 21, 1905, on the following terms: (*a*) the Council to supply both continuous and alternating current as required up to 60,000 8-c.p. lamps at its exhibition stands at 1¾d. per unit; (*b*) a charge of 10s. 6d. to be made for connection and meter hire to each stand requiring 20 lamps or less, and 21s. for each stand of larger requirements; (*c*) if the cost of distribution of current is less than ¾d. per unit, such saving to be equally divided between the Council and the association; (*d*) a deposit of £600 to be paid to the Council by the association when the Council commences the outlay for distributing inside Olympia; (*e*) the Council to show the amount of current used by each exhibitor, but to render the accounts to the executive committee of the association, who hold themselves responsible for the whole supply.

**Govan.**—The Town Council, after considering the report by the electrical engineer with regard to the matter of charges for electric lighting to private consumers, have agreed not to take any action in the matter meantime. The engineer's report stated that during the 12 months ending Nov. 15 last the department sold for lighting 399,178 units at the following prices: 286,079 units, at maximum demand, 6d. and 1d., £3.572. 12s., showing a realised price per unit 2·951.; 36,294 units at flat rate of 4d., £604; 73 215 units at flat rate of 3½d, £1,067. 14s. 4d.; and 3,590 units at flate rate of 3d., £44. 17s. 6d. Exclusive of the accounts charged on the flate rates of 3½d. and 3d., there were 207 accounts that had run the full 12 months. These represented 288,322 units, equal to £3,813. 5s., or an average price per unit of 3·17d. He thought it fair to take these 207 accounts for a basis of comparison, and if the system of supply were changed from the maximum demand to a flat rate of 3½d. these 288,322 units would bring in £4,209. 13s. 1d. The rate would be lowered to 104 consumers, using 84,571 units, costing £1,545. 13s. 10d., and raised to 103 consumers, using 203 751 units, costing £2 297. 11s. 2d. If the maximum demand system were retained as at present, and the optional flat rate reduced to 3½d., the total revenue from the 288,322 units would be £3,530. 17s. 8d., a decrease of £282. 7s. 4d. It would be seen that the bulk of the units sold were on the maximum demand system, and that the average price was under 3d. per unit, so that to adopt a universal flat rate of 3½d. would not be to the advantage of the majority of the consumers. On the other hand, if this optional flat rate were reduced to 3½d. it was possible that for a year or so the department might suffer a little loss, but he thought the reduced charge would be an additional inducement for consumers to come on, and that they should probably gain in the long run.

**New Issue.**—The Adelaide Electric Supply Company, Limited, are issuing at par 10,000 6 per cent. cumulative preference shares of £5 each, payable as follows: 10s. per share on application, 10s. per share on allotment, £2 per share on May 15, 1905, and £2 per share on July 15, 1905—£5. This company was formed for the purpose, *inter alia*, of acquiring from the Electric Lighting and Traction Company of Australia, Limited, the business and undertakings in Adelaide and Port Adelaide now owned by that company. The properties to be acquired by the company include a freehold central station in Adelaide, supplying electricity in the city and suburbs; a small leasehold station, also in operation, at Port Adelaide; and the South Australian Electric Light and Motive Power Company's Act, 1897, granted by the Government of South Australia. About 72 miles of mains have now been laid, and the total connections at Jan. 31, 1905, were equal to 52,733 8 c.p. lamps. The advantages of electric light in the climate of Adelaide are becoming generally recognised, and the rate at which additional applications for supply are being received continues to be satisfactory: there is a growing demand also for motive power, the equivalent of 714 h.p. having been connected to the mains up to Jan. 31, 1905. Electric supply has heretofore been chiefly confined to the business area of the city of Adelaide proper, but mains are now being laid in the residential districts surrounding the city, and new consumers are being rapidly connected. The generating station at Adelaide is equipped with machinery of most recent construction, and the cost of generating electricity compares favourably with that of other modern electric supply stations in Great Britain and elsewhere. The capacity of the generating plant already installed is equivalent to 760 kw., and the existing station buildings are large enough to accommodate future extensions of plant for several years to come. A small station at Port Adelaide has been in operation for about five years, and the connections at Jan. 31, 1905, were equivalent to 6,482 8 c.p. lamps. This station has hitherto worked at a loss, the average deficit being about £250 per annum. It is proposed to supply the district from the Adelaide station, which will, it is believed, convert the present loss into profit, especially as negotiations are in progress for extending the Port Adelaide mains into districts hitherto untouched, from which there is a good prospect of revenue.

**Sudbury.**—A long discussion took place on the electric lighting question at the last meeting of the Town Council. The minutes of a meeting of the General Purposes Committee of the Council of April 10 stated that the Mayor had referred to the recent lawsuit between the Council and the Empire Electric Lighting Company. At the meeting the town clerk read the following statement: "When the Council decided (in consequence of the refusal of the Local Government Board to sanction a loan) to enter into an arrangement with a company to carry out the provisions of the order, I wrote, by the instructions of the Council, to the Board of Trade, informing them of the intention of the Council, and asking if the Board would be prepared to sanction such an arrangement. The Board replied that they did not appear to have any power to do this, which seemed to mean that the matter was not within their jurisdiction. Mr. Bartley Dennis, who conducted the Local Government Board enquiry on behalf of the Council, advised that an agreement could be legally entered into without any sanction from the Board of Trade. The agreement was prepared on behalf of the Council, and by their instructions, under Mr. Hawtayne's supervision, by his own solicitors, who were stated to possess the necessary technical knowledge, and they also had the assistance of Mr. Bartley Dennis, who has very large experience in these matters. This agreement was approved by the solicitors to the Empire Company, and the directors, and also by the Town Council, and finally sealed by both parties in duplicate. During the negotiations the Board of Trade was kept fully informed of all that was being done, and they twice extended the time of the order for the negotiations to be completed. I need not refer to the default of the company to carry out the agreement, nor the instruction to proceed against them for damages. In the action, the only defence put in by the Empire Company was that the agreement was invalid, because the sanction of the Board of Trade had not been obtained under Section 11 of the Electric Lighting Act of 1882, which is as follows: 'Any local authority who have obtained a license, order, or special Act for the supply of electricity may contract with any company for the execution and maintenance of any works needed for the purposes of such supply, or for the supply of electricity within any area mentioned in such license, order, or special Act, or in any part of such area, but no local authority, company, or persons shall, by any contract or assignment, transfer to any other company or person, or divest themselves of any legal powers given to them, or any legal liabilities imposed on them by this Act, or by any license order, or special Act, without the consent of the Board of Trade.' It will be seen from the first part of this section that a council

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may contract for the carrying out of the works, which is all that this agreement was intended to do; and that, by the second part of the section, a council may, with the consent of the Board of Trade, actually transfer and get rid of all their legal liabilities and obligations and rights, which was never contemplated as intended by the agreement. I have always advised the Council that the agreement could not operate to transfer any legal liabilities to which they must always remain subject, and, in support of this view, there is the following clause in the agreement: 'Nothing herein contained shall be deemed . . . to create any relationship between the Corporation and the company which the Corporation are prohibited from transferring, or creating by the order and the Electric Lighting Acts, 1882 and 1888, and particularly by Section 11 of the Act of 1882, the intention being for the Corporation to give to the company every facility in their power for carrying out this agreement without transferring or assigning any of the powers or duties under the order.' It would seem that nothing could be clearer; but at the trial the judge held that the whole intention and effect of the agreement was to transfer the legal liabilities of the Council to the company, and that the above-mentioned clause was useless; that the agreement was consequently invalid, and there was no basis on which to form an action for damages. I cannot think this decision is good law, and I think the Council should appeal, as there is every reason to hope that the decision would ultimately be in favour of the Council." The committee recommended that a small committee be appointed to consider the question, to take counsel's opinion with the view to an appeal against the decision of the judge, and to report to the Council. The report was adopted.

**Telephone Exchange Fire.**—The coroner's enquiry into the two fires which occurred simultaneously in the premises of the National Telephone Company at Mansion House-chambers, 11, Queen Victoria-street, and 1 and 2, Oxford-court, Cannon-street, on the morning of Tuesday, Feb. 28, was concluded on Tuesday. Mr. C. B. Clay, the metropolitan superintendent of the National Telephone Company, recalled, said that no special instructions were issued to the company's exchanges as to any action to be taken during a thunderstorm, because there was no special danger, and no one had yet met with an accident during a storm since the company's existence of 23 years. Signalman Doyle, of the District Railway Company at Westminster Bridge Station, said that at 1.39 on the morning of Feb. 28 he saw a flash under the girders on the up-line, and then a bright arc appeared and burned fiercely for about 10 minutes. At two o'clock a similar thing occurred on the down line. Some of the signal wires were fused, and also a gas-pipe, the gas burning as it came out of the ground. He turned the gas off at the main. Mr. Bennett thought it would be quite safe to leave the telephone wires in the District Railway tunnels, but they should be removed entirely from proximity to the power cables, and cased in wood or earthenware or non-conducting material. It was not safe to put the telephone wires in iron troughs, because, if a fault occurred, they might become "alive," and carry the high potential of the power cable into the telephone wires. Protectors should be provided at all telephone exchanges and at all subscribers' premises. Mr. Gaine, general manager of the National Telephone Company, said if a fire occurred in a subscriber's house he had first to ring up the telephone exchange. Then the call had to be put through to Southwark, and Southwark had to send it on to another station. In every large town in Great Britain a telephone user could get straight through to the station in a few seconds. Lieut.-Colonel Fox, chief of the Salvage Corps, regarded the practice of erecting heavy derricks for supporting telephone cables over buildings most dangerous. Overhead telegraph and telephone wires constituted a grave danger to the public in case of fire. Nobody was injured at this fire, but if it had occurred in the daytime the falling cables might have killed half a dozen people. The Coroner said the duty of making this investigation was thrown upon him as City coroner because there was no jurisdiction in the present case other than that afforded by the City of London Fire Inquests Act, 1888. The Board of Trade had no power to order an enquiry. Being of comparatively modern introduction, telephone systems appeared to have hitherto remained outside any official control. It was for the jury to decide whether the evidence laid before them in the present enquiry revealed such a state of affairs as to render Government enquiry and action desirable in the interest of the community at large. The jury submitted the following answers to his questions: (1) When and where did the fire of Feb. 23 last originate in the National Telephone Company's premises at Mansion House-buildings and Oxford-court? We find that the fire occurred at about two o'clock on the morning of Feb. 28 in both cases, and in what are known as the test-rooms of the National Telephone Company. (2) The cause of the fire in each case? Caused by a powerful current of electricity transmitted through the cables of the National Telephone Company to the test-room at the Bank exchange, and from there to the test-room at Oxford-court. The above current was derived from a charged conductor rail of the District Railway Company through the contact or arcing between the cables of the National Telephone Company at Westminster Bridge Station and such conductor rail. (3) Was the cause due to accident or negligence? There is not sufficient evidence to show. (4) Should telephone cables or wires be laid near high-tension currents? Not unless effectually protected. (5) Is the contact of a telephone wire with a high-tension current likely to be dangerous on account of fire in the subscribers' houses and shock or fatal injury to operators or subscribers? We say "No," when properly protected in both cases. (6) Do you consider the National Telephone Company's testing and distributing rooms were reasonably constructed to resist fire? We consider the construction of the test and distributing rooms leaves great room for improvement, and would suggest a greater use of non-combustible material and the use of modern safety devices in all exchanges. (7) Are special powers required to regulate all structural and other matters connected with the telephone service? Yes. (8) Is a Government enquiry needed into the telephone risks and needs? We see no necessity. (9) Do you consider the Oxford-court premises satisfactorily provided with means of escape in case of fire? No, we do not.

## PROVISIONAL PATENTS, 1905.

APRIL 6.

**7277. An improved case and cover for fire alarms, electric bell calls, and the like.** Joseph Henry Golding, Amhurst Electric Works, Garnham-street, Stoke Newington.

**7295. Improvements in or relating to alternating-current electric motors.** Benjamin Garver Lamme, The Westinghouse Patent Bureau, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, May 3, 1904, being date of application in United States.) (Complete specification.)

**7304. Improvements in electrically-operated burglar and like alarms.** Thomas William Senior and James George Farquhar, 55, Chancery-lane, London.

APRIL 7.

**7350. Electro-mechanical tenter hook detector.** Wilfrid Hemingway, Arthur Silcock, and Clifford Broughton Hogg, 100, Meadow-lane, Leeds.

**7359. A device for automatically regulating the resistance on a switchboard for electrical-driven machine or lights in conjunction with the governor of the engine.** John Lamb and Orlando Thomas Newton, 56, Strand-road, Bootle, Liverpool.

**7360. An improved device for keeping the trolley rope of a electric car tight, when the boom is in various positions.** James Lawson Dawson, John Clark, and Robert Blackmore, Victoria House, Manchester-road, Mossley.

**7405. Improvements in contact devices for electric switches.** The Elektrizitäts Actien-Gesellschaft vorm. W. Lahmeyer und Co., 47, Lincoln's-inn-fields, London. (Date applied for under Patent Act, 1901, May 9, 1904, being date of application in Germany.) (Complete specification.)

**7416. Improvements in vapour electric apparatus.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

**7417. Improvements in signals for railways and the like.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

**7418. Improvements in relays for electric circuits.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

**7419. Improvements in and relating to signalling systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

**7420. Improvements in electric systems for controlling guns and the like.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

**7421. Improvements in and relating to electrically-driven vehicles.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

**7422. Improvements in signals and mechanism therefor.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

APRIL 8.

**7436. Improvements in automatic motive power by electricity.** William Norman Lascelles Davidson, 20, Middle-street, Brighton.

**7438. Improved method of securing the removable cover of a tumbler or like electrical switch.** Edward Thomas Davies, 11, Burlington chambers, New-street, Birmingham. (Complete specification.)

**7443. Apparatus for recording the time in which a current has been flowing in an electrical circuit.** Kelvin and James White, Limited, and Joseph Menmuir, 154, St. Vincent-street, Glasgow.

**7444. Improvements in or connected with electric lamps, particularly applicable to the tail lamps of motor vehicles.** James William Greenwood, Palatine-chambers, Market-street, Halifax.

APRIL 10.

**7534. Improvements in and relating to heating by electricity.** Frank Wynne, Lightwater House, Bagshot.

**7591. Improvements in connection with alternating-current machines for synchronising and connecting them with distributing conductors.** James Yate Johnson, 47, Lincoln's-inn-fields, London. (Voigt und Haeffner Akt.-Ges., Germany.) (Complete specification.)

**7595. Improvements in means or apparatus suitable for indicating leakage of electricity.** James Frederick Driver, 46, Lincoln's-inn-fields, London.

**7596. Improvements in or relating to apparatus for supplying alternating electric currents.** Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

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**7605. Improvements in collecting devices for dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

**7606. Improvements in and relating to electromagnetic switches.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

**7617. Improvements in electric cut-out switches.** Joseph Frechette, 18, Buckingham-street, Strand, London. (Complete specification.)

**7626. Apparatus for the measurement of X-rays and other similar radiations.** Georges Eugène Gaiffe, 53, Chancery-lane, London.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published April 27.*

1904.

**13223. Electrolytic meters.** Holden, and Chamberlain and Hookham, Limited.

**13952. Apparatus operating with automatic regulation for submitting gases and vapours to the action of the electric arc.** Imray. (Soc. Anon. d'Etudes Electro-Chimiques.)

**16301. Self-restoring inter-communication telephone.** Freeman and Pearce.

**20846. Electric circuit breakers or switches.** Liddle. (Hartman.)

**21642. Electrical apparatus for adjusting tramrail points from the car.** Macaulay.

**25639. Space telegraphy.** Stone. (Date applied for under International Convention, Nov. 24, 1903.)

**25898. Switchboards for telegraphic, telephonic, and other electrical systems.** Mills. (Hammond.)

**26679. Electric circuit protecting devices.** Schäffer. (Date applied for under International Convention, Dec. 9, 1903.)

**27135. Hangers or ears for overhead electric trolley wires.** Heap, Bailey, Brierley, Billington, Richardson, Haydock, and Jones.

**27637. Vapour electric apparatus.** Dempster. (Date applied for under International Convention, Dec. 19, 1903.)

**28455. Central telephone station installations.** Siemens Bros and Co., Limited. (Siemens und Halske Akt.-Ges.)

**28601. Apparatus for electro-deposition of metals.** King.

*To be published May 4.*

1904.

**8323. Telephonic repeating system.** Downing. (Gally.)

**8403. Alternating electric current motors and generators.** The British Thomson-Houston Company, Limited. (General Electric Company.)

**8501. Controllers for the motors of electrically-propelled vehicles.** Cummins.

**8620. Electric motors.** Von Zweigbergk.

**10502. Prepayment electricity meters.** Griesbach.

**10880. Transmitting power electrically and controlling same.** The British Thomson-Houston Company, Limited. (General Electric Company.)

**10882. Electric meters.** The British Thomson-Houston Company, Limited, and Holden.

**11704. Railway or tramway signalling systems.** The British Thomson-Houston Company, Limited. (General Electric Company.)

**11880. Magneto electric generators.** Albion Motorcar Company, Limited, and Murray.

**12337. Thermal cut-outs for electric circuits.** The British Thomson-Houston Company, Limited. (General Electric Company.)

**12338. Electric switches.** The British Thomson-Houston Company, Limited. (General Electric Company.)

**13158. Plastic composition suitable for the manufacture of buttons, electrical insulating material, or other articles, and process of manufacturing same.** Geipel.

**13161. Manufacture of filaments for incandescent lamps.** Carolan. (General Electric Company.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ⅞-¼ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 7/16-17/32 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | – | 5¼-6 xd |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | – | 5¼-6 |
| —— 4½ per cent. Mortgage Debentures | 100 | – | 101-104 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 99-101 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | – | 2¼-3¼ |
| —— 4 per cent. Mortgage Debenture Stock | 100 | – | 91-95 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 | 2 | – | ¼-¾ |
| —— Non. Cum., 6 per cent. Pref. | 2 | – | 1½-2 |
| —— 4½ per cent. 1st Debenture Stock | 100 | – | 92-95 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | – | 79-82 |
| Callender's Cable, Debentures | 100 | – | 107-109 |
| —— Ordinary | 5 | – | 11 11¼ |
| —— 5 per cent. Pref. | 5 | – | 5¼-5½ |
| Crompton and Co. | 3 | – | 2¼ 2⅜ |
| —— 5 per cent. Debentures | 100 | – | 96 98 |
| Edison and Swan United, "A" Shares, 1-98,261 | 3 | – | 1-1¼ |
| —— "A" Shares, 01-017,139 | 5 | – | 1⅜ 2¼ |
| —— 5 per cent. Debentures | 100 | – | 84 89 xd |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 80 85 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | – | 1¼-1⅜ |
| —— 7 per cent. Cumulative Pref. | 2 | – | 2¼-2½ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | – | 97-99 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | – | 9¼-10 |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | – | 97-101 xd |
| W. T. Henley's Telegraph Works, Ordinary | 5 | – | 11¼ 12¼ |
| —— 4½ per cent. Preference | 5 | – | 6⅜ 6⅝ |
| —— 4½ per cent. Debentures | 100 | – | 109 111 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | – | 16 17 |
| —— 4 per cent. Debentures | 100 | – | 100-103 xd |
| Parker, Thos., Limited, Ordinary | 10 | – | 10-10¼ |
| Telegraph Construction and Maintenance | 12 | – | 36 38 |
| —— 5 per cent. Bonds | 100 | – | 103-105 |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary | 10 | – | 11¾-12¼ xd |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | – | 9¾-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | – | 11-12 |
| —— 4½ per cent. Debenture Stock, Red. | 100 | – | 105-107 |
| Bromley (Kent) Electric Light and Power Co. | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. 1st Debenture Stock, Red. | 100 | – | 103-106 |
| Brompton and Kensington, Ordinary | 5 | – | 9¼-10¼ xd |
| —— 7 per cent. Preference | 5 | – | 9¼-10⅛ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 | 5 | – | 9 9¼ |
| —— Nos. 60,001-80,000 | 5 | – | 6¾ 7¼ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | – | 12¼-13¼ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 105-108 |
| Charing Cross and Strand, 70,001-80,000 | 5 | – | 7¼-8¼ |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5⅝-5⅞ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 5-5⅛ |
| —— 40,001-80,000 | 5 | .. | 5-5⅛ |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | – | 105 107 |
| Chelsea Electricity Supply | 5 | – | 6¼ 7 |
| —— 4½ per cent. Debentures | 100 | – | 109 111 |
| City of London, Ordinary | 10 | – | 11-12 |
| —— 6 per cent. Cumulative Pref. | 10 | – | 13½-14 |
| —— 5 per cent. Debenture Stock | 100 | – | 125-127 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | – | 103 105 |
| County of London Electric Supply, Ordinary | 10 | – | 9-9½ xd |
| —— 6 per cent. Cum. Pref. | 10 | – | 12-12½ xd |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 104-106 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. | 100 | .. | 110-113 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | – | 6-6¼ |
| —— 6 per cent. Cum. Pref. | 5 | – | 6¼ 6⅝ |
| —— 4½ per cent. First Mort. Deb. | 100 | – | 106-108 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 2¼-2⅜ |
| —— 5 per cent. Debenture Stock, Red. | 100 | – | 86-91 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | – | 5¼-6 |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | – | 101-104 |
| Havana Electricity, Limited, 1-15,000 | 10 | – | 9¼-10¼ |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | – | 7⅜-7¾ |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 101-103 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 | 1 | – | 11/16-13/16 |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | | 12-13 |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red | 100 | – | 101-103 xd |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9¾-10¼ |
| London Electric, Ordinary | 3 | – | 2¼-2⅜ |
| —— 6 per cent. Pref. | 5 | – | 5¼-5⅜ |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | – | 99-101 |
| Metropolitan Ordinary | 10 | – | 17½ 8½ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | – | 109-114 |
| —— 4½ per cent. Cum. Pref. | 5 | .. | 5⅜ 5⅛ |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | – | 97-99 |
| Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb. | 100 | – | 99-101 |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | – | 98-101 |
| —— Preference | 4 | – | 100-102 |
| Notting Hill Electric Lighting | 10 | – | 14½-15½ |
| —— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.) | 100 | – | 100-102 xd |
| Oxford Electric, Ordinary, 1-96 and 3[illegible]-14,510 | 5 | – | 6¼-6½ |
| —— 4 per cent. Debenture Stock | 100 | – | 98-100 |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures | 100 | – | 98-100 xd |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 | – | 2⅜-2¾ |
| —— 4 per cent. Debenture Stock | 100 | – | 79-85 |
| South London, Ordinary | – | – | 3¾-4¼ |
| South Metropolitan Electric Light and Power Co., Ord. | 1 | .. | ⅝-1 |
| —— 7 per cent. Cum. Pref. | 1 | .. | 1¼-1 7/16 |
| —— 4½ per cent. 1st Mort. Deb. | 100 | .. | 105 108 xd |
| —— Ditto, June, 1904 | | .. | |
| St. James's and Pall Mall, Ordinary, 101-20,000 | 5 | – | 13½-14½ |
| —— 7 per cent. Pref. | 5 | – | 8¼-8¾ |
| —— 3½ per cent. Deb. | 100 | – | 98-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | – | 4 15/16-5 1/16xd |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5-5¼ xd |
| Westminster, Ordinary | 5 | – | 12-13 |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | – | 6-6¼ |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 | 5 | – | 5¾-6 |
| —— Ord. | 5 | .. | 8 11/16-8 15/16 |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | – | 140 143 |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 105-107 |
| Barcelona Tramways, Limited, Ord., 1-20,000 | 10 | .. | 12-12½ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 | 10 | .. | 9¼-10 |
| —— 5 per cent. Deb., Red., 1-600 | 100 | .. | 99-102 |
| —— 4½ per cent. Red. Deb. Stock | 100 | .. | 96-100 |
| Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606 | 1 | .. | 13/16-15/16 |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 | 1 | .. | 15/16-1 1/16 |
| Belfast Street Tramways, Ord., 1-26,600 | 10 | .. | 10¾-11¼ xd |
| Blackpool and Fleetwood Tramroad | 10 | – | 13¾-13⅞ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | – | 1-1½ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | – | 3¾-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 94-96 |
| British Columbia Electric Railway Co., Ord. Def. | 100 | – | 104-107 |
| —— Ord Pref. | 100 | – | 100-103 |
| —— Non. Cum. 5 per cent. Pref. | 10 | – | 10-10¼ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each | 40 | – | 105-107 p c |
| —— 4½ per cent. Vancouver Power Deb. | 100 | – | 93-102 |
| British Electric Traction Ord. 1-500,000 & 60,001-80,000 | 10 | – | 9-9¼ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | – | 10¾-11¼ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | – | 120-122 xd |
| —— 4½ per cent. 2nd Deb. Stock | 100 | – | 98-100 |

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| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| | £ | | £ |
| Buenos Ayres and Belgrano Tram. Ord., 1-100,000 | 5 | – | 3¾-4 |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | | 5⅝ 5¾ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | – | 5⅝ 5¾ |
| —— 5 per cent. Deb. Stock, Red. | 100 | – | 107-109 |
| —— Prov. Cert., all paid | 100 | – | 103-106 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | – | 97-99 |
| Calcutta Tramways, Limited, 1-102,268 | 5 | .. | 8½-8¾ |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | .. | 106-108 |
| Cape Electric Tramways Nos. 1-480,000 | 1 | – | 1⅞-1⅞ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | – | 4¾-5⅛ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | – | 101-104 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | | 103-105 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | | 9½-10 |
| —— 5 per cent. Cum. Pref. | 10 | – | 11-12 |
| —— 4 per cent. Debentures | 100 | – | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | – | 13¼-14½ |
| —— 5 per cent. Pref., Nos. within 1-60,000 | 10 | – | 15½-16¼ |
| —— 5½ per cent. Mort. Debs., 1-3,000, Red. | 100 | – | 94-97 |
| Imperial Tramways Ordinary | all | – | 18-19 |
| —— 5 per cent. Cum. Pref. | all | – | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 | – | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000 | 5 | | 2¾-3¼ |
| —— 4 per cent. Debenture Stock | 100 | – | 85-90 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | – | 8-8½ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | – | 10-10¼ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | – | 99-102 |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 | .. | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016. | 1 | .. | 13/32-15/32 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | .. | 1-1 1/16 |
| —— 4½ per cent. Deb. Stock, Red. | 100 | .. | 105-107 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000 | £1,000 | .. | 106-110 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 | .. | 101-104 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 | .. | 103-105 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 54,001-74,000 | 5 | – | ¼-1½ |

| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| | £ | | £ |
| Oldham, Ashton, and Hyde Tramway, Ordinary | 10 | | 12½ |
| —— 6 per cent Cum. Pref. | 10 | – | 9¾-9¾ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk. | 100 | – | 105 108 |
| Potteries Electric Traction, Ordinary 20,001-40,00 t | 10 | – | 9¼-10 |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | – | 9¼-10 |
| —— 4½ per cent. Debenture Stock | 100 | – | 103-107 |
| South Lancashire Electric Traction and Power Company | | | |
| —— £250,000 Ordinary | 1 | | 1 |
| —— £101,138 5 per cent. Preference | 1 | | |
| —— £597,170 4½ per cent. Debenture Stock | 100 p.c. | – | 100 p.c. |

## Electric Railways.—

| | | | |
|---|---|---|---|
| Central London, Ordinary | 100 | – | 92 94 |
| —— 4 per cent. Pref. | 100 | – | 101-103 |
| —— ,, ,, deferred | 100 | – | 82-85 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | – | 111-113 |
| City and South London, Consolidated Ordinary | 100 | – | 44-45 |
| —— 4 per cent. Debenture Stock | 100 | – | 109-111 |
| —— 5 per cent. Pref. Stock '91 | 100 | – | 120-123 |
| —— ,, ,, ,, '96 | 100 | – | 118-121 |
| —— ,, ,, ,, '01 | 100 | – | 115-118 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | – | 10-10¼ |
| —— Ordinary, 1-50,000 | 10 | – | 3¾-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | – | – | 98-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | – | – | 99½-100¼ |
| Waterloo and City, Ordinary | 100 | – | 92-94 |

## Telephones.—

| | | | |
|---|---|---|---|
| National Telephone, Preferred | 100 | – | 109-110 |
| —— Deferred Stock | 100 | – | 101-103 |
| —— 6 per cent. Cum. First Pref. | 10 | – | 12¼-13¼ |
| —— 6 per cent. Cum. Second Pref. | 10 | – | 11¼-12¼ |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | – | 5¼-5¾ |
| —— 5½ per cent. Deb. Stock, Red. | 100 | – | 100-102 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 104-106 |
| —— 4 per cent. Prov. Cert. | – | .. | 103½-105¼ |
| Oriental Telephone and Electric Company | 1 | – | 1¼-1⅜ |
| —— 6 per cent. Cum. Pref. | 1 | .. | 1 3/16-1 5/16 |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905. | 1904. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | April 15 | 1,116 | 1,206 | – 90 | — A | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·14 |
| Ayr Corporation | ,, 15 | 242 | 204 | + 38 | + 635 | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 336,049 | 1·03 | 10·11 | 1,770 | 5 0 |
| Barking Corporation | ,, 1 | 43 | 41 | + 7 | + 306 | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 16 | 1,022 | 1,001 | + 21 | — | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,319,701 | 1·158 | 9·98 | 2,383b | 6·1 |
| Birmingham Corporation | ,, 15 | 368 | 299 | + 93 | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | — | — | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 12 | 816 | 785 | + 60 | – 414 | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10 94 | — | 4·58 |
| Blackpool Corporation | ,, 15 | 440 | 555 | – 112 | – 1,085 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 15 | 231 | 267 | – 45 | – 651 | 16½ | 16½ | Dec. 31 | 32,021 | 2,268,984 | 600,757 | 3·34 | 12·75 | 2,001 | 7 05 |
| Bolton Corporation | ,, 16 | 1,826 | 1,810 | + 16 | – 445 | 38 | 38 | March 31 | 94,151 | 19,895,496 | 2,188,030 | 1·14 | 10·28 | 3,766 | 5·89 |
| Bournemouth Corporation | ,, 12 | 991 | 1,148 | – 157 | — | 10·15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 8 | 3,912 | 4,805 | – 873 | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 16 | 879 | 881 | – 2 | – 216h | 9 | 7½ | ,, 31 | — | 10,432,508 | 1,031,988 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 14 | 4,607 | 4,725 | – 119 | — | 51½ | 51½ | Dec. 31g | 253,150 | 44,391,439 | 6,033,528 | — | — | — | — |
| Burnley Corporation | ,, 15 | 1,028 | 945 | + 83 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 14 | 302 | 320 | – 18 | — | 8½ | — | March 31i | 11,574 | 2,556,134 | 282,378 | 1·08 | 9·84 | 1,570 | 7·57 |
| Cardiff Corporation | ,, 8 | 1,817 | 2,134 | – 237 | – 514 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 15 | 182 | 180 | + 2 | – 379 | — | — | Dec. 31g | 9,987 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 8 | 7,158 | 6,672 | + 486 | + 2,161h | 6 | 6 | ,, 31 | 362,471 | 44,953,988 | 1,292,674e | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 16 | 2,759 | 2,704 | + 55 | – 2,481h | 6½ | 6½ | ,, 31 | 165,003e | 19,069,139e | — | — | — | — | — |
| Colchester Corporation | ,, 12 | 160 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork B. T. and L. Company | ,, 13 | 432 | 433 | – 1 | — | — | — | ,, 31g | 25,657 | 6,353,323 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | ,, 14 | 226 | 210 | + 16 | — | 7·23 | 7·23 | March 31g | 12,341 | 2,340,735 | 254,279 | 1·25 | 11·66 | 1,707 | 9·36 |
| Dover Corporation | ,, 8 | 177 | 216 | – 39 | — | 4½ | 4½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0 94 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | ,, 14 | 103 | 105 | – 2 | — A | 7 | 6½ | Dec. 31g | 6,234 | 588,905 | 107,164 | 3·88 | 14·09 | 952 | 7·39 |
| Dublin U. T., electric cars | ,, 7 | 3,805 | 4,018 | – 213 | } — | 47 | 46 | ,, 31g | 134,648 | — | 3,489,356 | — | — | — | — A |
| Dublin S. District, Electric | ,, 7 | 812 | 918 | – 106 | | | | | | | | | | | |
| Dundee City Tramways | ,, 12 | 865 | 892 | – 27 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 15 | 747 | 706 | + 41 | + 1,651 | 10·77 | 10·75 | March 31 | 34,312 | 12,950,269 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 15 | 15,064 | 13,995 | +1,068 | +35,154h | 145 | 123 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Gloucester Corporation | ,, 12 | 256 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 5 | 2,648 | 3,003 | – 345 | — | 33 | 30½ | March 31 | 68,289 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,069 | 8·77 |
| Huddersfield Corporation | ,, 15 | 1,259 | 1,136 | + 123 | — | 35 | 35 | ,, 31 | 66,645 | 11,899,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | ,, 15 | 2,020 | 2,047 | + 32 | – 355 | 25 | 19 | ,, 31 | 87,707 | 21,066,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | — | — | — | — | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | ,, 12 | 107 | 119 | – 12 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 12 | 201 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 18 | 5,442 | 5,124 | + 318 | — | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | ,, 8 | 1,954 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | ,, 8 | 10 391 | 10,453 | – 72 | + 5,553 | 103 | 103 | Dec. 31g | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | ,, 16 | 1,533 | 1,629 | – 96 | – 1,125h | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185e | 1·82 | 19·30e | 5,110 | — e |
| London County Council | ,, 1 | 13,251 | 10,864 | +2,337 | — | 46½ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | ,, 13 | 106 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 15 | 12,146 | 11,367 | + 779 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 15 | 119 | 103 | + 16 | — | 2¾ | — | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corpn. | ,, 15 | 3,579 | 3,399 | + 180 | — | 45 | 38½ | March 31 | 5,200 | 1,480,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newport (Mon.) Corporation | — | — | — | — | — | 15 | — | ,, 25 | 185,027 | 39,715,120 | 4,069,907 | 1·1 | 10·94 | 4,111b | — |
| Oldham Corporation | ,, 9 | 1 452 | 1 188 | + 263 | + 695 | 34½ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 15 | 1,683 | 1,677 | + 7 | + 1,229 | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·16 | 12·39 | — | — |
| Reading Corporation | ,, 13 | 596 | 567 | + 29 | — | — | — | — | — | — | — | — | — | — | — |
| Rochdale Corporation | ,, 8 | 497 | 128 | + 369 | — | 4½ | 4½ | 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 14 | 391 | 392 | – 1 | — | — | — | ,, 31 | 27,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·68 |
| Salford Corporation | ,, 10 | 3,865 | 3,771 | + 94 | — | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 13 | 74 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 15 | 4,548 | 4,393 | + 155 | — | 34½ | — | ,, 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·488 | 7,510 | 7·0 |
| Southampton Corporation | ,, 12 | 853 | 923 | – 70 | – 258 | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 12 | 254 | 250 | + 4 | — | 6½ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 7 | 488 | 568 | – 80 | — | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | Mar. 20 | 1,144 | 1,064 | + 80 | + 1 676 | 19 53 | 18·48 | ,, 31 | 62,506 | 14,848,958 | 1,433,463 | 1·01 | 10·46 | — | 6·02 |
| Swindon Corporation | April 8 | 109 | — | — | — | 3½ | — | — | — | — | — | — | — | — | — |
| Wallasey U. D. C. | ,, 15 | 687 | 651 | + 36 | — | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·23 | 11·36 | 4,10 | 7·50 |
| Warrington Corporation | ,, 6 | 319 | 352 | – 33 | — | 7½ | — | — | — | — | — | — | — | — | — |
| West Ham Corporation | ,, 13 | 1,033 | 691 | + 402 | + 782 | 8·62 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 12 | 704 | 517 | + 187 | — | 7½ | — | ,, 31g | 20,878 | 4,263,066 | 417,335 | — | 12·006 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. e Train mile.
Per mile of single track. g Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1905. h Half-year's figures.
Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**New Publications.**—"The Telegraphists' Guide," by Jas. Bell and S. Wilson. (London: S. Rentell and Co. 2s.) The authors have compiled a treatise designed to meet the requirements of the Government telegraph service in regard to higher appointments. Students preparing for the examinations in telegraphy of the City and Guilds of London Institute, and of the Science and Art Department, will also find the book serviceable.

**International Fire Service Council.**—The International Fire Service Council, which was founded in 1900, and represents the interests of the world's various fire brigade and fire preventive societies, held its annual executive meeting at Brussels on the 17th and 18th inst. Matters relating to fire-alarms were discussed at length, and a standing committee, comprising, among others, Chief Officer Meier (late of the Dutch Royal Engineers) and Chief Officer Reichel (of the Royal Technical College, Hanover), both authorities on the subject, has been formed. The council's enquiry office at Luxemburg is now open, and technical questions can be addressed there through any of the three British societies represented on the council. Mr. Edwin O. Sachs represented the British Fire-Prevention Society at the conference.

**Royal Meteorological Society.**—At the monthly meeting of this society Dr. H. R. Mill read a paper on the "Rate of Fall of Rain at Seathwaite." This was a consideration of the records from a Negretti and Zambra self-recording rain-gauge during a period of 18 months. Seathwaite, which is in Borrowdale, Cumberland, is in almost the wettest spot of the British Isles, the average yearly rainfall being about 137in. Dr. Mill's results seem to show that the rainfall at Seathwaite in an average year indicates a tendency to be greater during the hours of darkness than in daylight, that rather less than half the time during which rain is falling it continues without intermission for at least six hours at a time, and that rather more than half the total amount of rain is deposited in these long showers.

**Society of Arts.**—Two illustrated lectures on "The Uses of Electricity in Mines" are to be delivered before this society by Mr. H. W. Ravenshaw, the dates being May 15 and 22. The first lecture will deal with the following subjects: application of electricity and character of load; winding; hauling; pumping; coal-cutting; other uses underground; surface requirements; generating stations; cables and distribution; lighting; signals; telephones; shot-firing. The second lecture will deal with different kinds of currents; precautions; enclosed motors; Home Office rules and cost, while typical and historical plants will be described. These lectures, which will no doubt prove both instructive and interesting, come at an opportune time, having regard to the regulations on this subject recently promulgated by the Home Office. We notice that the society's conversazione will again be held at the Royal Botanic Gardens, Regent's Park, on Tuesday, July 4, from 9 to 12 p.m. The programme will be announced in due course.

**Electric Lighting in New York.**—The legislative investigation into the cost of gas and electric light in New York is proceeding, and the technical evidence is of general interest as showing the cost of electricity in that city. From the evidence which has appeared in our American contemporaries we gather that 7½d. per unit is the rate charged for the first two hours. For the next two hours the rate falls to 3¾d., and further consumption is at the rate of 2½d. per unit. It was shown that only 34 per cent. of the current is sold below 7½d. per unit. The average income per unit works out at 6·13d. Public lighting is provided at 6d. per unit with certain exceptions. These exceptions are made when a considerable amount of power is used in addition to the lighting. The evidence given as to the cost of generation and supply is also of interest. These figures show that the average cost per unit sold at Manhattan and Bronx was 1·83d. The total cost was 3·16d., and the average total cost for the last five years 3·99d. Taking the power consumption in with the lighting, the average income for the last year for energy supplied by these companies was 4·02d., and for the last five years 4·05d. We gather that the New York companies are paying good dividends, but that they are at the same time reducing the cost of electrical energy to their customers.

**Incorporated Municipal Electrical Association.** The tenth annual convention of this organisation will be opened at Edinburgh on June 27. In the morning the presidential address will be delivered, after which there will be reading and discussion of papers. A visit will be paid to the electricity works in the afternoon, and in the evening there will be a reception by the Lord Provost. The party will proceed to Glasgow, and on the following day, June 28, the morning will be devoted to the reading and discussion of papers, the electricity and other works being visited in the afternoon. Returning to Edinburgh, more papers will be read and discussed on the morning of the 29th, and in the evening the annual dinner will take place. The conference will terminate with the annual general business meeting on the morning of the 30th. The subjects to be discussed include "Load Factor—its effect upon an Electricity Station," "Street Lighting," "Extensions to Outlying Areas," "Free Wiring and Supply on the Prepayment System," "Allocation of Costs," and "The Supply of Electricity in Industrial Areas, from a Municipal Point of View." A detailed official programme will be issued in due course, and in the meantime all communications should be addressed to Mr. C. McArthur Butler, Staple Inn-buildings, Holborn, W.C. The North British Railway Hotel, Princes-street, Edinburgh, has been selected as the headquarters.

**Electrical Distribution in the States.**—The *Electrical World* gives an interesting abstract of a report by the Massachusetts Board of Gas and Electric Light Commissioners for the year 1904. It seems from this that there were in that State 21 municipal electric light stations and 82 owned by companies. The proportion of municipal undertakings is thus very much lower than in this country. Of the 21 above mentioned three were only distributors, and bought their supply of electricity in bulk. Of the 82 companies 56 operated electric light stations only, the others being interested in other commercial undertakings as well. Of these 56 central stations one did not earn enough to meet expenses, and 26 others did not declare any dividend. The other 29 paid dividends ranging from 2 to 10 per cent. The financial results with the municipal central stations were even less satisfactory. Thus during the year the income of all the stations amounted to £47,368, and the expenditure to £64,379, leaving an apparent loss of £17,011. This, however, was without including interest on loans and depreciation, which would make the deficit almost 200 per cent. more. We gather from the report that the use of arc lighting is on the decrease in the districts in question, but that the increase in incandescent lamps more than makes up for any falling off in this respect. It also appears from the report that municipal lighting is not spreading in Massachusetts.

**Platinum Resources of the United States.**—The United States Geological Survey has decided to make an examination of the platinum resources of the Republic, the

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demand for this metal having greatly increased. It is proposed to collect the heavy sands from all placer mines in the United States where evidence of platinum has been found by preliminary tests. The samples thus obtained will be used in determining the best methods of extracting the various minerals which have economic value. It is considered that the separation and sale of useful minerals, such as magnetite, chromite, garnet, monazite, rutile, topaz, zircon, gold, platinum, iridosmine, etc., may become a permanent and profitable industry. As a preliminary step in this investigation, owners of placer deposits have been invited to transmit likely samples of their placer deposits to the Geological Survey. This material will be carefully examined, and the owners duly notified of the results. After an examination of these preliminary samples, experts will be sent to all localities where the tests give promise of platinum in profitable quantity. The expert will report on the size of the deposit and superintend the collection of representative samples for concentration. Concentration experiments will probably be carried out in connection with the exhibits of mining machinery at the Lewis and Clark Centennial at Portland, Ore, between June 1 and Oct. 15 of this year. Platinum has been discovered in California, Oregon, Idaho, Montana, New York, North Carolina, Georgia, Pennsylvania, Wyoming, and Alaska, in the United States, and in Canada, Mexico, Central America, the West Indies, and South America.

**The Institution of Civil Engineers.**—At the annual meeting of the Institution of Civil Engineers, held last week, Sir Guilford Molesworth, K.C.I.E, president, in the chair, the result of the ballot for the election of officers was declared as follows: president—Sir Alexander Binnie; vice-presidents—Dr. Alexander B. W. Kennedy, Mr. W. R. Galbraith, Mr. William Matthews, C.M.G., and Sir Leader Williams; other members of council — Colonel W. P. Anderson (Ottawa, Canada), Mr. C. Napier Bell, (Wellington, New Zealand), Mr. B. Hall Blyth, M.A. (Edinburgh), Mr. C. A. Brereton, Mr. R. Elliott-Cooper, Colonel R. E. B. Crompton, C.B., Mr. W. J. Cudworth (York), Dr. G. F. Deacon, Dr. F. Elgar, Mr. Maurice Fitzmaurice, C.M.G., Mr. R. A. Hadfield (Sheffield), Mr. G. H. Hill, Mr. C. W. Hodson, C.S.I., Mr. J. C. Inglis, Mr. G. R. Jebb, Sir William Thomas Lewis, Bart. (Aberdare), Mr. A. G. Lyster (Liverpool), Sir Charles Metcalfe, Bart. (Cape Town), Sir Andrew Noble, Bart., K.C.B. (Newcastle-on-Tyne), the Hon. Charles A. Parsons, C.B. (Wylam-on-Tyne), Mr. A Ross, Mr. A. Siemens, Mr. John Strain (Glasgow), Sir John I. Thornycroft, Prof. W. C. Unwin, B.Sc., and Mr. A. F. Yarrow. The council have made the following awards for papers read and discussed before the institution during the past session: Telford gold medals to Lord Brassey, K.C.B., and Mr. C. S. R. Palmer; a George Stephenson gold medal to Mr. Lyonel E. Clark; a Watt gold medal to Mr. J. F. C. Snell; Telford premiums to Messrs. L. F. Vernon-Harcourt, M.A., R. W. Allen, and Wm. Marriott; a Crampton prize to Mr. A. Wood-Hill, and the Manby premium to Mr. E. D. Pain. The presentation of these awards, together with those for papers which have not been subject to discussion, and will be announced later, will take place at the inaugural meeting of next session.

**Car Obstruction**—We have instanced several cases from time to time in which trams have been obstructed more or less deliberately, but for sheer wilfulness it would be difficult to surpass the conduct of a baker's assistant who, as reported in our last week's issue, was summoned at the Spelthorne Petty Sessions. The defendant's conception of the law appears to have been that it was quite permissible for him to delay any vehicle, provided he limited this form of pastime to 20 minutes. Our senators have accomplished some remarkable legislative feats at various times, but, notwithstanding Sam Weller's historic declaration, we do not remember to have heard that the Statute Book contains any such asinine provision as would countenance deliberate obstruction. It appeared that the defendant habitually indulged in the practice of placing his van, while he was unloading goods, so that the wheels on one side projected over the tramline. On one occasion when an onlooker pulled the van off the rails after it had obstructed a car for eight minutes, the defendant deliberately replaced it on the line and further delayed the car. Several witnesses testified to the fact that there was an ample margin between the kerb and the tramlines. The accused's advocate endeavoured to draw a herring across the path by pleading that the company had agreed with the Teddington Urban District Council to widen the road and had failed to do so, but this side issue was promptly ruled out as irrelevant. After hearing all the evidence the Bench unanimously came to the conclusion that the defendant was acting with intent to cause annoyance, and inflicted fines totalling £5. At the same time it was intimated that a repetition of the offence would be visited with the maximum fine—which it would well merit—if, indeed, such conduct deserves the option of a fine.

**Electrical Activity in the Transvaal.**—The activity lately exhibited in electrical matters in the Transvaal—for which country the Colonial Secretary has just promulgated a new Constitution—is likely to receive a further stimulus from the proposals of the Johannesburg and Krugersdorp Corporations. The former authority contemplates raising a loan of 2½ millions, of which the tramway and lighting scheme is expected to absorb considerably more than half. It appears that a portion of the new lighting plant has already been installed. The Corporation expects to be in a position to change over a large proportion of the present consumers in the inner area to 230 volts, and to connect up new consumers in October. For the outer area alternating current will be supplied at a pressure of 200 volts. A limited supply will be available by about June. The Johannesburg Chamber of Trade recently considered the question of the alteration of pressure, and finally referred the matter to committee with an instruction to ask the Corporation for a reduction in cost corresponding to the increased expenditure involved by such change of pressure. The Town Council of Krugersdorp has likewise propounded an electric lighting scheme, though naturally of a much less ambitious character, the cost being estimated at £16,000. We notice from the report of Lord Milner's valedictory speech that the late High Commissioner, in vindicating the Transvaal from the charge of stagnation since the war, took occasion to congratulate engineer and electrician upon the progress made during that period in railway and telegraph construction. His Lordship said: "In these last two or three years we have constructed—I am now speaking of both the Transvaal and the Orange River Colony, which for railway purposes are happily one State—275 miles of railway. We are constructing 311 more. We have provided for 488 miles in addition—that is, upwards of 1,000 miles of line together. To look at the Transvaal alone, we have spent over £300,000 upon the repair and improvement of our telegraphs and telephones. I do not know whether it is due to that, but, at any rate in this year the service under the Postmaster-General will for the first time in its history show a surplus." With competition so keen in the home market, the need of finding an outlet abroad is constantly asserting itself, and manufacturers will act advisedly in keeping our South African Colonies well in mind.

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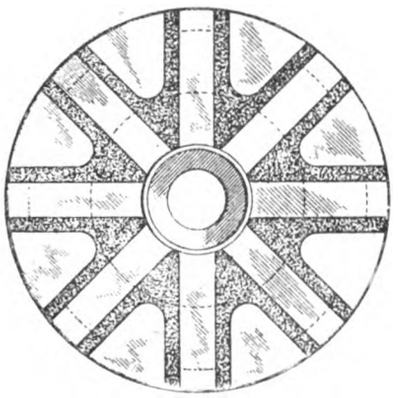
**Magnetic Clutch.**—A series of 12 patents, containing numerous claims, has been granted in the United States to Mr. H H Cutler in connection with a form of magnetic clutch and numerous applications of same. The distinguishing feature of the clutch consists of the means employed for controlling the accelerating torque so as to eliminate the undesirable jerk usually associated with magnetic clutches. The accompanying illustration, which we reproduce from the *Electrical World* of New York, shows a front view of the magnet member of the clutch. When the magnet is energised the triangular pieces become of one polarity, while the radially extending pieces are of the opposite polarity, the spaces between the poles being filled with non-magnetic Babbitt metal. The dotted lines indicate the location of the magnetising coil, which is surrounded completely with metal, which protects it from mechanical injury and from any detrimental effect due to oil employed for lubricating purposes. The Babbitt metal affords, with the polar faces, a continuous frictional surface against which the armature bears. The magnet member is thus so constructed that the energising winding is entirely surrounded by iron. The large inductance of the winding ensures that when the circuit is closed to a source of current, the current will rise gradually to its final value without giving to the driven member that sudden acceleration which has been the cause of serious objections to magnetic clutches of the ordinary type.



The inventor proposes to utilise both the torque due to friction and that due to eddy currents in the armature structure when there is motion between the two members of the clutch. For a certain magnetising force the frictional torque is practically constant during the period of acceleration, while the torque due to eddy currents uniformly decreases with increase of speed. By variation of the magnetising force any torque may be obtained at any speed up to full synchronism. The subdivision of the magnet into a large number of individual circuits aids in causing a rapid disappearance of the residual magnetism in the armature member when the magnetising force is removed, and thus allows the clutch to be released practically instantaneously. The more prominent applications of the clutch are for starting synchronous motors, throwing loads gradually upon motors, and for the operation of electric vehicles. When applied to an alternating-current motor the inventor would use a rectifier of either the aluminium or mercury vapour type for supplying direct current to the magnetising coil of the clutch.

**Post Office Employes.**—The scheme of improved conditions of service prepared by Lord Stanley for the benefit of Post Office employés was discussed at the annual conference of the United Kingdom Postal Clerks' Association. It is pretty evident that the staff still hope to secure the full concessions recommended by the Bradford Committee, and general dissatisfaction was expressed at the revised rates of pay proposed by the Postmaster-General. In a resolution passed by the meeting it is stated that the Bradford Committee, which the Postmaster-General only consented to appoint after years of agitation, was composed of expert and impartial business men, who thoroughly investigated the question, and that the concessions now made are inadequate. There is no doubt that, as Lord Stanley has frequently stated, the Bradford Committee exceeded the terms of the reference, which has complicated the position. It was pretty generally acknowledged that the conditions of service stood in need of considerable amelioration, and perhaps the improvements proposed by the committee were not excessive, but they represented a substantial addition to the annual expenditure, and confronted Lord Stanley with the problem of doing justice to the staff and to the public at the same time. The concessions announced by his lordship appear to bring the conditions of service up to the average of those obtaining in other fields of an analogous character, and entail an increased expenditure of £224,000 for the first year and over £370,000 for subsequent years. There is doubtless room for further improvement, but it is to be hoped that the employés will not be too exacting in their demands. The Postmaster-General has also had his attention engaged by the National Telephone Company's staff, a deputation from which interviewed him last week with reference to their status on the transfer of the company's undertaking being completed. The deputation urged that the whole of the present telephone staff and operators should be taken over bodily by the Post Office when the transfer takes place, and submitted that under the present agreement for the transfer all members of the staff receiving a salary of £100 yearly and upwards, and who had contributed 2½ per cent. of their salaries to the pension fund with a view to making provision for their old age, would be deprived of this advantage. In the course of an informal discussion, the Postmaster-General intimated that, although he could not promise any particular individual that he would be taken on the General Post Office staff, he could safely promise that the telephone staff collectively would be employed under the new conditions. As to pensions, Lord Stanley explained that the Government pensions could not commence until the telephone employés had actually joined the Post Office service, but those telephone employés taken over would not have to wait 10 years before the pension started, as was the case when the present Post Office employés entered the service.

**Electricity in Coal Mines.**—The *Electrical Review* of New York publishes a description of the Hampton central power station, which has now been at work for two years supplying current to eight collieries in the vicinity of Scranton. The generating station is located near one of the collieries, from which its coal supply is drawn. The prime movers are Curtis turbines, of which four of 500 h.p. each have been installed. These run at 1,800 revolutions per minute, with steam at a pressure of 150lb. per square inch superheated 200deg. F. The alternators, which are directly driven from these turbines, are of the three-phase 60-cycle type, wound for 230 volts. The energy is transmitted at this voltage to all but one colliery, in the supply of which a higher voltage is needed, and step-up and step-down transformers are used. We do not need to give a description of the turbines, as they have already been illustrated in our columns. The interesting feature is that the power required for these eight collieries is all taken from the one generating station. The boiler-house equipment is of a thoroughly up-to-date character, with 15 Babcock and Wilcox boilers with mechanical stokers. The ashes are removed in a novel way, being

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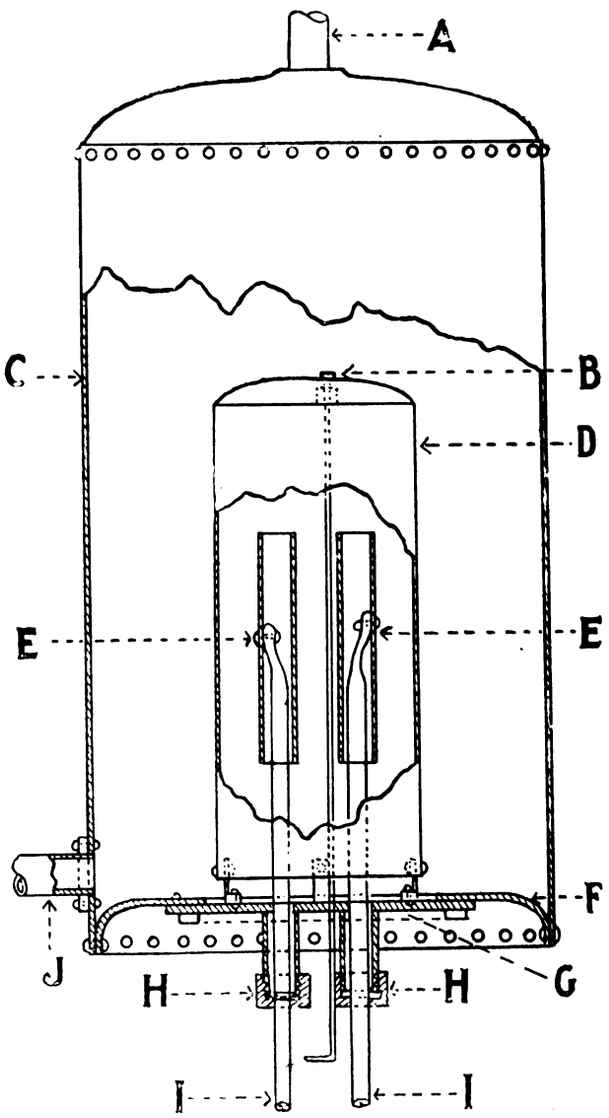
flushed from the ashpits with water, and the mixture is forced through a borehole into the mine. An interesting use of electricity in the immediate neighbourhood of the power-house will be a water hoist, now nearly completed, which requires an 800-h.p. motor to drive it. This water hoist is located about 500ft. from the power station, where a shaft 460ft. deep has been driven into the mines. The bottom of this shaft will drain all the mines in the immediate vicinity. Water will be hoisted from this shaft by means of two buckets suspended from a hoist tower over the shaft. Around the base of the tower has been built a concrete basin, into which the buckets will be emptied. The water will be piped from this basin to the boiler and turbine station, where such of it as is needed for condensing and other purposes will be utilised. The remainder will be carried on down the hill, and discharged into the Lackawanna River. The hoist tower is 93ft. from the base to the centre of the sheave at the top. It is built of structural steel, roughly in the shape of an A. From the tower are suspended two buckets 6ft. in diameter and 19ft. 6in. deep. The capacity of each bucket is 17 tons of water. In the bottom of the bucket are located two lift gates with an area practically equal to the cross-section of the bucket. These gates are lifted automatically when the bucket reaches the top, and the water is discharged through the bottom into a spout fitted below the bucket, and which deflects it to either side of the shaft. Each bucket makes a complete round trip in one minute and 55 seconds, the total lift being 555ft. The buckets are raised and lowered by means of an 800-h.p. induction motor running at a constant speed of 400 revolutions per minute, driving a pair of drums on which the cables from the buckets are wound. These drums are conical, in order to obtain a slow starting speed. The two diameters of the drum are 16ft. and 10ft. The motor is set at right angles to the drums, and motion is transmitted to the latter through a friction clutch and bevel gearing. Band brakes are placed at a number of different points, in order to make a quick stop if necessary. A good deal of the current used in connection with these collieries is converted from three-phase into direct current by means of rotary converters. The distance of the outlying collieries from the power-house ranges from two to four miles. In the different mines are installed 21 electrically operated hoists, worked by 28 motors with a total capacity of 1,915 h.p. There are 23 motor-driven pumps, the motors having a capacity of 1,571 h.p. In addition to this machinery there are installed 24 other motors for miscellaneous uses, having a total capacity of 318 h.p.

**Automatic Electric Water Heater.**—An electric water heater possessing the great advantage of being entirely automatic has been devised by Mr. A. C. Pratt, of the Missouri River Power Company, and is described in the *Journal of Electricity, Power, and Gas* of San Francisco. Its construction is based on the principle of a water rheostat operated under an inverted tank, all being enclosed in an outer tank. The inner tank contains the electrodes, E E, shown in the accompanying diagram. These electrodes, which are 1½in. apart, are subjected to a 500-volt 60-cycle alternating current. Any steam formed by the heating of the water rises within the inner can, and as its pressure increases it drives the water downwards, and consequently off the electrodes. This automatically controls the current consumption, and keeps the tank nearly full of steam, which in turn maintains the temperature of the water in the water-tank at a point near to boiling. The hot-water outlet, consisting of a 1in. pipe, is shown in the diagram as A; B is the air and steam vent pipe and valve; C is a 15-gallon galvanised iron tank; D is the steam-tank; F shows the concave bottom of the water-tank; G is a removable plate with a watertight gasket; H H are stuffing boxes; I I are extra-insulated rubber wires supplying current to the electrodes; and J is a 1in. pipe through which cold water is supplied to the tank. The particular form of apparatus described has been in service by the inventor's company for three years, and is still in operation. While its maximum current consumption when both tanks are filled with cold water is about 5 kw., this gradually decreases as the temperature of the water rises until it reaches a minimum of $\frac{3}{10}$ kw. No material electrolysis of the electrodes has occurred in the three years. A small valve is located at the hot-water outlet for the purpose of passing trapped air from the inner tank, or blowing steam from it, so as to hasten the heating of the water in the outer tank




when an extra amount of hot water is needed quickly. The steam-tank and electrode are mounted on the bottom plate of the outer tank, to which they are attached by cap screws. It is desirable that the tank should be insulated, and that its inlet and outlet pipes should consist of rubber hose, to prevent the grounding of the current supply.

**Water Power in Upper Italy.**—A recent communication by Mr. Semenza before the Society of Civil Engineers of France on the above subject gives a *résumé* of the water power used in Upper Italy, and that which has still to be harnessed. The paper commences with some meteorological information as to the rainfall in the district in question, and also as to the general character of that part of the country. Practically all the water from the high-lying lands in the North of Italy finds its way eventually into the River Po. The author showed how by the ancient

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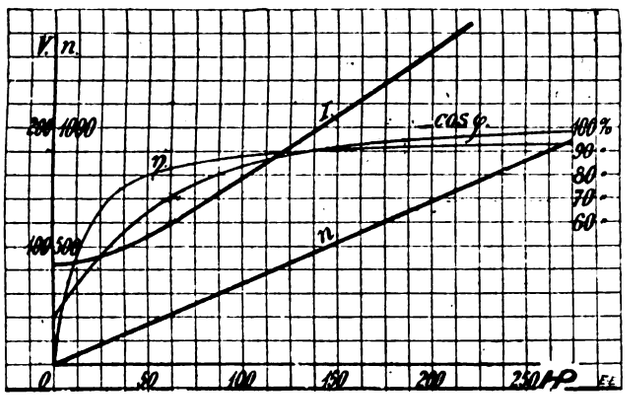
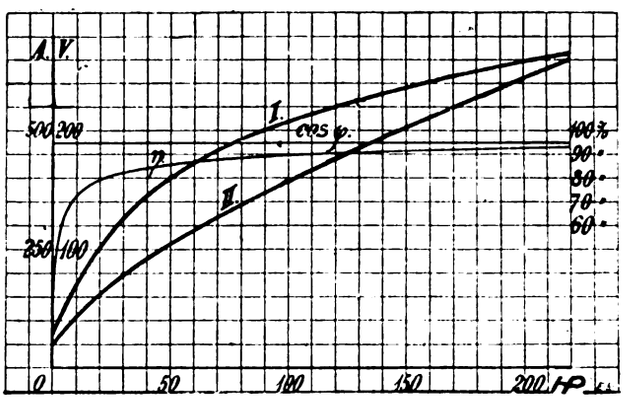
use of the water for irrigation and navigation the country had been prepared for its utilisation with more modern plant. The water power is the more valuable because Italy is almost without any combustible mineral. The Italian legislation for the transmission of electrical energy has co-operated with the above two conditions in the development of the industry. In order to facilitate the construction of water-power installations for the transmission of energy, a law has made it obligatory upon landowners to grant wayleaves over their property for the wires. Mr. Semenza gave a short history of the earlier electrical installations, and spoke of the one at Genoa as having been the first of considerable importance. It is, however, since the success of the Paderno installation that large water-power plants have begun to be constructed in Upper Italy. He then proceeded to describe the important installations which have been developed by different undertakers to serve the town of Turin. The water-power plants from which Milan and Monza are supplied were also described. These installations are remarkable for their size and completeness, and for the way in which the transmission lines are constructed. The author insisted on the importance of having iron supports for the line, and claimed that by these means the first cost was also reduced. One of the most interesting installations described was that of the Societa Lombarda, which distributes about 25,000 h.p. in a zone of some 550 square miles. In this zone there are no towns of importance, but the district is highly industrial. He then described the works which exist and those which are now under construction for the supply of the town of Genoa. In one of these the salient feature is that there are large reservoirs on one side of a mountain while the water-power plant is on the other. The water is led from one side to the other by tunnels. Amongst the large works there is also that of Venice, by which power is transmitted at 30,000 volts over a distance of 56 miles. The author then briefly described the equipments designed for the supply of small towns, or of factories and workshops. Only approximate figures as to the cost of supply and the charge for power were given, owing to limitations of time and space, but the author showed the effect of these schemes on the industries of the country. The development of these industries has during the past few years been very marked. His estimate of the total horse-power involved in such installations was 160,000, and that of the annual increase about 17,000. He considered that water power was likely to supersede the steam-engine in a large number of cases, and to permit of the development of existing industries and the creation of others. The author's conclusions as to the water power still available in the highlands of Italy for electrical transmission point to a large demand for electrical machinery in the near future.

**Single-Phase Locomotives.**—The Oerlikon Company has developed two types of single-phase alternating-current locomotives, with which extensive tests are to be carried out. The first of these has already entered upon regular service on the company's Seebach-Wettingen line. It was designed two years ago, at a time when there was still considerable scepticism regarding the feasibility of alternating-current single-phase traction, and the design was therefore based on the retention of direct-current motors for propelling the locomotive, and a means of converting the alternating current into direct current. The equipment of this locomotive includes a single-phase induction motor, with a speed of about 980 revolutions per minute when supplied with single-phase alternating current of 14,000 volts at a frequency of 50 cycles per second. This motor serves for driving a four-pole direct-current generator of 400-kw. rating, to which it is direct-coupled. The rotor has a short-circuit "cage" winding, and the stator has two windings—one designed for a potential difference of 14,000 to 16,000 volts and one of 700 volts. The second of these was provided in case it should be found desirable to use a low-potential third-rail line at the station or in the switch yards, instead of the overhead system. The high-potential winding, despite the severe strains to which it is subject, has not exhibited the slightest defect. The efficiency of the motor is about 94 per cent., with a power factor of about 89 per cent. at full load. The dynamo is designed for a full load current of 650 amperes and a voltage which can be varied




between zero and 600 volts. There is a 6-kw. motor-generator set, which normally serves for the excitation of the fields of the large generator, but can be employed to restore the speed of the large set should the latter chance to get "out of step." The second locomotive will be equipped with two 200-h.p. single-phase alternating-current motors, which can be operated under varying conditions, though designed more especially as alternating-current series motors for a voltage of 15,000 at a frequency of 15 periods per second. They are eight-poled motors, with inter-poles for the compensated winding, and are designed for maximum speeds ranging between 650 and 1,000 revolutions per minute. The results of tests with these motors are shown in the accompanying diagrams,




which we reproduce from the *Street Railway Journal*. The power factor is 94 per cent. at 650 revolutions per minute, and 97 per cent. at 1,000 revolutions per minute for all loads when the frequency is 15 periods per second, and it is 87 per cent. and 93 per cent. respectively with a frequency of 25 periods per second. In the first diagram the motor is run with a constant current of 600 amperes, with a frequency of 15 cycles. In the second diagram the motor is run at a constant speed of 650 revolutions per minute, with the same frequency. The motor was also tested for direct current work, and gave highly satisfactory results. In order to make the forthcoming tests as comprehensive as possible, the company propose to include an alternating-current motor of similar design to the above, but suitable for a higher frequency.

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## THE ELECTRIFICATION OF GOODS WAREHOUSES ON THE LANCASHIRE AND YORKSHIRE RAILWAY.

BY VERAX.

Within the last decade a change has taken place in the personnel of the Lancashire and Yorkshire Railway, and a distinct improvement, correlatively, is noticeable in the company's method of working. The solution to the problems of (*a*) "quick dispatch of traffic between different towns" and (*b*) "the speedy liberation of wagons at the point of destination," has been found in a system whereby thousands of tons of merchandise are conveyed to and fro with the regularity of clockwork. Nowhere is the transformation more apparent than in the goods department, and the reason is, perhaps, not far to seek. Nowadays the travelling public are familiar with the sight of goods trains comprising 70 or 80 loaded wagons coupled to a powerful engine and safeguarded in the rear by two massive brake vans; such trains afford striking contrast to those of bygone years. At various points on the railway "refuge" sidings and loop lines are laid parallel to the main track, it being the duty of signalmen to divert and shelter these long freight trains whenever the electric bell gives warning of a passenger train approaching in the rear. Immediately after the block section becomes clear ahead, the refuge siding signal is lowered, and the freight train re-enters the main line, continuing its journey with a minimum of inconvenience and delay. In spite of adverse criticism, intelligent observers have not been slow to realise that long trains mean *fewer* trains, and that wagons loaded to their full capacity tend towards a diminution of rolling stock; consequently every mile saved is money saved, and the measure of success attendant on these efforts is the measure of general efficiency.

It is to the question of (*b*), speedily liberating and loading wagons, that we desire to confine our observations. It should not require elaboration on our part to convince the readers of the *Electrical Engineer* that it is not sufficient merely for the various termini to be staffed with men who understand their work, but what is of equal or greater importance, a complement of up-to-date machinery, capable of dealing promptly with goods on arrival, is an imperative necessity. The Lancashire and Yorkshire Railway evidently recognises that electrical energy applied to their goods warehouses and cotton sheds produces the best results. Hence the following brief survey describing what has been done in the direction named should be of interest to those enterprising manufacturers in a less pretentious line of business. It must, however, be clearly understood that the particulars following represent but a small percentage of stations more or less under electrification.

### BRADFORD.

As might be expected at an important centre of industry like Bradford, the goods station is electrically equipped with machinery of modern design. Prior to the year 1899 an ordinary mechanical outfit was the vogue, but the date named will be memorable in the annals of English history as the outbreak of hostilities in South Africa, and as such an event would presumably result in large army contracts for clothing and woollen goods generally, the railway company foresaw the prudence of better facilities to cope with the changed condition of affairs. An order was, therefore, placed with a Manchester firm for three electric travelling cranes, which were quickly got in working order. Each crane travels along parallel spans the entire length of the old warehouse. Built to carry a load of 15cwt. each, the lateral and longitudinal movements are quickly performed. Electrical energy is supplied along bare conductors and collected by means of gunmetal shoes. These cranes rendered good service and served to demonstrate the advantages of electric traction, so that in 1902 when the new Bridge street warehouse—fronting the Great Northern Victoria Hotel—was finished it was not surprising to find that complete electrification had been decided upon. Electric light was installed throughout. The lamps used were either incandescent, open arc, ordinary enclosed, or twin-carbon enclosed type, and the respective position of each kind was suggested from a glance at the geography of the place.

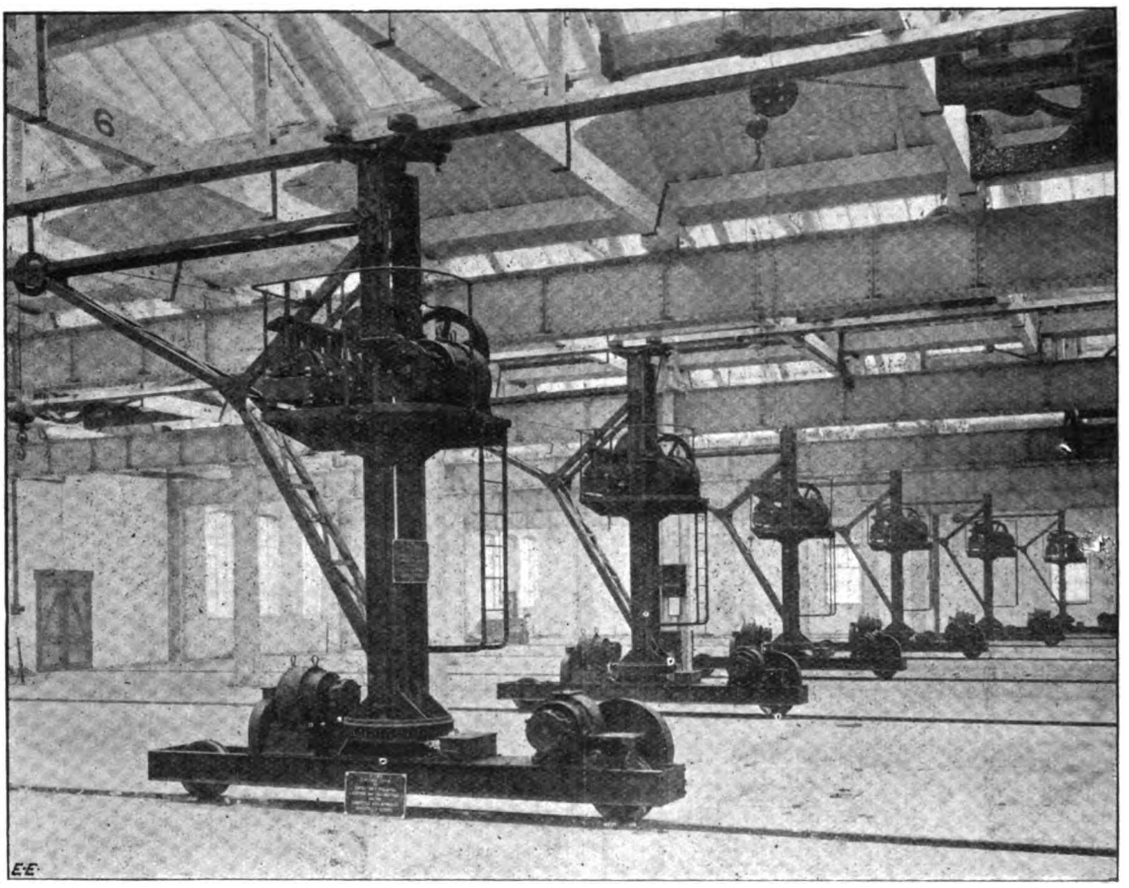

FIG. 1.—Crompton Single-Rail Walking Electric Cranes at the Bradford Depot of the L.Y.R.

Twenty-four "walking" cranes were built by Messrs. Crompton, Limited, three in the basement and seven on each of the three floors. The working load is 15cwt., and the travelling speed 150ft. per minute. A 10-h.p. motor running at 700 revolutions per minute with magnetic brake

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on the motor spindle controls the lifting motion. The slewing movements are actuated by a 2-b.h.p. motor, and the magnetic brake connected thereto is arranged to come into operation when the circuit is broken. Current from the mains is connected by gunmetal shoes along two bare copper wires strained inside the top guide channel. On the driver's platform a combination three-motor controller is fixed for starting, stopping, and reversing any of the three motors. A double-pole switch and fuse is also provided for isolating each crane. The driver's cage is fixed on the pillar of the crane and works with it, so that the driver and the jib head are always in the same relative position. A general view of these cranes is shown in Fig. 1.

An electric lift was requisitioned about this time from the last-named firm for the conveyance of small goods packages between the basement and top floor or intermediate rooms; packages such as would be too heavy for a workman to carry up a flight of steps, yet too light to be dealt with efficiently by the main electric hoist. On the occasion of our last visit, immense quantities of wool were being hauled from different sections of the new warehouse to freighters' lorries in the street below, suitably designed motors being used in connection therewith. All the machinery is maintained in good working order; indeed, the only serious stoppage occurred in December last, when the Corporation mains unfortunately took fire at various parts of the city. Possibly the railway officials derived *some* consolation from the thought that other firms were in a similar predicament.

FIG 2.—Electric Capstan at Halliwell.

### MOSES GATE

This station is on the main line between Manchester and Bolton, the goods warehouse being fitted up for the reception of Egyptian cotton and other commodities. Goods may be transferred direct from railway wagon to carter's dray if required, but when large consignments arrive it frequently happens that mill owners, etc., through lack of accommodation at their respective depôts, are not in a position to receive the whole of their goods at once; consequently the railway company proceed to hoist what remains of the consignment to the second or third storey of the warehouse before mentioned. The mechanical power necessary in operations of this kind was formerly obtained from a small engine and boiler situate in a building near the "enquiry" office, but when the Farnworth Urban District Council commenced running electric cars, arrangements were made for a supply of electrical energy on the usual day-load motor terms. A paper-insulated armoured cable was laid from the District Council's meter box to the top storey of the warehouse, and connected through the usual fuses, switches, and rheostat to a multipolar shunt-wound motor. This machine was designed and built at the chief locomotive works, Horwich. As soon as the substitution was complete a vertical shaft 60ft. long, together with pulleys, cranks, and bevelled wheels, were scrapped, and the engine and boiler loaded in a wagon. The engine-man was no longer required, and his services have been more usefully employed elsewhere. Moreover, the valuable space which the power plant occupied was soon put to better use; after the walls were beautified, a National telephone was connected, and the room fitted with desk accommodation for a staff of clerks who are now busily engaged therein.

### HALLIWELL.

As many of our Lancashire readers are aware, Halliwell is a populous district within the borough of Bolton. Except at the outskirt, it cannot boast of many verdant fields, still less of luxuriant foliage, but its cotton mills and ironworks provide employment for thousands of willing hands. Railway companies, as a rule, are not slow to discern in what direction business lies, and the goods station at Halliwell is a fair embodiment of that proposition. A large tract of land was acquired in this district many years ago, the total area exceeding the actual requirements at the time. Within recent years, however, a development of business has taken place necessitating an additional warehouse, which has been erected on the spare ground referred to. Instead of enlarging the existing steam plant, it was resolved to equip this new building with the latest type of electrical machinery and obtain current from the Bolton Corporation electric supply system. The pavement was accordingly dotted about with electric capstans, and by the time these were connected to the power mains two overhead electric travelling cranes had been erected and finished. Before the work of electrification could be considered complete, arc lights were needed to illuminate the warehouse and goods yard; hence 20 open-type lamps with automatic cut-outs and compensating resistances, were duly installed—five in series on a 230 volt circuit.

A brief description of the capstans and cranes, both of which work at a pressure of 460 volts, will perhaps be opportune. There are 11 capstans in all, designed and manufactured by the railway company. These appliances resemble in general configuration a capstan on board ship; the latter, however, is mechanically driven, while the former are electrically operated. An 18 b.h.p. series-wound motor is fixed below pavement level, the armature shaft being geared to the capstan bell. Ball thrust bearings are provided, and these, together with the worm gearing, are immersed in an oil bath, compact and out of sight. By the aid of a stout rope lashed several times round the capstan bell and hooked to a distant truck, it is only

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necessary to depress a pedal, when current is supplied to the motor and the capstan commences to revolve. Loaded wagons are thus drawn into this new shed and hauled out again when empty. The photograph reproduced (Fig. 2) was taken under actual working conditions, but a critical eye will detect the brakes momentarily pinned down to secure a taut rope.

With reference to the overhead electric cranes, we should explain that 30ft. above loading stage two railway lines were laid longitudinally, one on either side the warehouse wall. It is along these metals that the cranes travel. The span is a much longer one than those at Bradford—namely, 75ft. 6in., the longest, we believe, of any span traversed by an electric crane—and it has been necessary to make the end carriages proportionally stronger to carry the latticed ironwork structure with the usual margin of safety. These cranes, depicted in Fig. 3, lift 30cwt. each, and get through an immense amount of work per day, rapidity of movement being the distinguishing feature. The contracting firm was Messrs. Crompton, Limited, London.

FIG. 3.—Electric Travelling Cranes in operation at Halliwell Goods Warehouse.

PRESTON.

For a longer time than we have data to tabulate, the famous old town of Preston has had two keen competitors for the bulk of its traffic—viz., the London and North-Western and the Lancashire and Yorkshire Railways respectively. With the commencement of the present year, however, business rivalry ceases, a reciprocal arrangement having been entered into for a period of 50 years, with advantage, we are assured, to the general public. Nevertheless, a cursory glance at what the last-named company has done at their warehouse on the East Lancashire side, previous to the above agreement, may not be without

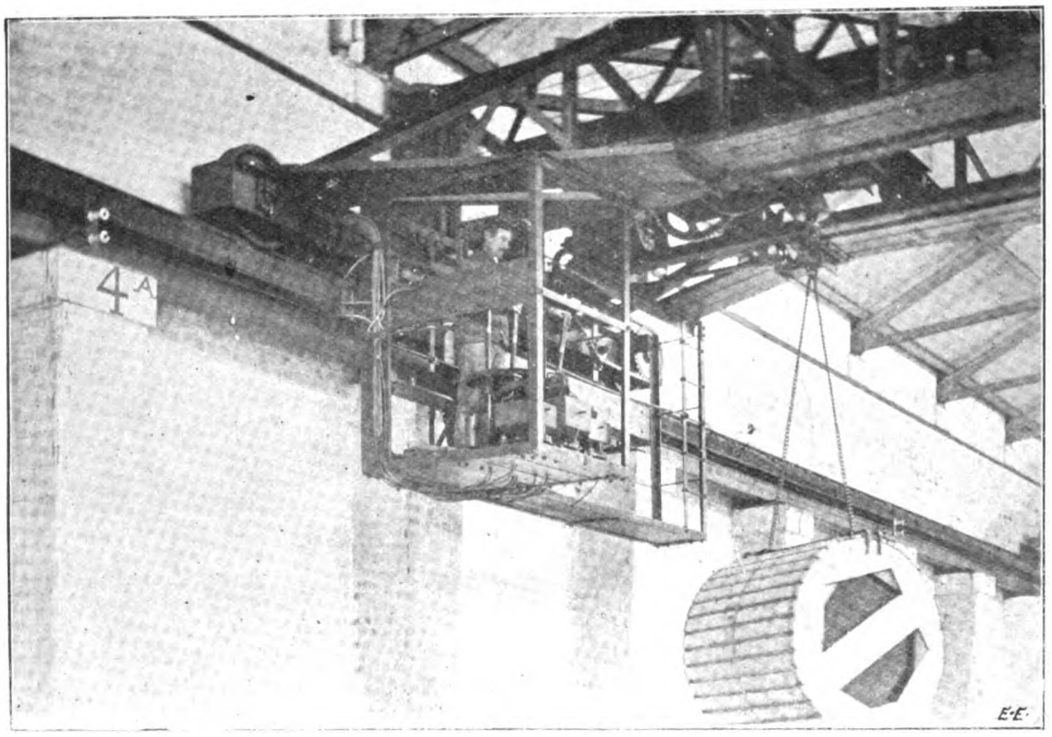


FIG. 3A.—Details of Driver's Cage of the Halliwell Cranes.

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interest at the present juncture. In short, the time had arrived when the old steam plant should either be thoroughly overhauled or scrapped. The latter was decided upon, and in lieu thereof one of Messrs. Mather and Platt's shunt-wound motors was installed in the topmost storey, together with an automatic starting rheostat of Messrs. Sturtevant's design. The function of this motor is limited to "jigger" work—admittedly a rather ambiguous term, but sufficiently comprehensive amongst railway men. A bale of cotton has sometimes to be raised through four or five trap doors to a height of 100ft., and the "jigger" motor supplies the power, electrical energy being served from the Preston Electric Supply Company.

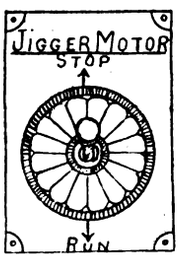


FIG. 4.

A novel feature in connection with the starting resistance is the presence of a number of eight-ampere tumbler switches joined in parallel, one fixed near each trap door (Fig. 4). The motor can be started from any of the tumbler switches, and not until *all* these have been turned to "STOP" will the motor cease running. There would be an objectionable waste of time and electrical energy were it necessary to stop and start the motor always at the top floor, and this is obviated in the manner explained, whilst the electrical connections are shown diagrammatically in Fig. 5.

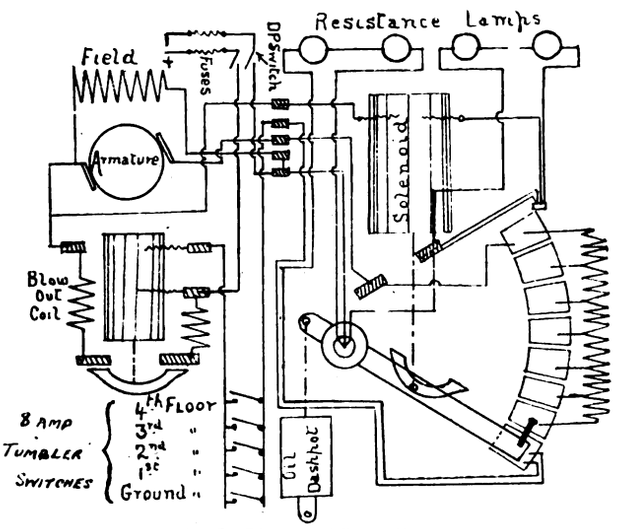


FIG. 5.—Diagram of Connections.

Many of the foregoing items may be regarded by some as minor detail in railway management, but it should not be overlooked that close attention to *detail* is an important factor in the art of success.

## THE LAHMEYER OIL TESTER.

BY H. E. HODGSON.

In large factories and power plants where there is always a large quantity of machinery continuously in operation, it is very necessary to use the highest grade of lubricants obtainable. And as the lubricants often constitute a considerable portion of the working expenses, it is very desirable before purchasing a quantity to thoroughly test the various oils in order to determine the right kind of oil to use in a particular piece of apparatus, as well as to be able to ascertain whether subsequent shipments come up to the original standard. A compact machine for testing lubricants is that made by the Lahmeyer Electrical Company (Elektricitäts Aktien-Gesellschaft of Frankfort). In this machine, which is shown in section in Figs. 1 and 2, the bearing in which the lubricant is tested is situated between two flywheels, F F (shown in Fig. 3), which is an outline drawing of the commercial form of the apparatus, the weight of the wheels producing the ordinary pressure on the bearing, which in this apparatus is about 44lb. per

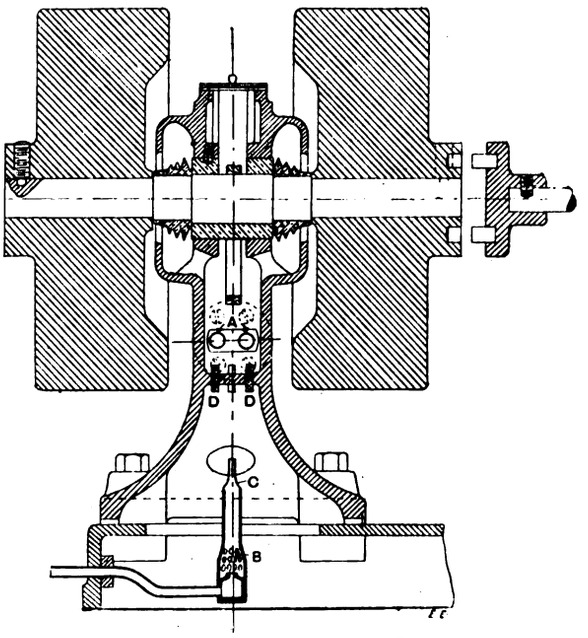


FIG. 1.—Section through Axis of Oil Tester.

square inch.* The bearing pedestal forms the oil reservoir, into which dips a lubricating ring, by which a constant stream of oil is fed into the bearing. The bearing brasses are all in one piece in order that a constant mean thickness of lubricant can be maintained at all loads; it having been found that with divided brasses the mean thickness of the lubricant decreases with the load, causing an increase in the frictional resistance.

The apparatus is designed to be driven by an electric motor, by mechanical means, or by hand. Probably the most convenient method of driving is by means of a variable-speed continuous-current motor, which is the method shown in Figs. 3 and 4. The motor, which has an

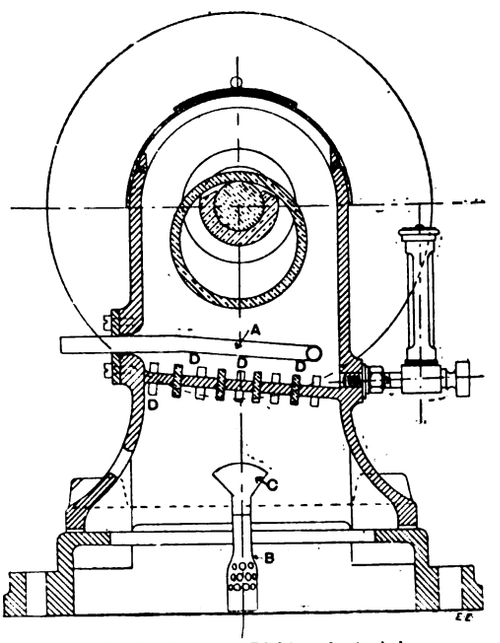


FIG. 2.—Section at Right-angles to Axis.

output of $\frac{1}{8}$ h.p. at 100 volts and 1,800 revolutions per minute, is mounted on a common base-plate with the oil-testing machine, and drives the latter by means of the dowel clutch, G (Figs. 1 and 3). The starting and regulating

* The makers also supply auxiliary flywheels, a pair of which are shown in position in Fig. 7, by means of which the pressure on the bearing can be increased about 70 per cent.

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resistances, which are placed in the base-plate immediately underneath the motor, are connected to the switch, S, as shown in the diagram of connections (Fig. 5). From this it will be seen that the first four stops constitute the starting resistance proper, while the remaining stops are for speeding up the motor by putting resistance in the field, thus obtaining a considerable range of speed. When the

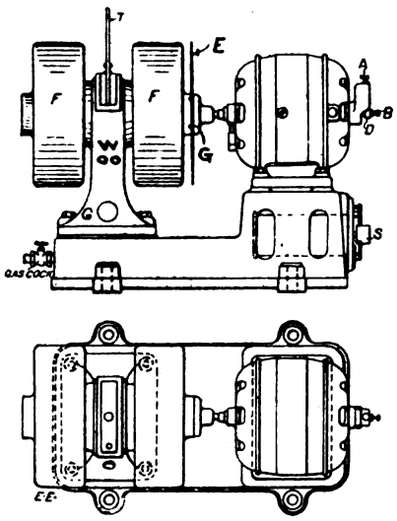


FIG. 3.

clutch plate, G, is moved away from the wheels, the dowels come out of their respective recesses, and the motor is entirely separated from the wheels. The separation is effected in the following manner: The motor spindle has a certain amount of end play, and the armature is compelled, when the clutch, G, is in gear with the wheels, to run slightly out of its central position by means of a hardened

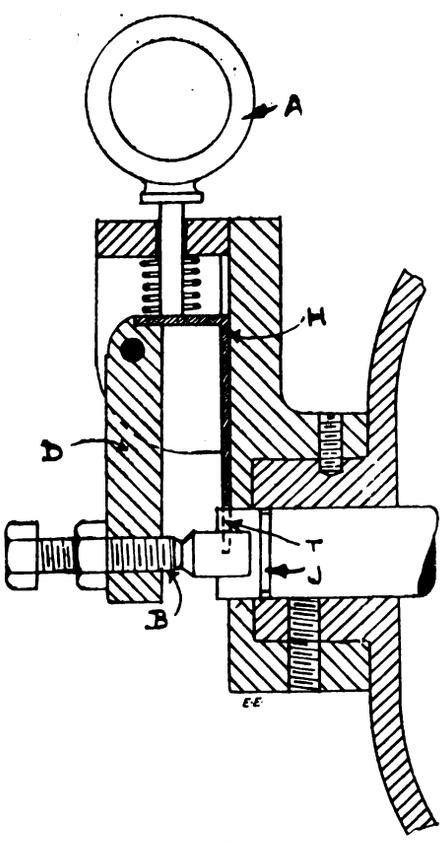


FIG. 4.

set screw, B (Fig. 6), in the end of the hinged arm, D, the arm being held in position by the catch-pin, H. Now, when an armature is displaced in the direction of its axis from its magnetic central position, the field magnets try to pull it back again. Hence when the arm, D, is released from its vertical position, by lifting the catch-pin, H, the armature automatically restores itself to its central position and withdraws the clutch plate, G, from the wheels. After A is lifted and the clutch disengaged from the wheels, the catch-pin should be allowed to regain its original position, and in so doing compels a fork, T, to descend astride the spindle into a circumferential groove, J, cut in it for the purpose, thus holding the motor spindle in its central position and maintaining the clutch free from the wheels. To couple up again, which must be done after the wheels have come to rest, simply press in the set screw, B, while the wheels are turned gently by hand until the dowels fall into their respective recesses. The catch-pin, H, then holds the arm, D, in position until the clutch is again disengaged by lifting A.

When an alternating-current motor is used to drive the wheels, as shown in Fig. 7, a separate starting resistance is employed, and the uncoupling mechanism is of slightly different construction. A dowel clutch is still employed for transmitting the power to the wheels, but in this case it is held in position by a lever shown in Fig. 7, and is withdrawn by means of a spring which is brought into action by depressing the lever. A mechanically-driven apparatus

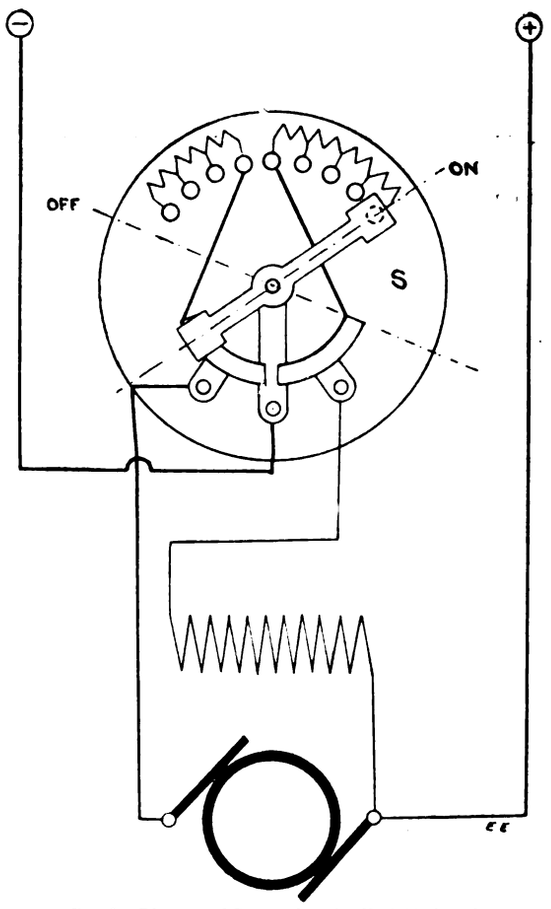


FIG. 5.—Diagram of Connections for Variable-Speed Continuous-Current Motor.

is shown in Fig. 8, from which it will be seen that the machine proper is of exactly similar construction to the one just described. In the type where hand driving is resorted to, two small reduction gear spindles are arranged so as to obtain a speed of from 1,500 to 1,700 revolutions per minute at the flywheel spindle.

For measuring or testing the quality of an oil, the so-called running-down system is employed, which consists in running the flywheels up to speed, uncoupling, and allowing them to run down to rest, their kinetic energy being dissipated in overcoming the frictional resistance of the lubricant. In the ordinary way, to compare two oils it is only necessary, as will be seen latter, to note the time taken with each oil for the flywheels to come to rest from a certain speed. For the purpose of measuring the speed the makers supply a special form of speed counter (Fig. 4), which can be connected to the end of the spindle by means of a suitable coupling. This counter has two hands like a watch, the long one indicating tens and the short one the hundreds, and is furnished with a small knob at the side which serves to rapidly adjust the hands to zero. The

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counter is used in the following manner: After the wheels have been run up to speed, the counter is connected up and the number of revolutions made in a known interval of time observed, the second reading of the counter being taken with it in motion. The counter is then disconnected, the motor uncoupled, and the wheels allowed to run down. Where the tester is used for scientific purposes, besides knowing the time of running down, the actual shape of the running-down curve is usually required, which necessitates the speed being observed several times while the wheels are running down.

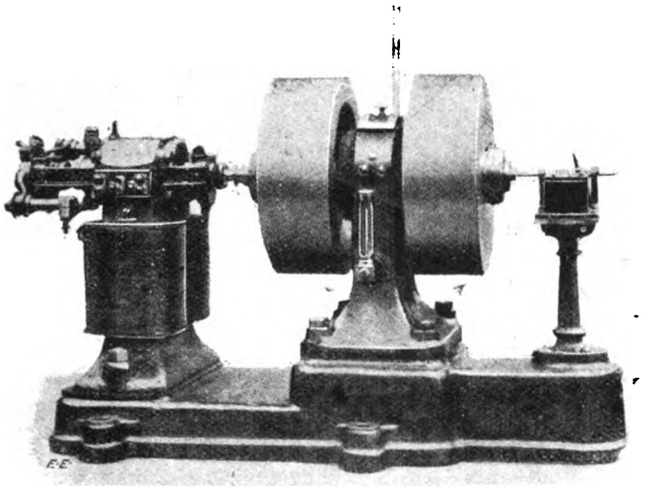

FIG. 6.—Oil Tester coupled to Continuous-Current Motor, showing Speed Counter.

To obtain the whole curve in one run with the ordinary counter, the latter must be connected up during the whole time that the flywheels are running down, which will introduce considerable error. Of course, the curve could be obtained by taking a series of runs with different initial speeds, the speed in each case being measured before uncoupling, as described above. But besides making the taking of a single curve a long and tedious operation, the method tends to introduce irregularities due to varying conditions unless very great care is exercised. In order to enable the running-down curve to be obtained during one run, without introducing the error due to the speed indicator requiring a certain amount of power to drive it, the apparatus used by the writer has been fitted with a

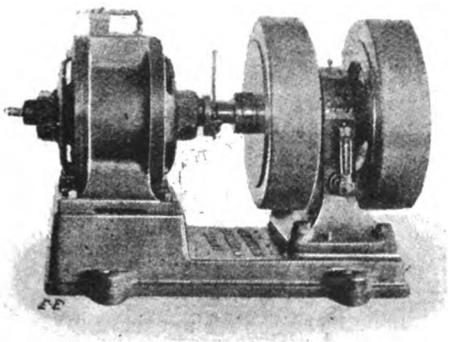

FIG. 7.—Oil Tester coupled to Induction Motor, showing Auxiliary Flywheels in position.

stroboscopic speed indicator and an autographic time-recording apparatus. The stroboscope consists of a sheet-iron plate, E (Fig. 3), having the same diameter as the flywheels, and rigidly fixed to the dowel plate, G—*i e*, to the motor spindle. This disc has an hole about 1in. diameter cut near the circumference, and on the flywheel are painted 10 corresponding white spots. When both the wheel and the disc are rotating in the same direction, and the white spots are observed through the hole in the disc, the spots in general will appear to be moving in one direction or the other; when the spots appear stationary the wheels are running at either ·1, ·2, etc., times the speed of the disc—*i e*, of the motor. This effect may be briefly explained as follows: Suppose the motor and its attached disc containing one hole to be running at 2,000 revolutions per minute, and the wheels to be running at 1,800 revolutions per minute—that is nine-tenths as fast as the disc. Then if spot No. 0 coincides with the aperture in the disc at the top of one revolution, at the next revolution the spot No. 9 will coincide. Thus, so long as the wheels run at nine-tenths the speed of the motor, and so lose one interval per revolution, there will always be a spot to coincide with the aperture. As the disc is making 2,000 revolutions per minute, each spot will be viewed 2,000 times a minute, and an apparently stationary series of spots will result. If the speed of the wheels is decreased

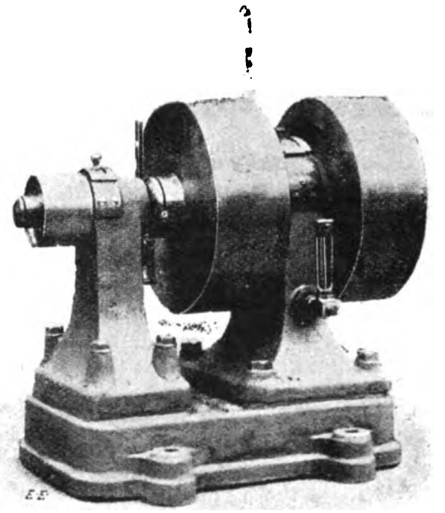

FIG. 8.—Oil Tester arranged for Mechanical Driving.

they will lose a little more than one interval per revolution, and the spots will drift backward until the wheels lose 1½ intervals per revolution, when they will drift in the opposite direction till the wheel loses two intervals per revolution, when they will again appear stationary; the coincidence being now given by every eighth spot, the speed of the wheels being eight-tenths that of the disc.

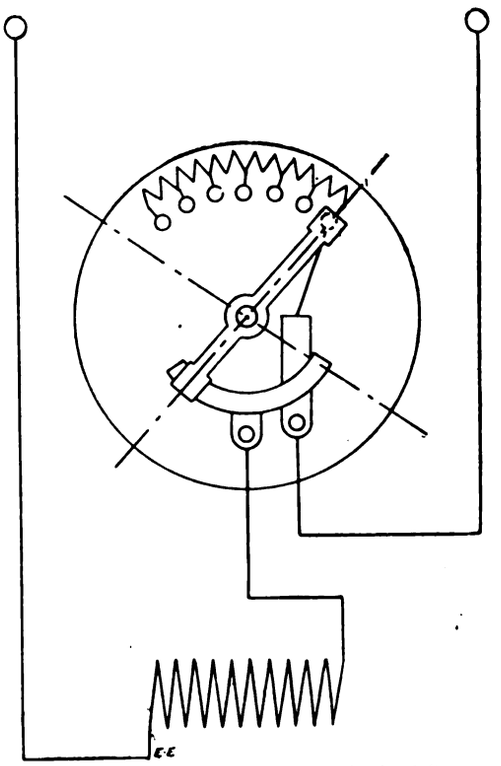

FIG. 9.—Diagram of Connections of Heating Coil.

The recording gears consists of an ordinary Morse telegraph recorder, the energising circuit being completed through a seconds pendulum and a mercury cup. The time of the spot being stationary is recorded by depressing a spring tapper key, which is in parallel with the pendulum and makes a somewhat longer dash on the tape than those made by the pendulum. The speed of the motor should

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be observed once or twice while the wheels are running down by means of a tachometer.

In order to ascertain the effect of heat on the oils under test, the apparatus is provided with suitable heating appliances. To obtain the lower temperatures such as are usually met with in bearings, a copper heating coil (A, Figs. 1 and 2) is fitted in the oil container, through which hot water or steam at atmospheric pressure can be circulated. The oil should be warmed up while the machine is standing still till the temperature is raised to about 25 per cent. higher than that required while the machine is running. The cooling action which takes place when running up will then bring it down to about the right temperature. To ascertain the effect of cold, the same coil can be used for circulating cold water or brine instead of hot water.

The higher temperatures—*i.e.*, up to 200deg. C.—are obtained either by means of an electrical heating coil in the oil container or by means of a gas-burner in the pedestal. In the case of electrical heating, the coil, which takes a maximum current of about two amperes, is connected up to the regulator, as shown in Fig. 9. The maximum current should not be allowed to flow immediately through the coil, but the current should be gradually increased by cutting the regulating resistances out of circuit, thus obtaining a more gradual and uniform rise of temperature. Great care should always be taken before switching on the heating coil to see that there is a supply of oil in the container, as otherwise there is a considerable risk of the coil being burnt out. For heating by means of gas, a specially constructed Bunsen burner, B (Figs. 1 and 2), having a fan-shaped mouthpiece, C, is fitted underneath the oil reservoir, the bottom of which contains a number of copper pins, D, to facilitate the conduction of heat into the oil. Some skill, however, is required to manipulate the gas heating satisfactorily, owing to the fact that the variation of the oil temperature lags considerably behind the variation of the size of the flame. A good plan for temperatures up to about 150deg. C. is to vary the flame as little as possible and regulate by means of cold water flowing through the copper coil. The temperature of the oil is measured by a mercury thermometer, T, which passes through an aperture in the cover of the bearing and dips in the oil to about the same depth as does the lubricating ring. This thermometer, unfortunately, does not give any information as to the temperature of the bearing itself, and hence one would expect rather uncertain results, especially at the higher temperatures. This uncertainty can be minimised to a large extent by running the machine for some time at a constant temperature before attempting to take any readings.

The theory of the machine may be gathered from the following :

Let W = weight of the wheels ;
$r$ = radius of gyration of the wheels ;
$v$ = velocity of a point at the outer end of the radius gyration ;
$n$ = number of revolutions per minute made by the wheels ;
E = kinetic energy stored in the wheels ;
T = time in seconds of running down from $n$ revolutions per minute to rest.

Plot the speed vertically and the time of running down horizontally, and let the suffixes 1 and 2 refer to any two points on the time speed or running-down curve. Then

$$E_1 - E_2 = \frac{W}{2g}(v_1^2 - v_2^2);$$

and as

$$v = \frac{2\pi r n}{60},$$

$$E_1 - E_2 = \frac{W r^2}{2g \times 90}(n_1^2 - n_2^2).$$

Now $E_1 - E_2$ equals the energy used in doing work against the frictional resistance of the oil during the interval of time $T_1 - T_2$ seconds, hence the total work done per second

$$= \frac{E_1 - E_2}{T_1 - T_2}$$

If we assume the average resistance offered by the oil over this time to be R, then the work done per second equals R × distance moved by the surface of the journal per second, which is equal to $R \times \frac{\pi d n}{60}$, where $d$ equals the diameter of the journal and $n$ is the mean speed during the interval of time considered. These are two expressions for the same amount of work, and must therefore be equal ; hence

$$\frac{R \times \pi d \times n}{60} = \frac{E_1 - E_2}{T_1 - T_2}.$$

Replacing $E_1 - E_2$ by its value found above we have

$$\frac{R \times \pi d \times n}{60} = \frac{W r^2}{180\, g}\left(\frac{n_1^2 - n_2^2}{T_1 - T_2}\right),$$

or,

$$R = \frac{W r^2}{9{\cdot}4\, g\, n\, d}\left(\frac{n_1^2 - n_2^2}{T_1 - T_2}\right),$$

and since $n = \frac{n_1 + n_2}{2}$,

$$R = \frac{4 r^2}{4{\cdot}7\, g\, d}\left(\frac{n_1 - n_2}{T_1 - T_2}\right).$$

It is customary to speak of the area of the bearing as its length multiplied by its diameter. If we let $\rho$ be the specific resistance of the lubricant—that is, the resistance per unit of projected area—then

$$R = \rho\, l\, d,$$

and

$$\rho = \frac{R}{l \times d} = \frac{W r^2}{4{\cdot}7\, g\, d^2 l}\left(\frac{n_1 - n_2}{T_1 - T_2}\right).$$

Now the quantities W, $r$, $d$, $l$, and $g$ are all constant in this machine. Hence we may write $c$ for the quantity of the left of the bracket. Then

$$\rho = c\frac{n_1 - n_2}{T_1 - T_2}.$$

It will be observed that the fraction in this equation is the slope of the running-down curves between the points considered. The value of $c$ for this machine when the dimensions are measured in metric units is 0·01368, the intensity of pressure on the bearing being expressed in kilogrammes per square centimetre. It was found by Beauchamp Tower that the resistance $\rho$ is proportional to the square root of the speed when the speed is above a certain small critical value where solid friction comes in. Hence we have $\rho = m\sqrt{n}$, but $\rho$ also equals

$$c\frac{dn}{dt},$$

therefore

$$\frac{dn}{\sqrt{n}} = \frac{m}{c}\, dT.$$

Integrating we have

$$2\left[\sqrt{n}\right]_2^1 = \frac{m}{c}\left[T\right]_2^1$$

or,

$$\sqrt{n_1} - \sqrt{n_2} = \frac{m}{2c}\left[T_1 - T_2\right]$$

but

$$m = \frac{\rho}{\sqrt{n}}$$

then

$$\frac{\sqrt{n_1} - \sqrt{n_2}}{T_1 - T_2} = \frac{\rho}{2c\sqrt{n}}$$

and

$$\rho = 2c\sqrt{n}\left(\frac{\sqrt{n_1} - \sqrt{n_2}}{T_1 - T_2}\right) \quad . \quad . \quad (1)$$

The fraction $\frac{\sqrt{n_1} - \sqrt{n_2}}{T_1 - T_2}$ is as nearly as possible constant for any one running-down curve, hence we get $\rho = K \times \sqrt{n}$, where K is the characteristic constant of the oil.

When considering a point on the running-down curve, some distance from rest, the equation (1) can be written $\rho = 2c\frac{n}{T}$, where $n$ is the starting speed and T the time in seconds of running down to rest, without introducing any sensible error. And as when taking a test the starting speed is always high (1,800 to 2,000 revolutions per minute),

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this equation can be used to determine the constant K, which then equals $\frac{2c\sqrt{n}}{T}$.

The machine is used in the following manner: Drain from the reservoir any oil it may contain and thoroughly clean it first with paraffin, and afterwards with benzine, the former being run off before the latter is applied. When the latter is run off, the bearing should be well blown out with a pair of bellows, while the wheels are slowly rotated by hand, to thoroughly dry it. The reservoir should now be filled up to the mark on the gauge glass with the oil to be tested, and the temperature

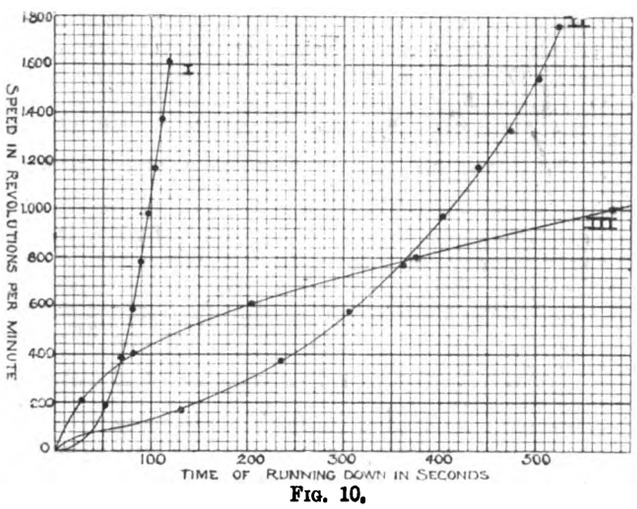


FIG. 10.

adjusted as previously described. The clutch is then thrown in gear, and the machine is ready to start. Turn the lever of the starting switch, S, on to the first contact, and allow it to remain there until the speed of the wheels does not appear to increase. The lever can then be moved on to the second contact, and so on. Especial care should be taken to see that the oiling ring is working properly, and is not prevented from rotating by the thermometer or connections to the heating resistance. When the desired speed is obtained it should be measured either by means of a tachometer or a revolution counter; the temperature should then be observed and the motor disconnected, and a stop-watch started. The motor should now be switched off, and should not be started again till the wheels have come to rest and the clutch put into gear. When the wheels come to rest, the stop-watch should be stopped and the temperature again noted. Should the mean temperature in any two trials not be the same, it may be corrected on the assumption that K varies inversely as the temperature.

Fig. 10 shows three typical running-down curves. Curve I. was taken with "Valvoline" cylinder oil, K at 30deg. C. = ·00930; Curve II. was taken with "White Loom" machine oil, K at 30deg. C. = ·00221; and Curve III. was taken with paraffin oil, K at 30deg. C. = ·000989. A few other oils may be cited to show the order of K: "Vacuum" gas-engine oil, at 27deg. C. = ·00313; vacuum cylinder oil, K at 27deg. C. = ·0139; "Vacuum" engine oil, at 30deg. C. = ·00261; "Vacuum" marine engine oil, at 30deg. C. = ·00255. Fig. 11 shows some running-down curves taken at different temperatures with "Valvoline" cylinder oil; the value of K and the temperature is marked near each curve.

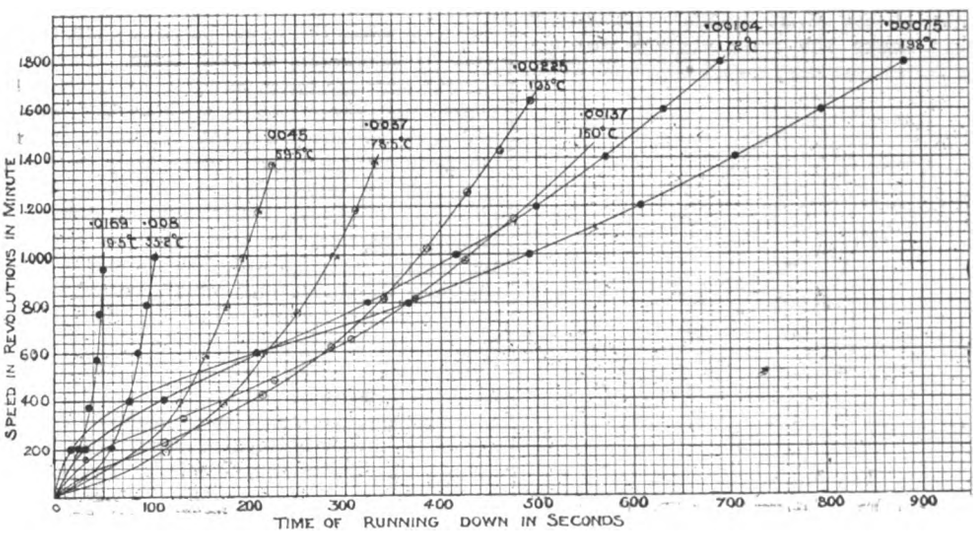


FIG. 11.

## THE ALTERNATING-CURRENT SERIES MOTOR.*

BY F. CREEDY, STUDENT.

Within the last few years much attention has been devoted to various forms of single-phase commutator motor, in the hope of finding, in some of them, a solution of the problem of electric traction by alternating currents.

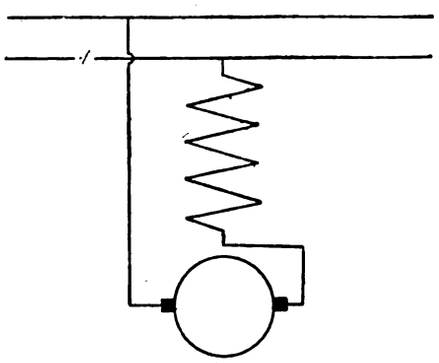

FIG. 1.

One of the most successful of these motors appears to be the old-fashioned alternating-current series motor, which is now coming into commercial use for railway work. The following paper is an account of some investigations carried out at the Central Technical College between March and July, 1904, which are intended to show the effect, on the performance of the motor, of varying the elements of the design. I propose, in the first place, to deal with the theory of the series motor; next, I give an account of a series of experiments verifying the theory; and lastly, an account of some experiments on the commutation of these machines.

### THEORY OF THE SERIES MOTORS.

The simplest way to study the theory of the series motor is, as in the case of many other motors, by means of its circle-diagram. I describe below a circle-diagram which I worked out for this motor some time ago, showing very clearly the leading characteristics of the machine. This diagram (Fig. 1) may easily be deduced as follows: The motor at standstill is a mere choking coil, and a current, O S (see Fig. 2), will flow in it, such that the

* Paper read before the Institution of Electrical Engineers.

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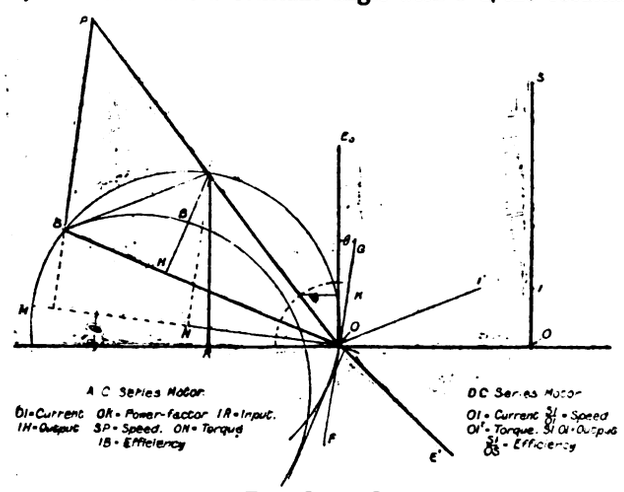
vector sum of all the E.M.F.'s in the circuit (the impressed E.M.F. and those induced by the current) is zero. Consequently, if another E.M.F., such as the counter E.M.F. produced by the rotation of the armature, be applied to the circuit, it will produce a further current, O I′ = S I, lagging behind it by a certain fixed angle. The vector sum of this current and of the standstill current, O S, will be the resultant current, O I. Now, since the counter E.M.F., O E′, of the motor is exactly in opposition to the resultant current, except for a small but constant angle due to the iron losses, and the current S I = O I′ lags by a constant angle behind it, S I must make a constant angle with O I, the resultant




FIGS. 2 AND 2A.

current. Since O S is constant and O I = O S + S I vectorially, O I must obviously move on a circle passing through the origin. In Fig. 2 the angle S I O is equal to the angle I O I′, since O I′ and S I are parallel. Now the angle between O S and O $E_0$ is the same as that between O E′ and O I′. Consequently, if $\theta$ is the small angle of phase difference between counter E.M.F. and current, and if O E′ leads O I by an angle $\pi - \theta$, O I′ will lead O I by $\pi - \theta - S O E_0$. Thus

$$S I O = \pi - (S O E_0 + \theta) = S O F$$

where the line F G makes the angle $\theta$ with O $E_0$; but, by Euclid, this is the condition that F G shall touch the circle at O. The diameter of the circle passing through the origin will, of course, make the same angle $\theta$ with the line of zero power factor that the tangent does with O $E_0$.

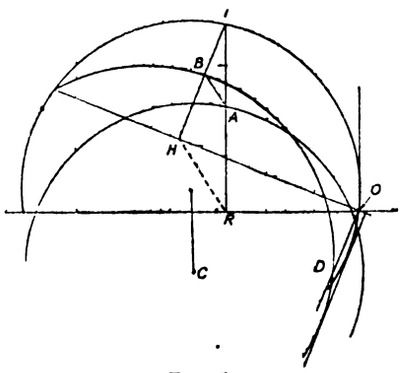


FIG. 3

Since S I is proportional to the counter E.M.F. of the motor, it must be proportional to the product of speed × flux, or, since the flux is proportional to O I, we have S I is proportional to $s \times O I$, or $\frac{S I}{O I}$ is proportional to $s$, where $s$ stands for the speed of the motor. This construction for the speed may easily be simplified as follows: Draw a line S P, such that the angle O S P equals the angle S I O, and produce O I to meet it in P. The two triangles O S P and S I O will now be similar, since the angle O S P equals the angle S I O, and the angle S O I is common. Therefore $\frac{P S}{O S} = \frac{S I}{O I'}$, and since O S is constant, the speed must be proportional to S P. Moreover, since O S P = S I O = S O F, as shown above, S P must be perpendicular to that diameter of the circle which passes through the origin. The torque, of course, is proportional to $(O I)^2$. Since output = torque × speed, we have output $= \frac{S I}{O I} \times (O I)^2 = S I . O I$. The following reductions of the torque and output constructions to a linear form I take from Blondel's paper on the series motor in *L'Eclairage Electrique* last year.

Since the angle S I O is constant, the product S I . O I is proportional to the area of the triangle S I O, which is simply proportional to its altitude, I H, since the base, O S, is constant. Thus we see that the output corresponding to any current may be represented by an ordinate I H drawn from the point I perpendicular to the standstill current. Also, since in a circle $(O I)^2 = O M . O N$* where O M is the diameter through O, and O N is the projection of O I on it, we see that the torque is proportional to O N, since O M is constant. Since we have output = I H, and, obviously, input = I R, we have efficiency = $\frac{I H}{I R}$. This may easily be reduced to a linear form as follows: Draw a circle (see Fig. 3) equal in size to the current circle, and with its centre, C, a fixed distance, measured along a line parallel to I R, below that of the current circle. This circle will cut off from I R a distance, I A, equal to the distance between the centres of the circles. Draw through A a line parallel to H R, cutting I H in B. Then $\frac{I B}{I A} = \frac{I H}{I R}$, and as I A is constant, I B measures the efficiency. Now, the locus of B, as the speed varies, is very nearly a circle, there being one circle for every position of C.† This can easily be verified by trial.

Every such circle will pass through the point S, and be tangent to a line drawn perpendicular to O S, and touching the current circle at a point near the origin. These conditions enable us to draw in a suitable circle at once on our diagram. It will be proved below that O D (Fig. 3) represents 100 per cent. efficiency. This gives us the scale of the construction (approximately). Thus the efficiency is measured simply by the intercept between the current circle and the efficiency circle of a line drawn through I perpendicular to O S. It may be seen that the efficiency continually rises from standstill to infinite speed, so that when the power factor is good the efficiency will be good also. Moreover, from the construction for the output it can be seen that when the power factor is good, the output, though past its maximum, is still large. These facts form the reasons why the series motor is so much superior to some other single-phase motors, such as the repulsion motor, in which, as the circle diagram shows, it is very difficult to get good power factor concurrently with good efficiency. It should be noted that the efficiency used above is the electrical efficiency, account being taken only of those losses proportional to the square of the current, such as the eddy-current loss—in this discussion the loss by the short-circuit current under the brushes‡ is considered as an eddy loss—the resistance loss, and (roughly) the hysteresis loss due to the alternation of the flux. No account is taken of the hysteresis loss due to the rotation of the armature or of the friction and windage.

A diagram, similar in many respects to the above, which allows of a very interesting comparison between the two motors, may easily be deduced for the direct-current series motor. At standstill a current O S = $\frac{e_0}{r}$, if $e_0$ be the impressed E.M.F. and $r$ the resistance of the motor, will flow through the circuit, the impressed E.M.F. being balanced by the resistance drop. Consequently, if another E.M.F., such as the counter E.M.F., $e_1$, of the motor, be applied, a further current S I = $\frac{e_1}{r}$ will flow in opposition to the current O S. Thus as the motor speeds up the point I moves from S

* A proof of this proposition will be given in Appendix I. The geometrical proof is as follows:

We know that $(I N)^2 = O N . N M$. Add to both sides $(O N)^2$. Then $I N^2 + O N^2 = O I^2 = O N (O N + N M)$;

$$\therefore O I^2 = O M . O N.$$

† The accuracy of this construction is discussed in Appendix II.

‡ This current is the principal cause of the phase difference between the current and the back E.M.F.

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towards O, along the straight line O S (see Fig. 2*a*). For the same reasons as in the alternating-current motor, the speed is proportional to $\frac{S\,I}{O\,I}$, and the torque to $O\,I^2$. We also have efficiency $= \frac{e_1}{e_0} = \frac{S\,I \times r}{O\,S \times r} = \frac{S\,I}{O\,S}$, which becomes unity or 100 per cent. at infinite speed when S I = O S. As in the alternating-current motor, the output is a maximum when $S\,I = O\,I = \frac{1}{2}O\,S$. Thus we arrive at the well-known proposition that when the output of a direct-current motor is a maximum its efficiency is 50 per cent.

A similar investigation in the case of the alternating-current motor gives much more favourable results. In this motor the only E.M.F.'s in phase with the current are $i\,r$, the drop caused by the various resistances of the motor, and $e_1 \cos\theta$, a component of the counter E.M.F.; $\theta$ will usually be so small that it can be neglected. Thus we can express the input in the form $i\,(e_1 \cos\theta + i\,r)$, since the above are the only E.M.F.'s that consume power. Now, since $i^2\,r$ represents all the losses that we can take into account (see above), $i\,e_1 \cos\theta$ must be the output. Thus, as in the direct-current motor and in the synchronous motor, we have output = current × projection of counter E.M.F. upon it. Indeed, a proposition similar to this may be proved for any motor. Thus we get

$$\text{Efficiency} = \frac{e_1\,i\cos\theta}{e_0\,i\cos\phi} = \frac{e_1\cos\theta}{e_0\cos\phi} \quad . \quad . \quad . \quad (1)$$

where $\cos\phi$ is the power factor. Moreover, if $z$ be the total impedance of the motor, we have $e_1 = S\,I \times z$ and $e_0 = O\,S \times z$, and therefore efficiency $= \frac{S\,I\cos\theta}{O\,S\cos\phi}$. Thus, when the output is a maximum, the efficiency will be much greater than 50 per cent., because, owing to the phase

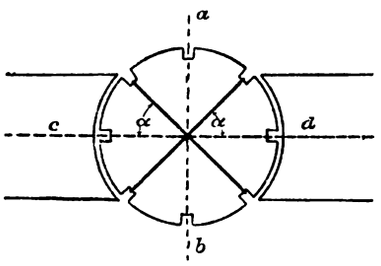


FIG. 4.

difference between the current and the E.M.F., the power consumed will be much less than that consumed in the direct-current motor under similar conditions. At infinite speed, since $\theta = \phi$ and S I = O S, we get 100 per cent. efficiency, as in the direct-current motor. This, as was pointed out above, is the electrical efficiency only.

The fact that the efficiency is 100 per cent. at infinite speed serves to fix approximately the scale to which the constructions given above measure the efficiency and output; and also, if we know the speed scale, it will give us the torque scale. The values thus obtained, however, will be a little too high, for the reason mentioned above. Thus we arrive at the conclusion that by working well beyond the top of the circle in Fig. 2 we can get good power factor, high efficiency, and good "weight efficiency." The next question which arises is how to design the motor so as to attain this end.

In the following investigation, the resistance of the motor and the small angle $\theta$ between the counter E.M.F. and the current will be neglected. Let

$n$ = number of turns on the field.

$n_1$ = " " " armature between brushes. Thus $4\,n_1$ will be the number of conductors on the armature.

$s$ = speed in revolutions per second.

$p$ = permeance of main magnetic circuit, or, in other words, the number of lines produced in it per ampere-turn. If there are more than one pair of poles, $p$ will be the sum of the permeances of all the magnetic circuits in parallel.

$p_1$ = permeance of the armature magnetic circuit.

$\nu$ = leakage coefficient.

$f$ = frequency of supply in cycles per second.

Now, if we are to have good power factor, etc., we must make the ratio $\frac{S\,I}{O\,I}$ (Fig. 2) large. Now, S I is the current produced by the counter E.M.F.,

$$\therefore S\,I = \frac{\text{counter E.M.F}}{\text{impedance}} = \frac{4 \times O\,I \times n\,p \times n_1 \times s}{2\,\pi\,f\,(n^2\,p\,\nu + n_1^2\left(\frac{2}{\pi}\right)^2 p_1)} \quad (2)$$

as the counter E.M.F. is obviously given by the same formula as in a direct-current machine.*

The reactance of the field is obviously given by the expression $2\,\pi\,f\,n^2\,p\,\nu\,10^{-8}$, since $n^2\,p\,\nu\,10^{-8} = L$, the coefficient of self-induction; but on account of the fact that the armature winding is not on a bobbin, as is the field, somewhat greater care is necessary in determining its reactance. Let $a\,b$ (Fig. 4) be the line of the brushes, and $c\,d$ a line perpendicular to it. If we consider two turns, each making an angle $\alpha$ with $c\,d$, one on each side of the brush line, we see that the magnetising force in the direction $c\,d$ due to one turn is exactly balanced by that due to the other. In the direction $a\,b$, however, the magnetising force of the two turns will be added. Since half the main current flows through each turn, the pair produce, in the direction $a\,b$, $i \sin\alpha$ ampere-turns, where $i$ is the current through the brushes. If for the sake of simplicity we suppose the winding evenly distributed, the ampere-turns produced by the whole armature will be

$$i\,n_1 \frac{1}{\pi}\int_{-\alpha}^{\alpha} \sin\alpha\,d\,\alpha = \frac{2}{\pi}\,i\,n_1.$$

Thus only $\frac{2}{\pi}\,n_1$ of the armature turns can be said to be active, and the reactance is therefore $2\,\pi\,f\left(\frac{2}{\pi}\,n_1\right)^2 p_1$, or $0{\cdot}405 \times 2\,\pi\,f\,n_1^2\,p_1$.

Thus we see that $\frac{S\,I}{O\,I}$ is increased by: (1) Raising the speed, if allowable. (2) Lowering the frequency. It will, as a rule, be much easier to design a satisfactory series motor for low frequencies than for high, though I believe it can be done for any frequency not much exceeding 50. (3) By suitably designing the winding.

The expression for $\frac{S\,I}{O\,I}$ above will have a maximum for a definite value of $n$ if we regard $n_1$ as constant. Differentiating with regard to $n$, equating to zero, and solving the equation thus formed, we get

$$n = \frac{2}{\pi}\,n_1\sqrt{\frac{p_1}{p\nu}} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Substituting in (2) we get

$$\frac{S\,I}{O\,I} = \frac{4\,n_1^2\sqrt{\frac{p_1\,p}{\nu}}\,\frac{2}{\pi}\,s}{2\,\pi\,f\left(\left(\frac{2}{\pi}\right)^2 n_1^2\,p_1 + \left(\frac{2}{\pi}\right)^2 n_1^2\,p_1\right)} = \frac{s}{2f}\sqrt{\frac{p}{\nu\,p_1}} \quad (3A)$$

This expression obviously increases indefinitely with the decrease of $p_1$, and is independent of the number of turns on the armature. We also see that the maximum value of $\frac{S\,I}{O\,I}$ occurs when the field impedance is equal to the armature impedance. Thus it is very important to make the permeance in the path of the armature flux as small as possible. The permeance of the main circuit should, as usual, be made as great as possible and the magnetic leakage as small as possible. It is in order to make $p_1$ small that the alternating-current series motor is made with salient poles, like a direct-current machine, instead of being wound like an induction motor.

If the speed of the motor and the number of turns on the armature are constant, the counter E.M.F. will be proportional to the ampere-turns on the field alone. Since

* By taking $p$ as constant, we are, of course, assuming that the iron is worked well below saturation, which is necessarily the case in alternating-current machines. $\frac{S\,I}{O\,I} = \cot\phi$ if we neglect resistance.

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it is in phase with the current we may compare it to the resistance drop in the field, which is also proportional to the product of the current into the number of field-turns (if the same size of wire is used throughout). This point of view enables us to consider the effect of varying the number of turns on the field in a very simple way. Let $r_0$ be the "resistance" per turn $= 4\,p\,n_1\,s\,10^{-8}$. Then

$$\text{Efficiency} = \frac{i^2\,n\,r_0}{i^2\,(r + n\,(r_0 + r_1))}$$

where $r + n\,r_1$ is the total equivalent resistance of the motor and $r_1$ is the resistance of one turn of the field. Cancelling out $i^2$, dividing by $n$, and putting $n = \infty$ we get

$$\text{Efficiency} = \frac{r_0}{r_0 + r_1},$$

Thus we see that as the number of field-turns increases the efficiency at a given speed rises continuously.

The above investigations regarding power factor and efficiency become much clearer when regarded from a geometrical point of view (see Fig. 15), as is done in Appendix I.

### Design of the Series Motor.

In designing a series motor the following information will generally be given:

| | |
|---|---|
| Output at full load... | $= W$ watts |
| Speed ..... | $= s$ revolutions per second |
| Power factor to be not less than | $\cos \phi$ |
| Overall efficiency ... | $\eta$ |
| Impressed E.M.F. ... | $= e_0$ |
| Frequency ..... | $= f$. |

Let us first consider the design of a winding for a given carcase. We must first find the current at full load:

$$i = \frac{W}{e_0\,\eta\,\cos\phi}$$

Next we must find the counter E.M.F. For the present purpose we may neglect the small phase angle between current and counter E.M.F. We then have from equation (1)

$$\text{Electrical efficiency} = \frac{e_1}{e_0\,\cos\phi}.$$

This serves to determine $e_1$. The electrical efficiency must, of course, be estimated from experience. It should be possible to take account of a large part of the iron losses in it, but if this proves impossible they must be estimated in the usual way. With this exception, those losses which are not taken account of in the electrical efficiency will be much the same as in direct-current machines, and thus experience gained with these would apply in estimating them. We now have

$$e_1 = \frac{4\,n_1\,s\,i\,n\,p}{10^8}, \text{ or } n\,n_1 = \frac{e_1\,10^8}{4\,s\,i\,p} \quad . \quad . \quad (4)$$

Since the magnitude and phase of $e_1$ are known, we can compound it with $e_0$ graphically, and find the E.M.F., $e_2$, which actually causes the current to flow. Now,

$e_2 = i\,z$ or $\frac{e_2}{i} = z$, where $z$ is the total impedance of the motor.

Neglecting, for a first approximation, the resistance of the motor, we have

$$\frac{e_2}{i} = 2\,\pi\,f\left(p\,\nu\,n^2 + \left(\frac{2}{\pi}\right)^2 p_1\,n_1^2\right)10^{-8} \quad . \quad . \quad (5)$$

since $p\,\nu\,n^2\,10^{-8}$ is the coefficient of self-induction of the field and $\left(\frac{2}{\pi}\right)^2 p_1\,n_1^2\,10^{-8}$ that of the armature, as considered before. From this equation, together with the one above, $n$ and $n_1$ may be calculated.

Solving these two equations, we get

$$4\,\pi\,f\,p\,\nu\,10^{-8}\,n^2 = \frac{e_2}{i} + \sqrt{\left(\frac{e_2}{i}\right)^2 - \frac{p_1\,\nu}{p}\left(\frac{e_1}{i\,s}\right)^2 f^2}$$

and

$$4\,\pi\,f\left(\frac{2}{\pi}\right)^2 p_1\,10^{-8}\,n_1^2 = \frac{e_2}{i} - \sqrt{\left(\frac{e_2}{i}\right)^2 - \frac{p_1\,\nu}{p}\left(\frac{e_1}{i\,s}\right)^2 f^2},$$

two formulæ which are not so formidable as they look. It should be noticed that it will not be possible to fulfil the conditions given by equations (4) and (5) for all values of W, $\eta$, and $\cos\phi$. For instance, from equation (3A) we see that there is a maximum value of $\frac{S\,I}{O\,I}$, and therefore of $\cos\phi$, which is independent of $n$ and $n_1$. If we assume $\cos\phi$ greater than this, equations (4) and (5) will give imaginary value of $n$ and $n_1$. Having roughed out the design in this manner, we may now check back, and introduce corrections, to take into account the resistance, etc.

We may, however, if we choose, take the resistance into account from the beginning. Although in a large machine this may not be necessary, in a small one it will be more important. In order to take the resistance into account, all that we need do is to substitute the expression $\sqrt{\left(\frac{e_2}{i}\right)^2 - r^2}$ (where $r$ is the total effective resistance of the motor) for $\frac{e_2}{i}$ in equation (5), and all succeeding equations. We may easily determine $r$ from the equation

$$r = \frac{\text{input} - \text{electrical output}}{(\text{current})^2} = \frac{W\,(1 - \eta_1)}{\eta\,i^2},$$

$\eta_1$ being the electrical efficiency, and $\eta$ the overall efficiency. These formulæ furnish us with all that is necessary for designing a winding for a given carcase.

If, however, the carcase as well is to be designed, we must, of course, proceed differently. Having worked out the full load current and the counter E.M.F. as above, the next thing to do appears to be to settle tentatively the number of armature turns. In doing this three considerations must be taken into account: (1) the counter E.M.F. required, (2) the impedance of the armature, (3) the commutation of the motor.

It will be found that unless a very large and massive field magnet be employed, and also a very small air-gap, that it is practically impossible to obtain a strong flux. Thus, in order to get the required counter E.M.F., it will, in almost all cases, be necessary to use a large number of turns on the armature. It is important to notice that for a given current and given flux through a coil, far more E.M.F. will be induced in it, if the magnetic circuit has a low permeance, than if it has a high one. The reason of this is that we shall require a larger number of turns in the former case, and shall therefore get a larger E.M.F. of self-induction since this E.M.F. is proportional to the square of the number of turns in a coil, while the flux through it is proportional to the first power only. Thus we see the importance of making $p$ the permeance of the main magnetic circuit as large as possible. On account of the large number of armature turns which will, as a rule, be necessary, the impedance of the armature will be very considerable, unless we take very special precautions to reduce $p_1$, the permeance of the armature magnetic circuit, by thoroughly slotting the poles, and by using compensating coils. The best way to convince oneself of the importance of doing this is to work through an example or two, such as the one given below.

With a little previous experience of a similar machine it would be easy to settle approximately the number of turns on the armature without much risk of error. Without this, however, all one can do is to work through various designs until one gets a satisfactory one. The considerations mentioned above may serve to some extent as a guide. Having settled the number of armature turns, we can find $n\,p$ from equation (4) and then $n$ and $p$ from equation (5).

It is of considerable interest to compare briefly the design of the alternating-current and of the direct-current series motor. In both machines the number of armature turns determines the flux, and the dimensions of the field magnet, the number of turns which will be required on it in order to give this flux. In the alternating-current motor, as soon as we have determined these quantities, we have practically determined the impedance of the machine as well, according to equation (5). The resistance of the direct-current motor, on the other hand, is not determined by the numbers of turns on the field and armature, since it may be given any value, by putting sufficient copper on the machine.

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Thus we see that in the alternating-current motor, since the impedance is determined by the number of field and armature turns, there are not so many independent variables as in the direct-current machine, and consequently the limits of good design are much narrower. With regard to the design of a carcase, I am at present unable to say much, since there was only one carcase at my disposal, and I was compelled to conduct all my experiments on that. The weak point of the above method of design, when we come to apply it to the design of a complete motor, is clearly the absence of any method of determining the self-induction of the armature from its dimensions. To calculate this self-induction rigorously seems impossible, and we must therefore have recourse to approximate formulæ of the same nature as those of Behrend and Behn-Eschenburg for the "dispersion coefficient" of the induction motor. To obtain such a formula it is obviously necessary to test many different machines. For instance, instead of the $\left(\frac{2}{\pi}\right)^2 p_1$ used in equations 2, 3, 3A, and 5, which is only the roughest of approximations, we should use an expression which will be a function of the air-gap, pole-pitch, shape and number of slots, etc., and should also express the effect of the compensating coils. The reluctance, and hence the self-induction, of the field, and the leakage coefficient, can easily be calculated by the well-known rules.

*Example of the Design of an Alternating Current Series Motor.*—In order to illustrate the method of design given above, I reproduce a design for rewinding the motor used in the experiments described below. On account of the unsuitability of the carcase, however, it is impossible to obtain very good results even at such a low frequency as 25. Specification:

| | |
|---|---|
| Output at full load ..... | = 1 kw. |
| Speed ..... | = 2,000 r.p.m. |
| Power factor ..... | = 0·75 |
| Electrical efficiency ..... | = 70 per cent. |
| Impressed E.M.F. ..... | = 100 volts |
| Frequency ..... | = 25 |

$$i = \frac{1{,}000}{100 \times 0{\cdot}75 \times 0{\cdot}7} = 19 \text{ amperes.}$$

$$0{\cdot}7 = \frac{e_1}{75}, \text{ therefore } e_1 = 52{\cdot}5 \text{ volts.}$$

Compounding $e_1$ with $e_0$, we get $e_2 = 64$ volts. (It must be remembered that $e_1$ is *opposite* in phase to the current.)

$\therefore \frac{e_2}{i} = 3{\cdot}37$ ohms, the permissible impedance of the motor.

As a mean of several sets of experiments on the carcase to be rewound, we obtain $p = 290$ so long as the magnetic circuit remains unsaturated, and

$$\left(\frac{2}{\pi}\right)^2 p_1 = 60.$$

$\nu$ is practically equal to 1·24. Thus we get

$$n\, n_1 = \frac{52{\cdot}5 \times 10^8}{4 \times 33{\cdot}3 \times 19 \times 290} = 7{,}180 \text{ (about),}$$

and $$3{\cdot}37 = 157\,(360\, n^2 + 60\, n_1^2)\, 10^{-8}.$$

Since there are 36 slots on the armature, we are obliged to choose some value for $4\, n_1$, the number of conductors on the armature, which is divisible by 36. The most suitable value appears to be 504, which gives

$$n = 56, \text{ and } n_1 = 126.$$

These values will be found to satisfy approximately the above equations. These values give

| | |
|---|---|
| Field reactance..... | = 1·75 ohms. |
| Armature reactance..... | = 1·49 ohms. |
| Total reactance of motor | = 3·24 ohms. |

Since the armature impedance is nearly equal to the field impedance, we see that the power factor is almost the best possible.

*(To be continued.)*

## READING ELECTRICAL EXHIBITION.

The electrical exhibition organised by the Reading Electric Supply Company, Limited, under the able management of Mr. A. T. Cooper, the engineer of the company, was opened on Monday at noon by the Mayor of Reading (Mr. Sutton).

The exhibition is held in buildings adjoining the generating station, which for the week is thrown open for inspection to the visitors. The plant consists of high-speed engines driving tandem continuous-current generators supplying current to the central portion of the town on the three-wire system, while the outlying districts are supplied with high-tension alternating current. One of the features of the station is the new gas-producer plant now in the course of erection, which is to supply gas to two slow-speed 750-b h.p. gas-engines made by Messrs. Willans and Robinson driving Siemens continuous-current generators, which will when completed take up the steady load, the existing plant taking the peak and light loads, the gas-engines under these conditions working at their most economical point, which will enable the company to reduce their rates of supply.

The local firms were well represented, as well as several from London, the exhibits consisting principally of fittings, lighting and heating appliances, and practical applications of electric driving to printing, wood-working, ice and bread-making machinery. Prominent amongst the local exhibitors is Mr. S. Griffith, of the Railway Foundry and Engineering Works, Reading, who exhibits the manufactures of his electrical department, managed by Messrs. Griffith and Biliotti, of 8, John-street, Adelphi. The machinery on this stand consists of continuous-current motors, ranging from 2½ h.p. to 25 h.p., which are seen at work. The 25-h.p. motor drives a 20-kw. generator supplying current to various polyphase motors. These motors are particularly noticeable for their substantial and compact design and excellent performance. One of these motors fixed on the ceiling drives a drilling machine, a special manufacture of the firm which will drill a ⅜in. hole through 1in. cast-iron plate in 20 seconds, and which by a very convenient arrangement allows holes to be readily drilled at any angle.

Another novelty is an electric clock which is arranged to ring a number of bells in different shops at the times of starting and stopping of work, and does not ring during the night. In addition to the above, there are a number of time element cut-outs, two of them shown at work on a two-phase motor circuit set to act within 7½ minutes with 50 per cent. overload. Two other types are also shown, one of them for quick action, specially suitable for feeders acting within 90 seconds with 50 per cent. overload, and in 30 seconds with 100 per cent. overload, the other for slow action working within half an hour with 50 per cent. overload.

The above firm has also a good show of Messrs. Johnson and Phillips's instruments and cables, for which they are sole agents for the district.

Another interesting exhibit is that of the Industrial Storage Battery Syndicate, showing the Elieson patent accumulator in various stages of manufacture. This accumulator, specially suitable for electric cars, can be charged to its full capacity within half an hour or an hour, and discharged at the same rate without injury. The exhibition, which will be open till Saturday next, was well attended during the opening days, and has every prospect of being a success.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### ELECTRIC PUMPING.

SIR,—I should like to correct a statement which appeared in my reply to Question 770, April 21. The maximum speed of the pump is given as five revolutions per minute, which obviously corresponds to five double strokes, or half the maximum number specified in the question.

London, W., April 23, 1905. E. AUSTIN.

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### TO CORRESPONDENTS.

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## SINGLE-PHASE TRACTION.

We are pleased that the Institution of Electrical Engineers have under discussion the question of the use of single-phase alternate-current motors for traction purposes. The matter is one which brings out most clearly the international character of the competition in electrical engineering. The discussion which took place at St. Louis last autumn on Mr. Bion J. Arnold's address on this problem was most interesting, although somewhat general in character, and more detailed information may now be available. In fact, this is a fault which is common to most of the information given on this important subject. This charge cannot be brought against Mr. F. Creedy's paper on the alternating-current series motor, which was discussed last night with Mr. Arnold's address. In this full details are given of an interesting experiment on a motor which, although small, enabled the author's theories to be investigated and proved. The information is hence the more valuable as the whole truth is given, as cannot be the case with the information published by commercial firms, who have to depend for their profits on the superiority of their machinery over those of their rivals. Reverting to the development of the single-phase motor, this was largely due to the success of the Swiss and other Continental firms in the adaption of the three-phase induction motor for railway working. On railways through mountainous districts these induction motors give great satisfaction, and led other engineering firms to push forward their experimental work which had for its object the design of a rival system more applicable for ordinary railway working. The work carried out in connection with single-phase traction has been mostly done by American and Continental firms. The magnitude of the experiments makes the cost almost prohibitive except in the case of large manufacturers, who can afford to devote considerable sums on the development of new specialities. The results obtained on both sides of the Atlantic lead one to agree with Mr. R. G. Lamme in his statement before the St. Louis Convention—*i.e.*, that "The single-phase system is the one means presented at the present time as a solution of the heavy railway problem. It has all the advantages of the direct-current motor in the variable speed characteristics, and has also the advantage possessed by alternate current in the ability to use any line pressure desired and to vary the pressure applied to the motor, and thus vary the speed over any range desired. It has also the advantage of permitting a system of control that can be obtained without sparking." This last advantage refers to sparking at the controller and to the system by which a variable-ratio transformer in which the relative positions of the primary and secondary coils is altered to give any voltage on the motor without any step-by-step interruption in the circuit. The use of these single-phase motors for railway working is likely to be developed more quickly from the fact that so many firms are working on the problem independently. Thus, when tenders were asked for for the equipment of the trial line of the London and Brighton and South Coast Railway Company on this system to Mr. Philip Dawson's specification, the competition was almost as keen as if direct-current motors had been called for. Each of the firms who tendered have independently investigated the problems involved, and most of them have conducted trials with single-phase motors on a scale which is comparable with normal railway conditions. It seems likely, therefore, that in the future, for main-line working at least, the single-phase system will be adopted. It does not follow that there will be much change in the method of generating and distributing the energy required. Three-phase alternators

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working at a frequency of twenty-five will still be applicable. All the alterations that will be necessary will be in the sub-stations. Here the static transformers now employed to feed the rotary converters can be replaced by others so connected as to convert the three-phase currents received into two-phase currents. One phase can then be used to supply the line in one direction, while the other will be connected to the overhead wires proceeding in the opposite direction. In this way the advantages of three-phase plant for generation and transmission can be retained, while single-phase current is employed on the line. The reductions in cost by the employment of a higher line voltage and the supersession of the rotary converter will make th conversion problem a much simpler one financially. It remains to be proved, however, that while the single-phase system greatly simplifies electrical running on main lines, it will also be able to compete with the direct-current motor on suburban branches or in tube railways, where the traffic is dense and the distance between stations such that the trains are always either accelerating or being braked. It is only fair to add that while this query seems a reasonable one with the information now before us, it must be remembered that we are comparing the results of a new type of motor with those from the series direct-current machines as perfected by years of trial. The newer types of single-phase motor after similar experience may be able to hold their own even when extremely rapid acceleration is required.

## UNSOLVED PROBLEMS IN ELECTRICAL ENGINEERING.*

BY COLONEL R. E. B. CROMPTON, C.B., M.I.C.E.

*(Concluded from page 562.)*

Whilst on the lighting question, I wish to mention a matter which has interested me, although it can only indirectly be called an electrical problem. Years ago I was fortunate enough to observe the following phenomenon. Whilst in a carefully closed tent with double top, and walls thick enough to exclude the faintest ray of the Indian sun, I, in the course of a severe thunderstorm, was able to distinguish minute details of the outside scenery by the walls being rendered practically transparent by intense flashes of lightning. Personally, I have no doubt of this, but the phenomenon appeared inexplicable, until it was suggested to me that the lightning flashes were so rich in violet short wave-length rays of low refrangibility that they were able to render transparent all substances which owe their opacity to the centrifugal refraction of the white or yellowish ray of sunlight. As in the Cooper Hewitt lamp we are now able to command rays of the right colour by condensing a beam of this blue light, we may hope to render transparent many vegetable substances, such as wood and similar materials, which have hitherto been considered completely opaque to ordinary vision.

A problem of real moment to both suppliers and users of electrical energy would be the discovery of a direct method of producing artificial cold by electrical means. If we had a ready means of producing artificial cold so as to obtain cold storage in our larders, and so preserve our perishable foods, vegetables, and fruit, it would obviously greatly add to the pleasure of our lives and to the economy of our housekeeping. Of course, we can now produce artificial cold by connecting an air-compressor to be driven by an electric motor, and by expanding the air into the cold storage chamber, but the method is costly and cumbrous. Probably something may be done by a well-designed high-speed air compressor, but the real solution we are looking forward to is a direct method of producing cold from the electrical energy in our supply mains, and this probably is a problem for the electro-chemist, as we may conceive the apparatus taking the form of a battery abstracting heat from the surrounding air.

The use of electricity for cleaning purposes has been considerably developed during the last year or two, as we are familiar with the vacuum cleaning apparatus, which in most cases is driven by an electric motor, but it ought to be within the power of the designer of electrical novelties to produce electrical cleaning apparatus of a simpler character which would be within the reach of all of us who have the electrical supply in our houses.

The recent experiments of Lodge in dispersing fog and collecting dust by communicating static charges to the atmosphere containing such particles deserves mention as worthy of further development.

The application of electricity to these domestic purposes will have the secondary effect of increasing the day load of our lighting companies, and will react by reducing the cost of electricity not only for these purposes, but for heating and for lighting, hence the importance of the problems involved.

A few years ago, when in India, the problem was put to me of pulling punkahs by electricity. Although I said it was a simple one I was challenged to make it good. Since that time the problem has nearly reached complete solution. Many secondary ones arose out of it, not the least being that as the slow-speed fans used were placed immediately overhead in living-rooms and bedrooms it was quite impossible to adopt any means of oiling on account of the danger of the oil dripping. The wonderful perfection recently obtained in ball bearings and in mechanical winding of armatures has enabled this problem to advance very closely to perfect solution; at any rate, I am told that since the introduction of the electrical fan, life in Calcutta during the hot weather has become far more tolerable than heretofore.

Time will not permit me to speak at any length on the interesting subject of electrical heating. At first our attention was directed to means by which our electrical energy could be used for the production of low temperatures, such as radiators for heating our rooms, boiling water, heating ovens, and similar domestic uses, and although the demand for this class of apparatus has up to the present not been great, owing to the cost of the energy being in most cases still too high, yet steady progress has been made, and in certain towns its use has been extended in a very encouraging manner; but there is another use for electric heating, and that is the production of much higher temperatures, such as those required by the chemist and metallurgist. The importance to the mechanical engineer, chemist, or physicist of being able to maintain in quite small furnaces extreme regularity of high temperature for very long periods of time cannot be over-estimated, and this problem is already satisfactorily solved; but when we deal with electrical furnaces on the larger scale, I may point out that although when Keller read his paper on electrical metallurgy before the Iron and Steel Institute in 1903, the possibility of electric smelting taking the place of heating direct by fuel was received with much incredulity, since that time so much attention has been given to the matter that this problem has already been successfully grappled with, and appreciable advances have been made in the practical application of electrical smelting. De Laval, Ross, and others have arrived at very concordant results, and already the Heroult furnace for the production of steel from scrap iron has been carried out on a commercial scale in France and in Sweden, and in both cases we are told that the high quality of steel thus obtained shows that the process is already a commercial success, and may be of great importance to those countries which possess water power, so that this direct process of electric smelting may be readily developed.

In discussing the past and future problems of the core and coil on which so much of the efficiency of our generating, transforming, and utilising apparatus depends; again, in discussing the problems of storage, of the electrical driving of our railways, and of the further utilisation of electrical energy for the needs of our daily life, I have been more struck with the extreme difficulty I feel in confining myself to matters which have been hitherto considered strictly electrical ones. I am sure all my brother engineers will feel with me that the necessities of our profession compel us to take up and study the far wider field of knowledge of general engineering. The power engineer is called

* The "James Forrest" lecture, 1905, delivered before the Institution of Civil Engineers.

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upon—at all events, in this country—to deal with the problems of fuel and water supply, the use of steam, or the internal-combustion engine, and the whole range of subjects connected with the properties and strength of materials, and of the methods of manipulating them, which to many are considered purely the province of the mechanical engineer. We claim that already we have profoundly influenced that profession. Our requirements have already modified the boilers, have practically given to the world the modern high-speed steam-engine, the steam-turbine, and have been a predominating influence in developing the internal-combustion engine. For instance, in the work we are now carrying on in standardising the electrical apparatus we use so as to facilitate the manufacture and interchangeability of parts, we find electrical requirements are already so predominant that they greatly influence the requirements of other uses of mechanical apparatus.

Finally, I believe the greatest problem of all, and the one which will have the most profound influence on the well-being of our fellows, is the satisfactory development of our power schemes by which we hope to send the population back to the land. Power distribution schemes of various degrees of magnitude have already been started in many countries. In those where water power was available they have made considerable progress, but in this country, where we have to look to the generation of our power from fuel, the series of problems involved are of the highest interest, are extremely hopeful of speedy solution, and the social consequences that will follow on them are likely to be so important to the health and better development of our race that they deserve the most careful consideration of our best men.

We already see that the necessity for bringing our working population into huge factories so that they may work within the range of power allowed by revolving shafting is already at an end; that nearly all power can be supplied through electric motors, and therefore the factory units themselves can be small, spaced more widely apart, and many classes of manufacturing processes can be carried out most perfectly in the worker's own home unaided by the other members of his family.

Already in Switzerland, France, and Germany, trades are being profitably carried on under conditions very closely approaching those that have been foreshadowed to us by the promoters of garden cities. A large proportion of our workers can carry on their business at home in a workshop attached to the dwelling-house, and separated from the neighbour by the garden in which the children can grow up under the best conditions of light, air, and sunshine. The electrical engineer who has been a chief cause in bringing about this vast social change will be honoured among those who have really benefited mankind.

I hope my audience will sympathise with me in my difficulties in dealing at all adequately with this interesting subject, which really calls for a course of lectures. My choice lay between giving you a mere list of the electrical problems which are still unsolved or of treating a few in the manner I have attempted, and which I fear is wholly unsatisfactory.

In one sense the preparation of this lecture has been to me a source of keen pleasure. My correspondence with my scientific and electrical friends, not only in England, but in France and America, has made me feel quite certain that one electrical problem is already thoroughly and completely solved—that is, the kindness, sympathy, and help that we electrical engineers can count on from one another. I hope those of my friends who have helped me by advice and information will understand when they hear or read this lecture that their assistance has been appreciated at its full value.

## APPOINTMENTS VACANT.

**Foreman** of switch and controller department. See advertisement in last issue.

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**Borough Electrical Engineer and Tramways Manager**, Southend Town Council. Salary £400 per annum.

## RECENT TYPES OF AMERICAN ELECTRIC BLUE PRINTING MACHINES.

BY FRANK C. PERKINS.

A great step in advance in the making of blue prints is the application of electric arc lights and motor-driven

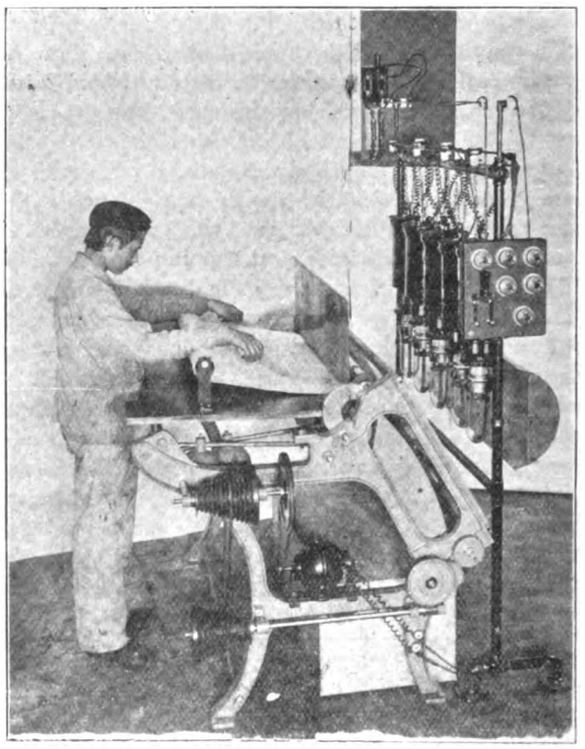

FIG. 1.—Franklin Electric Blue Printing Machine.

machinery, as it permits the production of prints made upon completion of the tracings, and the drafting-room is thus made entirely independent of weather conditions. The electric blue printing machines produce copies of uniform colour, and they have the advantage of making a continuous print of almost any length desired.

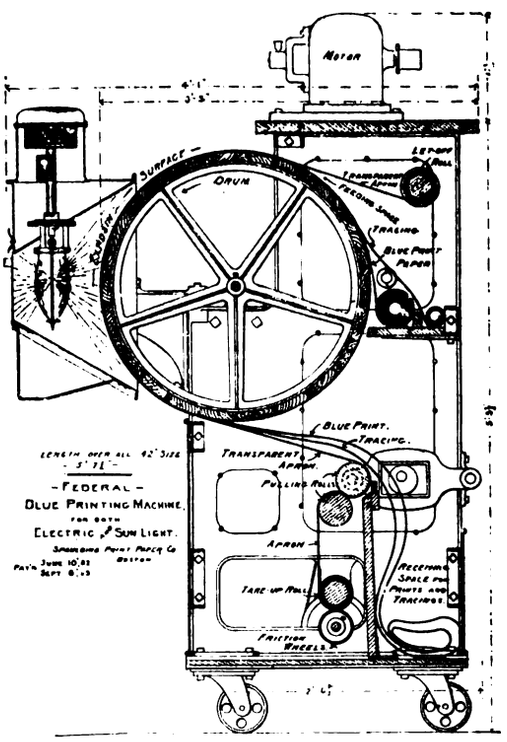


FIG. 2.—Drawing of Federal Blue Printing Machine.

The accompanying illustration (Fig. 1) shows the method of operation of the Franklin electric blue print machine, which has two continuous bands of transparent celluloid, which are held in position firmly by two rollers, one of which is the driving roller, which actuates the band, while

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the other is an idler. The bands are caused to revolve synchronously, as the driving rollers are geared together and revolve at exactly the same rate of speed. As the transparent celluloid bands travel from one roller to another they pass over a convex surface shaped in a section of a cylinder, and are held by an automatic adjustable tension device in absolute contact with this surface and one another.

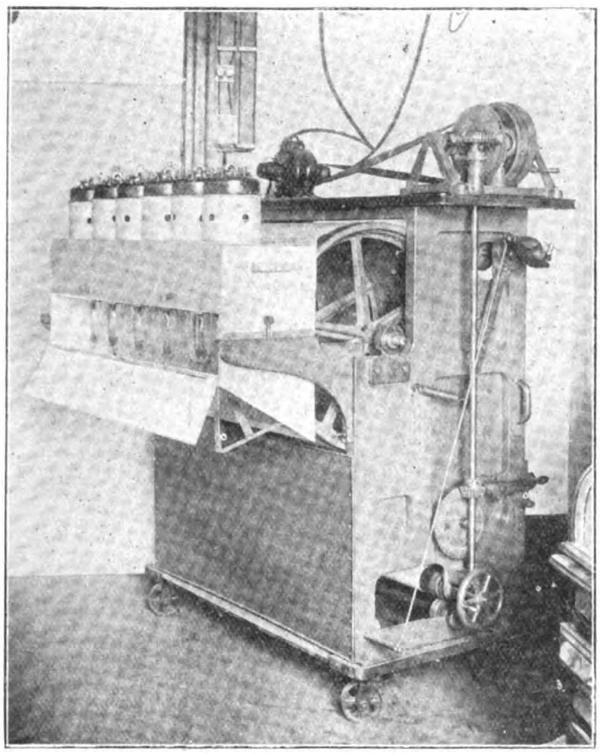

FIG. 3.—The Exposure Side of the Federal Machine, showing Arc Lamps.

The motor is of $\frac{1}{10}$ h.p. capacity, operated on a current of 104 volts or 220 volts, and the four or five enclosed arc lamps are employed, each taking a current of $2\frac{1}{2}$ amperes at 220 volts or five amperes at 110 volts. The speed of the motor may be varied by a cone device or by rheostat,

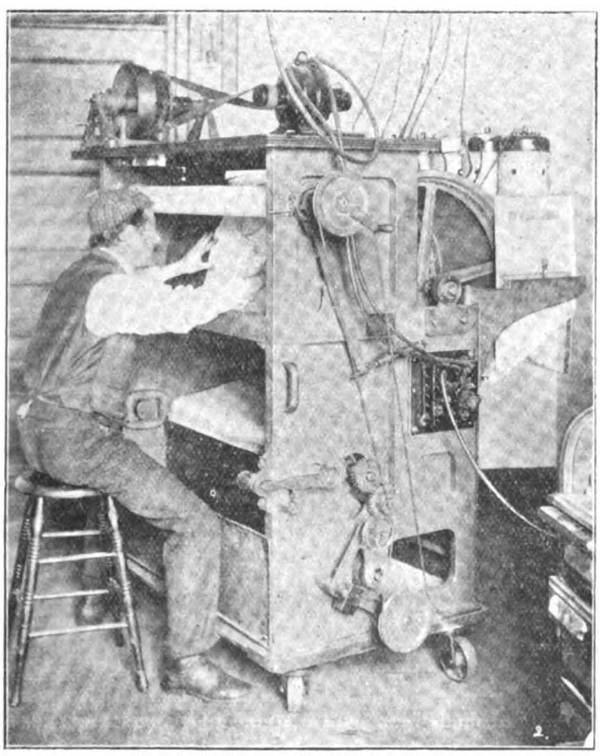

FIG. 4.—Federal Blue Printing Machine.

and in this way the bands may be operated at a slow or rapid speed, so that the tracings and sensitised paper may pass across the convex surface with a long or short exposure. The sensitised paper and the tracings are introduced between the transparent bands, which hold them in absolute contact as they pass in front of the electric lamp. It will thus be noticed that the printing is automatic in its operation and continuous as well, printing a long strip or making a number of prints from the same tracing in rapid succession. Prints may be made at a maximum speed of one minute exposure, or a minimum speed of 10 minutes, giving a wide range for all kinds of sensitised paper.

The drawing (Fig. 2) and illustrations (Figs. 3 and 4) show the construction of the "Federal" electric blue printing machine, which consists essentially of a drum revolving freely in roller bearings; a feed or let-off roll above the drum, and carrying a long, transparent, flexible apron; as well as a pair of pulling rolls under the drum and connected to the power through a speed-controlling mechanism. The transparent apron is drawn from the feed roll against a tension device around the surface of the drum, surrounding the latter about half of its circumference. The transparent apron, which is in contact with the surface of the drum, constitutes the exposing surface for printing. It will be noted that the blue print paper and the tracings are fed between the apron and the surface of the drum at the top of the machine, being carried around as the drum revolves, and are exposed to the action of electric light and then dropped automatically into a box below provided for the purpose. A roll of tracing cloth is used as a transparent apron, and this is wound upon the let-off roll, passing around the periphery of the drum to two pulling rolls, and then to a take-up roll, which winds it up automatically as fast as used. As soon as its entire length has been drawn around through the machine it is rewound ready for another run of exposure. It is claimed that the tracing cloth, when in close contact with the work, will transmit the rays of light in nearly the same time as plate glass. The ordinary roll is about 24 yards long and 42in. wide, and with this size six arc lamps are employed, each taking five amperes, and burning 130 hours continuously. With machines for printing copies 54in. in width, seven or eight electric lamps are employed. A small electric motor of $\frac{1}{4}$ h.p. capacity is used for operating this machine, and is mounted on the top of the machine and belted to a speed controller. Exposures are made either on a continuous roll of blue print paper or on separate sheets. When the continuous roll is used, the end of the paper is started under the transparent apron on the upper side of the drum, and the tracings placed one after another upon it as the drum revolves.

## ELECTRIC LIGHTING AND AIR-PUMPING ENGINE.

Through the courtesy of Mr. F. W. Baylis, the chief officer of the Manchester fire department, we are able to give the following particulars of a new engine recently bought by the department. The object of this engine, with its numerous equipments, is to enable firemen to adequately deal with fires in which large volumes of smoke are given off. In such cases the difficulty of approaching the source of the fire and of seeing in the smoky atmosphere have greatly handicapped the efforts of all fire brigades. The new engine, which has been supplied with all its accessories by Messrs. Merryweather and Sons, Limited, of Greenwich-road, London, S.E, enables the fireman to take light and air with him in such cases. The illustration which we give herewith shows that this engine is modelled after the firm's well-known fire-engines. It has the same type of water-tube boiler which enables steam to be quickly raised. This boiler supplies a vertical single-cylinder engine. The air-pump used to supply air to the helmets worn by the firemen is driven from the crankshaft of the engine. There is, however, a coupling inserted, by which the air-pump can be thrown out of gear if need be. This engine also drives, by means of a belt, a small dynamo which is placed on the fore-carriage to supply the hand lamps which are carried by the firemen when entering smoky buildings. It is capable of lighting eight lamps of 32 c.p. each. In order to regulate the voltage on these, a rheostat is provided in the shunt circuit of the dynamo. The six hand lamps used have each some 200ft. of insulated cable arranged on reels, so that it can be easily paid out

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and wound up again. The air-hose used to supply fresh air to the helmets is carried on the drums shown in the illustration in 60ft. lengths. This hose is of the flexible metal type, and is used also as a conduit for the telephone conductors. Special couplings, with insulated contacts for the telephone circuit, are provided so that the lengths of hose can be quickly joined together. The most interesting feature, perhaps, of the equipment is the helmet itself. The earlier form is shown in Fig. 1, from which it will be seen that the helmets are provided with a leather mask which comes down over the firemen's shoulders. The air-hose was coupled at the back and the draught passing round the fireman's head tended to keep his eyes and nose clear of smoke. The air then passed out under the front of the mask. In the more recent types of helmet (illustrated in Figs. 2 and 3) the air connection is forked and supplies through two openings, one at either side of the helmet. It will be seen that a strap is provided to ensure a closer connection between the mask and the fireman's tunic. In this helmet also the front window is made to open, so that until the fireman enters the smoke he can breathe freely through this opening. The telephone receiver is fixed to one side of the mask, and the transmitter is in the front. As mentioned above, the wires for these telephones are led through the air-hose. The telephones are connected to an instrument on the engine itself, by means of which the officer in charge can keep in close touch with the fireman's requirements. With these helmets the men can enter buildings which would otherwise be inaccessible owing to smoke, and taking a strong light with them, they will be able to render a great service in locating the source of the fire. We understand that the engine and helmets have given satisfactory results on trial, but that up to the present the equipment has not been called upon for active service.

FIG 1.—View of the Merryweather Electric Lighting and Air Supply Engine.

FIGS. 2 AND 3.—Views of the New Helmet.

## FORTHCOMING EVENTS.

FRIDAY, APRIL 28.

**Tramways and Light Railways Association.**—At 8 p.m., "Lubrication," by Mr. W. F. Parish.

THURSDAY, MAY 4.

**Institution of Electrical Engineers.**—At 8 p.m., discussion on Mr. A. M. Taylor's paper, read before the Birmingham Section, "Stand-by Charges and Motor-Load Development."

**Rontgen Society.**—At 5 p.m. (medical members only), "Forty-two Cases of Ureteral Calculus Diagnosis by X-Rays proved by Operation on the Passage of the Calculi"; and at 8.15 p.m. (general meeting), "Measurement and Technique in Therapeutic Dosage," both by Dr. C. Lester Leonard, of Philadelphia.

**Chemical Society.**—At 8 p.m., general meeting.

**Civil and Mechanical Engineers' Society.**—At 7.30 p.m., annual general meeting, followed by a paper, entitled "Card Indexing and Filing," by Mr. J. C. Osborne.

SATURDAY, MAY 6.

**Electrical Engineers' Corps (R.E.V.).**—At 8 p.m., Bohemian concert at the Caxton Hall.

**Rugby Engineering Society.**—May 20, visit to the Lots-road power station at Chelsea.

**Incorporated Municipal Electrical Association.**—June 27-30, annual convention. Particulars in another column.

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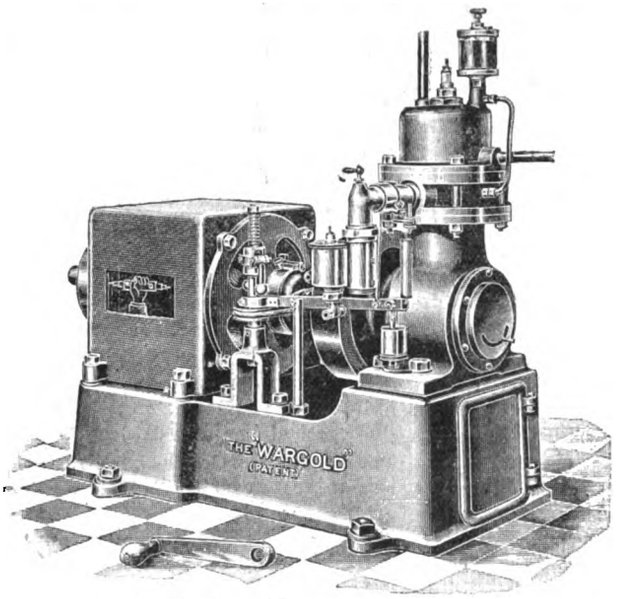
## TRADE NOTICES AND NOVELTIES

### Electric Lighting from Petrol.

The perfection of the petrol engine makes the combination of these prime movers with the dynamo an exceedingly portable one for electric lighting purposes. While such combinations were first introduced in connection with searchlight work in the army, they are becoming common for isolated installations where the number of lights required is small. Messrs. Ward and Goldstone, of Dutton-street, Strangeways, Manchester, are supplying a petrol engine connected to an enclosed type dynamo for such work.

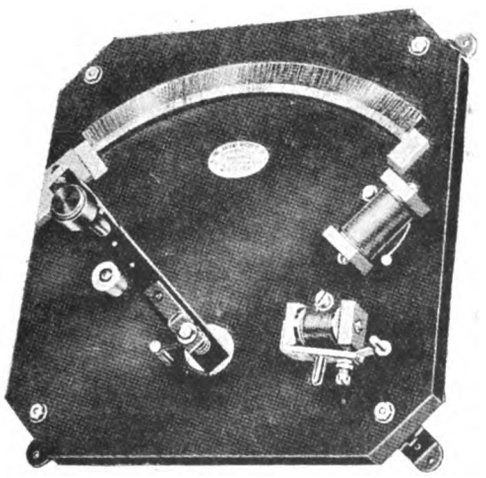



The Wargold Petrol-driven Dynamo.

The illustration herewith shows a combination capable of supplying 30 8-c.p. lamps at the same time. The engine is of the two-cycle type, giving an impulse at every revolution, which ensures an even turning moment. The makers calculate that with petrol at 9d. per gallon, the cost of fuel is equal to 1¼d. per horse-power hour, or, say, 2d. per unit. This type of plant will recommend itself to those owners of motorcars who wish to introduce electric lighting into country houses in inaccessible districts. The motorcar driver will then have no difficulty in supervising the running of the lighting plant.

### Improved Rheostats.

The Patent Rheostat Company, 18, Chapman-street, Hulme, Manchester, have sent us particulars of an improved form of starting rheostat which they are about to place on the market. In this rheostat the usual box of wire resistance coils is dispensed with, as also the contact studs, a patent contact resistance being substituted. This resistance is composed of thin sheet-metal stampings, packed into a channel in the slate base.



Front View of Motor Starter, showing Resistance mounted on the face of the Switch.

It is exposed upon the face of the switch, as shown in the accompanying illustration, and the contact lever makes contact directly with the resistance in the operation of switching on. Since the resistance is composed of a considerable number of segments, each of which represents a resistance unit, an ideal cutting-out arrangement is obtained, equivalent to that of a starter furnished with several hundreds of contact studs. Moreover, it enables a constant current increment to be maintained, and a motor to be consequently brought up to speed with perfect smoothness. For all uses the resistance is given a large cross-section, and is practically indestructible at proper current loads. It should be mentioned that the stampings of which the resistance is composed are of a non-rusting alloy. They are closely packed in the channel, and provision is made, by means of a spring inserted at the end of the resistance column, for expansion movements; also to ensure, with certainty, continuity in the resistance circuit. For the larger sizes of starters, where heavy currents have to be dealt with, two or more resistance columns are used in parallel, but all on the face of the switch, so as to obtain a large heat-dissipating surface. Special attention is drawn to the low price at which rheostats of the type in question can be manufactured.

### Accumulator Acid.

Messrs. F. W. Berk and Co., Limited, 1, Fenchurch-avenue, London, E.C., inform us that they have now registered their special accumulator acid as B. A. A. This acid is manufactured expressly for use in electrical batteries. It is made from the best Sicilian brimstone and distilled water, and is tested for chlorides, nitrates, lead, iron, and any other impurities before leaving the factory. Moreover, Messrs. Berk and Co., Limited, supply it in a concentrated form, or broken down to any degree of strength. We need not dwell here upon the importance of using suitable acid where electrical accumulators are concerned.

### Catalogues, etc., Received.

SIEMENS'S PUBLICATIONS.—Leaflet 560 just published by Messrs. Siemens Bros. and Co., Limited, York-mansion, York-street, Westminster, S.W., gives the outputs, weights, and dimensions of the firm's open-type G motors and new pattern G A motors, protected, ventilated-enclosed and fully-enclosed, the range being from 40 b.h.p. to 150 b.h.p. Specification 6A describes these G A motors.

ALTERNATING-CURRENT MOTORS.—List No. 4 (Section A) just issued by the Electrical Company, Limited, 121-125, Charing Cross-road, London, W.C., describes the firm's single, two, and three phase motors. These motors are of the semi-enclosed (protected), ventilated-enclosed, or totally-enclosed type, the windings and moving parts being well protected in all types from injury or accidental contact. They have been designed to meet the demand for motors occupying small space, of light weight, and possessing a large overload capacity, together with high efficiency, large starting torque, high power factor and low temperature rise. A special feature is the comparative small diameter of the rotor, in consequence of which its inertia is reduced to a minimum. Special consideration has also been given to the reduction of waste power by bearing and slip-ring friction, as well as to absolute safety to attendants with motors wound for high pressures.

D.C. VARIABLE-SPEED MOTORS.—Messrs. Vickers, Sons, and Maxim, Limited, River Don Works, Sheffield, have just issued section No. 2 of their new D.C. catalogue, containing prices and particulars of continuous-current variable-speed motors. The Vickers variable-speed motor is a specially constructed shunt machine, which will give on a single voltage the full power through a range of speed of 3 to 1, or even up to 6 to 1, if necessary, by shunt regulation. The motor runs with sparkless commutation at all speeds, and the efficiency is as high as that of an ordinary well-designed constant-speed motor. At the slow speed the starting torque is very high. Up to date upwards of 350 motors of this type have been made by the firm, in sizes from 2½ b.h.p. up to 90 b.h.p. The first of them were applied to a number of machine tools in 1897. Thus they have been thoroughly well tried.

## PERSONAL.

In view of his retirement on the 30th inst. as engineer and general manager of the Brighton Corporation tramways to take up the position as general manager to the Hastings and District Tramways Company, Mr. T. B. Holliday has been presented with a handsome silver bowl.

The Brighton Town Council have appointed Mr. Christie engineer and manager of the electricity undertaking in succession to Mr. Arthur Wright.

Mr. Lambert, the electric lighting engineer of Perth, has been appointed general manager of the electric tramways at a salary of £350, £75 of which is to be paid by the Tramway Committee.

We are asked to state that one of the directors of Messrs. Harris, Lee, and Co., Limited, Johannesburg, S.A. (Mr. H. M. Harris), will be in London at the beginning of next month, and can be seen by appointment at 165, Queen Victoria-street, E.C.

The Reason Manufacturing Company, Limited, have appointed Mr. F. Barnes Spencer, M.I E.E. (late sales manager to Messrs. Ferranti Limited) as their contract manager. Mr. Spencer, who is shortly visiting the United States, will take up the appointment about the beginning of June next.

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## A NEW DYNAMO.*

At a recent meeting of the Elektrotechnischer Verein Prof. E Rosenberg described in detail a novel and ingenious dynamo designed by him for the lighting of railway carriages. Numerous machines of this type have already been made, and tried in actual work, and many more of various sizes are on order for the Prussian State railways, the Bavarian State railways, the Bagdad Railway, etc., and there is no doubt as to the suitability of the machine for the work.

As is well known, the chief requirement for a successful railway lighting dynamo for use either with or without accumulators, and suitable for driving from the car axle, is the production of a practically constant uni-directional voltage (current), in spite of very wide variations of speed in either direction of rotation. Once this is attained it is possible to carry out the lighting whilst the train is running from the dynamo and accumulators in parallel, and whilst the train is at rest at a station the accumulators alone would do the work. In this way, by adjusting the dynamo current once for all, it would be possible to arrange for the cells when in parallel with the dynamo to act simply as a steadying adjunct, and to receive, on the whole, a greater charging than discharging current, and so remain as fully charged at the end of the day as at the beginning. The ordinary shunt, series, or compound dynamo is, of course, quite unsuitable for such work, and the difficulty has, up to the present, been met either by the employment of complicated differential windings or by the use of special mechanical or electromechanical devices for neutralising

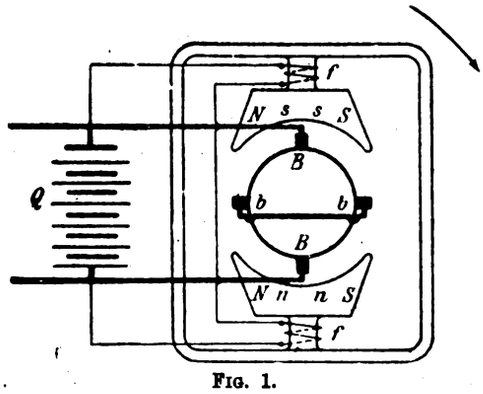


FIG. 1.

the effect of the variable axle speed—*e g*, by means of a belt or friction gear arranged to slip when the speed exceeds a fixed value. These systems can, however, only be made really automatic by the use of complicated relays and the like, and on this account cannot be considered satisfactory.

The dynamo now described is designed to avoid the use of all additional apparatus except the ordinary shunt regulating resistance, and when used with accumulators, some simple form of non-return apparatus, such as an aluminium cell, to prevent the battery sending current back through the machine when the train is at rest. Fig 1 shows the arrangement of the new machine diagrammatically. It will be seen that the chief differences from an ordinary dynamo consist in the addition of two extra sets of brushes short-circuited together and set at right angles to the main brushes, and in the proportion of pole-face area to magnet-core area. The diagram shows a two-pole machine, though the arrangement is equally applicable to multipolar ones. The armature employed differs in no way from an ordinary armature. In an ordinary dynamo the cross field set up by the armature ampere-turn at practically 90deg. to the main magnet field is found objectionable on account of its distortion of the main field, and it is suppressed, as far as possible, by saturating the pole tips, etc, but in this new machine the cross field fulfils an important function in the regulation of the output.

The machine is self-exciting, just like any shunt dynamo, but it will be simpler to consider it as connected in parallel with a battery (Fig. 1), as it would usually be when used for train-lighting. The battery sends a certain current round the exciting winding, *f f*, and produces what may be called the "original flux," shown by the small letters *s s* and *n n*, through the armature in the vertical direction. This flux produces no effect on the main (vertical) brushes because the volts induced in the different quadrants neutralise one another, but it induces a voltage between the short-circuited brushes, *b b*, and causes a current to flow through the short-circuit. This current sets up a cross flux of its own in the horizontal direction, passing from the armature into the air, through the pole-pieces back into the air and the armature, as shown by the large letters, S S and N N. This flux actually combines and forms a resultant field with the original flux, weakening the leading pole-tips and strengthening the trailing ones, but for all practical purposes the two fluxes may be considered as existing separately.

Now, the horizontal cross flux is relatively to the main (vertical) brushes in the position of the main flux in an ordinary dynamo, and consequently induces a definite voltage between these brushes. This voltage will pass a certain current through the external resistance (battery or lamps) connected to the main brushes, and this current tends to set up a vertical cross field directly opposing the original flux, *s s*, *n n*. Any reduction of this original flux, however, leads to a reduction in the short-circuit current in the horizontal cross flux, and consequently in the voltage and current of the main brushes. For every value of the ampere-turns in the coils, *f f*, there is a definite external current, and this current is always somewhat less than the current which makes the vertical (main brush) cross field ampere-turns equal to the ampere-turns in the coils, *f f*, for when this equality exists there can be no "original flux,"

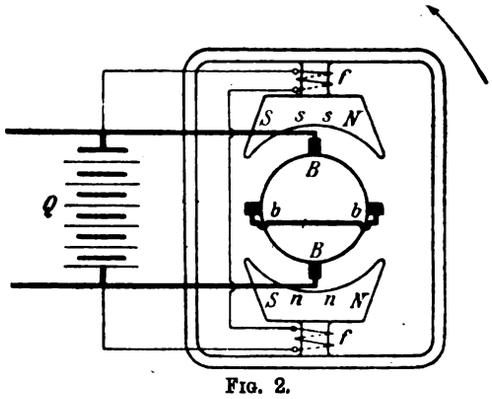


FIG. 2.

no current through the short-circuited brushes, no main (horizontal) flux, and no voltage induced between the main brushes. The external current will, in fact, always attain such a value A that the vertical flux, *s s*, *n n*, set up by the difference in ampere-turns between the exciting coils, *f f*, and the vertical cross ampere-turns due to current A will generate a short-circuit current through the horizontal brushes capable of setting up that particular value of main horizontal flux which, at the speed at which the dynamo happens to be running, and with the external resistance which happens to be across the main brushes, will produce an external current A.

The effect of reversing the direction of rotation of the machine is shown in Fig. 2. The "original flux" remains unchanged; the current in the short-circuited brushes, therefore, becomes reversed; the main (horizontal) flux consequently also reverses, and this, in combination with the reversed rotation, keeps the main external current unchanged in direction. A little consideration will show that, since the horizontal brushes are short-circuited, only a very small vertical flux would be required to produce even full-load current through the short-circuit. In the machines actually constructed it is found that at normal speed a short-circuit current equal to about 40 per cent. of the useful output current is sufficient to set up the required main flux, and in order to produce this 40 per cent. short-circuit current the ampere-turns in the coils, *f f*, have only to exceed the vertical armature ampere-turns due to the useful external current by about 10 per cent. If, therefore, the speed increases to double the normal or even to an infinite value, the utmost that can happen is the increase of the external current by something less than

* *Elektrotechnische Zeitschrift*, April 20, 1905.

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10 per cent., for with a 10 per cent. increase the original flux would be entirely neutralised, and the whole action of the machine would come to an end. If, on the other hand, the speed fall to, say, 70 per cent. of its normal value, the external current tends to fall, but should it fall even as little as 10 per cent., the original flux would be immediately doubled, and this, in spite of the lower speed, would produce about 40 per cent. more current through the short-circuited brushes, and would increase the main (horizontal) flux sufficiently to compensate almost exactly for the drop in speed and leave the external current almost unchanged. The fact that the compensation for speed depends on the differential action of two almost equal quantities in this way, is the chief reason for the very exact automatic regulation obtainable with these machines.

The connection between external current and speed for one of these machines working in parallel with a battery—

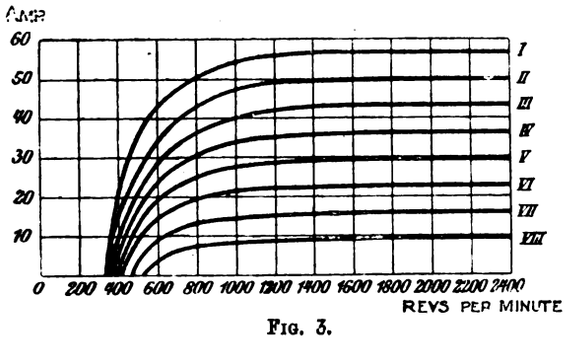


FIG. 3.

*i e*, with constant external voltage—is shown by Fig. 3. The various curves indicate the results obtained with various values of the exciting current in the coils, *f f*. Curve I. represents maximum excitation, and shows that at a low speed of about 340 revolutions (9¼ miles per hour) the terminal volts of the machine become equal to the battery volts, and that the current delivered by the machine rises rapidly with increase in speed from this point. By the time that 700 revolutions (19 miles per hour) is reached the bend in the curve is practically passed, and from there onwards the curve runs asymptotically towards a definite limiting current. Thus a change of speed from 2,400 to 800 revolutions per minute (65 to 21½ miles per hour train speed) only produces a drop in current of about 12 per cent. If the excitation of coils, *f f*, is reduced by varying the field regulating resistances, such curves as those marked II. to VIII. are obtained. At half excitation (Curve V.) the speed at which the battery voltage is reached is only slightly higher than before (390

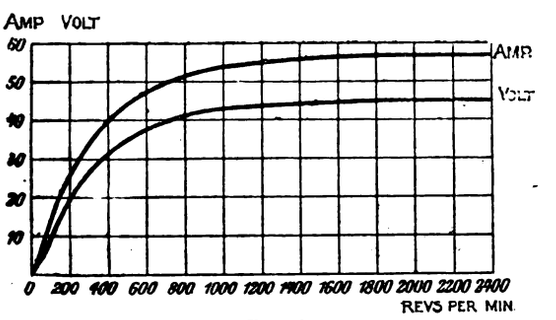


FIG. 4.

instead of 340), and the limiting value of the external current is almost exactly half that with full excitation. If the machine works direct on to a constant external resistance instead of on to a battery, the curves of volts and amperes for a given exciting current are as shown in Fig. 4. Here the curves naturally start from zero, but after a speed of 600 or 700 revolutions is reached the current curve takes almost exactly the same form as the corresponding curve in Fig. 3. When working on incandescent lamps, the effect of speed variations is even less noticeable, owing to the fall in the resistance of the lamps as they get hot. Fig. 5 shows the way in which the current through the short-circuited brushes varies with the speed. It will be seen that at low speeds (when, of course, the useful output current, which neutralises more or less of the original flux, falls off) the short-circuit current rises rapidly. In order to prevent the possibility of the short-circuit current under any circumstances reaching a dangerous value, it is found advisable to let the iron of the magnet yoke or core become saturated when the flux reaches a value corresponding to the maximum safe short-circuit current. Then, if the speed falls still lower than that corresponding to this point, the short-circuit current will decrease again, and the voltage of the machine will fall below that of the battery. In order to prevent a reversed current being sent from the battery through the machine in these circumstances, an aluminium cell is inserted between the two.

Another interesting curve in connection with this machine is given in Fig. 6. This shows the ordinary load characteristic (with constant separate excitation of the coils, *ff*) taken at constant speed, and with variable external resistance. The normal load would occur at about the

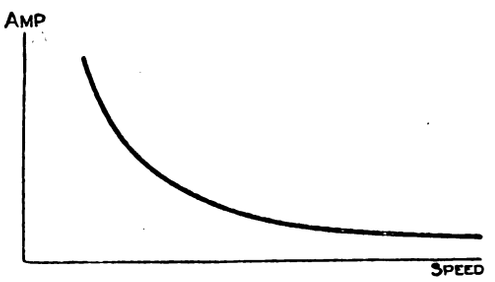


FIG. 5.

point *m*. If the machine were short-circuited the current would only rise slightly, whilst if the external resistance is increased the voltage rises rapidly in attempting to maintain a constant current. The current, however, does gradually fall off in spite of the fact that by the time open circuit is reached the terminal voltage will have risen to several times the normal value. At the same time the current through the short-circuited brushes rises correspondingly. Such a machine, therefore, needs no protection against damage through short-circuiting, but must be safeguarded against the opening of the external circuit. This can be arranged for by inserting a fuse between the short-circuited brushes.

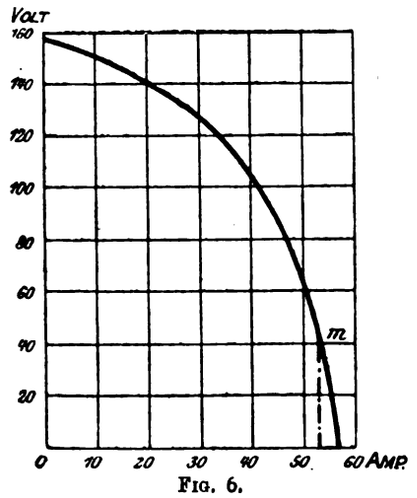


FIG. 6.

Turning next to the question of the size of such a machine as compared with that of an ordinary dynamo for the same output, a little consideration will show that the armature, in spite of the fact that it carries the additional short-circuit current, will not be appreciably affected. For instance, in the above described machine the short-circuit current at normal speed is some 40 per cent. of the useful output current, and this short-circuit current is added to the normal current in two of the quadrants of the armature, but is subtracted from it in the other two quadrants. Calling the useful current 1, the $C^2 R$ losses in an ordinary armature may be represented by 1, whilst with the same armature used in the new way the $C^2 R$ losses would be represented by

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$$\frac{(1\cdot4)^2}{2}+\frac{(\cdot6)^2}{2}=1\cdot16$$

*i.e.*, they would be increased by the same amount as if the current taken from the ordinary armature were increased only some 7½ per cent.—so that if the machine is going to run most of the time at normal or higher speeds no allowance need be made, whilst if it is to run for long periods at low speeds (when the short-circuit current will be correspondingly increased) the copper sections on the armature must be somewhat increased. The commutator must be designed to carry double the usual number of brushes, and, in order to avoid crowding the brushes together too much, the brush rocker is conveniently placed over the centre of the commutator, the main brushes being placed on one side of it and the short-circuited brushes on the other side.

Coming next to the magnets, a decided saving in material is found to result from the new design. The main flux of the machine is set up in the armature, and passes from the armature into the air and the pole-shoes and back again into the armature, so that only the iron of the pole-shoes has to have sufficient section for this flux. The magnet yoke and magnet cores have only to carry the small "original flux" set up by the coils, *f f*, and can, therefore, have an extremely small section. The coils, *f f*, have only to have slightly more ampere-turns than the normal armature ampere-turns, and have only to enclose the small "original flux" iron section, so that only a very small weight of copper is necessary.

There is still the important question of commutation to be investigated. The short-circuited brushes (*b b*, Figs. 1 and 2) are working in a neutral zone, and are no worse off than those of every reversing motor—in fact, they are better off, because, as has been stated, the current to be commutated at these brushes at normal speed is only some 40 per cent. of the normal full load current. Further, the current in these brushes varies almost exactly inversely as the speed, so that the product of commutated current by speed (which determines the reactance voltage) is almost constant, and makes commutation at high and low speeds equally satisfactory. The main brushes (B B, Figs. 1 and 2) are directly opposite the middle of the "original flux" poles, but in the neutral zone of the main flux. Now the "original flux" is always only of such amount as to produce a certain limited current through the resistance of the armature and the short-circuited brushes *b b*, and the separate short-circuiting of certain sections by the brushes B B cannot cause anything more than this limited current to flow. Looked at in another way, the coils, *f f*, may be considered as helping commutation by acting the part of compensating coils, neutralising and rather overpowering the armature ampere-turns due to the main external current, just as in the Deri compensated dynamos. The compensation, however, is not very exact, for, as the external current (the current to be commutated at B B) increases, the amount by which the ampere-turns in *f f* exceed the armature ampere-turns falls off instead of increasing. On this account, as well as to allow for slight want of magnetic symmetry in the main flux, it is found preferable to cut recesses in the pole-faces just opposite the brushes B B, and so let commutation at these brushes take place in a real neutral zone. In this way the brushes B B also work under the same conditions as the brushes of an ordinary reversing motor, and, in practice, they are found to be perfectly sparkless when running in either direction.

As regards efficiency, the new machines compare favourably with ordinary machines of the same output, for the slightly increased commutator losses are neutralised by the reduced magnet winding loss. The efficiency at a given output also remains practically constant over a wide range of speed, for the increased friction losses at the high speeds are counteracted by the reduced short-circuit current loss.

In conclusion, detailed drawings and photographs were exhibited of various machines already completed, including 50-volt, 70-ampere, 240 to 1,200 revolution, four-pole dynamos (see Figs. 7 and 8) and six-pole dynamos for mounting direct on the wheel axle, and suitable for an output of 77 volts 200 amperes at from 165 to 530 revolutions.

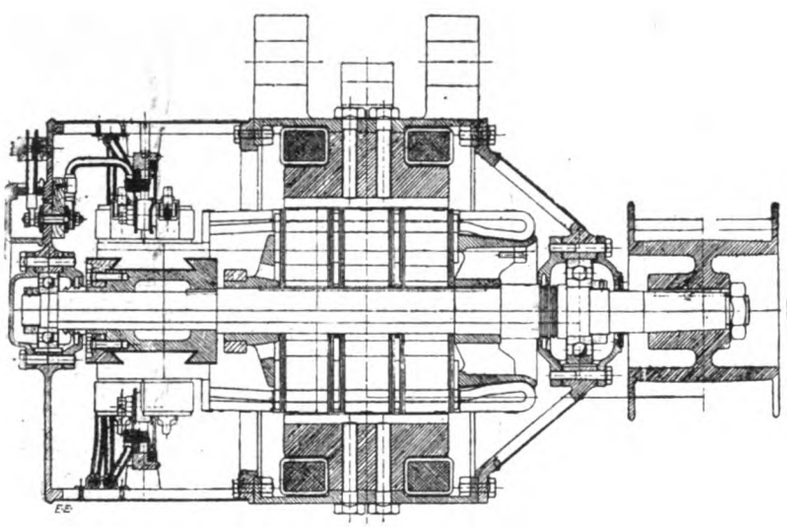

FIG. 7.

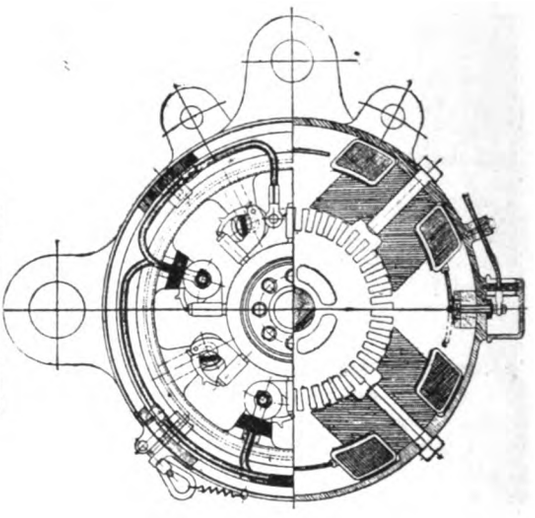

FIG. 8.

## LEGAL INTELLIGENCE.

### FIRES FROM ELECTRIC MAINS.

### Midwood v. Manchester Corporation.

This case, in which Mr. Justice Lawrance and a jury awarded the plaintiffs £677 and costs, and which was reported in our issues of March 24 and 31, was mentioned in the Court of Appeal last week.

Mr. GORDON, on behalf of the Corporation, applied for a stay of execution and also for leave to expedite the hearing of the appeal which the defendants had entered.

The MASTER OF THE ROLLS said that the application must be made to the judge who tried the case.

## COMPANIES' MEETINGS AND REPORTS.

### INDO-EUROPEAN TELEGRAPH.

The ordinary general meeting of this Company was held on Tuesday, Mr. J. Herbert Tritton presiding. Particulars of the report appeared in our issue of the 14th inst.

The CHAIRMAN said that the prospects of receipts for the next financial year were not as satisfactory as the directors could wish, mainly owing to the reductions which were possible in the rates, but he did not think it necessary to take a pessimistic view. The shareholders had been informed at the last general meeting that the Russian section of the line would pass to the Russian Government at the end of 1904. That section had become the property of the Russian Government since Jan. 31 last, and would be formally handed over to the representatives of that Government as soon as the necessary formalities were completed. As some misapprehension seemed to have arisen in that connection, he thought it would be well to mention that under the concession, which would continue until Jan. 31, 1925, the Company had the sole use of the same lines as hitherto, although they were now leased to the Company instead of being its actual property. The transfer of the Russian section from the financial point of view would, of course, be dealt with in the accounts for 1905, and would involve the writing off of the cost of that section, which stood in the balance-sheet at £313,285, against the reserve fund of £446,045. The

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Company was thus entering upon a prolonged concessionary period with its capital absolutely intact, and a list of investments which could stand the most rigorous inspection.

The report was adopted.

## NORTH OF SCOTLAND ELECTRIC LIGHT AND POWER.

The annual general meeting of this Company was held at Montrose last week, Dr. Stone presiding.

The report stated that the lamp connections in Montrose had been increased from 11,670 to 15,130, and in Brechin from 7,359 to 12,081, and up to the present time 1,920 additional lamps had been applied for in Montrose and 2,050 in Brechin, making a total for the two towns of 31,181 equivalent 8-c.p. lamps. The result of the year's trading, including a balance of £469. 15s. 2d. brought forward from the previous year, showed a profit of £2,422. 4s. 9d., which, after paying interest on loans amounting to £1,659. 3s., as against £918 paid in 1903, left a balance of £727. 1s. 9d. available for distribution. The directors recommended a payment of a dividend at the rate of 2½ per cent., which would absorb £293. 12s. 3d., leaving a balance of £433. 9s. 6d. to be carried forward.

The report was adopted.

## KALGOORLIE ELECTRIC TRAMWAYS.

The first annual meeting of this Company was held at Winchester House last week, Mr. A. H. P. Stoneham presiding. Particulars of the report appeared in our issue of the 14th inst.

The CHAIRMAN remarked that, satisfactory as their profits were, they could make much more in the future. They were now paying the Kalgoorlie Electric Power Company 4d. per unit for power, which was a reasonable rate when they entered into the contract, because at that time water was very expensive, and the power company, not believing that the Government water scheme would be successfully carried through, went to enormous expense in erecting condensers. Fortunately for Kalgoorlie the Government water scheme has been successful, and the vast expenditure on condensers had proved to be totally unnecessary, so they were now putting up their own plant, and would get power a great deal cheaper than the power company could afford to supply them. He did not anticipate that the shareholders would be asked for capital.

The accounts were unanimously passed.

## CAPE ELECTRIC TRAMWAYS.

An extraordinary general meeting of this Company was held on the 19th inst. for the purpose of considering the following resolution: "That Mr. Alfred Parrish be and he is hereby removed from the office of director of the Company."

Colonel Sir CHARLES EUAN-SMITH (the chairman of the Company) reviewed the transaction in connection with the Camp's Bay line, which had not turned out so favourably as had been expected. Mr. Parrish, who had not taken a very active part in the Company's business of late, had recently issued, on his own initiative, a circular in which he sought to exonerate himself and to impugn the action of his colleagues, who, under the circumstances, could not co-operate with him any longer.

After some discussion the resolution was put to the meeting and lost on a show of hands. A poll was demanded, which was taken at once.

The poll resulted as follows: in favour of the directors' motion, 291,327 votes; against the motion, 54,711 votes. The motion was then declared to be carried by the requisite majority.

## MARKET DRAYTON ELECTRIC LIGHT AND POWER.

The annual meeting of this Company was held last week, under the presidency of Mr. R. C. Donaldson-Hudson.

Although only a little over two years since the Company commenced, it was shown that during the year the number of lamps connected with the works had increased from 4,759 to 7,161. There was a net profit of £562, which, with the balance of £75 brought forward, gave a total of £630. This it was decided to deal with by writing off £32 from the preliminary expenses, to carry £368 to the reserve fund and renewal account, and the balance of £230 to the next account.

## OSWESTRY ELECTRIC LIGHTING.

The annual meeting of this Company was held on Tuesday, Mr. Wynne Corrie, the chairman, presiding. It was reported that the increase in the receipts continued to be very satisfactory, and that the available balance of profit amounted to £538. After adding £163 to the reserve fund, it was decided to declare a dividend of 4½ per cent.

## ORIENTAL TELEPHONE AND ELECTRIC.

The report for the year ended Dec. 31, 1904, to be presented at the meeting to-day, states that including £1,737 brought forward at Dec. 31, 1903, and after deducting the interim dividends of 3 per cent. paid Nov. 1 on both the preference and ordinary shares and other charges, the amount to be dealt with is £12,422. The directors recommend a final dividend of 3½ per cent. on the ordinary shares, making 6½ per cent. for the year, transferring to reserve account £3,000 leaving to be carried forward £1,721. The Telephone Company of Egypt has been enabled to declare dividends of 7½ per cent. for the past year on both its preferred and deferred shares, which have been included in the accounts of this Company. The Egyptian company has received a further contract from the Government of the Khedive for the installation of an additional batch of provincial telephone lines. At Singapore land has been purchased for new exchange premises, which are now in course of erection. At Maulmain a suitable building has also been purchased for exchange and residential premises. The Indian local companies have paid the same dividends as for 1903. The Bombay Telephone Company's new premises will be completed very shortly. The work of underground cabling its system in the city of Bombay has already commenced. The Government of India having compulsorily acquired the premises in the occupation of the Bengal Telephone Company in Calcutta, the removal of that company's central exchange has become necessary. The Government has granted compensation for this compulsory removal. New and improved switchboards have been ordered, and it is hoped these will be installed during the autumn, by which time it is expected underground cabling operations will also be in progress. In Rangoon, Maulmain, and Madras the work will be commenced within the next 12 months. The China and Japan Telephone and Electric Company has received a license from the Hong-Kong Government for a term of 25 years. The system there will now be thoroughly overhauled and reconstructed with underground and overhead cables. The business at Hong-Kong is progressing very favourably.

## BRITISH COLUMBIA ELECTRIC RAILWAY.

An extraordinary general meeting of this Company was held at Winchester House on the 19th inst., Mr. R. M. Horne-Payne presiding, to approve an agreement providing for the electrification and operation by this Company of the railway line from the city of Vancouver to Steveston, Lulu Island, to increase the capital to £1,000,000 by the creation of 150,000 new shares of £1 each, and to adopt new regulations.

Confirmatory resolutions were unanimously adopted.

## CALCUTTA ELECTRIC SUPPLY.

The report for the year 1904 states that the number of units of electrical energy sold during the year was 2,760,457, compared with 2,044,681 for the preceding year, an increase of 35 per cent. The gross revenue from all sources amounted to £60,243, compared with £47,139, an increase of 27¾ per cent. The working costs, including provision for renewals, were £30,744, compared with £25,552, an increase of 20 per cent., and the net revenue £29,499, compared with £21,587, an increase of 36½ per cent. The directors, in view of the capital outlay, have increased the amount set aside for renewals fund account to £11,000, which is £2,500 over the amount set aside in the preceding year. Of the sum so provided, £4,092 has been expended in repairs and renewals, and £370 has been written off, leaving a balance of £21,815 carried forward as a reserve for renewals. During the year the directors made a further issue of 20,000 shares of £5 each at a premium of £1 per share. The premiums, less the cost of issue, have been added to the reserve fund, which now stands at £54,592. The available balance of net profit, after deducting the interim dividend paid in November, interest on loans, and income tax, is £21,279, and the directors recommend a final dividend at the rate of 10 per cent. per annum for the half-year, making 8 per cent. for the year, and the balance of £4,720 is carried forward.

## RAND CENTRAL ELECTRIC WORKS.

The report for 1904 shows a gross profit of £48,450, and after providing £16,670 for depreciation, there remains a balance of £31,780. From this has to be deducted the balance standing to the debit of profit and loss account, as at the end of 1903, of £11,947, and £307 balance of royalty due to the Transvaal Government under the concession, leaving a net balance of £19,525. Out of this the directors recommend a dividend of 5 per cent. per annum, carrying forward £4,525 to the new account. The power supplied during the year has yielded a revenue which exceeds that of the preceding year by £24,305, and, as a result, the working profit, before deducting the sum allocated to depreciation, amounts to £48,450, as compared with £28,540 for 1903. The receipts derived from the supply of power and rent of plant aggregated £94,818, against £70,513 for the year 1903. Interest on deposits and profit on exchange, etc., have further increased the revenue by £1,361, bringing up the gross receipts for the year to the sum of £96,179.

## WOKING ELECTRIC SUPPLY.

The report for the year ending Dec. 31, 1904, states that the total revenue was £10,356. 16s. 7d., and the expenditure connected with the generation and distribution of electricity and management amounted to £6,031. 18s., leaving a balance of £4,324. 18s. 7d., to which has been added £785. 0s. 7d., the amount brought forward from last year, making a total of £5,109. 19s. 2d. The directors propose to appropriate this as follows; payment of interest on the 4½ per cent. debentures £1,074. 15s. 1d., payment of interest on temporary loans £215. 6s. 6d., payment of dividend on the 6 per cent. cumulative preference shares to Dec. 31, 1904 (six months to June 30, 1904, having been paid on Oct. 1, 1904), £1,332. 7s. 2d., payment of a dividend of 5 per cent. per annum on the ordinary shares £771. 18s. 7d., to depreciation fund account £1,000, leaving a balance to be carried forward to the credit of profit and loss account of £715. 11s. 10d. The following table will show the rate at which the Company's business has progressed during the last four years: 1901, number of consumers 417, lamps connected 15,090, revenue £4,466. 15s.; 1902—543, 19,566, £6,276. 2s. 5d.; 1903—660, 25,010, £7,951. 15s. 10d.; 1904—783, 29,566, £10,340. 19s. During the year 123 new consumers were obtained.

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## EASTERN EXTENSION TELEGRAPH.

The report for the half-year ended Dec. 31, 1904, to be submitted to the meeting on the 3rd proximo, states that the gross receipts have amounted to £331,788, against £265,259 for the corresponding half-year of 1903. Working expenses, including £35,471 for maintenance of cables, absorb £150,035, against £142,419 for the corresponding period of 1903, leaving a balance of £181,753. From this is deducted £2,793 for income tax, and £12,048 for interest on mortgage debenture stock, leaving a net profit for the half-year of £166,911. After adding £110,270 brought forward from the previous half-year there is an available balance of £277,181. One quarterly interim dividend of 1½ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1904. The sum of £120,000 has been transferred to the general reserve fund, leaving £22,181 to be carried forward. Since the close of the financial year the capital account has been increased by a further issue of £150,000 of 4 per cent. mortgage debenture stock, thus making the total issue to date £752,400.

## BATH ELECTRIC TRAMWAYS.

The directors state that during the year 1904 the construction of the system originally contemplated under the Company's light railway order was continued, and sections of the line were opened from time to time, until, on Aug. 1 last, the final section was opened for traffic. A further order, acquired in the latter part of 1903, in connection with the extension over the Midland Railway, and known as the Midland bridge route, is still in course of construction. In November, 1904, powers were sought from the Board of Trade for the construction of two additional lines, one of which—the extension to Newton St. Loe about 1 mile 5 furlongs 9 chains in length—was authorised by the Light Railway Commissioners. The capital account of the Company shows an expenditure to Dec. 31, 1904, of £302,545, which includes, under the advice of counsel, the cost of registration and formation, all management of the Company prior to opening for traffic, and the expenses of loans, etc., raised for capital purposes. The traffic receipts for the year 1904 amounted to £33,161, which must be regarded as satisfactory, especially as in the earlier part of the year the Company was operating, under difficult conditions, only a portion of its system. After charging operating and administration expenses, there remains a balance of £11,250, from which must be deducted interest accrued on the 4½ per cent. debenture stock £737, and dividend on the preference shares to Dec. 31, 1903, paid Dec. 29, 1904, leaving a balance of £7,670. Out of this the directors recommend the payment of a dividend at the rate of 5 per cent. per annum upon the preference shares to Dec. 31, 1904, which will absorb a sum of £3,750, leaving to be carried forward £3,920.

## RIVER PLATE ELECTRICITY.

The report for 1904 states that the net revenue for the year, after providing debenture interest, writing off depreciations and the balance of preliminary expenses, amounts to £10,436. To this must be added £2,829 carried over from last year, making an available balance of £13,265. The directors recommend the payment of the year's dividend upon the 6 per cent. preference shares, that £4,000 be placed to a contingency fund, and that the balance of £3,265 be carried forward. The accounts might have permitted a distribution on the ordinary shares, but the Board are of the opinion that, pending the reconstruction of the Company's stations now in progress, it is in the best interests of the shareholders that they should carefully husband their resources. During the year the transfer of the Buenos Ayres property to the German Trans-Oceanic Electric Company of Berlin has been formally completed. The agreement between the Company and the Government of the province of Buenos Ayres for the acquisition by the Company of the Government's interest in the La Plata station and for the extension of the public lighting contract, having been approved by the Chamber of Deputies and the Senate, has been executed by the governor of the province. The Board have sanctioned the erection of a new and enlarged station upon the site acquired. It is hoped that the new station will be in operation and the transfer over from the existing station substantially complete within 15 months. Important improvements and extensions have also been authorised at Tucuman, the works in connection with which have already made some progress.

## COVENTRY ELECTRIC TRAMWAYS.

The report for 1904, to be presented at the meeting to-day, states that the net earnings for the year have amounted to £3,410, a decrease of £1,232, as shown by the following figures: gross earnings, £15,981, a decrease of £892; cost of operation, £12,571, an increase of £340. After allowing £1,190 for interest paid on the £34,000 mortgage bonds, a balance remains of £2,220, which, added to the sum of £1,373 brought forward from last year, makes a total of £3,593 available for distribution. The directors recommend a dividend of 2 per cent. for the year on the amounts paid up on the share capital, and that £500 be placed to reserve. This will absorb £2,846, leaving a balance of £647 to be carried forward. The decrease in earnings above referred to is entirely owing to the unavoidable loss of traffic and disorganisation of the tramway service caused by the reconstruction of the portion of the system referred to in last year's report. Those works were commenced in October, 1904, and the reconstruction of the tracks within the city boundary was completed in February last, whilst the extensions to Earlsdon and Chapel Fields authorised by the Act of 1903 were completed and came into operation on March 22, 1905. There only remains the reconstruction of a portion of the line from Foleshill to Bedworth, and it is expected that through traffic on that route will be resumed about the end of May.

## KALGOORLIE ELECTRIC POWER AND LIGHTING.

The report for 1904, to be submitted at the meeting on the 3rd proximo, states that contracts for power have been made during the period under review with several of the largest gold-mining companies, the full benefit from which will not be derived, however, for a few months, pending completion of the erection of the machinery ordered by them. Considering the amount of power to be taken under these contracts, and the extensions to the northern end of the field which are in progress, it is evident that the load factor of the plant will be much improved. The profit on working for the year—namely, £18,334—is nearly 100 per cent. above that of the previous year. After paying debenture interest and London expenses, the directors propose to carry to reserve for depreciation £6,750, writing off the balance of preliminary expenses £5,487, and the cost of issuing debentures £344, making provision for the premium payable on redemption of debentures £660, and carrying forward £812. The whole of the bank overdraft and bills of acceptance, amounting in the last balance-sheet to £13,651, has been paid off, and at Dec. 31 last there was a cash balance of £4,713. Although the plant is efficiently maintained out of revenue, the directors have deemed it advisable to establish a reserve against depreciation, which, with the contingency fund of £1,000, gives a total on reserve accounts of £7,750.

## AUCKLAND ELECTRIC TRAMWAYS.

The report for 1904, to be presented at the meeting on the 1st prox., states that during the year £85,100 debenture stock has been disposed of, and the issued share and debenture capital now amounts to £585,100. The total capital expenditure during the year amounted to £63,951. Traffic receipts for the year amounted to £110,573, as compared with £81,772 for the previous year, and the total revenue to £112,429. After deducting all expenses chargeable to revenue, including £12,235 for debenture and other interest, £2,521 for rental and percentage of profits payable to the Auckland City Council, and £4,658 balance of expenditure in connection with the Kingaland accident, there remains a profit of £26,275, which, added to £2,323 brought forward from the previous account, makes £28,598 available for distribution. The directors recommend that there should be reserved to meet depreciation £7,500, and after paying a dividend at the rate of 6 per cent. per annum, there remains to be carried forward £3,098. The depreciation and reserve fund will then stand at £18,050. Since the date of the last report the system has been extended by the completion of a further 1·44 route miles, which were opened for traffic on Aug. 24, making the total length of the Company's lines at present under operation 18·64 miles. It is intended to immediately construct a further extension of 0·57 mile, which will complete the system as at present determined upon. The Company has been approached by various local authorities in the vicinity of Auckland with a view to the extension of the Company's system into their districts, and these proposals are receiving the careful consideration of the Board. The serious accident which occurred on Dec. 24, 1903, involved the Company in an expenditure of £8,658 in excess of the amount covered by insurance. To meet this £4,000 has been provided by the utilisation of the amount set aside out of the revenue in 1903 for contingency provision account, the balance being debited to profit and loss account for 1904. To meet improving traffics the rolling stock has been increased to 55 by the purchase of 12 additional passenger cars; only four of these were available up to the end of the year. An additional 600-kw. set has been installed in the Company's generating station, which is now capable of an output of 1,525 kw. The resolution of the Auckland City Council extending the Company's tenure of the lines in their district until June 1, 1932, has been confirmed by the ratepayers and embodied in a further deed of delegation dated May 18, 1904.

## NEW COMPANIES REGISTERED.

**Richardson Electrical Company, Limited.**—Capital, £2,500. Objects: to carry on the business of electrical, gas, and mechanical engineers, electricians, suppliers of electricity, etc. Registered office: 16, Dorset-street, Baker-street, W.

**Edinburgh Suburban Electric Tramways Syndicate, Limited** Capital, £10,000. Objects: to construct, lease, or otherwise acquire, equip, maintain, and work by electricity, steam, horse, or other power tramways between any part of Edinburgh or Leith and any places within the counties of Midlothian, East Lothian, and West Lothian, etc. Registered office: 45, Victoria-road, Seacombe, Cheshire.

**Dundee, Broughty Ferry, and District Tramways Company, Limited.**—Capital, £90,000. Objects: to purchase or otherwise acquire the control of the statutory rights and powers under the Dundee, Broughty Ferry, and District Tramways Order (Confirmation Act) for the construction and working of certain tramways in the county of Forfar, and to construct and maintain any tramways or railways in the United Kingdom or elsewhere.

**Wandsworth Electrical Manufacturing Company, Limited.**—Capital, £4,000. Objects: to acquire the business of electrical manufacturers carried on by E. T. Davies, A. Reynolds, F. J. Ritchie, A. B. Smith, M. H. Galsworthy, and S. S. Galsworthy, trading at 9, St. Paul's-square, Birmingham, as the Wandsworth Electrical Manufacturing Company, and to carry on the business of art metal workers, manufacturers of and dealers in all kinds of electrical fittings and

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accessories, electricians, engineers, suppliers of electricity for light, heat, motive power, and other purposes, etc. Registered office: 9, St. Paul's-square, Birmingham.

### Liens Registered.

**Auto-Electric Rifle and Target Company, Limited, London, W.** Lien registered April 11 for £100 7 per cent. debentures, part of £5,000; amount previously issued, £2,700; no trustees; charged on the undertaking and all the property, present and future.

**Yorkshire Electric Tramways Construction Syndicate, Limited.**—A debenture, dated March 24, 1905, to secure £50,000 has been registered. Property charged: the company's undertaking and property, present and future, including uncalled capital (if any), subject to a debenture dated July 22, 1904, for securing £70,000. Holder: H. S. Leon, Bletchley Park, Bucks.

**Kidderminster and District Electric Lighting and Traction Company, Limited.**—A trust deed, dated April 5, 1905, to secure £30,000 debenture stock (with power to issue further debenture stock, ranking *pari passu*, up to a total amount not exceeding the issued capital for the time being) has been registered. Property charged: the company's undertaking and property, present and future. Trustees: E. Garcke, Litton House, near Maidenhead; and C. S. B. Hilton, 41, Roland-gardens, Kensington.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Portsmouth.**—The Council require annual stores for tramways. Tenders by May 1.

**Edinburgh.**—The Corporation invite tenders for water-tube boilers. Tenders by May 8.

**Dublin.**—The Port and Docks Board invite tenders for an electric generating station. Tenders by May 15.

**Bournemouth.**—The Town Council invite tenders for Contract No. 6—11 electric cars. Tenders by 29th inst.

**Cataquoxes (Spain).** — The local light and power company require tenders for electrical plant. Tenders by July 1.

**Montreal.**—The Montreal Water and Power Company, 107, St. James-street, require tenders for machinery for a pumping station.

**Johannesburg.**—The time for sending in tenders for this contract (particulars of which appeared in former issues) is May 8 (London).

**Hull.**—The Trustees of the William-street Primitive Methodist Chapel invite tenders for lighting premises by electricity. Tenders by April 29.

**Baeza (Spain).**—The Municipality require tenders for supply and maintenance for 10 years (from Aug. 4) of public electric lighting. Tenders by May 3.

**Paris.**—The Colonial Office, 4 bis, Rue Jean-Nicot, require tenders for the supply of lamps and lighting accessories for three years. Tenders by May 23.

**Glasgow.**—The Corporation invite tenders for the electric light wiring and fittings complete required in connection with the reception house in Braid-street. Tenders by May 1.

**Cork.**—The Cork Electric Tramways and Lighting Company, Limited, invite tenders for the supply of white wood casing and capping. See advertisement.

**Liria.**—The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

**Dax (Province of Landes, France).**—The Municipality require tenders for their concession to erect and work electric lighting for 35 years. Tenders to the Mayor by May 14.

**French West Africa.**—The Governor-General of French West Africa, at Dakar, requires tenders for the erection and equipment of a central station at that place. Tenders by May 15.

**Laventhem (Belgium).**—The Municipality require tenders for erection of central station, laying of mains, etc. Particulars (3s. 4d.) may be obtained from the Secretary of the Mayor of that place.

**Bournemouth.**—Tenders are invited for the following, for the Corporation Tramways (Christchurch extension): Contract No. 5—feeder cables, troughing, excavation, etc. Tenders by April 29.

**Wimbledon.**—The Urban District Council invite tenders for the supply and erection of a 1,000-kw. steam-driven turbo-alternator, with condensing plant, high-tension switchgear, and pipework. Tenders by April 28.

**Antwerp.**—Tenders will shortly be invited by the Belgian State Railways for the installation of electric light in their local railway station. Specification No. 619 may be obtained from the Government Railways Office, Brussels.

**Bristol.**—The Docks Committee invite tenders for the construction, delivery, erecting in place, fitting, testing, and maintenance for 12 months after completion of two electric goods lifts and one electric passenger lift. Tenders by May 1.

**London.**—The London County Council invite tenders for the supply, erection at its generating station, East Greenwich, S.E., and maintenance for a period of 10 years, of a battery of 280 accumulator cells having capacities of 645 ampere-hours at a three-hour discharge rate and of 450 ampere-hours at a one-hour discharge rate. Tenders by May 16. Full particulars in advertisement columns.

**Switzerland.**—M. R. Vontobel, of Winterthour, and M. Charles Probst, of Lucerne, have obtained a concession for the construction of a narrow-gauge electric railway from Meiringen to Gletsch. The total cost of the enterprise is estimated at £241,600; £19,600 is to be expended on rolling-stock.

**Irvine (Scotland).**—The Corporation invite tenders for the supply and erection of the following plant: (Contract 1) buildings; (Contract 2) power-house plant—(Section A) suction gas plant, gas-engines, and generators; (B) balancers and boosters; (C) battery of accumulators; (D) switchboard; (E) crane; (Contract 3) mains—(Section A) cables, trenches, etc.; (B) converting street lamps; (C) meters. Tenders by May 15.

**London, N.**—Tenders are invited for the road work, platelaying, and paving, etc., required for the construction for electrical traction on the overhead trolley system of the short length, equivalent to about three-fourths of a mile of single track, of authorised tramway in Archway-road, Highgate, between the Archway Tavern and the Highgate Archway, in the metropolitan borough of Islington, for the London County Council. Tenders by May 8.

### RESULTS OF TENDERS.

**Croydon.**—The County Council have accepted the tender of W. Cory and Son for the supply of coal to the electricity works.

**Hull.**—The Telephones Committee have accepted the tender of the Electrical Company, Charing Cross-road, London, at £3,374. 4s. 4d., for the supply of cables required for extensions.

**Morecambe.**—The Town Council have accepted the tender of C. Lindley and Co. for blowers for the electricity works, and instructed the engineer to carry out the work at a cost of £50.

**Barrow-in-Furness.**—The Corporation have accepted the tender of W. Gradwell and Co., Barrow-in-Furness, at £4,271. 8s., for erection and completion of extensions to the electricity works, Buccleuch-street.

**Liverpool.**—The Mersey Docks and Harbour Board have accepted the tender of the Electrical Company for the supply and erection of arc lamps, posts, cables, etc., required for lighting the entrance to Sandon Dock, the north and south passages to Huskinson Dock, and the Huskinson Dock and branches.

**Pontypridd.**—The Directors of the Great Western Collieries have accepted the tender of the Electrical Company, Limited, for the electrification of their Penhriw colliery and the supply of the following materials: high-tension transmission lines, sub-station equipment, switchboards, power and lighting transformers, motors for electric haulages and dip pumps, motor-generator, and motor-driven high-lift centrifugal pump.

**Woolwich.**—The Council have received the following tenders for lighting the union infirmary and nurses' home, etc., by electricity:

| | | | |
|---|---|---|---|
| Barlow and Young | £1,983 | 0 | 0 |
| A. H. Marshall | 1,500 | 0 | 0 |
| Bosz | 1,250 | 0 | 0 |
| J. C. Berry | 1,194 | 0 | 0 |
| Bean Company | 1,154 | 14 | 0 |
| Lightfoot | 1,027 | 15 | 0 |
| National Electrical Construction Company | 998 | 0 | 0 |
| Woolwich Borough Council | 892 | 16 | 0 |
| Lea, Son, and Co. | 845 | 0 | 0 |
| A. H. Wood | 817 | 0 | 0 |
| Clements, Booker, and Co. | 747 | 15 | 0 |

## BUSINESS NOTES.

### TRACTION.

**Salford.**—The route from Heaton Park to Bury, linking up the two towns, was opened last week.

**Leith.**—A recent *plébiscite* shows the inhabitants to favour Sunday running by a majority of two to one.

**Tyneside Tramways.**—The extension from Front street, Whitley Bay to the Links has been opened for traffic.

**Exeter.**—Major Pringle last week inspected and approved on behalf of the Board of Trade the St. Thomas and Heavitree sections.

**Dartford.**—The contractors, Messrs. J. G. White and Co., expect to commence the construction of this tramway system in a few weeks.

**Gorton.**—The Urban District Council publish formal notice of the provisional order for the construction of tramways just issued by the Board of Trade.

**Luton.**—The Corporation have published the statutory notice of the grant of a provisional order by the Board of Trade for the construction of tramways.

**Erith.**—The consulting engineers reported at last week's meeting of the Urban District Council that satisfactory progress is being made with the construction of the track.

**Aberavon.**—The Aberavon District Tramways Syndicate publish formal notice of the provisional order for the construction of tramways just issued by the Board of Trade.

**Sunderland.**—New offices and headquarters, erected at a cost of £6,000, for the Corporation tramways were opened last week. A recreation room for the employés and a reading-room are included.

**Perth.**—The tramway reconstruction is progressing. A number of poles for the overhead equipment have been erected in the Glasgow-road, and in the centre of the town the fittings are well advanced.

**Rochdale.**—There is a loss on the year's working—or, rather, non-working—of the Corporation tramways amounting to £8,358. Owing to the work of reconstruction only one or two small sections have been in operation.

**British Electrical Engineering Co.**—The directors propose to pay the full dividend of 6 per cent. on the preference shares, to place £7,000 to the general reserve, to transfer £6,500 to the depreciation reserve, and to carry forward £3,060.

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**Bath.**—At the meeting of the Bath Electric Tramways, Limited, on Wednesday, Sir Vincent Caillard, who presided, said that the directors proposed to introduce a system of motor omnibuses to feed the tramways, as they would be able to penetrate much further into the country than the trams.

**Edinburgh.**—The Dolter Surface-Contact Company have exhibited at Edinburgh a model installation of their system, which was inspected by several members of the Corporation. As various electric lines in and around the city are projected, considerable interest was manifested in the system, especially from the æsthetic point of view.

**Clydesdale.**—It is reported that the engineers representing the Caledonian Railway have been engaged in surveying the Carluke, Orchard, and Crossford districts, with a view to the extension of the Caledonian line into the extensive fruit-producing district of Clydesdale. A tramway extension has also been in contemplation.

**City of Birmingham Tramways Co.**—In their annual report the directors recommend a further dividend of 2½ per cent. and a bonus of 5 per cent., making 10 per cent. for the year, and leaving a balance of £54,007 to be carried to the reserve fund (increasing it to £296,751) to provide for depreciation of assets, redemption of debentures, and for general purposes.

**Parcel Traffic.**—A proposal to develop parcel traffic by car was considered at a meeting of the Dundee Tramway Committee on Tuesday. A suggestion was made that at certain points on the routes shopkeepers and others should be arranged with to take in and receive parcels, and that the department should make provision for their delivery. The manager was instructed to formulate a scheme.

**Chester.**—The annual report for the year ending March 25 gives total receipts, £9,221. 10s. 9d.; average per day, £25. 5s. 3·4d.; receipts per car mile, 8·1d.; passengers, 2,095,518; mileage, 271,718·25; total units used, 251,760; current used per mile, ·92 of a unit. No serious injury to any passenger occurred throughout the year. The rolling-stock has been maintained in good condition.

**Blackpool.**—Colonel Druitt has visited Blackpool on behalf of the Board of Trade, and inspected the double line of electric tramways which the Corporation have constructed along the newly-widened promenade between the north and central piers. With the exception of a small section near to the Hotel Metropole, there is now a double line along the whole length of the promenade from South Shore to the Gynn (three miles).

**Tranent.**—The committee recently appointed at a public meeting in Tranent to act conjointly with the Town Council for the purpose of inducing the National Constructive Electric Tramways Company to stretch their system from Levenhall to Tranent have now finished their canvass. The petitioners for the electric tramway system from Tranent, Elphinston, Ormiston, Macmerry, etc., number over 6,000. These numbers do not include some 2,500 from Wallyford and Drumore.

**Tramways and Light Railways Estates Co.**—The report of the Tramways and Light Railways Estates Company, Limited, for 1904, to be submitted at the meeting to-day, states that the total revenue for the year, including £176 brought forward, amounts to £1,276, and expenses to £847, leaving a credit balance of £429. The directors propose to apply in reduction of goodwill account £100, and after paying a dividend at the rate of 2½ per cent. per annum, there remains to be carried forward £78.

**Easter Traffic.**—Although the clerk of the weather was none too well disposed during the holidays, some of the tramway systems succeeded in beating their records. At Salford the receipts for the week ending Monday amounted to £4,803. 2s., an increase of £98 as compared with the corresponding week last year, and £426. 8s. 3d. over the amount earned during Easter week last year. At Bradford the receipts were nearly £650 in advance of the revenue during Easter last year. For the five days from Good Friday to Easter Tuesday the receipts totalled £4,634, against £3,986.

**Municipal Trams.**—At the eighth annual meeting of Thomas Tilling, Limited, last week, Mr. R. S. Tilling, who presided, continued the attack on municipal trams which his company initiated recently in a circular. It will be remembered that this elicited a spirited reply from the Chairman of the London County Council Highways Committee. After congratulating the shareholders upon the progress of the motor 'bus, Mr. Tilling stated that municipal tramways were instituted for the relief of the rates, and yet in only 12 of the 43 boroughs possessing them was any contribution made to the rates.

**Crowding at Termini.**—The Easter holidays have again illustrated the difficulty that arises, particularly on special occasions, in dealing with tramway traffic at the termini. The queue erected at the Blackfriars termini some two years ago has been found very satisfactory, but the idea has not been generally adopted in the Metropolis. The arrangement of the passengers in queues by means of pens, so that they are kept in position, has answered excellently in the provinces, notably at Sheffield, where it has been in use for several years; and this method seems to provide the rational solution of the problem.

**North Staffordshire Railway Co.**—In order to compete successfully with the electric trams the North Staffordshire Railway Company are establishing a system of steam motor vehicles, which will run on their ordinary rails. At present the service of trains between many of the North Staffordshire towns and colliery districts is very inadequate, and the object is to link up the entire north of the county by a frequent service of these motor trains. The vehicles will stop almost anywhere to pick up and set down passengers. The cars, which are being built in Manchester, have a seating capacity for 40 passengers each, and accommodation for a large quantity of luggage.

**Belfast.**—At an extraordinary general meeting of the Belfast Street Tramways Company last week, the Chairman recapitulated the result of the arbitration, and the directors' scheme for distributing the amount awarded was unanimously agreed to. It is reported that another strike has occurred in connection with the work of reconstruction, the paviors claiming time rates on the ground that sufficient material was not forthcoming to justify piece rates. At the meeting of the Tramways Committee, Mr. Nance, the general manager, said that the present rate of progress of their cars was six miles per hour. He proposed to start the electric cars at eight miles per hour.

**Accidents.**—A fatal accident occurred on the Manchester Corporation tramways on Saturday. A labourer named James Callary was running across Oldham-road when a car knocked him down. Presumably the lifeguard failed to act, as the deceased was stated to have been dragged along for seven or eight yards. When conveyed to the Manchester Royal Infirmary he was suffering from fracture of the skull, and death occurred shortly afterwards. On arriving at the Bradley terminus of the Huddersfield Corporation system on Sunday a driver of one of the trams lost control of the car, which left the rails, and crashed against a wall, finally falling into a garden. The driver jumped from the platform and was seriously injured, and the conductor was also badly hurt, but the only passenger escaped uninjured.

**Bury.**—At the monthly meeting of the Tramway Committee, a letter was read from the Radcliffe District Council asking when the committee would be prepared to go on with the negotiations in connection with the Radcliffe tramways extension to couple up the system with Bolton and Bury by way of Bolton-road. A discussion followed, and it was decided to report to the Town Council that the committee were unanimously of opinion that the Bolton-road extension should be proceeded with, and asking for the instructions of the Council. It was also decided to ask for the instructions of the Council with regard to the extensions of Jericho and Limefield sections to the borough boundaries. It was reported that the Black-lane section would probably be ready for inspection in a fortnight, and that the Dumers-lane section would be ready by Whitsuntide.

**Glasgow.**—A slight obstacle is reported concerning the extension of the tramways from Thornliebank to Barrhead, the parties being the Glasgow Corporation (as the tramway owners) and the Upper District Committee of Renfrewshire (who are the municipal authority in the district affected). The result of previous negotiations between these bodies was recently chronicled in our columns. The extension in question necessitates the rebuilding of Spier's Bridge, Thornliebank, and the District Committee stipulates that the ground for this purpose shall be provided by the Corporation, who will not agree to the request. Meantime a petition has been signed in Thornliebank in favour of the extension, and the volunteers who shoot at the Patterton and Darnley Ranges, which adjoin the proposed new line, are also being asked to adhibit their names. The petition will be presented in a short time to the Tramway Committee. The negotiations between the District Committee and the Paisley Tramways Company have not yet been completed. The company object to doubling the line between Cross Stobbs and Barrhead, and the county authorities insist that this shall be done.

**Heywood.**—At a meeting of the Tramways Committee last week, the suggested agreement with the Bury Corporation for the running of the electric cars between Bury and Heywood was submitted and approved. The terms which have been provisionally accepted by Bury and Heywood are that Heywood shall construct and equip the tramways, which shall be worked by Bury at a charge of 4½d. per car mile, Heywood taking balance of receipts, maintaining the track, and supplying current, while Bury will be responsible for maintenance of overhead equipment. It is understood that in view of the agreement originally arrived at between Bury and Rochdale, the provisional agreement has been submitted to the Rochdale Committee, who, it is expected, will agree to run cars to the Heywood Market-place on similar terms. If, however, Rochdale does not agree to these terms, there is a probability of Bury running cars as far as the Rochdale boundary. An interview has taken place between committees of Heywood and Bury, at which the proposed terms were discussed and a friendly tone prevailed. Apparently there is some hope now that an arrangement will be come to, as both parties seem disposed to take a reasonable view of the position.

**Broughty Ferry.**—An early start is expected to be made with the construction of the Dundee, Broughty Ferry, and District Tramways, which received the Royal assent in August, 1904. Messrs. J. G. White and Co.'s contract includes complete construction and equipment of the permanent way, overhead cars, power-house, car-shed, cables, etc. The price is £68,250. There are 5¼ miles of route, equivalent to 9¾ miles single track. The gauge is standard. The rails are British standard No. 1, 45fc. long, fitted with continuous rail joint and intermediate anchors. The points are 10ft. 6in., having a radius of 100ft. Crossings are iron bound. One mile of the track will run on a new road through the Craigie and Home Estates. This portion of the track will be laid with the usual 6in. bed of concrete and paved with tar macadam and granite edging. The bridge over the Dighty will be widened. The overhead construction will consist mostly of bracket arms. There will be double-trolley wire 2/0 B. & S., height from the ground 21ft. The cables will be laid on the solid system. The power-house will be a brick building, with a chimney shaft of 110ft. The plant will consist of two 200-kw. railway generators with high-speed engines. There will be three Lancashire boilers, superheaters, and usual condensing plant. The car-shed will be a brick building 176ft. long and 45ft. wide. The tracks in the car-shed will consist of Vignoles rails laid on sleepers. There will be 12 single-truck, double-decked cars, fitted with two 37-h.p. motors. The consulting engineer is Mr. J. W. Speight.

**Swansea.**—Major Druitt, on behalf of the Board of Trade, has inspected the permanent way of the company's extension, it being understood that the overhead equipment would be examined a few days later. A considerable party participated in the trial, including Messrs. D. James (manager of the tramways), C. A. L. Prusmann (Corporation electrical engineer), G. Bell (surveyor), Johnson (residential electrical engineer to the company), Gale (permanent-way

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engineer), J. Foley, Begg, and Schofield (Messrs. Dick, Kerr, and Co.), and Hudson (Messrs. Callender). The car, one of the new type single-deckers, went at a smart rate up High-street, through the Hafod, and thence on to Morriston, where, at the Swan, the course was steered past the church and through Woodfield-street, where the populace were in strong force. At the county boundary line the car retraced its way to the Palace, High-street, thence down Llangyfelach-road, through the Pentre, up to Cwm Level-road, and back to the town. The company have decided to issue transfer tickets on the Sketty and Brynmill section of the new tramway. At a meeting of the Tramways Committee it was reported that the company had returned the draft leases and required the lessors to bear the expense of providing and maintaining the mains between the generating station of the lessors and Villiers-street. This referred to such mains as are necessary to supply the current. The Corporation have agreed to bear the expense of so much of these mains as is necessary to supply the existing tramways of the company from Prince of Wales-road to Morriston, but do not think that they should be called upon to bear the whole expense. The only other point at issue was a proposal by the company to pay ·625 of 1d. per unit for current supplied to the Morriston section until the St. Thomas section is working. The committee were disposed to meet the company in this respect.

**Chester.**—We reported recently that the Tramways Committee had decided to adhere to their recommendation that the electric trams should be extended in lieu of introducing motor 'buses. The Corporation's officials were instructed to present their views on the matter, and these were embodied in reports by Mr. Sydney E. Britton, the electrical engineer; Mr. John Gardner, tramways manager; and Mr. L. M. Jones, city surveyor. Mr. Britton stated that though a certain amount of competition would take place, just as tramways competed with suburban railways, the motor 'bus would no more displace the tramcar than the latter would the railway train. That the motor 'bus had made great strides could not be denied, and there was every reason to believe it would yet be greatly improved upon in the near future; but its field of usefulness was not in the same category as the electric tramcar. Both systems had their special features and ways of catering for the transportation of passengers. British makers of motor 'buses frankly said that 'buses could not compete with, and generally speaking were not intended to deal with, such traffic as the tramcars dealt with. It was beyond their true province of utility. Comparing the two forms of traction, Mr. Britton states: "The two forms of mechanical traction are extensively different, and there can be no doubt as to which is the most reliable, the cheapest to run, and maintain in good repair. On the one hand you have the self-contained motor omnibus carrying its power generator, with multifarious mechaniam and moving parts, consuming practically as much fuel whether running light or at full load; vibrating, whether standing or travelling; and difficult to satisfactorily light. On the other you have the tramcar, with very little mechanism and few moving parts, deriving its energy from a power station as and when required; smooth running, and easily lighted and ventilated. The motor 'bus would show to greater advantage were it merely a question of the smallest capital required to inaugurate a town's system of transportation, but the working expenses are so heavy that it is difficult to see how it can profitably be used in such places as Chester." He estimated that at Chester for the past year motor 'buses would have entailed a loss of £3 000, as against a surplus of £340 earned by the trams. He felt confident that tramways giving a five to ten minutes' service could be worked more efficiently and infinitely cheaper than motor 'buses giving the same service. Mr. Gardner quoted the opinions of Mr. Clifton Robinson and Mr. J. Allen Baker in favour of electric trams, and that of Mr. E. A. Rosenheim, engineer to the Road Carrying Company, Limited, in favour of motor 'buses. It appeared to him that the whole question depended on the volume of traffic. Motor 'buses might pay very well with heavy metropolitan traffic, which was no dependable guide for a small place like Chester. He concluded with the following information: "At Torquay the District Motor Omnibus Company paid for the first year a dividend of 7½ per cent. There the total actual cost on 44,000 miles run was 8·4d. per mile; add 1·5d. for tyres (estimated), and 1·29d. for depreciation (at 10 per cent. per annum), and the revenue 12·68d. per mile. This gives net profit of 1·49d. per car mile. The Eastbourne Corporation motor 'bus department have furnished me with statistics, which show that there the cost of maintenance per car mile for the six months ending Sept. 30, 1904, including capital charges, was 10·4d. The gross income per car mile was 11·3d., which gives net earnings per car mile of 0·9d." If motor 'buses were adopted he suggested either the single-deck type for 18 or 20 passengers, costing £850, or the double-deck 'bus, costing £950. Mr. Jones, who visited the Olympia Motorcar Exhibition, recommended that, should the Corporation decide on motor 'buses, the double-deck type, carrying about 36 passengers in and out, should be adopted as the most suitable for Chester. After summing up the position generally, he returned an "open verdict," saying, in effect, that the question must be decided by the circumstances of the particular district, and that in the case of Chester the motor 'bus was at least worth a second thought. The matter came before the Corporation on Wednesday, when the committee's proposals were confirmed by a large majority.

## LIGHTING AND GENERAL.

**Bristol.**—Sanction has been received to the borrowing of £126,000 for electric lighting.

**Whitby.**—An enquiry has been held into the Urban District Council's application for sanction to borrow £1,500 for electric lighting.

**Glasgow.**—The Guardian Society for the Protection of Trade have agreed to present a petition to Parliament praying that the proposed telephone agreement be not ratified.

**Rawtenstall.**—The Corporation have entered into an agreement, subject to the approval of the Board of Trade, to take current from the Lancashire Electric Power Company for a period of five years.

**Bury.**—The borough electrical engineer (Mr. S. J. Watson) in his last report stated that he anticipated that after all expenses and charges had been met there would be a profit on the electricity works for the past year of about £3,000.

**Horsham.**—The Urban District Council have now 8,375 electric lamps connected with their system. It has become necessary to considerably increase the machinery plant in order to cope with the demands of new subscribers.

**South London Electric Supply Co.**—The company reports having sold during the quarter ended Lady Day last 2,457,880 units, realising £20,640. The figures for the corresponding quarter in 1904 were 2,120,539 units realising £18,600.

**Stock Exchange.**—Application has been made to the Stock Exchange Committee to allow the Electric Lighting and Traction Company of Australia further issue of £70,000 5 per cent. first debenture stock to be quoted in the official list.

**Woolwich.**—The cost of the erection of the electricity sub-station in Eltham-road, Lee, is estimated at £450, and that in Red Lion-lane, Shooters' Hill, at £740. This work is to be carried out by direct labour, under the supervision of the borough engineer.

**St. James's and Pall Mall Electric Light Co.**—The current sold during the quarter ended Lady Day, 1905, totalled 2,332,361 units, estimated to produce £34,985, as against 2,330,724 units, which produced £35,320, for the corresponding period of last year.

**Faversham.**—The Town Council have resolved to extend the electric supply cables into three new roads at present unlighted at a cost of £357 for the private service and £205 for the public service. The engineers are to obtain orders for the required supplies.

**Fire.**—We regret to learn that a large amount of damage has been done by a fire at the Morley Electrical Engineering Company's works at Stanningley. Patterns and drawings were destroyed, and dynamos and motors were drenched with water. The premises were insured.

**Brush Electrical Engineering Co.**—The directors recommend, subject to audit, payment of the full 6 per cent. dividend on the preference shares for the year ended Dec. 31, 1904, placing £7,000 to general reserve, £6,500 to depreciation reserve, and carrying forward £3,080.

**Southwark.**—The Borough Council are not out of the wood yet with regard to their electric light undertaking. At Wednesday's meeting notice was given of a resolution to sell the electric light undertaking as a going concern, in view of its heavy cost to the ratepayers.

**Torquay.**—The Local Government Board have suggested to the Town Council that, instead of spending £42 000 on a new electrical station, an endeavour should be made to utilise the existing station for six or seven years longer. In this case the current for the proposed trams would have to be provided by a company.

**Electric Pumping.**—The Electrical Company, Limited, 121-125, Charing Cross-road, have just completed the supply of a high-tension electrical pumping plant, with high-lift centrifugal pumps, at Messrs. Bolckow, Vaughan, and Co.'s, Limited, Shildon Lodge Pit. This plant is of special interest, being the largest of its kind installed in England.

**Stirling.**—The report of Mr. A. C. Hanson, electrical engineer, for the four weeks ending March 18 shows that 22,946 units have been generated, as compared with 20,236 for the corresponding period last year. The total number of equivalent 8-c.p. lamps connected for all purposes is 16,549, as compared with 14,110 at the corresponding date last year.

**Penrith.**—A letter from Messrs. J. and J. Enright, asking if the Urban District Council would be prepared to consider the transfer of the electric lighting provisional order on the understanding that the cost of the order would be refunded and the Council to have opportunity of purchasing the undertaking from time to time, is before the General Purposes Committee.

**Dunfermline.**—On Wednesday the Town Council discussed reports by Mr. W. B. Sayers, electrical engineer, Glasgow; Mr. Alexander Waddell, gas manager, Dunfermline; and Mr. Nigel H. Cohen, electrical engineer, London, on schemes for the provision of electric energy and light for the burgh. Eventually it was agreed to adjourn consideration of the reports and proposals.

**Telegrams.**—The Postmaster-General has stated that there is at present no likelihood of any reduction being made in the charges for inland and foreign telegrams. It appears that while it is not at present proposed to introduce the cash-on-delivery system in the United Kingdom, the question of introducing it between England and the British Colonies and possessions and Egypt is under consideration.

**Fraserburgh.**—A committee has been appointed to consider a letter of the Pneumatic Tool Company asking if the Town Council would require any electric current before the company quoted for supplying the harbour and railway authorities. If the Council required it, the company would take it into consideration in laying their cables. The Town Council may probably adopt electric lighting for one or two of the main thoroughfares.

**Longton.**—The Corporation Gas and Electricity Committee have made the following reduced rate at which current will be supplied for electric motors: for 500 units per quarter or less, 2½d. per unit; above 500 units, and under 1,000, 2¼d. per unit; above 1 000 units, and under 1,500, 2d. per unit; above 1,500 units, and under 2,000, 1¾d. per unit. The price paid by consumers of electricity for lighting purposes last year averaged 4¼d. per unit, a price which is cheaper than lighting by gas.

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**Exeter.**—The electrical engineer, in his last report, states that during the 12 months' working now completed there has been no failure of supply due to defects in the machinery at the new generating station. The tramway generators are particularly satisfactory in work. A sub-committee has been appointed to consider the question of the Council supplying motors on the hire-purchase system. It is proposed to erect a wood fence and gates at the power station at an estimated cost of £300.

**Wisbech.**—The Town Council have been informed, with regard to their electric lighting order, that certain questions having arisen with regard to the powers of local authorities to enter into contracts under Section 11 of the Electric Lighting Act, 1882, in which the Board have found it necessary to seek the opinion of the law officers of the Crown, the Board are unable to give a decision on the matters which have been referred to them by the Local Government Board until that opinion has been received.

**Brockenhurst.**—The Board of Trade have issued a provisional order with a view to the same being included in a Confirmation Bill, about to be introduced into Parliament, to Messrs. Christy Bros. and Middleton, of Chelmsford, authorising them to transfer the powers granted by the Brockenhurst order to a registered company to supply electrical energy for both public and private purposes within so much of the parish of Brockenhurst in the rural district of Lymington as is described in the first schedule to the said order.

**Underground Telegraphs.**—Satisfactory progress has been made during the past two months with laying the underground telegraph to the North, and the permanent cable will probably be ready for opening in a month or two. The permanent cable has been completed between London and Warrington, Warrington and Liverpool, and Warrington and Manchester. A temporary cable has been drawn into the pipes between Manchester, Leeds, and Bradford. The permanent cable has also been drawn in between Warrington and Carlisle *via* Preston, but that section of the work is not yet finished. The pipe line from London to Glasgow was completed a few weeks ago, except a small section on which the work was interrupted owing to a dispute with the road authorities.

**Dundee.**—At the last meeting of the Tramways Committee Mr. Richardson, the engineer, reported that he anticipated that next winter the Corporation electricity department would have to meet a maximum load of about 2,000 kw. There was only available plant of 2,300 kw. capacity to meet this demand, and the load on the outlying points had grown so rapidly that the long feeders to these districts would require to be considerably enlarged. Increased requests were coming in from parts at the extremities of the area for power and lighting, but these points were so far away from the station that it was both uneconomical and dangerous to try to connect them up to the present low-tension station. The committee have instructed the engineer to prepare a detailed report and alternative schemes, and as to the general policy of extension.

**London Gazette.**—The last day for receiving proofs in the estate of Arthur Edgar Brooks, electrical engineer, 110, Cheapside, London, is May 10. Arthur Stewart Maples, Trinity House-lane, Hull, has been released from trusteeship in the estate of Charles Wallis, electrical engineer, 121, Cleethorpes-road, Great Grimsby. Thomas Henry Peake, 6, Athenæum-terrace, Plymouth, has been released from trusteeship in the estate of Samuel Henry Thompson and James Edgar Thompson, electricians, trading as Thompson Bros. and Co. at Plymouth. The partnership between Charles Herbert Offord and Frank Clemens Wilson, carrying on business as electrical engineers at Woodcock-street, Birmingham, has been dissolved by mutual consent. A receiving order has been made out on creditors' petition in the estate of Arthur Driffell Poulter, printers' and electrical engineer, New Bridge-street, London, E.C.

**Dover.**—The Board of Trade have issued a provisional order with a view to the same being included in a Confirmation Bill about to be introduced into Parliament to the Corporation of Dover authorising them to supply electrical energy for all public and private purposes within the parishes of River Ewell, Whitfield, St. Margaret's-at-Cliffe, West Cliffe, and Guston in the rural district of Dover, and so much of the parish of Alkham in the said rural district as lies to the east of a line drawn from the south-eastern boundary of that parish at the junction of Minnis-lane and Abbey-road in a northerly direction to the road leading to Ewell Minnis at the point where the north-eastern boundary of the parish running in a south-easterly direction meets the said road. A proposal to light Folkestone-road by electric arc lamps at an increased cost of £165 was discussed at the last Council meeting, and a recommendation to light half the road in this manner as a test was carried.

**Ferranti Limited.**—A scheme of reconstruction has now been carried through, and the new company, "Ferranti Limited," has been registered. The directors and principal officials of the new company are as follows: directors—A. W. Tait, chairman (director of Messrs. Bruce Peebles and Co., Limited), Arthur Whittaker, J. M. Henderson (director of Messrs. Thos. Bolton and Sons, Limited), S. Z. de Ferranti, M.I.M.E., M.I.E.E., M.I.C.E.; general manager—A. B. Anderson; chief engineering staff—Michael B. Field, M.I.E.E., A.M.I.C.E., A.M.I.E.E. (America), W. Hamilton, B.Sc., W.Sch., C. C. Garrard, Ph.D., A.M.I.E.E. The business of the company will henceforth be confined to the manufacture of switchgear (with all necessary accessories), transformers, instruments, and meters; but in order to meet the convenience of the customers of the old company, arrangements have been made for dealing with the maintenance and repair of engines and alternators supplied by them.

**Cardiff.**—Mr. Arthur Ellis, the electrical engineer and manager, in his last report states that there are now 1,128 consumers whose premises are connected with the mains, with a total equivalent of 129,362 8-c.p. lamps, as against a total of 109,570 at the corresponding period last year. The estimated revenue was as follows; revenue from street-lighting, £595. 16s. 6d.; from private supply, £2,294. 8s. 4d.—making a total of £2 890. 4s. 10d. The estimated revenue for the corresponding month of last year was £2,576. Mr. Ellis reported the new sub-station at the docks is now completed, and we understand supply to the docks from the new sub-station has been commenced. The sub-station has been fitted up in such a way that the docks district can be entirely disconnected from the town, or, in the case of an accident, the docks sub-station can assist the town lighting by means of a battery which has been installed.

**Croydon.**—The following resolution has been carried: "That, having regard to the heavy expenditure involved in the present mode of lighting the borough, the Lighting and Electricity Committee be requested carefully to consider the matter, and to make such suggestions to the Council as may tend to a considerable reduction in the cost of street-lighting." During the year 1904 the Council have paid to the Croydon Gas Company and the Crystal Palace Gas Company for street-lighting £7,065, and for electric light £7,357, making a total of £14,423. There are 2,131 gas lamps, and 2,614 electric lamps. During the last 10 years the cost of the public lighting has greatly increased. In 1894 the total cost was £6,590, and in 1904 it was £14,423. In 1894 the lighting rate was 3d. in the £, and now it is 4½d., and 1d. in the £ on the district rate now amounts to £3 500. This is, of course, mainly due to the growth of Croydon during this time; in 1894 there were 132 miles of streets, and there are now 150½ miles.

**Edinburgh.**—An exhibition of a working model and full-sized section of the Dolter electric surface-contact system was opened at 100, George-street last week. The Electric Lighting Committee estimate that the ordinary expenditure for the year from May 15 will be £53,890 against the estimated expenditure of £49,265 last year, and an actual expenditure last year of £43,129. The revenue was estimated at £128,705 against the actual revenue last year of £116,178, and an estimate of £117,310. The sum for capital expenditure is estimated at £48,820. The committee have agreed to recommend that the charges for electric energy during the year from May 15 be as follows: for private lighting, 3½d. per unit; for motor power, 1½d. per unit; for the present public lamps, £10. 15s. per lamp; and for new public lamps, £10 per lamp. The committee agreed to recommend that a special charge of 1$\frac{1}{10}$d. per unit be made for consumers for motor power not using motors during the four winter months when the lighting is heaviest—November, December, January, and February.

**Stepney.**—The annual report of the Borough Council's Electricity Committee shows a gross profit of over 6¾ per cent. on the capital employed at the end of the year. After providing for interest, sinking fund, and other charges, a net profit of 2¾ per cent. has been made. The committee point out also that this profit has been earned in spite of additional charges for reduction in price to consumers, £2,300; interest, £1,208; sinking fund, £1,126; the net surplus being only £91 less than that of last year, although the revenue per unit has dropped from 2·36d. to 2·11d., a figure below that charged by any other undertaking (not supplying tramways) in the country. The charge for public lighting current has also been reduced to 1·55d. from 1·61d. This figure is also claimed to be lower than that of any other undertaking in London. On the expenditure side the cost of production has been reduced from ·94d. to ·85d. per unit sold, while the total cost, exclusive of interest and sinking fund, is 1·10d. per unit, which is also a reduction on the previous year.

**Luton.**—An enquiry has been held into the Town Council's application for sanction to borrow £5,000 for extension of the electric light works. The Town Clerk said the population was estimated at 38,500, and the total amount of outstanding loans was £116,106. The assessable value was about £162,000, and a penny rate produced £650. The poor rate in the past three years had been 3s. 3d. and 3s. 6d., the Corporation's district rate being 2s. 6d., and the borough rate 8d. last year. Mr. G. Sell, the electrical engineer, stated that the extension of the plant was absolutely necessary to supply next winter's demand. The total capital expenditure on the electricity works up to date was £32,000. The number of units sold increased from 160,844 to 276,458 in the last two years, the consumers from 154 to 235, lamps connected from 10,535 to 14,425, motors from 160 h.p. to 327 h.p. The present capacity of the works was 297 kw., and there were two Lancashire boilers. They proposed to add another boiler and a 225-kw. set. We understand that the Council expect next year to apply for another £7,000 for further extensions.

**Chester.**—The Lighting Committee have recommended to the Town Council as follows: That (1) the present charge of 4½d. per unit, with discounts, for current lighting be reduced to 4d. per unit, and that the discounts remain unaltered, and that the reduction take effect from June 30 next; (2) for all classes of meters a fixed charge of 1s. per quarter for each meter be made, to take effect from June 30 next; (3) under the powers conferred by Section 78 of the Chester Corporation Act, 1901, the Corporation provide and sell to consumers and contractors incandescent and Nernst lamps; (4) the uses to which electricity can be put, and the willingness of the department to give advice free of charge, be advertised in the local newspapers and by circulars, and that it be referred to the town clerk and the electrical engineer to prepare, from time to time, draft advertisement and circulars, with estimates of the cost, and submit them to the committee for approval; (5) the electrical engineer prepare and issue a model specification and schedule dealing with wiring work, stating the quality of the materials and the way in which the work should be executed; (6) the committee be authorised to rent and fit up a room in a central position in the city, wherein to exhibit and demonstrate the most improved and up-to-date electrical appliances, such as fittings, lamps, motors, stoves, ovens, kettles, pans, irons, and other heating and cooking apparatus, to be lent by manufacturers of these appliances; (7) an exhibition of all kinds of electrical appliances be held in the Assembly Room at the town hall for about 10 days in September next.

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**Manchester Exhibition.**—An exhibition and demonstration of motor vehicles and electric and pneumatic appliances is to be held from May 2 to 5, from 10 a.m. to 6 p.m., at the Key Engineering Company's showrooms, Scottish Insurance-buildings, 33, Deansgate, Manchester. The exhibits will comprise J. I. Thornycroft and Co.'s steam wagon, touring car, cylinder launch engine, etc.; Elliott Bros.' new patent moving-coil ammeters and voltmeters for direct and alternating currents and other instruments; Cowans, Limited, high-tension oil-brake mechanically-operated switch panel, equipped with Andrews patent discriminating cut-out and current direction indicator (in operation), motor starter, etc.; Witting, Eborall, and Co., Limited, reversible controller and a Heyland single-phase alternating-current motor with special starting switch for same. The Fibre Conduit Company will exhibit specimens of screwed and socketed conduits for electric cables and other purposes. There will be also a Reavell patent 60 cubic feet electrically-driven air-compressor and a pneumatic hoist (in operation). The Industrial Engineering Company will show patent valveless pneumatic hammers, rivetters, caulking tools, electric motors, etc. A demonstration will be given of the Harris combined chemical and mechanical process of removing oil and other impurities from condensed water. Other exhibitors will be the Delafon Batteries Company, Limited, the Reason Manufacturing Company, Limited, the Otis Elevator Company, Limited, the Phœnix Art Metal Engineering Company, the Bat Meter Company, Crosier, Stephens, and Co., and the T.P. Ford Company. A special day is to be set aside for a visit of electrical engineers. The Key Engineering Company are introducing a new conduit for electric cables. A considerable portion of 34 miles of this conduit has already been laid in Manchester, and Mr. Pearce, the Corporation electrical engineer, has arranged to lay some during next week.

**Greenock.**—At the last meeting of the Corporation the electrical engineer reported on the supply of electricity to the new combination hospital at Gateside that, the distance from the Corporation generating station to the hospital being 2,750 yards, in order to ensure constant pressure of supply under all conditions at this distance it would be necessary to run the cables direct from the works to the hospital. If a three-way system of cables be laid to give current at the same pressure as it was supplied in Greenock, the cables being of sufficient capacity to supply the equivalent of 1,600 lamps of 16 c.p., the capital cost would amount to £1,850. As it was probable, however, that a supply would also be required for Smithston Institution within the next few years, it would be advisable to lay a cable of sufficient size to supply current to this institution also, at an additional cost of £400, or say, a total of £2,250. He estimated that the average consumption of electricity by the hospital would amount to about 38,000 units per annum. If the supply was given at the ordinary rates, the system under which the current would be charged for would be method C—*i.e.*, maximum demand system. Under this system the average price to the hospital would probably amount to not more than 3d. per unit, and on this basis the income to the Corporation would be £475 per annum. He was of opinion that, in order to properly safeguard the interests of the Corporation, it would be necessary for the hospital authorities to enter into a contract with the Corporation for a period of not less than 10 years, to use or pay for electricity of a value at the above rates of not less than £400 per annum. The report was adopted, and it was decided to purchase a new generating set and a storage battery. The Corporation some time ago decided to adopt a scheme of free wiring to induce customers for electricity, and there are now so many applicants that the committee can select whom they think most desirable. During the last three months more electric lamps have been connected in Greenock than during the previous year.

**Blackpool.**—In his last monthly report, Mr. C. Furness, the borough electrical engineer, estimates that there will be an available balance from his department of approximately £5,000 towards the reduction of the rates. There is a large increase in the tramway receipts, amounting to £6,469, from April 1, 1904, to March 31, 1905, as compared with the corresponding period in 1903-4. The returns for the month of March showed a net increase in the works output over the corresponding month of last year of 16,445 units, made up as follows: Private lighting: 1904, 79,564; 1905, 75,027—decrease, 4,537. Public lighting: 1904, 14,711; 1905, 14,034—decrease, 677. Lytham and St. Annes trams: 1904, 9,892; 1905 4,466—decrease, 5,426. Corporation tramways: 1904, 72,748; 1905, 99,833—increase, 27,085. Total for month: 1904, 176,915; 1905, 193,360—net increase, 16,445. The total works output for year ending March 31 shows an increase of 257,967 units over last year. The figures are as under: Private lighting: 1904, 1,052,440; 1905, 1,086,272—increase 33,832. Public lighting: 1904, 231,296; 1905, 248 916—increase 17,620. Corporation tramways: 1904, 1,009,015; 1905 1,110,082—increase, 101,067. Lytham and St. Annes trams: 1904, 93,063; 1905, 115,763—increase, 22,700. Used on works: 1904, 39,569; 1905, 114,219—increase, 74,650. Losses, etc: 1904, 145,507; 1905, 153,665—increase, 8,098. Totals for year: 1904, 2,570,890; 1905, 2,828,857—increase, 257,967. New consumers in 1905, 55; against 68 in 1904. Mr. Furness points out that there has been a decrease in private lighting for the month of March of 4,537 units as compared with the corresponding month of last year, and he trusted that the revised charges recommended would be adopted at an early date. There has been a big reduction in the consumption of coal during the past year, as will be seen from the following figures: 1902, 15,289 tons, £7,867; 1903, 15,000 tons, £7,319; 1904, 14,869 tons, £7,202; 1905, 10,869 tons, £4,946. In the concluding paragraph of his satisfactory report Mr. Furness says: "Comparing the years 1902-3 and 1904-5, the coal saving represents £2,921, whilst, on the other hand, the works output has increased by no less than 566,000 units, or 25 per cent., and I anticipate that after meeting all loan charges and sinking fund, etc., we still shall have an available balance of approximately £5,000."

**Reading.**—An electrical exhibition, with which we deal in another column, was opened in the Exhibition buildings, Vastern-road, Reading, on Monday, and will remain open until Saturday, April 29, from 11 a.m. to 10 p.m. each day. The Reading Electric Supply Company have hired one of Edmundson's travelling exhibitions *en bloc* to form a nucleus, and have secured the co-operation of about 30 private exhibitors as well, among the firms occupying stands being J. S. Henry, Limited; Saunders's Launch Building Company, Limited; Vernon, Davenport, and Co., Limited; Industrial Battery Syndicate; Harper's Automatic Company; Simplex Conduit Company; Waygoods, Limited; Reason Company; Broom and Wade; Windsor Electric Company; Isometric Lens Company; Botley and Lewis; S. Griffith; W. H. Baugham and Co.; Verity's, Limited; Singer Manufacturing Company; A. E. Felgate; Hawkes and Sons. The company's own machinery room forms an annexe to the exhibition. The following reduced rates for the supply of electrical energy will come into force on July 2 next: For lighting purposes (supplied at 200 volts)—to consumers using 1,000 units and under during the half-year ending June 30 or Dec. 31, 6d. per unit, with a minimum charge per quarter of 5s.; to consumers using more than 1,000 units, but not exceeding 2,500 units, during the half-year, 5d.; to consumers using more than 2,500 units, but not exceeding 5,000 units, during the half-year, 4½d.; to consumers using more than 5,000 units, but not exceeding 7,500 units, during the half-year, 4d.; to consumers using more than 7,500 units, but not exceeding 10,000 units, during the half-year, 3½d.; to consumers using more than 10,000 units during the half-year, 3d. Meters supplied free. Special rate for basement lighting by separate meter, for which a rental of 3s. 6d. per quarter will be made, 3d. For motive power—for all demands up to and including 4 b.h.p., supplied at 200 volts direct current, 2d. (a minimum charge of 7s. 6d. per quarter will be made, which will include a meter rental of 3s. 6d.); for all demands above 4 b.h.p., supplied at 200 or 400 volts direct current at the company's option, 1½d. (a minimum charge of 10s. per quarter will be made, which will include a meter rental of 3s. 6d.). For heating, etc.—for all demands, 1½d. (a minimum charge of 5s. per quarter will be made, but no charge will be made for the use of meter). Also special terms will be quoted on application for installations requiring a long hour supply.

**Islington.**—The borough treasurer has prepared the following statement with regard to income tax: Income from all sources, £48,436; deduct income derived from street-lighting, £15,647—£32,789. Expenditure, £47,309; deduct expenditure in respect of street-lighting, £11,623; interest on loans, £12,180; repayment of loans, £6,173; income tax, £706; interest on deposits, £13—£16,614. Taxable income, £16,175. Three years' average amounted to £15,057; deduct amount allowed for depreciation on capital expended on boilers and machinery, electrical instruments, transformers, etc., £2,474—total, £12,583. Reporting on this statement the Finance Committee say: "Income tax at 1s. in the £ on this sum amounts to £629. 3s. There is, however, a substantial set-off against this charge in the amount of income tax deducted by the Council from interest on loans raised for the electricity undertaking. In a recent decision of the House of Lords in the case of the Attorney-General *v.* the London County Council, it was held that where the interest on the loans is paid out of profits the person who makes the payments and deducts the income tax is not accountable to the Crown for the duty deducted. The figures for the current year are not available, but we may mention that last year the amount of income tax deducted from interest on loans was £393. 16s. 3d. We are satisfied that the amount of £629. 3s. is properly payable, and we have accordingly included it in our list of proposed payments." In consequence of an application from the Westinghouse Brake Company for an additional supply of electricity to their premises in York-road, additional mains are to be laid and two transformers procured at a total cost of £390. An additional extension is to be made at a cost of £76. The electrical engineer has reported to the effect that an extension of generating plant is required, and the committee find that the present total capacity of the works is approximately 3,600 kw., and that the maximum load demanded during the past winter was approximately 2,400 kw., leaving a reserve of 1,200 kw. Islington at the peak of the load last winter had only a reserve of 33 per cent. The committee say that since the maximum load of last year was attained an equivalent of 5,000 lamps, or about 150 kw., has been connected, in addition to which they have recently received an application for an extension for supply to the Post Office premises in Upper street of 250 kw. Assuming that half of the 5,000 lamps mentioned are running at one time, there would be considerably over 300 kw. to add to the peak of the load next winter, apart from any other connections that may be made in the meantime, leaving with the present plant a bare 25 per cent. reserve. As it had taken in the past some 12 months to get plant into commission, they think that it would be running a serious risk to delay the extensions any further. They recommend the following expenditure: one 1,500-kw. turbo-alternator, including turbine, alternator, exciter, condenser, pumps, etc., £9,000; foundations for above, £250; steam-pipes, hot feed apparatus, etc., £1,500; one cooling tower capable of dealing with water for above, £3,750; motors, fans, piping, etc., £500; contingencies, £500—total, £15,500. The electrical engineer has reported as follows: "The 1,500 kw. turbine proposed would run the bulk of the evening load, and would in any case be practically fully loaded for about four hours every day. This would mean an output of about 6,000 units on this machine alone. As the majority of makers are prepared to guarantee a consumption of between 18lb. and 20lb. of steam per unit generated against an average of 35lb. of steam per unit generated consumed by the existing non-condensing plant, it will be seen that about 40 per cent. of the steam hitherto used to run the above section of load—viz., 6,000 units—would be saved, and as steam, even when generated by mechanical stokers, would cost 6d. per 1,000lb., it will be seen that if we assume a consumption of 20lb. of steam per unit

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for 6,000 units, which is a reasonable figure for turbines, and we assume 35lb. of steam per unit for the section of 6,000 units with the existing plant, we should effect, by the use of the turbo-generator, a saving each evening of 90,000lb. of steam, or representing in value at 6d. per 1,000lb. £2. 5s. To allow for the necessary cleaning of the plant, and machine being out of commission for other causes, it would be advisable to assume a weekly run to consist of five days. This would mean a saving of £11. 5s. per week in reduced steam consumption, or sufficient to pay the interest and redemption charges on the cost of the turbo, say £9,000. The charges on the new turbo would therefore be entirely paid for by the economies effected, and the department would therefore have the advantage of an additional revenue-earning machine without extra cost. The cooling tower estimated for will be more than sufficient to provide circulating water for the turbine, and the additional capacity will be utilised for an extension of our present condensing system, thereby effecting a reduction in the coal bill of some £300." The committee are of opinion that when the new plant has been running for 12 months there will be a marked difference in the cost of production.

## PROVISIONAL PATENTS, 1905.

APRIL 11.

**7645. Improvements in electrical transformers and the like.** Gordon Hanchett, 4, St. Ann's-square, Manchester.

**7700. Improvements in magneto-electric machines.** Edward Benthall Gray, 6, Bream's-buildings, Chancery-lane, London.

**7707. Improvements in lifting magnets.** Arthur Clarke Eastwood, 47, Lincoln's-inn-fields, London. (Complete specification.

**7720. Improvements in the manufacture of electric accumulators.** Henry Leitner, 4, South-street, Finsbury, London.

**7721. Improvements relating to electric single-phase motors.** The Phœnix Dynamo Manufacturing Company, Limited, and Wilhelm Oelschläger, 322, High Holborn, London.

**7732. New or improved means for electrically indicating and recording at a distance changes in level of liquid in reservoirs and for giving warning of any prearranged maximum or minimum level.** Paul Virgile Vaudrey, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, April 11, 1904, being date of application in France.) (Complete specification.)

APRIL 12.

**7814. Improvements in appliances for lighting gas lamps and the like by electricity.** William Phillips Thompson, 6, Lord-street, Liverpool. (Oscar Freudenthal, Belgium.)

**7819. Improvements in coil-winding machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

**7822. Improvements in systems of control for electric motors and apparatus therefor.** The British Thomson-Houston Company, Limited, 83 Cannon-street, London. (General Electric Company, United States.)

**7841. Improvements in and relating to telegraphic system and to apparatus therefor.** Walter Polk Phillips, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**7842. Improvements in flexible armoured electric cables.** Walter Claude Johnson and Sydney Paterson, Norfolk House, Norfolk-street, Strand, London.

**7843. Improvements in electric arc lamps.** Leon Galas, 18 Buckingham-street, London.

APRIL 13.

**7856. Improvements in or connected with electrically-propelled railway vehicles or locomotives.** John Paul Barker, 15, Water-street, Liverpool.

**7872. Improvements in magneto-ignition devices.** Edward Russell Clarke, 35, Leinster-gardens, Hyde Park, London.

**7874. Improvements in and relating to apparatus for the control of electric circuit breakers and like devices.** Leonard Andrews, 38, Deansgate, Manchester. (Complete specification.)

**7879. Improvements relating to trolley heads in connection with overhead electric transmission.** Joseph Wyatt Handcock, 17, Belvoir-street, Leicester.

**7892. Improvements in vapour electric apparatus.** Percy Holbrook Thomas, the Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, April 14, 1904, being date of application in United States.) (Complete specification.)

**7903. Improvements in electric accumulators or secondary electrolytic cells.** William Fennell and William Pagden Perry, 33, Cannon-street, London.

**7919. Improvements in and relating to electric rheostats.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**7920. Improvements in electric switches.** Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

APRIL 14.

**7956. Improvements in lifeguards for electrically-propelled vehicles and the like.** Edgar Ashley Greaves, 9, Tempest Hey, Liverpool.

**7987. Improvements relating to adjustable brackets or arms for supporting electric lights or the like, and applicable also to brackets or supports for other purposes.** William Henry Pick, trading as Collins and Co., 43, King-street, Leicester.

**7972. Improvements in or relating to electrical regulating, testing, and measuring apparatus.** Robert William Paul and George William Harris, Newton Avenue Works, New Southgate, London.

**8002. Improved construction of apparatus for winding coils and bobbins for electrical and other purposes.** Harry Bourne, 175, Fleet-street, London.

**8026. Improvements in starting devices for alternating-current dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**8027. Improvements in block signal systems for railways.** The British Thomson-Houston Company, Limited, London. (The General Electric Company, United States.)

**8028. Improvements in electric motor-controlling switches.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**8033. Improvements in terminals and connections for electric wires.** Alan John Downes, 412, Munton-road, New Kent-road, London.

APRIL 15.

**8049. Improvements in and relating to the working of electric or other tramway or railway points.** Wilfred Bruce Docharty, 96, Buchanan-street, Glasgow.

**8051. Improvements in and relating to electrical circuit breakers.** Veritys, Limited, and Arthur Edgar Gott, 11, Burlington-chambers, New-street, Birmingham.

**8071. Improvements in automatic electric circuit breakers.** James Ernest Spagnoletti, Palace-chambers, Westminster, London.

**8090. Improvements in and relating to trolleys for electric railways and the like.** Arnaldo Paolo Zani, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**8095. Improvements in and relating to electric switch mechanism.** The British Thomson-Houston Company, Limited, and Frank Holden, 83, Cannon-street, London.

APRIL 17.

**8122. Improvements in the construction of electric tramways.** Samuel Green Bennett, Clyde House, Heath Town, Wolverhampton, Staffs.

**8127. Gasproof disconnecting plug for electrical switches.** Albert Ernest Carter, 6, Gardner-street, Brighton, Sussex.

**8168. Improvements in and relating to electric telegraph apparatus and in particular to devices for indicating at a distance the position of a pointer, needle, or the like.** Hans Usener, Thanet House, Temple Bar, London. (Complete specification.)

**8190. Improvements relating to electric batteries.** Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (La Société Anonyme le Carbone, France.)

**8198. Improvements in or relating to multiple-unit control for electric motors.** Thomas Steel Perkins and Ray Philip Jackson, The Westinghouse Patent Bureau, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, June 6, 1904, being date of application in United States.) (Complete specification.)

**8200. Improvements relating to the transmission of electrical energy.** Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (Nikola Tesla, United States.) (Complete specification.)

APRIL 18.

**8215. Improvements in the regulation of the voltage of alternating electric current systems and in apparatus therefor.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**8253. Electric light hanger for walls.** Willy Harz Lau, 65, Chancery-lane, London. (Date applied for under Patents Act, 1901, April 23, 1904, being date of application in United States.) (Complete specification.)

**8267. Improvements in and means for electrically recording weights lifted by a crane or the like.** Charles Russo and Edward Caro Feinstein, 33, Chancery-lane, London.

**8278. Improvements in electrical switches.** Walter S. Mayer, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**8305. Improvements relating to electric wiring and controlling systems.** Alfred Blackmore, 322, High Holborn, London.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published May 4.*

1904.

**14087. Box or cell and lid for electric accumulators on board ships, motorcars, and the like.** Smethurst and Bishop.

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**13180. Electric radiaters.** Dowsing[1]

**20351. System and apparatus for electrically operating bulkhead doors, hatches, or the like.** Jones. (Long Arm System Company.

**20536. Bath for therapeutic treatment by means of electric and other forms of radiant energy.** Smyth.

**23012. Enclosed dynamo-electric machines.** Newbold. (Date applied for under International Convention, Nov. 3, 1903.)

1905.

**47. Magnetic compasses.** Wilke.

**315. Plates for secondary batteries.** Thompson. (Pflüger Accumulatoren-Werke Act.-Ges.)

**1378. Telephony.** Buell.

*To be published May 11.*

1904.

**9190. Arc lamp electrodes.** Weedon. (Date applied for under International Convention, April 21, 1903.)

**10459. Electric control systems.** British Thomson-Houston Company, Limited. (General Electric Company.)

**10672. Gas or vapour electric apparatus.** Le Tall. (Cooper Hewitt Electric Company.)

**10962. Electromagnetic apparatus for operating railway signals and points.** Timmis.

**11093. Electric meters.** Atkinson.

**11284. Counterweights for electric light fittings and the like.** Hirst and Collings.

**11633. Electromagnetic selecting or distributing device for use in type-distributing and other machines.** Wagner.

**11842. Apparatus for lighting railway vehicles by electricity.** Wright.

**12136. Manufacture of welded conduits for electric wiring.** Taylor.

**12214. Electrical cooking and heating apparatus.** British Prometheus Company, Limited, and Skipwith.

**12418. Electric switches.** De Veulle.

**13072. Electric condensers.** British Thomson-Houston Company, Limited. (General Electric Company.)

**13277. Coil-winding apparatus for electrical purposes.** British Thomson-Houston Company, Limited. (General Electric Company.)

**13516. Mechanical ear, used for the suspension of overhead trolley wire.** Taylor.

**13569. Electric controllers.** British Thomson-Houston Company, Limited. (General Electric Company.)

**13596. Electric alarm clocks.** Baynes.

**13686. Clocks controlled by reversals of electric current.** Howorth. (Firm Magneta, Fabrik Electrischer Uhren.)

**13720. Electrical traction overhead conductor equipment.** Schierwater.

**13864. Construction of dynamo-electric machines.** British Thomson-Houston Company, Limited. (Allgemeine Elektricitäts-Ges.)

**14128. Method of preliminary treatment for electric accumulator plates.** Leitner.

**14196. Electrodes for arc lighting.** British Thomson-Houston Company, Limited. (General Electric Company.)

**15294. Process of electrodepositing antimony.** Betts.

**22808. Alternating-current electric motors.** Lundell.

**25619. Wireless telegraphy.** Howorth. (Squier.)

**27982. Secondary batteries.** Gardiner.

**28370. Electric switches.** Harrison. (Guett.)

1905.

**352. Protective apparatus for alternating-current circuits.** Davis and Conrad. (Date applied for under International Convention, Jan. 20, 1904.)

**2266. Construction of spring jacks for telephone switchboards.** Siemens Bros. and Co., Limited. (Siemens und Halske Act.-Ges.)

**4832. Electrical fittings.** Dugdill.

**6865. Micro-telephones or instruments containing a telephonic receiver and transmitter in one casing.** Birnbaum. (Telephon Fabrik Akt.-Ges. vorm. J. Berliner.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ⅞-1 |
| Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 7/16-17/32 |
| British Insulated and Helsby Cables, Ord., 1-100,000 .... | 5 | – | 5¼-6 |
| —— 5 per cent. Cum. Pref., 1-100,000 .... | 5 | – | 5¼-6 |
| —— 4½ per cent. Mortgage Debentures .... | 100 | – | 101-104 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. .... | 100 | – | 99-101 |
| British Westinghouse Elec. and Manuf., 5 per cent. Pref., 275,001-375,000 .... | 5 | – | 2⅜-3¼ |
| —— 4 per cent. Mortgage Debenture Stock .... | 100 | – | 91-93 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 .. | 2 | – | ½-¾ |
| —— Non. Cum., 5 per cent. Pref. .... | 2 | – | 1¼-2 |
| —— 4½ per cent. 1st Debenture Stock .... | 100 | – | 92-95 |
| —— 4½ per cent. 2nd Debenture Stock .... | 100 | – | 79-82 |
| Callender's Cable, Debentures .... | 100 | – | 107-109 |
| —— Ordinary .... | 5 | – | 11-11¼ |
| —— 5 per cent. Pref. .... | 5 | – | 5¼-5⅜ |
| Crompton and Co. .... | 5 | – | 2⅜-2⅝ |
| —— 5 per cent. Debentures .... | 100 | – | 96-98 |
| Edison and Swan United, "A" Shares, 1-99,251 .... | 5 | – | 1-1¼ |
| —— "A" Shares, 01-017,139 .... | 5 | – | 1⅜-2¼ |
| —— 5 per cent. Debentures .... | 100 | – | 84-89 |
| —— 4 per cent. Deb. Stock, Red. .... | 100 | – | 80-85 |
| Electric Construction, Limited, Nos. 1 to 112,100 .... | 2 | – | 1-1¼ |
| —— 7 per cent. Cumulative Pref. .... | 2 | – | 2¼-2⅜ |
| —— 4 per cent. Perp. 1st Mort. Deb. .... | 100 | – | 97-99 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 | – | 9¼-10 |
| —— 4 per cent. 1st Mort. Deb. Stock .... | 100 | – | 97-101 |
| W. T. Henley's Telegraph Works, Ordinary .... | 5 | – | 11-12 |
| —— 4½ per cent. Preference .... | 5 | – | 5⅜-5⅝ |
| —— 4½ per cent. Debentures .... | 100 | – | 109-111 |
| India Rubber, Gutta Percha, and Telegraph Works .... | 10 | – | 16-17 |
| —— 4 per cent. Debentures .... | 100 | – | 100-103 |
| Parker, Thos., Limited, Ordinary .... | 10 | – | 10-10¼ |
| Telegraph Construction and Maintenance .... | 12 | – | 26-38 |
| —— 5 per cent. Bonds .... | 100 | – | 103-105 |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary .... | 10 | – | 11⅛-12¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 .... | 10 | – | 10-10¼ |
| —— 5 per cent. Cum. Second Pref., 15,001-22,500 .... | 10 | – | 11-12 |
| —— 4½ per cent. Debenture Stock. Red. .... | 100 | – | 106-108 |
| Bromley (Kent) Electric Light and Power Co. .... | 5 | .. | 5¼-5⅜ xd |
| —— 4½ per cent. 1st Debenture Stock, Red. .... | 100 | – | 103-106 |
| Brompton and Kensington, Ordinary .... | 5 | – | 9¼-10¼ |
| —— 7 per cent. Preference .... | 5 | – | 9¼-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 .. | 5 | – | 8⅜-9¼ |
| —— Nos. 60,001-80,000 .... | 5 | – | 7⅜-8¼ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. .... | 8 | – | 12¼-13¼ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 105-108 |
| Charing Cross and Strand, 70,001-80,000 .... | 5 | – | 7¼-8¼ |
| —— 4½ per cent. Cum. Pref. .... | 5 | – | 5⅜-5⅝ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 5-5¼ |
| —— 40,001-80,000 .... | 5 | .. | 5-5¼ |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 | – | 105-107 |
| Chelsea Electricity Supply .... | 5 | – | 6¼-7 |
| —— 4½ per cent. Debentures .... | 100 | – | 109-111 |
| City of London, Ordinary .... | 10 | – | 11-12 |
| —— 6 per cent. Cumulative Pref. .... | 10 | – | 13¼-14 |
| —— 5 per cent. Debenture Stock .... | 100 | – | 125-127 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) .. | 100 | – | 103-105 |
| County of London Electric Supply, Ordinary .... | 10 | – | 9-9¼ |
| —— 6 per cent. Cum. Pref. .... | 10 | – | 12-12¼ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 103-105 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. .... | 100 | .. | 111-114 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 .. | 5 | – | 5¼-6¼ |
| —— 6 per cent. Cum. Pref. .... | 5 | – | 6¼-6¾ |
| —— 4½ per cent. First Mort. Deb. .... | 100 | – | 106-108 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 2¼-2⅜ |
| —— 5 per cent. Debenture Stock, Red. .... | 100 | – | 86-91 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 .... | 5 | – | 5¼-5⅜ xd |
| —— 4½ per cent. First Deb. Stock, Red. .... | 100 | – | 101-104 |
| Havana Electricity, Limited, 1-15,000 .... | 10 | – | 9¼-10¼ |
| Hove Electric Lighting, Limited, Ord., 1-13,000 .... | 5 | – | 7¼-3 xd |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 102-105 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 .... | 1 | – | 11/16-13/16 |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | | 12-13 |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red .... | 100 | – | 101-103 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅜-10¼ |
| London Electric, Ordinary .... | 3 | – | 2¼-2⅜ |
| —— 6 per cent. Pref. .... | 5 | – | 5¼-5⅜ |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red... | 100 | – | 99-101 |
| Metropolitan Ordinary .... | 10 | – | 17½-18¼ |
| —— 4½ per cent. First Mortgage Debenture Stock .... | 100 | – | 109-114 |
| —— 4½ per cent. Cum. Pref. .... | 5 | – | 5⅜-5¾ |
| —— 3½ per cent. Mortgage Debenture, Red. .... | 100 | – | 97-99 |
| Midland Electric Power Dis., Ld., 4½ p c. 1st Mort. Deb.. | 100 | – | 99-101 |
| Newcastle-upon-Tyne Electric Supply, Ordinary .... | 5 | – | 98-101 |
| —— Preference .... | 4 | – | 100-102 |
| Notting Hill Electric Lighting .... | 10 | – | 14⅜-15¼ |
| —— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.) .. | 100 | | 100-102 |
| Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,510 .... | 5 | – | 6¼-6¾ |
| —— 4 per cent. Debenture Stock .... | 100 | – | 98-100 |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures .... | 100 | – | 101-104 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 .. | 5 | – | 2⅝-3¼ |
| —— 4 per cent. Debenture Stock .... | 100 | – | 79-83 |
| South London, Ordinary .... | | – | 3¾-4¼ |
| South Metropolitan Electric Light and Power Co., Ord... | 1 | .. | ¾-1 |
| —— 7 per cent. Cum. Pref. .... | 1 | .. | 1 11/32-1 13/32 |
| —— 4½ per cent. 1st Mort. Deb. .... | 100 | .. | 105-108 |
| —— Ditto, June, 1904 .... | | .. | |
| St. James's and Pall Mall, Ordinary, 101-20,000 .... | 5 | – | 13¼-14¼ |
| —— 7 per cent. Pref. .... | 5 | – | 8¼-8¾ |
| —— 3½ per cent. Deb. .... | 100 | – | 98-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 .... | 5 | – | 4 15/16-5 1/16 |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5-5¼ |
| Westminster, Ordinary .... | 5 | – | 12¼-13¼ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 .... | 5 | – | 6-6¼ |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 .... | 5 | – | 5⅛-6 |
| —— Ord. .... | 5 | .. | 8¼-8½ xd |
| —— Permanent 6 per cent. Debenture Stock, 1888 .. | 100 | – | 140-143 |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 105-107 |
| Barcelona Tramways, Limited, Ord., 1-20,000 .... | 10 | .. | 12-12¼ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 .... | 10 | .. | 9¼-10 |
| —— 5 per cent. Deb., Red., 1-600 .... | 100 | .. | 99-102 |
| —— 4½ per cent. Red. Deb. Stock .... | 100 | .. | 96-100 |
| Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606.. | 1 | .. | 13/16-15/16 |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 .... | 1 | .. | 1-1¼ |
| Belfast Street Tramways, Ord., 1-26,600 .... | 10 | .. | 10¼-11¼ |
| Blackpool and Fleetwood Tramroad .... | 10 | – | 15¼-15⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 .... | 5 | – | ¾-1¼ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 .... | 5 | – | 3¾-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 91-96 |
| British Columbia Electric Railway Co., Ord. Def. .... | 100 | – | 104-107 |
| —— Ord. Pref. .... | 100 | – | 100-103 |
| —— Non. Cum. 5 per cent. Pref. .... | 10 | – | 10¼-10⅜ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 | – | 103-105 p c xd |
| —— 4½ per cent. Vancouver Power Deb. .... | 100 | – | 99-102 |
| British Electric Traction Ord. 1-500,000 & 60,001-90,000 | 10 | – | 9¼-9⅜ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 .... | 10 | – | 10¾-11¼ |
| —— 5 per cent. Perpetual Debenture Stock .... | 100 | – | 120-122 |
| —— 4½ per cent. 2nd Deb. Stock .... | 100 | – | 98-100 |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Buenos Ayres and Belgrano Tram. Ord., 1-100,000 | 5 | 3¼-3⅜ xd |
| —— "A" 6 per-cent. Cm. Pf., 1-40,000 | 5 | 5 9/16-5 13/16xd |
| —— "B" 6 per cent. Cm. Pf., 1-27,600 | 5 | 5¼-5½ xd |
| —— 5 per cent. Deb. Stock, Red. | 100 | 107-109 |
| —— Prov. Cert., all paid | 100 | 103-106 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | 97-99 |
| Calcutta Tramways, Limited, 1-102,268 | 5 | 8¼-8½ xd |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | 106-108 |
| Cape Electric Tramways Nos. 1-480,000 | 1 | 1¼-1½ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | 4⅝-5 xd |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | 99-102 xd |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | 103-105 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | 9¼-10 |
| —— 5 per cent. Cum. Pref. | 10 | 11-12 |
| —— 4 per cent. Debentures | 100 | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | 13½ 14½ |
| —— ½ per cent. Pref., Nos. within 1-60,000 | 10 | 15½-16¼ |
| —— ½ per cent. Mort. Debs., 1-5,000, Red. | 100 | 94-97 |
| Imperial Tramways Ordinary | all | 13-13 |
| —— ½ per cent. Cum. Pref. | all | 14-14½ |
| —— ½ per cent. Deb Stock | 100 | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum Pref., Nos. 30,001-60,000 | 5 | 2⅜-3½ |
| —— 4 per cent. Debenture Stock | 100 | 85-90 |
| Kilmarnock and District Lighting and Traction, Pref. | 5 | 8 8¼ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | 10½-10⅝ |
| —— ½ per cent. 1st Mt. Db. Stock, Red. | 100 | 100 103 |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016. | 1 | 3 7/16 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | 1-1 1/16 |
| —— 4½ per cent. Deb. Stock, Red. | 100 | 105-107 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000 | $1,000 | 105-110 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 | 101-104 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 | 103-105 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000 | 5 | ¼-1¼ |

| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Oldham, Ashton, and Hyde Tramway, Ordinary | 10 | 12 |
| —— 5 per cent Cum. Pref. | 10 | 9⅞-9⅞ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Sk. | 100 | 105-108 |
| Potteries Electric Traction, Ordinary 30,001-40,00 | 10 | 9-9⅛ xd |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | 9¼-9⅝ |
| —— 4½ per cent. Debenture Stock | 100 | 103-107 |
| South Lancashire Electric Traction and Power Company | | |
| —— £250,000 Ordinary | 1 | 1 |
| —— £101,152 5 per cent. Preference | 1 | |
| —— £597,170 4½ per cent. Debenture Stock | 100 p.c. | 100 p.c. |
| **Electric Railways.—** | | |
| Central London, Ordinary | 100 | 92-94 |
| —— 4 per cent. Pref. | 100 | 101-103 |
| —— ,, ,, deferred | 100 | 82-85 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | 111-113 |
| City and South London, Consolidated Ordinary | 100 | 44-45 |
| —— 4 per cent. Debenture Stock | 100 | 107-109 xd |
| —— 5 per cent. Pref. Stock '91 | 100 | 120-123 |
| —— ,, ,, ,, '96 | 100 | 118-121 |
| —— ,, ,, ,, '01 | 100 | 115-118 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | 10-10¼ |
| —— Ordinary, 1-50,000 | 10 | 3¾-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — | 99-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | — | 99¼-100¼ |
| Waterloo and City, Ordinary | 100 | 92-94 |
| **Telephones.—** | | |
| National Telephone, Preferred | 100 | 108½ 109½ |
| —— Deferred Stock | 100 | 108-102 |
| —— 6 per cent. Cum. First Pref. | 10 | 12½-13½ |
| —— 6 per cent. Cum. Second Pref. | 10 | 11½-12½ |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | 5¼-5⅝ |
| —— 5½ per cent. Deb. Stock, Red. | 100 | 100-102 |
| —— 4 per cent. Deb. Stock, Red. | 100 | 104-106 |
| —— 4 per cent. Prov. Cert. | — | 103½-105½ |
| Oriental Telephone and Electric Company | 1 | 1¼-1⅜ |
| —— 6 per cent. Cum. Pref. | 1 | 1 5/16-1 5/16 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905. | 1904. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | April 22 | 1,133 | 1,230 | − 97 | + 5,359*h* | 19¼ | 19¼ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·14 |
| Ayr Corporation | ,, 15 | 212 | 201 | + 33 | + 635 | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 376,049 | 1·03 | 10·11 | 1,770 | 5·0 |
| Barking Corporation | ,, 1 | 48 | 41 | + 7 | + 305 | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 23 | 967 | 1,033 | − 55 | − 91 | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,319,701 | 1·158 | 9·98 | 2,383*b* | 6·1 |
| Birmingham Corporation | ,, 22 | 355 | 258 | + 87 | + 212 | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | — | — | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 19 | 857 | 831 | − 63 | − 457 | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10·94 | — | 4·59 |
| Blackpool Corporation | ,, 20 | 462 | 555 | − 91 | − 1,165 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 22 | 537 | 313 | + 224 | — | 16½ | 16½ | Dec. 31 | 32,021 | 2,258,984 | 600,757 | 3·34 | 12·75 | 2,001 | 7·05 |
| Bolton Corporation | ,, 23 | 2,354 | 1,794 | + 560 | — | 38 | 38 | March 31 | 94,161 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 5,766 | 5·89 |
| Bournemouth Corporation | ,, 19 | 994 | 1,165 | − 171 | − 1,032 | 10·15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 8 | 3,912 | 4,805 | − 893 | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 23 | 912 | 814 | + 148 | — *h* | 9 | 7½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 21 | 4,708 | 5,076 | − 368 | — | 51½ | 51½ | Dec. 31*g* | 253,150 | 44,391,439 | 6,033,528 | — | — | — | — |
| Burnley Corporation | ,, 22 | 1,367 | 1,035 | + 332 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 23 | 325 | 318 | + 7 | — | 8¼ | — | March 31*i* | 11,574 | 2,556,134 | 282,378 | 1·08 | 9·84 | 1,570 | 7·57 |
| Cardiff Corporation | ,, 8 | 1,817 | 2,134 | − 237 | − 514 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 22 | 188 | 197 | − 9 | − 338 | — | — | Dec. 31*g* | 9,987 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 22 | 6,216 | 6,538 | − 322 | + 2,003*i* | 6 | 6 | ,, 31 | 362,471 | 44,953,938 | 1,292,674*a* | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 23 | 2,525 | 2,778 | − 253 | − 2,734*h* | 6½ | 6⅜ | ,, 31 | 165,003*a* | 19,069,319*a* | — | — | — | — | — |
| Colchester Corporation | ,, 19 | 182 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 13 | 432 | 433 | − 1 | — | — | — | ,, 31*g* | 26,657 | 6,353,323 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | ,, 21 | 272 | 218 | + 54 | — | 7·23 | 7·23 | March 31*g* | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 15 | 187 | 201 | − 14 | — | 4½ | 4½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0·91 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | ,, 21 | 133 | 123 | + 5 | — *h* | 7 | 6⅜ | Dec. 31*g* | 6,234 | 588,905 | 107,164 | 3·88 | 14·09 | 952 | 7·39 |
| Dublin U. T., electric cars | ,, 21 | 3,783 | 3,885 | − 102 | — | 47 | 46 | ,, 31*g* | 134,643 | — | 3,429,356 | — | — | — | — *k* |
| Dublin S. District, Electric | ,, 21 | 810 | 1,031 | − 221 | | | | | | | | | | | |
| Dundee City Tramways | ,, 19 | 764 | 832 | − 68 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 22 | 801 | 753 | + 48 | — | 10·77 | 10·75 | March 31 | 34,312 | 12,950,269 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 22 | 14,716 | 14,935 | − 219 | +31,935*h* | 145 | 123 | May 31*g* | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489*b* | 7·40*d* |
| Gloucester Corporation | ,, 19 | 280 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 5 | 2,658 | 3,003 | − 345 | — | 33 | 30½ | March 31 | 68,283 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,069 | 8·77 |
| Huddersfield Corporation | ,, 22 | 1,259 | 1,237 | + 22 | — | 35 | 35 | ,, 31 | 65,545 | 11,893,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | ,, 22 | 2,194 | 2,026 | + 168 | — | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | ,, 15 | 414 | 426 | − 12 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | ,, 12 | 107 | 119 | − 12 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 19 | 202 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 22 | 5,414 | 5,532 | − 118 | − 237 | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | ,, 22 | 1,951 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | ,, 15 | 10,461 | 9,954 | + 497 | + 6,238 | 103 | 103 | Dec. 31*g* | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | ,, 23 | 1,475 | 1,618 | − 143 | − 1,268*h* | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185*a* | 1·82 | 19·30*a* | 5,110 | — *e* |
| London County Council | ,, 1 | 13,251 | 10,864 | +2,387 | — | 46½ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | ,, 20 | 107 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 22 | 12,610 | 11,700 | + 910 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 22 | 153 | 116 | + 37 | — | 2¾ | — | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newcastle-on-Tyne Corptn. | ,, 22 | 3,734 | 3,492 | + 242 | — | 45 | 38½ | ,, 25 | 185,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111*b* | — |
| Newport (Mon.) Corporation | — | — | — | — | — | 15 | — | — | — | — | — | — | — | — | — |
| Oldham Corporation | ,, 23 | 1,623 | 1,166 | + 462 | + 6,717 | 34¾ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 15 | 1,685 | 1,678 | + 7 | + 1,223 | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·16 | 12·39 | — | — |
| Reading Corporation | ,, 13 | 596 | 567 | + 29 | — | — | — | — | — | — | — | — | — | — | — |
| Rochdale Corporation | ,, 15 | 528 | 116 | + 412 | + 860 | 4½ | 4½ | 31*g* | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 20 | 787 | 458 | − 71 | + 2,539 | — | — | ,, 31 | 20,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·68 |
| Salford Corporation | ,, 24 | 4,803 | 3,831 | + 922 | — | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 15 | 74 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 23 | 4,623 | 4,553 | + 69 | + 720 | 34¼ | — | ,, 25*g* | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 19 | 893 | 938 | − 85 | − 345 | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 14 | 271 | 277 | − 6 | — | 6½ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 21 | 640 | 530 | + 110 | — | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 23 | 1,183 | 1,170 | + 13 | — | 19·54 | 18·48 | ,, 31 | 62,506 | 14,848,958 | 1,433,463 | 1·01 | 10·46 | — | 6·02 |
| Swindon Corporation | ,, 8 | 169 | — | — | — | 3⅔ | — | — | — | — | — | — | — | — | — |
| Wallasey U.D.C. | ,, 22 | 702 | 679 | + 23 | — | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·30 |
| Warrington Corporation | ,, 20 | 314 | 300 | + 14 | — | 7½ | — | — | — | — | — | — | — | — | — |
| West Ham Corporation | ,, 20 | 1,177 | 754 | + 423 | + 1,226 | 8·62 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 19 | 636 | 551 | + 144 | — | 7½ | — | ,, 31*g* | 20,878 | 4,263,066 | 417,335 | — | 12·006 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *b* Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1905. *h* Half-year's figures. *i* Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**The Electrical Engineers (R.E.V.).**—The Electrical Volunteers are holding a regimental Bohemian concert at the Caxton Hall to-morrow night, this being the last of the season. The chair will be taken by Colonel Crompton at 8 p.m.

**The American Institute.**—We have received a copy of this institute's *Proceedings* for April, the contents of which include papers on "Polyphase Metering," by D. J. Nies; "The Use of Instruments on Switchboards," by F. P. Cox; "The Oscillograph and its Uses," by L. T. Robinson; "Maintenance of Meters," by W. J. Mowbray; and "Cement in Central-Station Design," by E. B. Clark; also the discussions on "Two-Motor *versus* Four-Motor Equipments" and "Track Bonding."

**Personal.**—The council of the City and Guilds of London Institute have conferred the fellowship of the institute on Mr. H. Cecil Booth in recognition of the original and valuable engineering work which he has done since he gained his diploma of associate of the City and Guilds Institute in 1892. Since Mr. Booth left the institute's Central Technical College he has been engaged in many branches of engineering work, and is the inventor of the vacuum cleaning machine for cleaning carpets and furniture without removal.

**Tramways and Light Railways Association.**—We have received a copy of this association's *Official Circular* for April, which contains a paper by Mr. W. F. Parish on "Friction as affected by Lubrication." There is a synopsis of the information received from various tramway undertakings, private and municipal, as to their practice regarding the limitation of liability in cases of accidents to third parties. From the latest correspondence between the association and the Board of Trade it appears that the latter intend to adhere to the existing practice as to fixing tramway speeds.

**The Telephone Transfer.**—The future of the company's staff has been the subject of communications between the Post Office and the National Telephone Company. The Postmaster-General has practically promised to include the whole of the existing staff when the undertaking of the company is taken over by the Government, but no definite arrangement in regard to pensions has yet been arrived at. An association of employés, numbering 13,000, has been formed, and promises have been given by members of Parliament to support the movement for placing their pensions on an equitable basis.

**Electrical Radiography.**—From an abstract appearing in the *Journal* of the Chemical Society of an article by Mr. V. Gabritschewski it appears that if a radium preparation and any flat object are brought for a few minutes into the immediate neighbourhood of an electrified ebonite plate, and the latter is dusted with a finely-divided mixture of sulphur and red lead, a sharply-outlined dust figure of the object is formed on the ebonite plate. It is not necessary that the object should be in contact with the ebonite plate, nor with the radium preparation. If the latter is placed on the opposite side of the plate, the figures make their appearance. The author attributes this to the existence of a special force which attracts the electrical charge of the plate towards the object in its vicinity.

**Germany's Minerals.**—A preliminary statement has been issued by the German Imperial Statistical Bureau, showing the mineral and metallurgical production of the Empire for the year 1904. The output of coal in that year was as follows: coal, 120,815,503 metric tons, of the value of £51,700,000; lignite, 48,632,769 metric tons, of the value of £5,599,900—totals, 169,448,272 metric tons and £57 299,900. Compared with 1903, there was an increase of 3·5 per cent. in the output of coal and of 6·1 per cent. in that of lignite. The quantities of other minerals and salts produced in 1904 were: iron ore, 22,047,297 metric tons; zinc ore, 715,732 metric tons; lead ore, 164,440 metric tons; copper ore, 798,214 metric tons; silver and gold ore, 10,405 metric tons; cobalt, nickel, and bismuth ores, 14,016 metric tons; manganese ore, 52,886 metric tons; pyrites, 174,782 metric tons; asphalt, 91,736 metric tons; petroleum, 89,606 metric tons.

**Electricity in British Columbia.**—It is reported that the British Columbia Electric Railway Company's great hydro-electric enterprise at Coquitlam is now completed by the successful boring of its 2½-mile tunnel. The work was commenced in July, 1902, and it was estimated that it would take three years to complete, but the engineers have accomplished their task in three months less than the allotted time. The tunnel, which runs out of Lake Coquitlam into a smaller lake called Lake Beautiful, passes under a spur of the Cascade Range of the Rocky Mountains, 3,400ft. in height, has a fall of 32ft., is 12,775ft. in length, with dimensions 9ft. by 9ft. From Lake Beautiful to the power-house on Burrard Inlet the fall is 410ft. Thence the electric energy is conveyed to the railway company's sub-stations. The overhead wires are carried from twin steel towers where they pass over navigable waters in the route. The plant is capable of developing 35,000 h.p.

**Rontgen Rays.**—A congress was opened at Berlin at the commencement of the week to commemorate the decennium of Prof. Röntgen's great discovery. A great number of scientists, statesmen, and medical men assembled to do honour to the distinguished physicist, the medical element especially gathering in force in recognition of the valuable adjunct to therapeutics provided by the professor's researches. The opportunity was taken to survey the great achievements rendered possible during the past 10 years by the discovery of Prof. Röntgen, who, it may be mentioned, has persistently refused any personal reward, feeling satisfied by the service he has rendered to suffering humanity. In the German capital, however, a public monument has been erected in his honour while still alive—a rare distinction. Numerous papers were read, these being of interest to the medical rather than the electrical profession, but all testified to the beneficence of the discovery of a scientist who has deserved well of his fellowmen.

**Electro-Therapeutics.**—In the *Lancet* for April 29 Drs. Bain, Edgecombe, and Franklin detail some extensive investigations conducted by them with a view to ascertaining the effect of certain baths and other applications of electricity on the blood, blood-pressure, and metabolism. The tests were not conducted in this instance for curative purposes, but purely in the interest of research, the authors being themselves the subjects. The authors first describe their experiments with a high-frequency current, which was administered by auto-condensation at 350 to 450 milliamperes for 30 minutes on four successive days, followed by the effleuve of the maximum intensity obtainable without sparking, applied to the whole surface of the body in succession for 30 minutes on two consecutive days. An elaborate description of the various effects follows, and we gather that the authors favour this treatment more particularly for local affections of the nerves and skin. Then follow accounts of experiments with various electric baths, including the Dowsing, Greville, immersion, and the light and ozone types, and the article concludes with a

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summary of results showing the advantages of these various electrical treatments.

**Glasgow Section.**—Mr. E. G. Tidd, the hon. secretary, forwards us the fifth annual report, to be submitted at the general meeting on Tuesday next. At the same time the officers for 1905-6 will be balloted for, additional nominations having been received. The committee expresses its gratification at the satisfactory position and the progress made in the course of the past session, during which the interest manifested in the papers and discussions has been greater and more sustained than in any previous session, the attendance of members exceeding a hundred on two or three occasions. The table of membership for the last five years shows a progressive increase, the total of all grades now reaching 211, but, as is pointed out, there are many more qualified engineers in the district, and the committee express a hope that some at least of these will come into line. Special regret is expressed at the resignation of Mr. W. A. Chamen, who has quitted the post of electrical engineer to the Glasgow Corporation to enter into private practice. The social side has also been a distinct success, the inaugural dinner quite eclipsing previous functions of the kind. If the papers submitted during the session have been rather below the average in number, they have fully compensated for this in point of quality, the parent Institution having already accepted for publication Dr. Henderson's paper on "Armature Reaction in Alternators," Mr. H. B. Maxwell's paper on "Street-Lighting by Electric Arc Lamps," and Mr. W. W. Lackie's paper on "Earthing." The section is to be congratulated upon a capital season's work. Some interesting papers have already been offered for next session, and the committee hope that all members will co-operate both by such contributions and participation in the discussions.

**Niagara.**—His Excellency the Governor-General visited Niagara Falls last week to inspect the work of the Electrical Development Company of Ontario, of which Colonel Pellatt, of Toronto, who commanded the Canadian Coronation contingent, is president. This energy will be transmitted to Toronto, Hamilton, and the principal towns and cities of Ontario within a radius of 100 miles of Niagara. Lord Grey expressed himself highly upon the company's undertaking, and at the luncheon to which he was entertained His Excellency congratulated Colonel Pellatt and his fellow-directors on the progress made in their great enterprise. Reports in the daily Press state that horse-power to the extent of 25,000 will be developed by this plant, but a communication to the *Times* from Mr. J. G. Colmer explains that the company has the right to take water from the Niagara River for the purpose of generating electricity to the extent of 125,000 h.p., that the works are being constructed on that basis, that the machinery to be provided in the first instance will be sufficient for the generation of 65,000 h.p.; and that the further 60,000 h.p. can be readily made available at a comparatively small expense when it is required. The company has now obtained a concession from the Government of Ontario, subject to ratification by the Parliament of the Province, enabling it to develop an additional 125,000 h.p. The question of cheap power is attracting much attention all over Canada, and the utilisation of the numerous water powers to be found in every province for the generation of electrical power at a moderate price is confidently expected to give an enormous impetus to the development of the manufacturing and other industries of the Dominion and of local transportation facilities within the next few years.

**Radium.**—Various panaceæ for the dreaded cancer germ have been advanced from time to time, only to prove a qualified success at best, but the *Daily Telegraph* reports from America a new method which apparently contains more efficacy, solvent radium being the destroying agent. The treatment, as demonstrated at the Flower Hospital in New York, comprises the insertion of celluloid pencils coated with a solution of radium, differing from the use of radium in tubes as a destroyer of cancerous cells. Statements of the good results secured were treated with considerable suspicion until Dr. King lent the authority of his name to the value of the new treatment. That greater radioactivity is shown by radium in solution used as coating on pencils than in tubes has been clearly demonstrated. It is stated that the radium pencils inserted in the cancerous growth have destroyed the cancerous cells without breaking down the living tissues. The pencils are left in contact for 24 hours, or longer, and most satisfactory results are reported to have been obtained. Dr. William Harper, president of the University of Chicago, is cited as a notable example of the efficiency of the radium cure. A few weeks ago the doctors gave up hope in his case, declaring that he was suffering from fatal internal cancer. Since he has been under treatment by radium and X-rays he has progressed remarkably. The size of the cancerous tumour is rapidly diminishing, and has already been reduced from 18 to 7 square inches. Two cases guaranteed by Dr. King as genuine radium cures are those of a man treated for cancer of the tongue and of another for cancer of the foot. In both instances the growth has disappeared. Important experiments with the new agency are now being conducted at the leading hospitals in New York.

**Electric Lighting in the States.**—The Legislative Committee is proceeding with its investigation into the electric light and gas services of the city of New York. Evidence was given by Mr. Arthur Williams, of the New York Edison Company, that if the average hours in use were taken into consideration, current in bulk would cost the city 30 per cent. more than it does now, the average number of hours of service in the city buildings being very low. In reply to a question as to whether the company had a single customer who used approximately the same amount of current as that furnished to the city buildings, Mr. Williams replied that they had, and that the rate of supply was 1½d. per kilowatt-hour. Evidence was then given as to the financial relations of the Empire City Subway Company and the New York Telephone Company with the New York Edison Company, from which it appears that the latter are paid £40 per mile annually for maintenance of ducts by the Empire Company. The assets of the New York Edison Company were stated to total 5½ million pounds, exclusive of goodwill. The finances of the companies are being investigated in some detail, owing to suggestions of large profits through exorbitant charges. The situation in Brooklyn, the large New York suburb, was then dealt with. The treasurer of the United Electric Light and Power Company stated that the amount written off for depreciation averaged ½d. per unit, the same as the amount allowed by the New York Edison Company. This brought the average cost per kilowatt-hour sold up to 2·86d. Colonel Robert Grier Munroe, ex-commissioner of water supply, gas, and electricity, who had made allegations against the companies of excessive charges, admitted that his assertion was not based upon investigations, and that a comparative list of rates in different cities which he had published contained several discrepancies.

**Polyphase Meters.**—The American Institute of Electrical Engineers received on the 28th ult. a paper by Mr. J. D. Nies, entitled "Some Notes on Polyphase Metering." In these the author deals with the various ways in which the energy supplied to consumers by the three-phase

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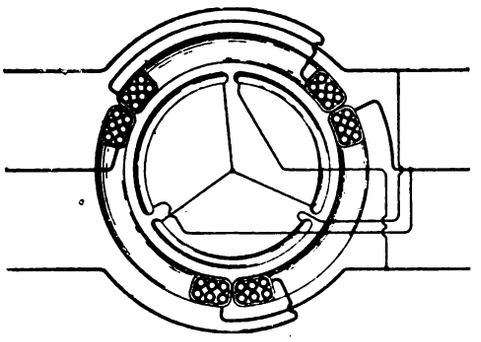
system may be measured. He deals particularly with large consumers, whose demand may range from 200 kw. up to 1,000 kw. It seems that in America polyphase meters have been largely used for such consumers, and that it is the practice to put two of these meters in series. As is to be expected, the results obtained in such cases are by no means concordant. The reason of this is that with a polyphase meter so many elements enter into the final reading that a large variety of errors can easily be introduced. The author goes into these, and shows the influence of current transformers on the accuracy of the reading throughout the full range of the meter and with differences in the power factor of the demand. At light loads and with low power factors the error caused by the use of current transformers may be serious. He also deals with the influence of the drop in the common return if a two-meter method is used. His conclusion after going into the various errors which can be introduced is that the most accurate method is to use three single-phase meters and to take independent records from each. It is true that there are errors which would affect all these three meters in the same way, but the chances are that they will not develop the same defect simultaneously. Under normal conditions, therefore, one should get equal readings from each meter, and if this is not the case it shows that there is something about either the meters or the installation which requires attention. Each meter should be connected between one wire and the neutral of the system. In those cases where the neutral conductor is not available it can be easily obtained by using pressure transformers, since the secondaries of these can be connected up in star fashion.

**Phase Indicator.**—A novel form of phase indicator has recently been patented in the United States by Mr. P. G. Watmough, jun., of Schenectady, and assigned by him to the General Electric Company. The device, which is described in the *Electrical Review* of New York, is of particular value for use in connection with



multiphase circuits for showing the phase difference between current and E.M.F. The instrument comprises two relatively rotatable members, the windings of one being connected in series with the polyphase mains, while the windings of the other are connected in shunt. Two connections are so made that the windings of each member when traversed by current set up a rotary magnetic field, the direction of rotation of the fields being the same. The movable member of the indicator assumes a position such that the polar line of the magnetic field due thereto is brought into coincidence with the polar line of the magnetic field due to the stationary member of the instrument. Since the two magnetic fields revolve at the same speed, the two members of the instrument remain in fixed relation to each other so long as there is no change in the phase relation between the currents in the two members. As soon, however, as the current in the polyphase mains begins to lag or lead, the field due thereto shifts backward or forward to correspond, thereby causing the movable member of the indicator within the influence of this field to shift correspondingly. The angle of displacement of this movable member thus furnishes a measure of the phase displacement between the current and the E.M.F. of the polyphase circuit.

**Royal Institution.**—The annual meeting of the members of this institution was held on Monday afternoon, the Duke of Northumberland, K.G., president, in the chair. The annual report of the Committee of Visitors for the year 1904, testifying to the continued prosperity and efficient management of the institution, was read and adopted, and the report on the Davy-Faraday Research Laboratory of the Royal Institution, which accompanied it, was also read. Seventy-one new members were elected in 1904. Sixty-three lectures and 19 evening discourses were delivered in 1904. The books and pamphlets presented in 1904 amounted to about 267 volumes, making with 721 volumes (including periodicals bound) purchased by the managers a total of 988 volumes added to the library in the year. Thanks were voted to the president, treasurer, and the hon. secretary, to the Committees of Managers and Visitors, and to the professors, for their valuable services to the institution during the past year. The following gentlemen were unanimously elected as officers for the ensuing year: president—The Duke of Northumberland; treasurer—Sir James Crichton-Browne; secretary—Sir William Crookes; managers—Sir William de W. Abney, the Right Hon. Lord Alverstone, Henry E. Armstrong, Esq, Shelford Bidwell, Esq, Sir Alexander Binnie, the Hon. Sir Henry Burton Buckley, the Right Hon. Charles Scott Dickson, Francis Elgar, Esq., Maures Horner, Esq, Dr. Ludwig Mond, Sir Andrew Noble, Bart, the Right Hon. the Earl of Rosse, Sir Thomas Henry Sanderson, Alexander Siemens, Esq., and Silvanus P. Thompson, Esq.; visitors—Dr. William Arthur Brailey, Dr. John Mitchell Bruce, Sir John George Cragge, Dr. James Mackenzie Davidson, Francis Fox, Esq, Robert Kaye Gray, Esq., Lord Greenock, Charles Edward Groves, Esq., A. Kirkman Lloyd, Esq., M.P., Sir Philip Magnus, Carl E. Melchers, Esq, Emile R. Merton, Esq, George Johnstone Stoney, Esq., John Jewell Vezey, Esq., and George Philip Willoughby, Esq.

**Electrolytic Estimation of Arsenic.**—The *Journal* of the Chemical Society contains an abstract of an article by Messrs. Carl Mai and H. Hurt, in which the authors describe their investigations regarding the electrolytic estimation of small quantities of arsenic and the apparatus employed. This latter consisted of a wide U-tube, in which the decomposition is carried out, and a six-bulb absorbing tube. Between these two parts, and connecting them, is placed a tube filled with pumice-stone soaked in alkaline lead solution. The electrodes consist of pure sheet lead. The ends of the U-tubes are closed with caoutchouc stoppers, through which pass glass tubes, elongations on the lead plates being cemented in these tubes, so that a plate is suspended in each limb of the U-tube. A safety tube passes through the cork of the anode limb, whilst the cork of the cathode limb is pierced by the capillary stem of a tapped funnel and the delivery tube of the apparatus. The U-tube is about two-thirds filled with a 12 per cent. sulphuric acid solution, and 10 c.c. of N/100 silver nitrate solution are placed in the bulbs of the absorption tube. The current may be obtained direct from the main and should be controlled by a suitable resistance. The solution to be examined is introduced drop by drop from the tapped funnel. Should arsenic be present, the silver solution is darkened, and at the end of two, or at the most three hours, the reduction is completed. The reduced

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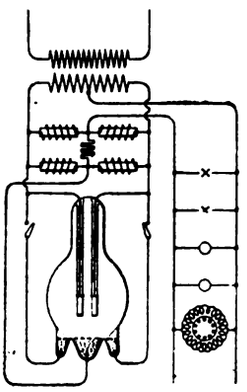
silver is collected on an asbestos filter, washed with a little water, and the excess of silver in the filtrate titrated with N/100 thiocyanate solution. One c.c. of N/100 silver nitrate solution is equivalent to 0·124 mg. of metallic arsenic. For quantities of less than 0 02 mg., the titration method fails and a calorimetric one must be employed, when 0·001 mg. of arsenic may be estimated and 0·0005 mg. detected. For the detection of minute traces, the absorption tube may be replaced by the combustion tube of a Marsh apparatus and a mirror obtained in the usual way. The authors state that all organic matter must be destroyed before estimating arsenic in such articles as beer, urine, etc. The results appear to be similar to those described some months ago by Mr. W. Thompson, to which we referred in our issue of July 1 last.

**Frequency Changer.**—An interesting application of the mercury-vapour rectifier embodied in a patent recently granted in the United States to Mr. O. O. Kruh is described in the *Electrical World* of New York. Although the inherent characteristics of the rectifier are such as to deliver a pulsating unidirectional current, the inventor proposes to use the rectifier in combination with inductance coils to obtain an alternating current of double the initial frequency. The connecting circuits are shown in the accompanying diagram. The two carbon anodes are



connected to the secondary leads of the main supply transformer. Owing to the selective behaviour of the mercury cathode, the current flows alternately through the anodes in a constant direction to the cathode. The inductance coils store energy during the time when current is flowing from one anode to the cathode, and discharges this energy in such a manner as to cause the current to continue to excite the cathode until the wave of E.M.F. has so far reversed as to start the flow of current from the other anode. The effect of the inductance coil in the circuit of the cathode is normally to fill up the gaps in the unidirectional current waves, and thus to produce a more or less even direct current. Instead, however, of merely filling the gaps in the current waves in the consumption circuit, the inductance coils as here arranged deepen the depressions, so to speak, and cause them to extend across the neutral line of current, and so produce an alternating current. The object of the use of four inductance coils and the connecting resistance is to equalise the waves due to the direct flow of current from the source and the waves of opposite polarity produced by the discharge of the inductance coils. The inventor claims that when the apparatus is arranged as here indicated all dissymmetry of the current is eliminated, and a smooth double-frequency current is obtained.

**The Italian Railways.**—Between the question of State control or the leasing of the lines and difficulties with the employés the Italian Government has had little opportunity for taking into serious consideration the suggestions for electrifying the railways of the peninsula which have been made from time to time. The country's bountiful water supply has been a considerable factor in the great expansion industrially which electricity has undergone in Italy during the past decade, and this has encouraged the idea that the same source of power might be utilised to drive the railways. Apart from technical questions, however, the commercial phase enters largely into the matter. In 1885 the railways were leased to companies for a term of 60 years, determinable by either party at the end of 40 or 20 years. It has long been known that the arrangement has not been satisfactory to either party, and at the end of next month the administration of the system will revert to the State, as negotiations with the companies for amended contracts proved abortive. The companies have been greatly handicapped by the demands of the railway employés, and the State seems likely to find the concessions to the staff provided for in the Bill which has just passed through the Italian Parliament a serious incubus for some years. In a memorial to the Throne last October it was claimed that "the State would be in a better position than a private undertaking to find a solution for the vexed question of the status of railway employés, and by guaranteeing their rights and exercising a just but rigid disciplinary control, to remove once for all any further occasion for strikes." The means taken by the Government to allay discontent consist of the establishment of a widows' pension fund, an advance in pay, and from the beginning of next year a share in any profits. If the receipts show a material improvement, it will probably be easier for the Government to provide a solution of the labour difficulty than for the companies, as stated in the above-mentioned memorial, because the Government will not now have to share any profits with lessees. On the other hand, if the financial position does not improve, the concessions to the employés are likely to entail further taxation upon Italy's overburdened citizens. It will be some recompense, however, if the new *régime* succeeds in averting such dislocations of the system as the labour troubles of a few weeks ago entailed Provision is made in the Bill for the improvement of the railways during the next 10 years, but the reforms are apparently in the nebulous stage at present. The measure is of a tentative character, and the future of the railways is left in a rather hazy condition; but by the time economic considerations permit of a general electrification scheme being entertained, the relative advantages of three-phase, single-phase, and direct currents for such work should be definitely determined.

**Testing Alternating-Current Generators.**—Messrs. H. M. Hobart and F. Punga contribute to the *Electrical World* of New York an article in which they describe a new method of testing large alternating-current generators. As one of the primary guarantees given by dynamo manufacturers is that the temperature elevation of the machine under continuous load shall not exceed a stated amount, the importance of such tests is obvious. Little difficulty in this respect occurs with small dynamos, but when the capacity reaches 1,000 kw., it usually becomes quite impracticable to supply the required load for the test in the factory, especially as the time during which the machine mounts up to its final temperature elevation is much larger. This renders it necessary to devise some convenient arbitrary method of testing for temperature elevation that shall not involve the waste of large amounts of energy. The authors commence by briefly reviewing the difficulties attending heat tests of large alternating-current generators, and allude to the drawbacks of the pro-

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posals of Mordey and Behrend, which involve special connections of the armature windings or of the field windings, in order to reduce the amount of power required for the test to the reasonable value represented by the internal losses of the machine. Such systems, moreover, have the great disadvantages that the method of reversed field windings is applicable only when the number of poles is very great, and it is not permissible to subdivide the field winding into two groups only, such connections being attended by a considerable degree of mechanical vibration. The authors' method requires no alterations to the windings, and no greater expenditure of energy than is necessary for covering the internal losses, and it has the advantage that the heating at all parts of the generator will be identically the same in distribution and amount as under actual full-load conditions. It is necessary that the component losses in the machine shall be determined in advance, as would in any event be done in the ordinary course of the tests. Instead of maintaining a steady testing *régime*, they test the machine on short-circuit and on open circuit alternately. During the short-circuit periods they send excessive current and energy into the armature copper with very weak field excitation, while during the open-circuit periods they send excessive energy into the field-magnet circuits with over-excitation. The cycle of operation is made 15 minutes, and the average power thus expended in the machine is made equal to that steadily wasted during the full-load operation. Although the thermal conditions of double or treble current strength with intermissions are not the same as those of steady normal current strength, the difference between them is likely to be insignificant in the case of very large machines, and in any case it is probably less than in other forms of test. The method promises much utility, and in any case it would be highly interesting, as our American contemporary remarks, to have it thoroughly tested.

**The Institution.**—Last week's meeting of the Institution was occupied with the discussion of Mr. F. Creedy's paper on "The Alternating-Current Series Motor," taken in conjunction with the presidential address delivered at St. Louis by Mr. B. J. Arnold. The ball was set rolling by a visitor in the person of Mr. T. H. Schoepf, who stated that Mr. Creedy's experiments had vindicated the theory of the alternating-current series motor. More difficulty was likely to be experienced in designing such motors for high than for low frequency. There were difficulties in the way of designing 100-h.p. or 150-h.p. motors of this type for traction, and he considered that the maximum frequency practicable in motors of large capacity for such purposes would be limited to 25 cycles. Sparking and unsatisfactory commutation were factors which confronted the railway engineer in this connection. The design of the winding was an important feature in the single-phase motor. He then defined the essentials of a good motor, which needed to be efficient and to possess the highest power factor possible. These two factors were influenced by the shape of the speed curve, which must yield good general results. Describing tests he had conducted upon an equipment comprising two 150-h.p. motors, he stated that the most important point related to the power factor. At the moment of starting this was about 26 per cent., and a maximum of 96 per cent. was attained. The rate of acceleration was one mile per hour per second. He anticipated favourable results from a 225-h.p. motor designed for a frequency of 18 cycles. Mr. Alexander Russell, who took exception to the author's method of calculating the efficiency of the series motor, considered that the paper clearly demonstrated the inferiority of the simple alternating-current series motor to the direct-current series motor. The next speaker was a youthful visitor from the States, Mr. L. Calisch, who has had personal experience of the series motor as operated upon the new line from Schenectady to Ballston. The motor used there can run with either direct or alternating current, and possesses a high power factor. He described a motor in use on the line which had an efficiency of from 70 to 79 per cent. with alternating current, and between 70 and 85 with direct current. With alternating current the power factor was 95 per cent. In conclusion, he expressed the conviction that the alternating-current motor had come to stay. The views of the speaker, who, like the author, is an ex-pupil of Prof. Ayrton, were enunciated with conspicuous precision, and the professor's countenance assumed an expression of gratification at the enthusiastic applause accorded his erstwhile *protégé*. Prof. Carus-Wilson remarked that in consequence of trade rivalry it had been rather difficult to obtain information on the subject of the alternating-current series motor. The power factor of motors of this type might be anything that was required, the question being whether a high power factor permitted of a form of design which provided a good railway motor. An improved power factor could be obtained by decreasing the number of armature turns—a conspicuous feature in the tendency of modern design in railway motors—if the limitations of rating were borne in mind, and this yielded what was considered a good design for railway operation. It appeared to him that the alternating-current series motor had not as high an overload capacity at starting as the direct-current type. Apparently the sphere of usefulness of alternating-current motors would be for high-speed running over long distances where few stops occurred. Prof. Ayrton stated that he thought Mr. Russell's criticism was based upon a misconception. He emphasised the point brought out by the author that the armature of the motor, not the field magnet, was relatively the more important consideration. Mr. Mordey alluded to the warning given at St. Louis by Mr. Arnold against the idea that electricity would ultimately lead to the extinction of the steam locomotive. He believed electrical engineers were agreed that the latter must at any rate remain on lines where the service was infrequent and the cost of electrification heavy; but he rallied Colonel Crompton upon a remark which he understood the colonel had made in his "James Forrest" lecture, to the effect that the steam locomotive could do all that electric traction could. He imagined that as Colonel Crompton was addressing the Civil Engineers on that occasion he desired to himself be a very civil engineer. Particularly in regard to acceleration and climbing heavy gradients Mr. Mordey did not think the former could compete with its rival, nor was it likely to attain the remarkable speeds achieved during the Marienfelde-Zossen trials. It appeared, however, that these remarks of Mr. Mordey's were based upon misapprehension—as, indeed, the speaker thought might be the case—Colonel Crompton's remarks applying to comparatively level tracks. It appeared to Mr. Mordey that the alternating-current motor could do all that the direct-current type could; and if some loss of efficiency occurred, there were ample compensating gains. Mr. Creedy replied in summary form, claiming that the alternating-current series motor permitted of an increased voltage for a short period, thus solving the overload problem. The President gave the audience some reminiscences bearing upon the subject, from which he drew the moral that young engineers should not despair if they did not immediately achieve a commercial success when carrying out experimental work, and then the proceedings concluded with a hearty vote of thanks to the author.

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## THE VALTELLINA RAILWAY.

### Working Costs and Test Figures obtained with Three-Phase Traction.

BY E. CSERHATI.

The main railway in the North of Italy, generally known as the Valtellina line, was opened for regular service on July 10, 1904, and is now operated by the Rete Adriatica. This railway company has taken over the whole plant erected by Ganz and Co., of Budapest, three months prior to the expiration of their period of guarantee. As this line had previously been worked regularly and opened for public traffic for 21 months, the experience obtained allows of the different items of working cost being ascertained with fair accuracy. On the other hand, thorough tests have been made by the engineers of the railway company in regard to the working efficiency and other important features of three-phase railway working. In the following article there will be given a brief summary of the results obtained by irregular working and on special tests.

The working cost for staff and material in the Morbegno power plant for the period from July 1, 1903, to June 30, 1904, amounted to 21,553 lire. During this period 3,420,502 kilowatt-hours were generated. Thus the works cost for generating a unit amounted to 0 63 centesimi, or about 0·66d. The cost for labour and material incurred for maintaining and inspecting the overhead conductors, poles and transformer stations included, amounted to 329 lire per kilometre of permanent line—*i e*, about 17s. 4d. per mile per annum. Expenses for maintenance and repairs of rolling stock, including electrical equipment and mechanical parts, per locomotive or motorcar kilometre amounted to 4·36 centesimi—*i e*, about 0·66d. per locomotive or car mile. The total expenses for service, including oil, stores, and management expenses, amounted for the period with but partly electrically-driven goods trains to 1·97 lire, for the period with trains conveyed exclusively electrically to 1·71 lire per 1,000 ton-kilometres—*i e*, 2s. 6d and 2s. 2d. per 1,000 ton-miles respectively.

The corresponding expenses on a steam line in Austria, selected by way of comparison owing to its representing conditions similar to the Valtellina as regards curves and gradients, although with a 30 per cent. denser traffic, amounted to 4 20 lire per 1,000 ton-kilometres. From the capital cost figures it has been calculated that the saving effected in traction expenses on the Valtellina line correspond in the first case to 3·98 per cent. on the capital expenditure, and in the second case to 5·53 per cent. The free lighting of all stations and motorcars, as well as heating of the latter, is also given by the electrical equipment.

*Current Consumption Tests.*—During the two years' operation of the Valtellina line thorough tests have been made as to current consumption and recuperation on levels and on gradients, as well as the energy consumed at starting the trains. These tests were undertaken by the engineers of the Rete Adriatica, Messrs. Novi and Donati, under the co-operation and superintendence of Mr. Celeri, engineer to the Italian General Inspection Service. The results of the same were published for the first time at the Congress of Italian Electricians held at Bologna in 1904. The test figures given herewith are taken from the reports of this congress. As mentioned above, 3,402,502 units were generated at the Morbegno power plant during the year. The number of ton-kilometres, including weight of locomotives and the electrical equipment of motorcars for the same period, amounted to 76,845. Therefore, the energy consumption per ton-kilometre averaged 44·3 watt-hours measured at the distributing board of the power station—*i e.*, 71·4 watt-hours per ton-mile. In these figures are included: (1) the energy required to drive the trains; (2) all the losses between the distributing switchboard of the power station and the driving wheel of the rolling stock; (3) the current for lighting all stations, for which 1,254 incandescent lamps of 16 c.p. are used; (4) the current for lighting and heating the motorcars and locomotives; (5) the consumption in the accumulator charging stations equipped with two motor-dynamos each of 21 kw. capacity on the continuous-current side; (6) the consumption for driving the machinery in the workshop at Lecco; (7) the energy required for the shunting service; (8) energy consumed during various tests made for the purpose of inspecting the electrical apparatus and equipment. The above-mentioned figures showing the average energy consumption of 44 3 watt-hours per ton-kilometre were ascertained by the above-named engineers of the Rete Adriatica.

The net consumption per ton-kilometre was ascertained by means of a motorcar specially equipped for the purpose, being fitted out with ammeter and recording wattmeter for both overhead phases. The average of 20 tests showed a consumption of 31 watt-hours per ton-kilometre—*i e*, 50 watt-hours per ton-mile measured in the car. This figure quite agrees with the test results obtained by the staff of Messrs. Ganz and Co. These tests were extended with a view to establishing the net consumption in the power station, the train used for the purpose having run during the night after the termination of the regular service. The current consumption per ton-kilometre amounted to 34 9 watt-hours, and, therefore, the working efficiency of the system to 88 8 per cent. In order to duly appreciate the importance of the figures quoted, it must be borne in mind that the profile of the Valtellina is a very unfavourable one, the average gradient of the whole line, as taken for both directions, amounting to ·25 per cent.—*i.e.*, a train running through all sections in both directions, from one end to the other, and returning to the starting point, must be lifted about 527·5m., which height corresponds to the mentioned average gradient, the length of the run being $2 \times 106{\cdot}5 = 213$ km. The section between Lecco and Colico on which the energy consumption tests were carried out had an average gradient of 0 21 per cent., hence the 31 watt-hours must be regarded as the specific consumption per ton-kilometre at a speed of 60 km., or 37·2 miles per hour on a constant gradient of 0·21 per cent, including starting. For acceleration from rest to a speed of 60 km., 95 watt-hours are required per ton weight; losses arising in the motor and rheostat amount to six watt-hours per ton-kilometre. Assuming an efficiency of 85 per cent. for the motors, the motor losses amount to 4 6 watt hours, so that there remain but 1·4 watt-hours for rheostat losses—*i e*, 4½ per cent. of the total specific consumption.

A 120-ton train consumes 31 watt-hours per ton-kilometre at a speed of 60 km. per hour while continually running on level track. A motorcar running singly requires 48 watt-hours per ton-kilometre, including starting energy. The large difference as compared with the 31 watt-hours for a 120-ton train is due to air resistance, which is diminished for a given weight by the increase in length of a train. It will be seen that from economical considerations it does not appear to be advisable to replace heavy trains by numerous light trains or cars. Moreover, it shows that rheostat losses at starting are on this line very small compared to the whole energy consumption.

*Recuperation of Energy.*—It is well known that alternating-current induction motors have the power of restoring energy to the line when running on down grades over a certain decline, which varies according to traction resistance, while the speed is thus maintained practically constant. The commercial value of this property has very often been doubted. However, the respective tests not only proved the possibility of recuperation, but settled at the same time the quantity of energy which could be returned to the line. On a section with a down grade of 2 per cent., with a 120-ton train and a speed of about 30 km. per hour, 28 2 watt-hours—*i.e*, about 80 per cent. of the energy—has been recuperated which otherwise would have been lost by the braking. The exceedingly favourable result in regard to energy consumption of the Valtellina line is due chiefly to this circumstance. The question as to how to utilise the energy recuperated has likewise been often discussed. The simplest solution would evidently be to equip for electric traction not only the steep grades of mountain lines, but also the adjoining level sections, in order to assure the utilisation of the return current from descending trains. The energy recuperation may be taken advantage of not only when trains run on down grades, but also when stopping the same, provided that the motors are designed for cascade working; in

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this case the speed will be reduced to within a fraction of synchronous speed when switching over to the cascade connection, and the energy which has been required for train acceleration from rest to full speed is partly given back by the momentum of the train. The current recuperated in this way amounts to from 35 to 40 per cent. of the energy for acceleration, and to about 10 per cent. of the total consumption. This advantage becomes of utmost importance in suburban railway service, where heavy trains have

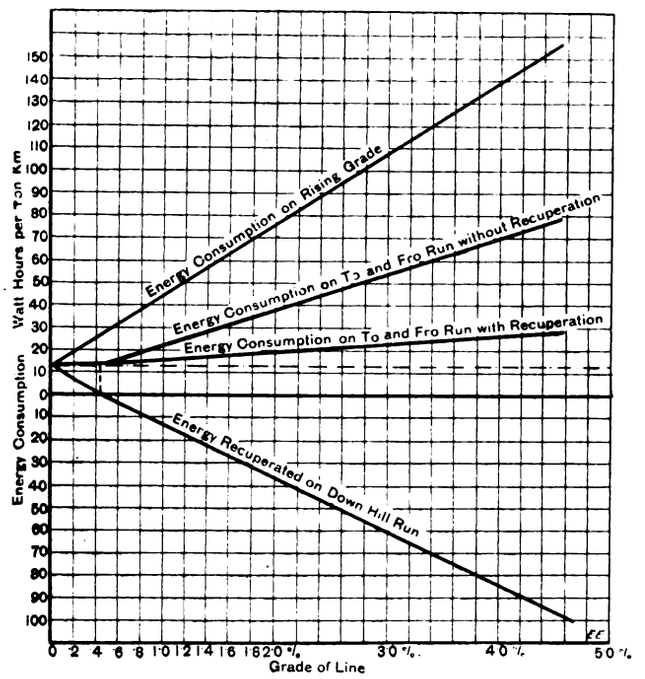


FIG. 1.—Curves for speed of 31 km. or 19·3 miles per hour. Drawbar pull, 8,000 kg. Traction resistance, 4 kg. per ton.

to be started and stopped in relatively short distances. It has, for instance, been proved—in a scheme worked out for the Vienna suburban lines—that with a four-step cascade connection, by means of one or two parallel working primary and two secondary motors connected in different combinations, more energy would be given back at stopping than the rheostat losses amounted to at starting. The importance of these facts cannot be denied either in the case of main railways when looking at the matter from an economical point of view, inasmuch as mixed and local

very simply as a function of the gradient. Assuming that the motors work with an efficiency of 100 per cent., the energy consumption per ton-kilometre expressed in watt-hours will be

$$s = c\,(w \pm l),$$

$c$ being a constant, $w$ the resistance on the level, and $l$ the gradient represented in metres per kilometre. The upper sign is to be applied on up grades, the lower one on down grades. The equation represents two straight lines cutting the ordinate axis at the same point. Halving the sum of

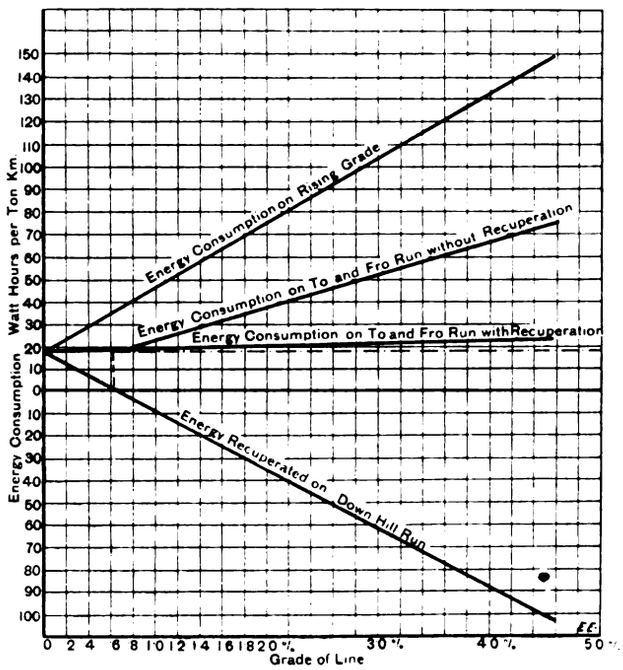


FIG. 2.—Curves for speed of 62 km. or 33·6 miles per hour. Drawbar pull, 5,000 kg. Traction resistance, 6 kg. per ton.

the ordinates, we get the average current consumption for a complete run to and from over a given section with due regard to recuperation. The equation shows that, provided motors would work with an efficiency of 100 per cent., the average current consumption would be the same on lines with grades as on level ones. By means of these equations and the curves showing motor efficiency at different loads the curves Figs. 1 and 2 have been drawn. They show the current consumption and recuperation on down grades from 0 to 4·5 per cent., and for speeds ranging from

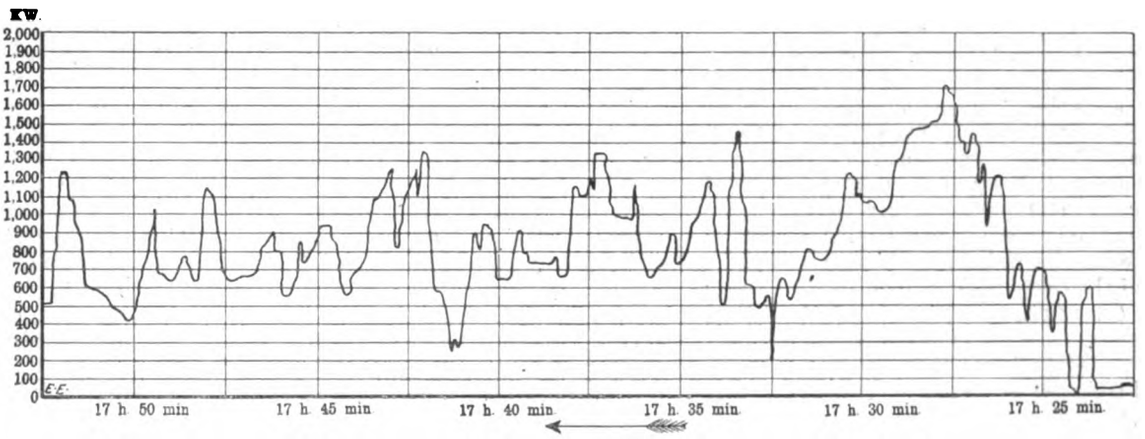


FIG. 3.—Record taken from the Registering Wattmeter at the Morbegno Power Station.

trains must be stopped rather frequently from high running speeds. The acceleration of these trains represents an important part of the total energy required. With simple cascade working, 35 to 40 per cent. of this energy, as above mentioned, may be saved, with four-step connections even more. In the case of water-power stations the energy recuperation is so far of importance, as it allows of a line with denser traffic or greater length being worked from the same plant than would be the case without recuperation. With steam plants much saving is effected in working cost.

*Energy Consumption as a Function of Gradients.*—For a certain speed the energy consumption may be represented

30 km. to 60 km. per hour. The half of the algebraic sum of ordinates represents also in these cases the actual consumption of a complete run up and down the hill. As will be seen, the consumption increases with the gradient relatively slowly. Where the curve cuts the abscissæ, when running down the hill, we get the down grade on which the train takes no energy from the line. In Figs. 1 and 2 a curve has likewise been drawn which gives the average energy consumption for a complete run when the train descends without recuperation, as no energy is required in the latter case. We therefore get the average consumption for a cycle by halving the ordinates for the up-grade run.

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From the above it will be clearly recognised how the economy increases with a system affording recuperation compared with one lacking that quality. The difference in favour of a three-phase system allowing recuperation on down grades is as follows:

| | | | | | |
|---|---|---|---|---|---|
| With gradients of ..... | 1·0 % | 2 % | 3 % | 4 % | 4·3 % |
| At a speed of 30 km. per hour | 40 % | 100 % | 132 % | 165 % | 169 % |
| ,, ,, 60 km. ,, | 90 % | 150 % | 200 % | 250 % | — |

*Flywheel Effect.*—As will be seen by the watt diagram (Fig. 3) taken at the Morbegno power station, the current rushes due to the starting of even the heaviest trains do not represent higher peaks than about 70 to 80 per cent. of the energy requirements corresponding to the average consumption of the train when running on the line. This favourable circumstance is due, in the first place, to the use of water rheostats, which give such a smooth starting that it is not easy to tell the exact starting moment. At the same time no sudden current rushes can arise due to this method of control. In the second place, it is due to the peculiarity of induction motors to take no current from the line as soon as the periodicity of the supply is reduced by about 1 to 2 per cent. If the latter is further diminished, then current is given back to the feeding conductors by the running trains. When starting a heavy train, the number of revolutions of the generators and prime movers is reduced and the periodicity diminished. Consequently, the short-circuited motors of the running trains will take no current until their speed drops below the value corresponding to the number of revolutions at the power plant. In this way the latter is relieved when starting up a heavy train. Should it happen that the number of revolutions of the generators is reduced suddenly by more than 2 per cent., current would be returned to the feeding line by the motors of all moving trains—that is to say, the whole of the moving train masses would represent a huge flywheel, having the effect of reducing very considerably the current rush from the power plant. This is an exceedingly valuable peculiarity of the three-phase traction system, which should be duly appreciated, as up to the present time very little attention has been paid to it.

On the latest type of the Valtellina locomotives* the slip-rings are not placed between the locomotive frames, but outside of them, as by this arrangement accessibility for supervision is facilitated, also the space inside the frame is then available for the motors, which can be made more powerful than would be the case with slip-rings arranged inside. This arrangement necessitates the three ends of the rotor winding being taken through the hollow crankshaft, the crank arm, and pivot, and also through the counter-crank to the three slip-rings. It is not difficult to carry out this arrangement with three conductors insulated from each other. If, however, the collector of a continuous or single-phase alternating-current motor were arranged in this way, more than 100 conductors would necessarily have to be brought out. This, although it would not be impossible in a technical sense, is at all events a very difficult matter. The possibility of thus equipping the locomotive with very powerful motors should be well appreciated, for the smaller the number of motors for a given total horse-power, the less the weight, and the simpler the mechanical features of the electric locomotive.

*Energy Consumption Compared with that of other Systems.*—The current consumption per ton kilometre is influenced by a great many circumstances, such as speed, gradient, curves, weight of train, length of train, distance between stations, etc. It is, therefore, difficult to compare the figures showing consumption of different railways equipped for different traction systems. Moreover, very little information has been published as to energy needed for the main-line railways or on lines with main railway traffic. This information applies usually to the consumption measured in the car, but not on the distribution board of the power plant. The gross consumption of 44 watt-hours per ton-kilometre, which includes all losses and the supply to other electric apparatus on the Valtellina line, must be regarded as a very low one, as most of the figures known concerning other lines and representing the consumption in the car are higher. Further, it must be considered that with direct-current lines the losses between the switchboard of the power plant and the line side of the rotating transformer sub-stations amount to about 20 per cent. On other systems a net consumption as low as 31 watt-hours (measured in the car) has never been reached before and with a profile similar to that of the Valtellina Railway. Figures relating to consumption on direct-current lines do not offer any particular interest, as nobody is likely to think nowadays of equipping any line of great length with the direct-current system, as this system is more expensive both as regards first cost and working expenses. More attention should be paid to the respective figures of single-phase railways, which, on the whole, offer the same advantages in regard to energy transmission on an extensive railway system as the three-phase traction system. In the *Street Railway Journal* of Aug. 24, 1904, are published the interesting results of tests carried out by the General Electric Company on an experimental line equipped between Schenectady and Ballston. A test run has been made there with the same motors, the latter having been fed first with direct and then with single-phase alternating current. The results show the following energy consumption: 53·5 watt-hours per ton-mile for direct current, and 78·1 watt-hours per ton-mile for single-phase alternating current. Hence 46 per cent. more current has been consumed by the same motor under identical conditions for single-phase alternating current than for direct current. Three-phase motors may be built with at least as high an efficiency as that of direct-current motors, and therefore conclusions may be drawn from the above test results as to the mutual behaviour in reference to energy consumption of three-phase and single-phase traction motors. The latter will require about 40 to 50 per cent. more energy than three-phase motors, provided that conditions be the same as those prevailing as the mentioned tests. According to Glaser's *Annalen*, 1904, No. 3, the Niederschoneweide-Spindlersfeld monophase railway of 4·1 km. length requires 45 watt-hours per ton-kilometre with a distance of 908m. between stations, a maximum speed of 34·6 km. per hour, and with a train weight of 170 tons. It must be remembered, however, that this line has no gradients, except one of 0·2 per cent. on a 500m. section.

In a scheme worked out by Ganz and Co. for the Vienna Suburban Railway, the watt consumption of a train of the same weight at a maximum speed of 31 km. per hour, and an average distance of 906m. between stations, has been stated at 30·7 watt-hours, and the firm was prepared to guarantee that figure. Also in this case the difference in energy consumption amounted to 45 per cent. in favour of the three-phase system, although on the Vienna line there are gradients up to 2·9 per cent. According to a publication in the *Zeitschrift für Elektrotechnik*, No. 3 of 1905, the Stubaithal Railway requires 70 watt-hours per ton-kilometre. The corresponding energy consumption has been figured out on the basis of an exact profile of the above line for three-phase traction with the same speed as that given in the mentioned publication, and without using cascade connection. For a complete cycle run in both directions with a train supposed to come back to the level of departure, an average consumption of 29·4 watt-hours per ton-kilometre has been arrived at in the car, thus about 31 watt-hours measured at the feeding point. This low figure is accounted for by the recuperation when trains run down the hill, and which amounts to 27·6 watt-hours, whereas the consumption on a run up grades is 57 watt-hours per ton-kilometre. The above figures relating to energy consumption on single-phase railways are taken from publications of the contracting firms. Those relating to the three-phase system have been ascertained by official tests of the Rete Adriatica, or, at least, represent conclusions drawn from the latter.

The peculiarities of the three-phase traction system as discussed in the foregoing represent the following advantages: (1) the possibility of recuperating both the energy stored up in the moving trains when the speed is being reduced at stopping, and also the energy available with the train running on down grades (this results in a low total consumption energy); (2) the reduction by flywheel effect of the current rushes arising owing to the starting of trains; (3) the possibility of arranging the slip-

* See description in the *Electrical Engineer*, vol. xxxv., pp. 155, 261, 403.

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rings apart from the motors, and thus to utilise the whole space available inside of the locomotive frame for motors. These advantages are obtained only by the use of induction motors amongst the different types, of which the three-phase motor. By choosing a motor other than of the induction type all the before-enumerated advantages are forfeited. On the other hand, with three-phase motors one is restricted as to variable speeds. Steam locomotives, as is known, may run with any desired speed within certain limits, which are fixed by the capacity of the boiler and the security of service. The behaviour is similar with direct and single-phase current series motors, whereas polyphase motors will run but at a few determined speeds according to the frequency, number of poles, and diameter of driving wheel. This feature of polyphase traction has been regarded as a drawback; but since the results of the operation and the experience gained during a two years' service on the Valtellina Railway have become known the peculiarity in question is recognised as an advantage by experienced railway men. The chief condition for a regular traffic is an exact observation of the time-table. All working systems allowing the staff to vary the speed require a highly trained staff, which, as it were, grow to living tachometers. Such experienced drivers will only give a safe service on lines with which they are well acquainted, and therefore their employment is limited. The polyphase alternating-current traction system does not require such a thorough training of the personel, owing to the speed remaining automatically constant without regulation after having reached the value peculiar to the system. Indeed, even on lines with a variable profile, the speed diagrams taken from actual service are almost horizontal lines. Thus individual skill of the staff is nearly eliminated, being restricted to correct starting and stopping. The property alluded to of the three-phase traction system is likewise important from a strategical point of view; besides, it materially facilitates the drawing-up of new time-tables.

## RELAYS FOR DIRECT AND ALTERNATING CURRENT CIRCUITS.

[CONTRIBUTED.]

The most important requirement of the modern central station is continuity of supply, which must be maintained under all conditions and at all costs. It is this fact, perhaps, more than any other which has led to the development of relays which operate in conjunction with circuit breakers, the primary object of these devices being to cut out faulty lines or apparatus only when they become a source of danger to the system rather than the protection of the apparatus itself. The large modern unit is much less liable to damage on the occurrence of trouble than were the small sets of a few years back, and although it is certainly desirable to protect all apparatus wherever possible, it is of first importance that the system be kept in continuous operation. For this reason time-limit relays have been developed which do not allow apparatus or circuits to be cut out until they are actually a source of danger.

The ordinary circuit breaker in its simplest form meets usual conditions with a certainty that has made it an indispensable accessory to practically every generating set; but its scope is limited to the function for which it was originally designed, hence, when other conditions have to be met, a suitable relay becomes a necessary addition. The opening of a circuit breaker under no load, overload, reverse current, or under or over voltage may be beyond the powers of the ordinary tripping coil, but any one of these conditions can be effectively met by the inclusion in the circuit of a specially designed relay actuated by the main current and controlling an auxiliary circuit for tripping the circuit breaker. Apparatus to cope with all the above widely different conditions necessarily varies materially in design, and, as will be seen from the following description of a series of direct and alternating current relays manufactured by the British Westinghouse Company, presents many ingenious and interesting features.

Figs. 1 and 2 illustrate two types of overload relay, both of which are operated from series transformers in the main circuit. Usually, they are mounted on the circuit breakers they control, but, if desired, they may be fixed separately on the switchboard. When the main current exceeds a predetermined value the relay contacts close a low-voltage circuit, which actuates the tripping coil of the circuit breaker, causing it to open. It is standard practice to apply direct current to this purpose, but coils can be specially designed for alternating-current tripping if necessary. The type shown in Fig. 1 is constructed on the induction principle. At the base of the slab are two laminated electromagnets, and projecting between the poles

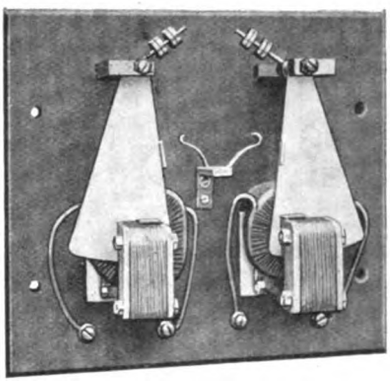

FIG. 1.—Overload Relay, Induction Type.

of each of these is an aluminium sector carrying the movable portion of the auxiliary contact. Part of each pole of the magnet is surrounded by a short-circuited turn of copper, which has the effect of producing a lag in that portion of the magnetic field passing through it, and, therefore, a shifting of the field across the face of the pole. This results in the generation of eddy currents in the aluminium sectors and their repulsion through an angle.

Until the current is of sufficient intensity to make them move, and so close the contacts of the tripping circuit, the vanes are practically stationary, having simply a tendency to deflect. The motion of each sector is opposed by an adjustable weight, as shown, and by means of this the

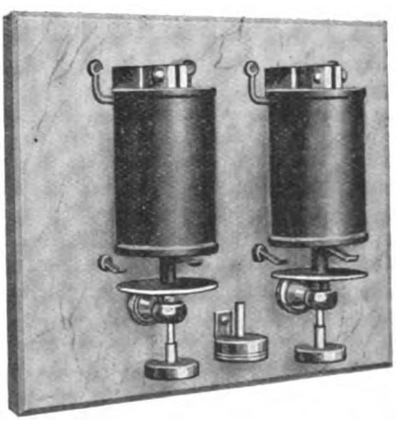

FIG. 2.—Overload Relay, Solenoid Type.

amount of current necessary to close the relay circuits may be varied. The two sectors work quite independently of one another, and either will operate the tripping coil. When used on a two-phase circuit, the movements are connected separately in the two phases through the medium of two series transformers. In three-phase working a series transformer is placed in each phase, and the secondaries are so connected to the relay that it will operate upon the occurrence of an overload in one or all of the main cables exceeding that for which adjustment has been made. For a single-phase circuit, a relay with but one vane is used. This relay is made for high or low frequencies as desired, but it is particularly suitable for high-frequency circuits, and may be connected in series with ammeters which operate from the secondaries of series transformers.

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It is adjustable over a wide range of action, extending from 80 per cent. to 150 per cent. full-load current.

The method of adjustment by weights and the operation of the solenoid type (Fig. 2) is evident from the illustration. The core of the solenoid carries a disc, which, upon the former being drawn up, closes the auxiliary tripping circuit by means of the contacts shown. Although not confined to them, this type is particularly suitable for low-frequency circuits, but cannot be operated with meters from the same series transformers. The function of a

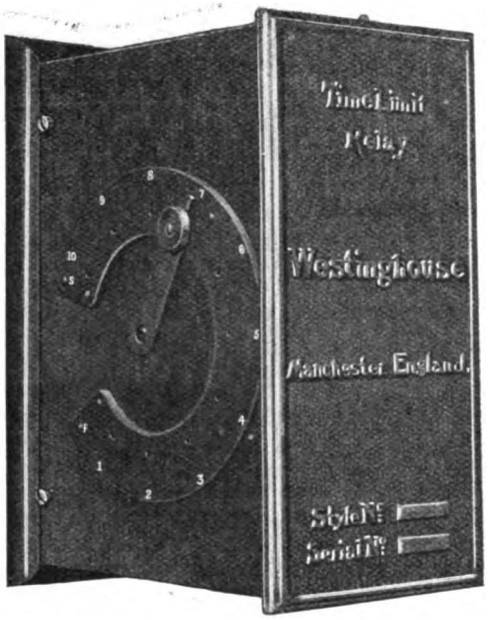


FIG. 3.—Time Limit Relay, Electro-Mechanical Type.

time-limit relay is to allow a certain small interval of time to elapse between the occurrence of an overload or reverse current and the tripping of the circuit breaker. Thus no interruption of the supply will take place if the overload or reverse current does not continue beyond the number of seconds for which the relay is set.

Figs. 3 and 4 illustrate two varieties of this instrument, termed respectively the electro-mechanical and electrical types. The essential part of the former is a spring motor, which is started by an electromagnet placed within the relay, and this magnet may be controlled by a reverse-current relay, an overload relay, by contacts on the circuit breaker, or by a push button. When the overload continues until the end of a predetermined time, varying from two to ten seconds, the auxiliary tripping circuit is closed by

FIG. 4.—Time Limit Relay, Electrical Type.

the spring motor, and the circuit breaker opened; should the overload, however, not continue throughout the time for which the relay is set, it will automatically reset itself, and resume precisely its former condition. With this type of relay it is necessary to keep the spring motor wound up, but it is so designed as to trip the circuit breaker when the spring runs down, and will not allow it to be reset until the motor is wound up The contacts which close the auxiliary tripping circuit will open one ampere at 125 volts.

The electrical type of time-limit relay requires no winding, and consists essentially of a dash-pot, the plunger of which is connected to a moving arm carrying contacts, which move through an adjustable distance to close the circuit of the tripping coil. The motion of this plunger is controlled by an electromagnet placed within the instrument, and the latter may be operated from the main circuit either by an overload or reverse current relay. The predetermined time during which the overload is allowed to continue may be varied from one to five seconds, at the expiration of which period the tripping circuit is closed and the circuit breaker opened. As before, the relay automatically resets itself if the overload is of a shorter nature than that which it is set for. The contacts which close the auxiliary tripping circuit will open 2½ amperes at 125 volts, or a proportionately smaller current at a higher voltage.

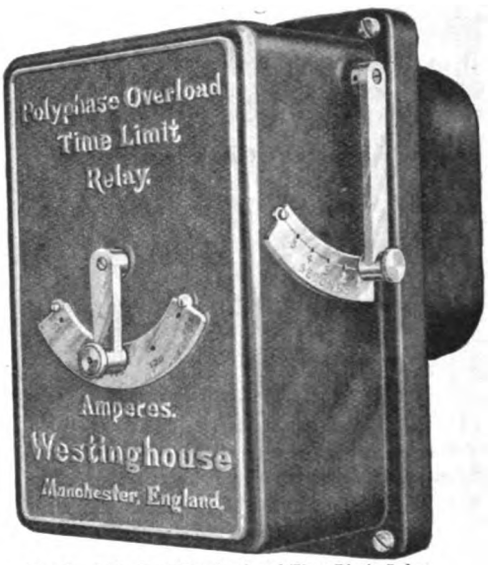


FIG 5.—Polyphase Overload and Time Limit Relay.

The polyphase overload and time-limit relay shown in Fig. 5 consists of a combination in one case of the solenoid type of overload relay and the electrical type of the time-limit relay. It is connected to the circuit containing the circuit breaker by means of series transformers, and is entirely automatic, resetting itself if the overload does not continue throughout the prearranged time, which may be varied from one to five seconds. The overload and time adjustments are made separately by the handles shown in the illustration.

Fig. 6 illustrates a form of direct-current reverse-current relay designed to control circuit breakers the current

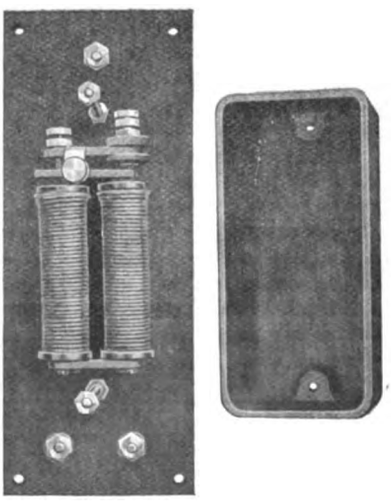

FIG. 6.—D C Reverse-Current Relay.

through which may from any cause be reversed. It is operated by a direct-current instrument shunt placed in the circuit of the circuit breaker controlled by the relay, and the armature and magnet cores are polarised by a permanent magnet fitted behind them. The relay is calibrated to operate on 25 millivolts and to open the circuit breaker on a minimum reverse current of 50 per cent. of the full load of the circuit when energised from one shunt, and on 25 per cent. thereof when energised from two shunts in series. The contacts which close the tripping circuit will

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open 0·25 amperes at 250 volts, but for high pressures a separate device attached to the circuit breaker should be used. This relay is unaffected by variations of 'bus-bar voltage, and is non-adjustable.

The apparatus illustrated in Fig. 7 is for use with direct current and operates with either overload or reverse current, being adjustable in both cases. The overload range extends from zero up to the maximum capacity of the relay, and the maximum reverse current is one-half of that in the normal direction of flow. These adjustments are made by the projecting rods seen above the scale. This relay acts on the moving-coil principle, the one illustrated being constructed for threading over the 'bus bar. For currents below 600 amperes the construction of the lower part is somewhat different, the apparatus then being connected directly in the circuit.

Mention may be included of two adjustable overload and reverse current relays for single and polyphase alternating-current circuits respectively. These are provided with contacts which close the tripping coil circuit, and are designed to control circuit breakers both when there is an overload on the circuit and when there is a reversal in the direction of flow of power. Thus a circuit breaker equipped with an overload and reverse current relay and connected in a generator circuit will open in the event of the load exceeding that for which the relay is set, and also in the event of the generator, from any cause such as loss of field or failure of the engine, operating as a motor and absorbing energy from the circuit. In order to protect the feeders from overload or short-circuits, it is necessary to use overload relays, usually with time limit, at the generator ends, and reverse-current relays only at the sub-station ends of

FIG. 7.—DC Adjustable and Reverse-Current Relay.

the feeders. By this arrangement any faulty feeder would be entirely cut out and the supply maintained. Both these instruments work on a principle similar to that of the induction wattmeter, and are operated from series and shunt transformers. The working range is adjusted by rotating the drums on which the scales are mounted until the required value is opposite the fixed pointer. Ordinarily direct current is used for tripping the circuit breaker, but coils can be specially designed for alternate-current tripping.

An auxiliary relay switch is supplied for use with any of the above-mentioned types of relay in cases where the current required to trip the circuit breaker is greater than that which the master relay can carry. It is of the solenoid type, the core carrying a disc which closes the tripping circuit through brush contacts. These relays are designed for intermittent service on direct-current circuits, and one such device may be used to operate two or more circuits breakers at the same time if necessary.

## THE METALLIC ARC.*

BY ISADOR LADOFF.

The numerous attempts which have been made to utilise the electrolytic arc as a source of light have not thus far led to any technical success. The fundamental idea of all these attempts consists in the combination of the oxides possessing luminiferous properties with non-luminiferous but more conductive oxides. Some investigators have even gone so far as to make the surfaces of the pencils conductive by surrounding them with a metallic tube or by reducing the oxides *on the surface* to a metallic state.

Experience with titanium oxide as an electrode indicates that it is by far the best luminiferous material so far known. Like other oxides of that nature, however, it is a poor conductor of electricity at the usual temperature. A series of experiments with a combination of titanium oxide with iron oxides has been conducted with more or less unsatisfactory results. The magnetite used contained impurities which caused a great deal of annoyance. The pencils were extremely brittle and had to be protected with iron tubes. These tubes served a double purpose, since they protected the pencils from breakage and made them sufficiently conductive. The disadvantages of the tubes were numerous. The pencils were very clumsy in appearance. The arc flickered badly and gave yellow streaks of low luminous power every few seconds. Attempts to improve the properties of the pencils by reduction of the surface of the electrode or electroplating it with iron or copper met with failure. The partial reduction undoubtedly increased the flickering of the arc and did not reduce the extreme brittleness of the pencils. The proportions of the ingredients of the pencils were about 80 parts of magnetite, about 20 parts of hematite, and about 7 or 8 parts of titanium oxide. If more than 10 parts of titanium oxide were added to the mass of the electrodes, a very unquiet and flickering arc was produced. The resistance of baked pencils having a diameter of about 0·5in. and a length of 5in. was from 44,700 to 624,800 ohms. When covered with a thin film of graphite the resistance of the same electrodes fell to 4 88 ohms or 6·24 ohms.

In order to determine the difference in the behaviour of the pencils with change in their conductivity, a number of them were partially reduced in carbon at 1,150deg. C. Their resistance varied from 11 to 28 ohms. Pencils heated without carbon at the same temperature showed a resistance varying from 594,000 to 9,830,000 ohms. As the degree of reduction seemed to play some obscure rôle in the arc, a few experiments were made to determine the influence of the process of oxidation in the arc. Electrodes for these experiments were prepared in the usual way and manner. One batch contained the usual proportions of hematite and magnetite. The second batch contained no hematite whatever. The third batch was free from magnetite. Each of the three batches contained an identical quantity of titanium oxide (of 7 5 parts), and each was treated at the same time under exactly the same conditions as far as practical. The most luminous arc was produced by the pencils containing only magnetite and titanium oxide. The least luminous arc was obtained with the pencils composed only of hematite and titanium oxide. The mixture composed of 80 parts of magnetite and 20 parts of hematite gave an arc of medium luminosity. As hematite represents the final product of oxidation of iron, it was concluded that oxidation is a factor favourable for the luminosity of the arc—that is, the more space there is left for the oxidation of the material of the electrodes in the arc the better must be the luminosity of the arc.

For the purpose of verifying the above conclusion, additional experiments were conducted. Electrodes of the identical batch were subjected to various degrees of reduction, and the luminosity of their arc tested. In each case the more reduced pencils gave a higher luminosity, and the luminosity of the perfectly reduced pencils was about double the luminosity of the pencils which had not been reduced. A batch containing 50 per cent. of magnetite and 50 per cent. of titanium oxide was subjected to various degrees of reduction, with the following results, the candle-power referring to horizontal measurements:

Well-reduced pencils produced an arc of a luminosity equal to 1,271 c.p.; partly-reduced pencils produced an arc of a luminosity equal to 1,000 c.p.; poorly-reduced pencils produced an arc of a luminosity equal to 868 c.p.; pencils not reduced produced an arc of a luminosity equal to 700 c.p. The current used was a direct one of 3·4 amperes, with 105-110 volts drop across the arc.

The reduction not only increased the efficiency of the

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arc by 100 per cent., but it allowed the use of high percentages of titanium oxide in the mass of the pencils. In the partially-reduced pencils an addition of more than 10 parts of titanium oxide was excluded, because such an amount caused the arc to flicker to an extent such that photometric reading could not be taken with any degree of accuracy. The arc of the reduced pencils was quite steady when even as high as 90 per cent. of titanium oxide was used with 10 per cent. of magnetite. There appears, however, to be a limit beyond which any further addition of titanium oxide ceases to be advantageous. The best results were obtained with pencils containing about 50 per cent. of titanium oxide and 50 per cent. of magnetite. The perfectly reduced electrodes are metallic throughout. They are harder than tool steel and take an excellent polish. When ready for use they look like ordinary steel cylinders. Obviously any luminiferous substance may replace the titanium oxide, and any metallic oxide may be substituted for the iron oxide. For instance, magnesium oxide could be combined with an oxide of copper, and then reduced to metallic state.

Additional experiments with the metallo-electrolytic arc indicated that an alloy of titanium with a well-conducting metal like iron, copper, etc., would furnish an ideal material. Various samples of titanium alloys were used for pencils for the electric arc. The results more than justified the expectations. Comparatively small quantities of titanium alloyed with other metals obscure the spectrum of the last, and produce an arc whose luminosity is entirely out of proportion to the quantity of titanium contained in the mass of the pencils. Alloys of other metals whose oxides are distinguished by their high luminosity in the arc—as, for instance, magnesium, zirconium, etc.—withnon-luminiferous but conductive metals produce similar results. It is believed, therefore, that the work here briefly outlined opens a new field for the metallo-electrolytic arc as a source of light of the future.

In order to ascertain the practical value of the new arc, Messrs. L. B. Stillwell and H. S. Putnam were requested to make a report upon the subject, and the following samples were submitted for test: B—two pieces marked F T., 80 per cent. ferro-titanium; C—one piece marked 4·1 L, 30 per cent. rutile, 70 per cent. magnetite; E—½in. plain carbon, moulded. The following description of the tests conducted is abstracted from their report. The results of the candle-power measurements and life tests of the ferro-titanium (B) and rutile (C) pencils, as well as a test made with plain open-arc domestic carbons, are summarised below. These tests are principally valuable as illustrating the nature of the pencils, and relative illumination and life as compared to an ordinary carbon when operated under the same conditions. The results as tabulated are the averages obtained by omitting such measurements as were abnormal in the judgment of Mr. Putnam, who conducted the tests:

RESULTS OF TESTS WITH HAND-FED ARC LAMPS.

| | B Ferro-titanium. | C Rutile. | E Carbons. |
|---|---|---|---|
| **At 3·5 amperes.** | | | |
| Mean spherical candle-power | 510 | 283 | 84 |
| Watts per candle-power | ·579 | ·701 | 2·5 |
| Amperes | 3·51 | 3·5 | 3·5 |
| Volts | 48·3 | 55·8 | 49·1 |
| Watts | 169 4 | 195·4 | 171·4 |
| Length of arc—inches (estimated) | ·375 | ·350 | ·125 |
| Life of negative—hours per inch | 3·85 | 11·1 | 2 8 |
| Diameter of pencil—inches | ·57 | ·52 | ·50 |
| Resistance per inch—ohms | ·00164 | ·00284 | ·0846 |
| Weight per inch—grammes | 9·64 | 14·33 | 4·83 |
| **At 6·6 amperes.** | | | |
| Mean spherical candle-power | 968 | 737 | 243 |
| Watts per candle-power | ·341 | ·436 | 1·35 |
| Amperes | 6·6 | 6·6 | 6·6 |
| Volts | 49·5 | 48·7 | 50·1 |
| Watts | 326·7 | 321·4 | 330·3 |
| Length of arc—inches (estimated) | ·400 | ·375 | ·180 |
| Life of negative—hours per inch | 1·1 | 1·96 | 1·7 |
| **At 9·6 amperes.** | | | |
| Mean spherical candle-power | 1,135 | Fused | 485 |
| Watts per candle-power | ·330 | excessively | ·986 |
| Amperes | 9·6 | with | 9·6 |
| Volts | 39 | 9·6 | 50 |
| Watts | 374·4 | amperes | 480 |
| Length of arc—inches (estimated) | ·375 | — | ·190 |

The results given were for the most part obtained with the positive carbon pencil placed at the top. The results with a positive copper pencil at the top were slightly, though not materially, lower in candle-power, and they have been averaged with the other results obtained.

The positive copper pencil is evidently not consumed in the arc when used in connection with the titanium pencils. There is a slight loss in weight, due probably to oxidation and scaling at the surface of the copper owing to its high temperature.

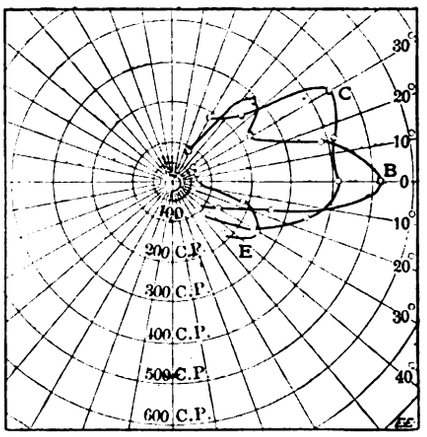


FIG. 1.—Distribution of Luminous Intensity.

The rutile pencil was further tested as a constant-potential arc lamp operating on a current of approximately 4·5 amperes. In this lamp the rutile pencil, C, was placed below and an ordinary carbon above, and the test made first with the carbon as a negative and then with it as a positive. Two sets of measurements were made, one at approximately 60 volts, and the other at 70 volts. The results are tabulated below.

| At 60 volts. | Carbon upper −. Rutile lower +. | Carbon upper +. Rutile lower −. | Rutile upper +. Rutile lower −. |
|---|---|---|---|
| Mean spherical candle-power | 544 | 448 | 624 |
| Watts per candle-power | ·521 | ·60 | 41 |
| Amperes | 4·52 | 4·18 | 4·25 |
| Volts | 62·8 | 64·8 | 61·2 |
| Watts | 283·9 | 270·9 | 260·1 |
| Length of arc—inches (estimated) | ·75 | ·75 | ·70 |
| **At 70 volts.** | | | |
| Mean spherical candle-power | 469 | 590 | 1 015 |
| Watts per candle-power | ·653 | ·56 | ·30 |
| Amperes | 4·35 | 4·35 | 4·30 |
| Volts | 71·5 | 72 | 70 |
| Watts | 311 | 314 | 301 |
| Length of arc—inches (estimated) | ·375 | ·875 | ·75 |

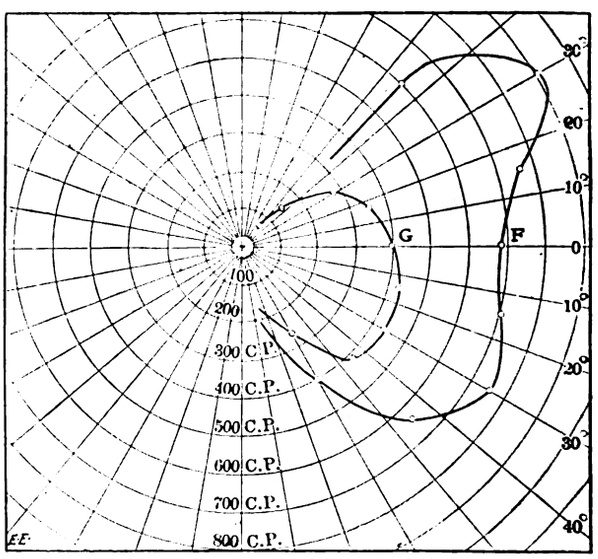


FIG. 2.—Distribution of Illumination.

The light distribution in the tests of the ferro-titanium, rutile, and carbon pencils at 3 5 amperes and from 50 to 55 volts is shown in Fig. 1. The light distribution of the test of the rutile pencil in a constant-potential lamp at 4·2 amperes and 70 volts is indicated by Curve G on Fig. 2

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All candle-power measurements were made on the arc photometer designed by Prof. C. P. Matthews. The life of the pencils is computed from a burning test of from 1½ to 2 hours, the pencils being first burned to shape and then weighed in a chemical balance before and after the test.

For purposes of comparison, in Fig. 2 has been plotted a curve, F, taken from the report of Prof. Matthews, included

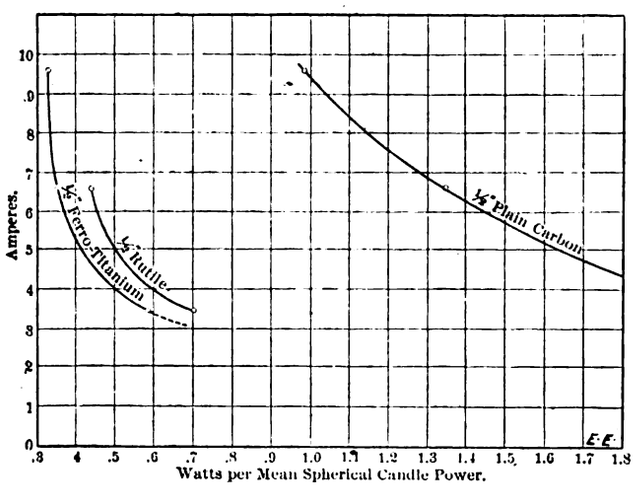


FIG. 3.—Efficiency Curves.

in the report of the Committee on the Photometric Measurements of Arc Lights to the National Electric Light Association, May 20, 1902. This curve is the result of many measurements, and represents the light distribution of the ordinary series enclosed arc lamp in common use in this country for street and interior illumination. The measurements were made on a constant current of 6·8 amperes, with 70 volts at the arc, with an opalescent inner and a clear outer globe. The series enclosed arc lamp gives 303 mean spherical candle-power at 476 watts, or 1·57 watts per mean spherical candle-power. It burns approximately 100 hours for one trimming.

The light produced by ferro-titanium and rutile (oxide of titanium and magnetite) pencils is pure white as judged by the eye. The spectroscope shows the entire solar spectrum with especial brilliancy in the bright yellow portion and in the neighbouring light green and orange.

The arc itself presents many peculiar characteristics and assumes different forms under different conditions. The normal arc with a positive copper or carbon pencil at the top and the ferro-titanium or rutile pencil below is approximately ⅜in. in length at from 50 to 55 volts, and increases to ¾in. or ⅞in. at 70 volts. It is from $\frac{3}{32}$in. to ⅛in. in diameter and emanates from the titanium pencil. At the higher voltage the arc is unstable, and is easily broken. At from 50 to 55 volts the familiar sound of a 'hissing" arc is produced. As the voltage and the length of the arc are increased this sound is diminished, and the only sound produced is similar to that of escaping steam, which, however, is not of an objectionable character. Under both of the above conditions of operation the point of contact of

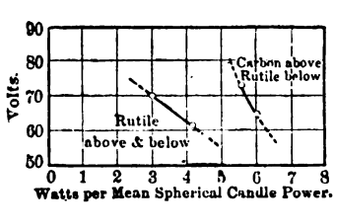


FIG. 4. Efficiency of Rutile and Carbon Lamps.

the arc with the upper and lower pencils is constantly in motion, causing a flutter in the light emitted. This feature is largely eliminated with a long arc.

As already mentioned, when the titanium pencil is made the negative and placed at the bottom, at 70 volts the arc is from ⅜in. to ⅞in. long and about ⅛in. in diameter, and of an unusually white colour, slightly more light being produced at or near the surface of the electrodes owing to the concentration of the arc and the incandescence of the surfaces. The arc itself is clean cut and well defined, and is a true arc and not a "flaming" arc, as is generally understood by that term. The same results were obtained with either a copper or carbon positive. As the arc fluttered and shifted, the apparent trend, with the gases and material carried by it, under normal operation, was from the negative to the upper positive pencils. Under the same conditions, but with the direction of the current reversed—that is, the lower titanium pencil made the positive—an arc of entirely different character was obtained. The diameter of the arc was increased from ⅛in. to ¼in. or $\frac{5}{16}$in. At the same voltage the length was also slightly increased, approximately to 1in. The "flutter" was absent, although the arc lazily shifted from one point to another. The direction of the arc seemed still to be from the lower positive to the carbon or copper negative above, but possessed but very little illuminating power, and had a decidedly reddish tinge. Frequently, for short intervals, the arc became suffused with the white light characteristic of titanium. On account of its steadiness, lack of "fluttering," and very large diameter and length, the arc presents many attractive features.

By placing the titanium pencils on both sides of the arc and making the upper electrode positive, there was obtained a third type of arc having a distinctly different character. Though differing from either, it seemed to be practically a combination of the two above mentioned. The arc resembled an inverted cone, having its apex on the lower pencil and its base on the upper pencil. Through the centre ran a core fairly representing the arc obtained in the first case mentioned above. Around it was a zone representing the second arc described, but of a diameter increased to possibly $\frac{5}{16}$in. or ⅜in., and suffused with the white titanium incandescent gases. The arc as thus obtained was absolutely steady, with no "fluttering" or shifting. Both upper and lower pencils were fused at their surfaces, but, contrary to expectations, the molten material from the upper pencil did not drop. The light is softened somewhat by the presence of what might be called the negative arc, but possesses all the colour characteristics of the titanium arc. The measurements made of these three arcs have shown that the candle-power efficiency at 70 volts is nearly doubled by placing a titanium pencil above as well as below. There is such an excess of incandescent vapour provided in this form of arc that apparently very promising results could be obtained with a longer arc. An efficiency of ·3 watt per mean spherical candle-power was obtained in this test, and it seems entirely probable that this can be improved. Fig. 3 shows the watts per mean spherical candle-power obtained at 50 volts approximately, with ½in. pencils, and at various current values. It is apparent from these curves that very little increase in efficiency results from an increase of current above 6 amperes under the conditions observed in the test—namely, with ½in. pencils, and about 50 volts at the arc.

In Fig. 4 are plotted the results obtained at 60 and 70 volts with a rutile lower negative and a positive electrode of carbon and rutile respectively. Unfortunately, the number of observations were not sufficient to construct a reliable curve, but the sheet indicates graphically the great increase in efficiency due to using a titanium positive as well as negative, and from the direction of the curves it indicates that an increased efficiency would be obtained at a higher voltage, especially in the case where the titanium is used for both positive and negative electrodes.

The light produced by titanium pencils is agreeable to the eye and pure white in colour, and produces the entire spectrum, with especial luminosity in the yellow zone. The luminous efficiency of titanium pencils is very high. At corresponding current values and voltages the energy consumption per mean spherical candle-power is from one-third to one-fourth of that required by carbon electrodes. The light from the titanium arc, as shown by the distribution curves, is produced in about equal amounts above and below the horizontal. It will be necessary, therefore, to use a lamp with a reflector to obtain the best results of illumination. When operated under proper conditions the life of the titanium pencils is much greater per inch of material than carbons. The rutile pencil gives longer life than the ferro-titanium, and with the former there is no doubt that a pencil can be designed to give a life as long as that of

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the present enclosed arc lamp. A much longer life seems possible.

The luminous efficiency of the ferro-titanium pencil is higher than the rutile, but the difference is so slight that the superior life of the rutile makes it more desirable. Very superior results are obtained by using titanium pencils in both electrodes. While objections to this might be revealed by further investigation, or an electrode of some other material might be found to give equally good results, this method of operation offers a promising field for investigation.

## IMPERIAL NOTES.

### New Zealand.

*City of Wellington.*—We are pleased to give herewith a very satisfactory account with regard to the undertaking of the City of Wellington Electric Light and Power Company, Limited. The results, indeed, are a glowing testimony of the ability of the resident engineer and manager, Mr. G. S. Maben, and must be highly gratifying to all concerned. Let it be remembered that Wellington, although it assumes the proud distinction of city, with all the dignity attaching thereto, has a population of some 40,000 souls only. Yet the consumers taking a supply of electricity from the company's mains numbered the extraordinary total of 2,921 at the time when the accounts for the past year were closed, and are increasing at the rate of about 250 per annum—the approximate equivalent of 10,000 8-c.p. lamps. This, it may be remarked, has been the actual average increase during Mr. Maben's three years' residence on the spot. The total number of 8-c.p. lamps, or their equivalent, connected to December, 1904, was 96,380. Included in this figure are 33 15-ampere open-type arcs and 900 20-c.p. 200-volt incandescent lamps used for public lighting; also 706 h.p. of motor load. The total number of units generated for 1904 was 1,674,532—1,200 kw. representing the maximum demand. Turning to the financial side, we find that the results have been no less satisfactory. Thus out of a total revenue of £34,106. 7s. 9d. the expenditure amounted to £16,737. 15s. 4d., leaving a net balance on the year's working of £17,368. 12s. 5d. In comparing these results with those obtained in the old country, the different conditions must, of course, be taken into account. Judging from the fullness of Mr. Maben's success, it might be assumed he has no gas competition to contend with, but that is not so; the results quoted having been obtained in the face of opposition, so much more the credit. With regard, however, to the net profit, it must be remembered that the purchasing value of money is considerably less in New Zealand than here, hence a smaller return, say, at Darwen, Ealing, Exeter, or any other town having approximately the same population, would represent an equivalent value. But even making due allowance for the difference, a search through "The Electrical Engineer's Central-Station Directory" fails to discover a single record of equal success in the old country.

The relatively small purchasing value of money in Wellington is eloquently reflected by the detailed costs of working the undertaking. Thus we find that 16s. 9d. per ton is paid for coal—the equivalent of that at about 4s. 6d. per ton in the North of England. The wages of greasers and stokers amounted to £2. 16s. per week of 48 hours, those of the charge engineers ranging from £6 to £3. 10s. per week. The works cost averaged 2·60d. per unit generated for the year, and the total costs 3·21d. Having regard to these figures, the readers will not be surprised to learn that 1s. with a sliding-scale discount is the price charged per unit for lighting, while 3d. per unit is charged for power, heating, etc. The average price obtained per unit was 6·20d.

It may not be out of place to add a few particulars here of the system and plant installed. An alternating-current supply is given. This is generated at 2,000 volts, 80 periods, and subsequently reduced to 200 or 100 volts for distribution. The steam-raising plant comprises six watertube and four Economic boilers by Babcock and Wilcox and Davey-Paxman respectively. These boilers work in conjunction with Green's economisers and supply steam at 160lb. pressure to three 400-h.p. Browett-Lindley triple-expansion and tandem compound engines, coupled to a like number of 300-kw. Westinghouse alternators; one 350-h.p. marine Brush engine, coupled to a 250-kw. Mordey alternator; one 200-h.p. Universal Brush engine, coupled to a 150-kw. Mordey alternator; and three 150-h.p. horizontal Davey-Paxman engines driving three 75-kw. rewound Gulcher machines. Separate exciters are provided. Variety is certainly not lacking here, nor is it absent outside the station, where overhead distributors are the order. The mains and distributor cables have been supplied by no less than four different firms—The British Insulated and Helsby Cables, Limited; Glovers, Limited; Callender's Cable and Construction Company, Limited; and the India Rubber, Gutta Percha, and Telegraph Works Company, Limited. It may be also noted that the total capacity of transformers installed is 2,750 kw. Supply was started in 1891.

It is satisfactory to learn that the use of electricity, both for lighting and power purposes, is going ahead steadily throughout New Zealand. All the large cold storage companies are adopting electric driving. By recent legislation, however, the Government have reserved all water power for themselves. This has caused many private schemes to be dropped.

### Cape Colony.

*King William's Town.*—Good progress is reported in regard to the King William's Town electricity works. The Corporation took over this undertaking in February last, the event being marked by much rejoicing in local circles. Previously it had been worked by a company for 15 months. The plant is not a large one at present, but is being extended. In the latter connection it is interesting to note that the high-tension feeders became fully loaded during the first winter's supply, due to consumers coming on at a much faster rate than had been estimated. The company in whose hands the undertaking then was ordered an additional feeder cable. This is now being laid by the British Insulated and Helsby Cables, Limited. As regards the extension plant since ordered by the Corporation, this includes a new Belliss-E.C.C. 100-kw. steam alternator, a Davey-Paxman Economic boiler similar to the two already installed, and four 20-kw. Ferranti transformers. The primary current is generated at 2,100 volts, 50 periods, being transformed down to 220 volts for distribution. The high-tension feeders are laid underground to sub-stations, whence the distributors (No. 0 S.W.G.) are carried overhead. It is understood that the Corporation will as soon as possible reduce the charge per unit for the supply. They do not seek to make any very great profit out of the undertaking for the purpose of applying it to other works. We congratulate the resident engineer, Mr. G. E. Sanders, on the satisfactory state of things above recorded. He is the man to whom the principal credit is due.

## INSTITUTION OF ELECTRICAL ENGINEERS.

### Stand-by Charges and Motor Load Developments.

BY A. M. TAYLOR.

The paper on the above subject was read by Mr. Taylor before the Birmingham Local Section on Dec. 14 last, and we reproduced in our issue for Jan. 15 an abstract of the same, with some interesting diagrams to show how the cost of supply in a station varied with the machinery in use. This paper has been rewritten and amplified for discussion before the parent Institution, to which it was presented last night. In his introductory remarks the author gave the following *résumé*, which can be read in amplification of our previous abstract. He stated that: The present paper starts with the assumption that existing prices for power from small stations are prohibitive, as far as the capturing of continuous loads is concerned; and that where they are not prohibitive they are unsound, except in a few favoured towns where the motor load does not clash with the lighting load. Analysis is made of the charges to be levied per unit for two classes of motor, representing extremes in load factor—viz., class 1 having 30 per cent. load factor and class 2 a 7½ per cent. load

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TABLE A.—SUMMARY OF RESULTS: ACTUAL AND POSSIBLE SELLING PRICES OF ELECTRICAL ENERGY FOR A 5-H.P. MOTOR.

| | Electric lighting only. Average of several stations of 2,000 kw. and under. 15 % load factor. | Motors of Class I. Station L.F. = 30%. D.F. = 1. Max. load = 2,000 kw. No night load assumed. | Motors of Class I. Ditto on "restricted hours'" system. Station L.F. = 46%. (37% motor load. 15% lights' load.) Small night load as per Fig. 1. | Motors of Class I. Ditto on "restricted hours'" system. Station L.F. = 64%. (58% motor load. 15% lights' load.) Large night load = day load. | Motors of Class II. Station L.F. = 11%. (7½% × 1·5.) D.F. = 1·5. Max. load = 2,000 kw. No night load assumed. | Motors of Class II. Ditto on "restricted hours'" system. Station L.F. = 26½%. (13½% motor load. 15% lights' load.) Small night load as per Fig. 1. | Motors of Class II. Ditto on "restricted hours'" system. Station L.F. = 33½. (21% motor load. 15% lights' load.) Large night load = day load. | Motors of Class I. Interest-paying rates. Station L.F = 60%. D.F. = 1. Max. load = 2,000 kw. Equal night and day load. | Motors of Class II. Interest-paying rates. Station L.F. = 22%. D.F. = 1·5. Max. load = 2,000 kw. Equal night and day load. | Motors of Class I. only. Station L.F. = 30%. D.F. = 1. Max. load = 10,000 kw. No night load assumed. |
|---|---|---|---|---|---|---|---|---|---|---|
| A. | 1·20d. | ·70d. | ·45d.* | ·40d. | ·95d. | ·50d.† | ·45d. | ·60d. | ·85d. | ·40d. |
| B. | 1·00d. | ·45d. | Nil. | Nil. | 1·21d. | Nil | Nil | ·22d. | ·60d. | ·32d. |
| C. | ·23d. (·115 + ·115) | ·079d. (·022 + ·057) | ·018d. $\left(·022 \times \frac{30}{37}\right)$ | ·011d. $\left(·022 \times \frac{30}{58}\right)$ | ·242d. (·104 + ·138) | ·090d. $\left(·104 \times \frac{11}{13\frac{1}{2}}\right)$ | ·055d. $\left(·104 \times \frac{11}{21}\right)$ | ·039d. (·011 + ·028) | ·121d. (·052 + ·069) | ·039d. (·022 + ·017) |
| D. | ·14d. (·12 + ·02) | ·040d. (·030 + ·01) | ·008d. $\left(·01 \times \frac{30}{37}\right)$ | ·005d. $\left(·01 \times \frac{30}{58}\right)$ | ·073d. (·060 + ·013) | ·011d. $\left(·013 \times \frac{11}{13\frac{1}{2}}\right)$ | ·007d. $\left(·013 \times \frac{11}{21}\right)$ | ·020d. (·015 + ·005) | ·036d. (·030 + ·006) | ·033d. (·025 + ·008) |
| E. | ·37d. | ·18d. | ·06d. | ·038d. $\left(·06 \times \frac{37}{58}\right)$ | ·44d. | ·165d. $\left(·06 \times \frac{37}{13\frac{1}{2}}\right)$ | ·105d. $\left(·06 \times \frac{37}{21}\right)$ | ·09d. | ·22d. | ·14d. |
| F. | 2·94d. | 1·45d. | ·54d. | ·45d. | 2·91d. | ·77d. | ·62d. | ·97d. | 1·83d. | ·93d. |

A.—Works cost.
B.—Interest and sinking fund at 7 per cent. on "productive" capital only.
C.—Maintenance, salaries, and office expenses.
D.—Rates, taxes, etc.
E.—Net profit.
F.—Selling price.
* Reduced from ·70d. by subtracting "stand-by" losses.
† Reduced from ·95d. by subtracting "stand-by" losses.

factor. The investigation is first made into charges for what are called "interest-paying motors"—*i.e.*, motors which are charged a sum to cover interest and sinking fund on new generating plant and mains rendered necessary by the over-lapping of the lighting and motor loads. The results are given in the columns 2 and 5 of Table A. A suggestion is then made to sell power at extremely low rates on the basis of the current being cut off during "peak" hours.

The generating plant having thus been protected so far as the regular evening peak is concerned, the question arises as to how far a day fog may endanger the lighting supply from the station. A case of quite phenomenal motor load development is worked out in detail, and the results as plotted show, the author thinks conclusively, that in any provincial town it would be perfectly safe to offer the suggested low rates without any danger of a day fog causing the lighting to be shut down; and even in London the system could be worked at the same rates if due precautions were taken to protect the lighting. Means are also indicated in the paper for further extending the load which might be taken up, should the development be exceptionally rapid.

Stand-by charges are next considered, and possible improvement in the works cost, due to the elimination of these, is worked out. Results so obtained are then combined with the other reduced charges consequent on supplying the additional units on the "restricted hours'" system, and are tabulated on columns 3 and 6 of Table A. The "restricted hours' system" has the advantage over a two-rate meter system that a much lower price can be offered, because with the former no material expense whatever, either in plant or mains, has to be incurred; whereas with the latter it would seem that an extra charge must be levied on all units, and not only those which are inside the limits of the peak, otherwise the charges on the latter would probably bring them above even lighting charges. In Montreal, where consumers of class 1 are charged respectively 1·24d. and 1·60d. per horse-power for "restricted hours'" and "unlimited hours'" supply (the flat rates are £10 and £21 per horse-power per annum), some 30 per cent. of the horse-power connected is voluntarily taken up on the former basis out of a total of 21,000 h.p. connected to the mains. If only half (with the greater reduction in price this should certainly be exceeded) this proportion were to hold for the 500,000 h.p. which, we are told, is going to the lowest bidder in London, there would be 75,000 h.p. in London which could be obtained on the "restricted hours'" system at the present time without a penny being spent in generating plant.

Taking account of the fact that they are essentially manufacturing towns, it is probably safe to say that in, let us say, Birmingham there must be quite 15,000 h.p. and in Sheffield 12,000 h.p. similarly obtainable, and in other towns in proportion. Will anyone maintain that this load is so insignificant as to be not worth the catering for? And would it not bring in its train quite a large proportion of "interest-paying" motors.

A suggestion is made for tiding over the peak load by a special arrangement of accumulator cells on consumers premises. The author has ascertained that responsible accumulator makers would be prepared to maintain cells, under the conditions stated, at not more than 10 to 15 per cent. of the capital cost per annum. Another table shows that on this basis a municipal electric lighting station could offer power at charges which would be of the order of only 50 per cent. of their present rates, or of only 60 per cent. if the maintenance rates were doubled. The author suggests that the "restricted hours'" system at ½d. to ⅝d. per unit, supplemented by the private battery system at ½d. per unit additional, will be found to provide a means for obtaining a class of load hitherto out of reach. The system might also be used to "prospect" for battery sub-stations.

The result of some later figures collected by the author relative to costs of gas suction plants for small powers are given in an amended table to replace Table C in the paper as circulated.

## Systems of Electric Units.

A discussion on "Systems of Electric Units" was initiated at a meeting of the Institution on the 6th ultimo. by Mr. W. H. Duddell, hon. secretary of the delegation which attended the St. Louis Congress, at which this subject was considered. The papers presented on that occasion by Profs. Ascoli, Giorgi, Carhart, Patterson, and Wolff were embraced in the present discussion.

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Mr. DUDDELL first drew attention to the question, What is the true value of the volt and ampere? It was pretty generally admitted that the true value of the volt ($10^8$ C.G.S. units) was such that the E.M.F. of the Clark cell at 15deg. C. was very much nearer 1·433 volt than 1·434 volt, the present legal value. From some recent experiments made by Mr. Trotter at the Board of Trade it appeared that the voltage of the normal Clark cell, determined in terms of our "standard" ampere and ohm, was nearly one-tenth of 1 per cent. less than the legalised value, so that there was a discrepancy between our legal standards of nearly one-tenth of 1 per cent., though this did not exceed the limits of error set forth in the Order in Council. As the volt, ampere, and ohm are connected by Ohm's law, if standards are fixed for any two the third is determined in terms of them. Accepting the present ohm, it is only necessary to legalise a standard to represent one of the other two. Was it better to adopt a standard to represent the volt or to represent the ampere? If a standard for the volt is adopted, it would probably be in the form of a cell. Was the Clark (Zn) cell or the Weston (Cd) the more suitable? If the ampere be adopted, is the silver voltameter the most satisfactory form for this standard, or should some form of current balance be used? The various countries which have made laws on the subject of electrical units have adopted different definitions for units, although the definitions are apparently intended to specify the same unit. Thus the legal definition here in Great Britain states of each unit that it *has the value* in terms of the C.G.S. and is *represented by* a certain concrete standard, whereas in the United States law the definition of the unit in terms of the C.G.S. system is qualified by the word *substantially* equal, which suggested the question, Should the legally-defined fundamental units be the C.G.S. units or those obtained by assigning values to the concrete standards? He then defined the various kinds of standards we require. He thought that for each of the electrical quantities we need three standards. First, the fundamental standard, which, he thought, all were agreed must be the C.G.S. This, however, is not a concrete standard. Second, a concrete representation of the fundamental C.G.S. standard or of a multiple of it. Third, the practical standard to be used in everyday work. Regarding magnetic units, Mr. Duddell stated that we require for practical purposes names for three magnetic units—viz., magnetomotive force, total flux, and reluctance. Here, again, there were three courses open in the choice of the magnitude of the units to be named. Firstly, there are already seven units with names in the practical—or volt-ampere-ohm—system. To these might be added three consistent magnetic units, such that the time rate of change of the flux would be in volts, the magnetomotive force would be $4\pi \times$ ampere-turns, and the unit of reluctance the quotient of the unit of magnetomotive force divided by the unit of total flux. Secondly, names might be conferred upon the so-called "rationalised" magnetic units which would involve moving the $4\pi$ from the magnetomotive force to the reluctance. Thirdly, the C.G.S. units could be given names. The question he wished to submit was, Shall the $4\pi$ be moved? Or, if not, Shall the C.G.S. magnetic units or those consistent with the volt-ampere-ohm system be given names? It had been suggested that all the C.G.S. units needed names. If this were so, how ought these names to be formed? The Chamber of Government delegates to the congress had resolved to advise their respective governments to appoint a permanent international commission to deal with these questions of units and standards, and it was greatly to be hoped that this excellent recommendation may be carried into effect. In this event there was one final question he wished to put, Can this Institution, which represents the great body of electrical engineers in this country, help the commission in any way by collecting data from its members by having experiments carried out, and by bringing the results before the commission?

Mr. R. K. GRAY reviewed the history of the delegation to St. Louis, and alluded to the kind treatment received at the hands of their American friends, which he thought was very gratifying in these days of strenuous competition. The opinions of the British delegates were received with great deference.

Lord RAYLEIGH first dealt with the employment of the volt or the ampere as the second principal standard. It seemed to him that too much had been taken for granted in regard to there being no residual uncertainty respecting the ohm. Had we been given the ohm from Heaven there would be a great deal in favour of accepting the volt as the other standard, but, as it was, the uncertainty respecting the ohm might be accentuated by taking the volt as the other standard. He appreciated the convenience of the cell from the practical point of view, and doubtless it would still be used in the workshop as a tertiary standard in any case. At the present time we certainly knew the ohm more accurately than the volt or the ampere, but research might alter this. Before long we might be able to concentrate attention on the advantage of the Weston over the Clark cell in regard to lower temperature coefficient. As the uncertainty found in the setting-up of the Clark cell at the mercury end was in a fair way to being solved; but it would be advisable not to supersede the older cell precipitately. He thought it might be as well to leave the $4\pi$ question in the hands of the rising generation. He hoped electrical terms would not be unduly multiplied, as it was liable to be a tax upon the memory of those who were engaged in other fields as well.

Prof. AYRTON recalled the discussion at St. Louis, when an important point was entirely omitted—viz., the degree of accuracy with which the ohm was known. He then tabulated the best determinations of the ohm that had been made in this country, specially detailing the researches of the late Prof. Viriamu Jones. As a matter of fact, this had not been definitely determined to a fifth decimal point—indeed, it was not absolutely known to a fourth point. It was quite immaterial that the resistance of coils in this country might be found to agree with those in Germany to one part in 100,000. This simply showed the possibility of making coils to a high degree of similarity in resistance. Perhaps the gift of £700 by the Drapers' Company for the construction of a new Lorenz apparatus for use in the National Physical Laboratory would enable a more accurate determination of the ohm to be made in a year or two. It was impossible to determine the volt absolutely in electromagnetic measure, though it could be done in electrostatic measure. The result of the latter could not, however, be converted into volts unless they knew the ratio of the electromagnetic and electrostatic unit of quantity, which was just as difficult to obtain as a determination of the ampere or the ohm. On the other hand, it was possible to determine the ampere to a very high degree of accuracy, and he had been greatly surprised that the last 30 years had seen no practical redetermination of it. In all these absolute measurements it was essential to know the position of the wire coils that were carrying current, and consequently there must be only a single layer of wire for the stationary coil in which the metal disc rotated. He hoped, through the apparatus in course of construction by Dr. Glazebrook and himself, to determine the ampere with certainty to one part in 10,000, and possibly in 20,000.

Mr. A. P. TROTTER, who prefaced his remarks by stating that they must not be taken as representing the official view of the Board of Trade, dealt with the distinction between a unit of E.M.F. and the standard of E.M.F. He quoted the following statement from Dr. Wolff's paper on "The Legalisation of the Electrical Units by the various Governments," read before the St. Louis Congress: "In England . . . a distinction is made between a unit of E.M.F. and the standard of E.M.F., the latter being defined as the one-hundredth part of the pressure producing a certain deflection of a Kelvin electrostatic voltmeter of the multicellular type . . ." Mr. Trotter instanced the British standard yard and the metrical unit of length. When the metallic bar representing the British standard yard was lost by the burning of the Houses of Parliament, the new standard was constructed, not by any scientific determination, but by a careful comparison between the best scales available. Similarly, the metre, as a practical standard, was represented by the platinum bar kept at Paris, irrespective of its definition as the metrical unit of length. A standard was, in fact, the material embodiment of a unit for practical purposes. The Order in Council of 1894 kept a clear distinction between a unit and a standard. Unlike any other country, the limits of accuracy attainable were declared by an Order in Council, which used the expression "is represented by," whereas in the United States, Germany, France, and Belgium the regulation read "substantially equal to," or similar words. Subsequently it became necessary to define the units, but it seemed to the speaker that, now that so much work had been done on absolute electrical measurements, if we were starting afresh, the C.G.S. definition would suffice for the units, leaving the selection of standards to the officials of each country. Mr. Duddell had spoken of units as primary standards, and of what he (Mr. Trotter) called standards as "secondary standards." Mr. Trotter quite agreed that it would be unwise to tie ourselves too tightly to these. If it were found that the standards diverged appreciably from the units, two courses were open to "scrap" the standards or to apply a correction. Clerk Maxwell considered that the original British Association ohm would not be altered, but that a correction would be applied when more accurate researches had been made. Alluding to the important work undertaken by the National Physical Laboratory in determining the absolute value of the ampere and of the ohm, the Board of Trade might or might not take official action in declaring a correction; but the result would be well known to the scientific world, and anybody could apply the correction for himself. At present there was no reason to suppose that the standards of this country differed from the units by more than the limits of accuracy which had been laid down. Suggestions had been made that the method of silver deposition described in the specification attached to the Order in Council was capable of improvement, but the method was not introduced for the purpose of defining the ampere by means of the electro-chemical equivalent of silver. A discrepancy between the declared and the observed value of the Clark cell had been discovered, and he had taken steps to let it

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be known semi-officially that the value appeared to be 1·4329 instead of 1·434 at 15deg. C. For work of the highest accuracy he preferred a saturated cell with a higher temperature coefficient to a semi-saturated cell with an almost negligible temperature correction. He was not prepared to recommend the Board of Trade that any amendment of the Order in Council was necessary, but if any amendment were made he would prefer that the definition of the volt should not contain reference to the Clark or any other standard cell, but that we should fall into line with Germany, Austria, Belgium, and Switzerland.

Mr. F. E. SMITH commented upon the consistency of the concrete mercury ohm, which appeared to be reproducible to within two or three points in 100,000. He had found that the value of the mercury ohm was subject to slight fluctuation, and he might add that the mercury standards of the National Physical Laboratory were not permanent, nor, he thought, was it desirable that they should be. Platinum potential leads must be led into the mercury, and it was impossible to say to what extent the platinum would go in solution in the mercury, and what effect that would have on the resistance. He concurred in the views expressed at St. Louis by Dr. Wolff and Prof. Carhart upon the standard cell. As, however, standard cells changed very gradually in E.M.F., they must be kept under observation for years, and so far no cadmium cell had been observed for the requisite period. If made in accordance with the new specification and maintained at a constant temperature, the Clark cell provided an excellent secondary standard, but for practical purposes the cadmium cell was preferable on account of its low temperature coefficient.

On the discussion being resumed on April 13, Dr. R. T. GLAZEBROOK, F.R.S., corroborated the importance of the point made by Lord Rayleigh that a determination of the ampere does not involve knowledge of the ohm, whereas a determination of the volt does require that knowledge. At St. Louis, however, the delegates were concerned with concrete standards for practical use which should be universally acceptable; and since the ohm, defined by the length of a certain column of mercury, was universal, it was felt that that fact might be taken as established, and that definitions of further quantities required might be based on it. Dr. Glazebrook then expressed his complete agreement with the remark made by Mr. Trotter, that as the concrete standards for England are certain instruments deposited at the Board of Trade laboratory, we are, so far as such standards are concerned, independent of their exact relationship to the fundamental C.G.S. units. At the same time he pointed out that the standards had been constructed originally with reference to the C.G.S. units, and were supposed to represent certain multiples of them, depending thus on the mercury resistance (with which the committee recommended that the standard ohm should be compared), the electro-chemical equivalent of silver, and the E.M.F. of the Clark cell. Other nations had endeavoured to set up standards depending also upon these units, with the result that in consequence of more recent investigations their concrete standards no longer agreed with the English. As to the practical need of any change, it had been pointed out at St. Louis that while the difference of a tenth of a volt only made an error of ·5 or ·6 in the candle-power of a 16-candle lamp, yet it made a difference of over 2 per cent. in the life efficiency of such lamps, and that since at least 10 million lamps per annum were purchased in the States on life efficiency tests, a difference of 2 per cent. was an appreciable amount, and had commercial consequences. Dr. Glazebrook took the opportunity of expressing his appreciation of the reception accorded to the delegates at St. Louis.

Prof. S. P. THOMPSON, F.R.S., averred that where a widely-used standard was found to differ from the theoretical unit, experience had shown the best plan to be to scrap the unit and retain the standard. The English legal gallon, for example, was not exactly 277·25 nor 277·274 cubic inches, nor was it exactly the volume of 10lb. of water, but simply a particular pot kept at the Board of Trade. He strongly advocated that we should retain the standard ohm legalised by the Order in Council, irrespective of any difference that might be found to exist between such ohm and the ideal definition. Prof. Thompson then pointed out that it was absolutely unnecessary to adopt, as primary standards, more than one electrical unit—the ohm—because, since the metric system is legal, the watt, which is $10^7$ ergs per second, is a definite quantity of power which cannot be altered, and is 1-746 of one horse-power (at London). Consequently, as the volt was equal to $\sqrt{\text{watt} \times \text{ohm}}$ and the ampere to $\sqrt{\text{watt} \div \text{ohm}}$, there was no need to define further either volt or ampere, if watt and ohm were both legal measures. Prof. Thompson then eulogised Georgi's system of units, of which an admirable exposition had been given by Signor Ascoli at St. Louis, and which eliminated the $4\pi$ difficulty.

Colonel CROMPTON stated that he had worked for years to secure a system of two standards instead of three, contending that this would better suit practical engineers. He favoured the E.M.F. and the resistance as the standards. It did not concern the manufacturer whether the standards were exactly correct, except that it would prevent him from accurate approximation to the mechanical standards. We must, therefore, be content with the watt and the ohm.

Mr. H. E. HARRISON, while agreeing with Prof. Thompson regarding the selection of standards, could not concur with him in regard to the $4\pi$ difficulty. If we altered our magnetic units, this factor still remained. It might be dealt with either algebraically or geometrically, but it could not be eliminated. Prof. Perry had stated that a hundred years hence people would wonder why we did not get rid of $4\pi$ long ago. He (the speaker) thought that in a hundred years' time people would regard Prof. Perry's view in much the same light as we look upon the attempts a hundred years ago to square the circle. What Prof. Ayrton had stated about the ohm emphasised the fact that we should have units which should be our ideal, and that our standards should be as far as possible in accordance with the units, and we should always be trying to make our standards more accurate. He thought that it would be a distinctly retrograde step if we adopted our standards as our units. Quoting Dr. Webster's remark at St. Louis, that the standards of the different countries differed by probably less than one part in 1,000, he expressed entire concurrence with him that such a margin was commercially negligible.

Mr. C. W. S. CRAWLEY said that it did not signify one iota whether standards were 1 per cent. out from the theoretical units, as errors could be allowed for. Prof. Thompson stated that we only needed the ohm, but this implied an absolute determination of the watt, which came to very much the same thing as determining the volt or the ampere, while from the users' point of view the ampere and the volt were wanted as absolute standards to be passed round the country for regular practical work. He predicted that in 10 years' time a practical man would not look at the mercury ohm. He concluded by recommending that we should adhere to our standards as they were "for ever and ever, Amen!"

At the suggestion of the PRESIDENT, a hearty vote of thanks was accorded to Mr. Duddell.

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**The following list of Council nominations for election of Council and hon. officers for 1905-6 was announced at the general meeting held last week:**

*President.*—Mr. John Gavey, C.B.*

*Vice-Presidents.*—Dr. R. T. Glazebrook, F.R.S.;* Mr. J. E. Kingsbury;* Mr. W. H. Patchell; Mr. W. M. Mordey.

*Members of Council.*—Mr. T. O. Callender; Mr. W. A. Chamen;* Mr. W. Duddell;* Colonel H. C. L. Holden, R.A., F.R.S.;* Mr. S. Z. de Ferranti; Mr. F. Gill; Mr. F. E. Gripper; Mr. J. S. Highfield; Mr. H. Hirst; Mr. Walter Judd;* Mr. Gisbert Kapp;* Mr. C. H. Merz; Mr. C. P. Sparks; Mr. G. Marconi; Mr. C. H. Wordingham.*

*Associate Members of Council.*—Mr. Albert Campbell;* Mr. T. Mather, F.R.S.; Mr. A. J. Walter.

*Honorary Auditors.*—Mr. F. C. Danvers; Mr. Sidney Sharp.

*Honorary Treasurer.*—Mr. Robert Hammond.

*Honorary Solicitors.*—Messrs. Wilson, Bristows, and Carpmael.

The names marked with an asterisk are those of gentlemen nominated to fill the vacancies in the Council in accordance with Article 45 of the articles of association. All the honorary officers being eligible are nominated for re-election.

---

## A HIGHLAND LAMENT.

BY SIMPLEX.

Oh waesome oor that saw the birrth
  Of turbine thochts in Pairson's heid!
I weesh that I wes aff the airth
  Or else the turbine men wes deid.

I'm a receeprocatin' mon,
  I luve tae hear the bearin's boomp.
I coont the piston's put upon
  That's relegated tae a poomp.

This whirrligiging thing I hate,
  For whatna gude is it ta dae?
Tae see the fearsome thing gyrate
  Gars ma puir stommick gang agley

I widna greet gin it hed ocht
  Tae need a feetter's tender haund,
But it hes rin sin' it was bocht,—
  I haena had tae slack a glaund

I've hed enouch! I winna bide
  Tae watch a high-speed coffee-mill
I'll droon me in ma native Clyde
  An' bid ma weary hert be still.

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## POWER v. LIGHT.

The paper on "Stand-by Charges and Motor Load Development" read by Mr. A. M. Taylor before the Birmingham Local Section in December last, was discussed last night before the parent Institution. It raised again the important question which every station engineer is interested in, of how the electrical plant in central stations can be used to the fullest extent. Indirectly, it also shows how large the diversity factor is in the qualifications of a successful central-station engineer. The first essential is without doubt that the man chosen to control an electricity supply undertaking should be a thorough engineer with a practical training in the construction of electrical machinery. Combined with this he needs the experience of a marine engineer in the running of steam-engines and maintenance of boilers. His undertaking will not be successful unless he is a good organiser of labour, and capable of getting the best output from each member of the staff. After these qualifications he needs to have a critical mind in the dissection of accounts, in order that he may, as Mr. Taylor has done, predetermine the cost of production and the price which must be charged to make the undertaking successful commercially. After all this he needs the power to convince his committee that his estimated figures are correct, and the tact of a diplomat to persuade a great variety of consumers that his proposals are fair to all concerned. The return for these qualifications is not superabundant, but we are proud to think that the central-station engineers of this country are second to none in the care with which they discharge their onerous duties. Coming now to the subject of Mr. Taylor's paper, it must be borne in mind that practically all the electrical undertakings in this country were started with the object of supplying electrical energy for lighting purposes. We naturally do not include amongst these those power distribution companies which during the last few years have commenced to give a supply in bulk to large consumers over considerable areas. The fact that the lighting load makes an exceedingly poor use of the machinery required to meet the demand in mid-winter, has led to numerous suggestions and many practical schemes for the improvement of the load factor. It was the Brighton Corporation, under the advice of Mr. Arthur Wright, that took the lead in this matter by introducing the maximum demand system, which is now so largely employed throughout the country and abroad. With this system no attention is paid to the time at which the maximum load of any consumer occurs when fixing the price which he has to pay for his electrical energy. Hence, although it very greatly reduced the cost of light or power to the long-hour consumer, it was not possible to give as low a price for power supply as is the case under the system which Mr. Taylor is supporting. With this the user of power who does not require his motor to be running during the lighting load peak gets special reductions which make it worth his while to reorganise his work to prevent this coincidence. In this matter, again, Brighton has taken a lead, and the Corporation are selling about three-quarters of a million units annually on the "restricted hours'" system. It will be seen from the brief *résumé* of the paper which we reproduce in this issue that to these "restricted hours'" consumers no charge is proposed for interest and sinking fund on the capital outlay. This is on the ground that the plant used would have in any case to be placed in the stations to meet the lighting load. In consequence of this the whole of these charges are to be paid for by the consumer using electric light, and the power consumer gets specially favourable terms. We think this is not unreasonable in view of the fact that

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the restricted hours' consumer is debarred during the winter from using his motor after, for instance, 3.30 p.m. in November, 3 p.m. in December, etc. This makes it impossible for a considerable number of power users to adopt the system, and these then have to bear a fair share of the capital charges on the generating plant. The system in question is by no means a new one on paper, and it has been used extensively both at Brighton and in Montreal. In this last instance the ordinary charge per horse-power per hour is 1·6d., whereas the consumers who agree to the limited hour supply are only charged 1·24d. That this concession is appreciated is shown by the fact that some 30 per cent. of the total number of motors connected to the mains come under the cheaper rate. This percentage is on a total demand of 31,000 h.p. We heartily endorse Mr. Taylor's advocacy of the system, and his figures and curves for determining actual stand-by costs form a valuable addition to the literature on the subject. At the same time we do not think his proposal to instal isolated batteries on a consumer's premises to meet his demand during the peak load should be undertaken by the municipalities. It is obviously open to any consumer to instal such a plant as will enable him to get the cheapest supply of electricity with the alternative systems of charging in vogue. The upkeep of this additional plant of a large number of sets of small accumulators scattered throughout the town should not be undertaken by a municipal body. The conclusion of the whole matter is that there is a very large field for the supply of power in nearly every town which can be developed rapidly if the prices are reduced, as they can be. It remains for the engineer in each town to convince his committee, where he has not already done so, that these low prices are commercially feasible. He will then have to meet the complaints of small lighting consumers and of the gas industry that he is selling under cost price and showing favour. These charges can best be answered by satisfactory balance-sheets.

## FORTHCOMING EVENTS.

FRIDAY, MAY 5.

**Junior Institution of Engineers.**—At 7 p.m., "The Influence of Depth of Water on Speed of Vessels," by Mr. Leslie C. Lambert; and "Condensing Plant," by Mr. James N. Boot.

SATURDAY, MAY 6.

**Electrical Engineers' Corps (R.E.V.).**—At 8 p.m., Bohemian concert at the Caxton Hall.

MONDAY, MAY 8.

**Institution of Mechanical Engineers (Graduates' Section).**—"Design and Construction of Horizontal Engines," by Mr. A. B. Scorer.

TUESDAY, MAY 9.

**Institution of Electrical Engineers (Glasgow Section).**—At 8 p.m., "A.C. Motors in Industrial Service," by Mr. P. D. Ionides.

THURSDAY, MAY 11.

**Institution of Electrical Engineers.**—At 8 p.m., "Telephone Traffic," by Mr. H. Laws Webb.

**Iron and Steel Institute.**—At 10.30 a.m., at Institution of Civil Engineers, annual meeting.

FRIDAY, MAY 12.

**Iron and Steel Institute.**—At 10.30 a.m., annual meeting continued; at 7 p.m., annual dinner at Hotel Cecil.

**Physical Society.**—At 8 p.m., "A Simple Method of Determining the Radiation Constant, suitable for a Laboratory Experiment," by Dr. A. D. Denning; "A Bolometer for the Absolute Measurement of Radiation," by Prof. H. L. Callendar; and "The Resistance of a Conductor the Measure of the Current Flowing through it," by Mr. W. A. Price.

SATURDAY, MAY 13.

**Birmingham Electric Club.**—At 7.30 p.m., "Cheap Electrical Energy for Power Purposes," by Mr. J. A. Jeckell (provisional).

**Junior Institution of Engineers.**—Visit to Dorking water, gas, and electricity works.

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**Rugby Engineering Society.**—May 20, visit to the Lots-road power station at Chelsea.

**Incorporated Municipal Electrical Association.**—June 27-30, annual convention.

## ON THE SELLING OF SPECIFICATIONS.

*(With Apologies to Mr. Dooley.)*

"Well, sir," said Mr. Dooley, "th' Free Traders say that if we ain't fitted f'r an industry we should let th' Dutchmen take it, an' thin we can make a livin' be buyin' th' things fr'm thim. But I don't believe it; we couldn't. If I couldn't make this bar pay, begob, divvle-a-bit would I let Schwartzmeister come into possession, an' thin hang around th' bar meself drinkin' his pisen, like you're always doin' here, Hinnissy. (Mr. Hennessy started.) I'd sell him sausages or tillyphones, an' say I made thim in me wur-ruks at Ballymarroo, even if I didn't. That's why I like th' way th' architec's have ——"

"Phwat's that?" asked Mr. Hennessy.

Mr. Dooley raised his eyebrows. "An architec'," he said, "is a man who knaws a lot about fees an' nawthin' about th' elictric. Whin he is busy he's countin' th' number iv bricks in th' drawin' iv a house, an' charging a guinea a piece f'r his trouble. Whin times is slack he's a sort iv insultin' ingineer, but iv coorse he can't live be that alone. He's got to knaw 'how to git on.' So he publishes spicificayshuns an' sells thim. In th' past, whin a conthractor wanted a job, he jest wint to th' nearest insultin' ingineer an' asked f'r a spicificayshun. 'I'm sorry,' says th' insultin' ingineer, 'but I'm out iv spicificayshuns to-day, owin' to th' failure iv th' blarney crop,' he says. 'But if ye'll call in again nixt month, maybe ye can have, wan or two if ye'll jest lave your goold watch or umbrella,' he says, 'as a pledge iv your boney-fidees.'

"You see, Hinnissy, some conthractors may be honest, but insultin' ingineers is quite right to protect thimsilves fr'm handin' th' sweat iv their brows to men who may, f'r all ye knaw, be sleepin' on th' Embankment at nights. If th' electric trams was there, they might be able to get home to th' County Council dwellin's be sellin' a box or two iv ma-atches.'

"But all that's altered now. Th' architec' is diff'rent fr'm th' real insultin' ingineer. He is used to deal wid Ganderbilks an' Waldorf Asthors an' Bentley-Martins. He's much too keerful f'r to hand the sweat iv other people's brows in exchange f'r goold watches or umbrellas, which may have been lifted in th' House iv Commons or at th' Duchess iv Belgraviah's ball. Th' architec' ain't goin' to run th' risk iv bein' becked f'r rayceivin' stolen property. If he parts wid a spicificayshun, it's f'r hard cash down, an' he never gives discount, although I might be wrong in sayin' he wouldn't take any. He's not givin' away nawthin' free. That's phwat I call th' right sort iv Free Trade. Why, th' counthry that can projooce men wid noshuns like that f'r raisin' th' wind deserves to prosper. Think iv it, Jawn, how th' simple, foolish insultin' ingineers have been givin' back th' deposits f'r years, an' losin' a honest means iv keepin' a motorcar, begob. Suddinly th' architec', who knaws more points about gettin' fees than a lawyer, comes along an' advertises: 'Spicificayshun f'r th' lightin' be elictric iv th' Pig an' Beetle public-house will be sent on rayceipt iv ten guineas, which will not be rayturned.' Whin he comes down nixt mornin', th' post orfice vans are blockin' th' whole street, an' th' architec's fortune is made be a stroke iv masterly genius, as Hogan says.

"You can get a spicificayshun any day fr'm a common insultin' ingineer. But if you knaw you're goin' to get your money back, you can bet your last cent, Hinnissy, that he don't think much iv the spicificayshun himself. But it's different whin an architec' offers f'r to sell his spicificayshun f'r ten guineas. You can tell that he thinks a lot iv it, an' besides, you an' me an' everyone else would pawn all th' masses f'r our souls to get an elictric spicificayshun be an architec'.

"I see be th' pa-apers that William I. is rayturnin' he' th' Siberian Railway fr'm Tangier to th' Salt-iv th'-Earth; an' if I'm not mistaken he's got wind iv th' fur-rust new industry started in this free counthry f'r th' last 50 years. Mark my wur-ruds, Jawn, they'll be dumpin' spicificayshuns into Dover befure th' month is out; an' thin you'll see Joe Chamberlain introjoocin' a depootayshun iv architec's to th' Prime Minister."

"Well, well," said Mr. Hennessy, "it's a pity to see good wur-ruk spoiled, avick."

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"True f'r ye," replied Mr. Dooley, "but ye may be assoomin' too much."

## THE MARCONI-DE FOREST LITIGATION IN THE UNITED STATES.

In our issue for April 14, on p 521, we referred to a decision given in the United States Circuit Court on the above case, which is the first in which wireless telegraph patents have been fought. We now reproduce from the columns of the *Electrical World and Engineer* of New York the following fuller extracts from the judgment:

On April 11 Judge Townsend handed down an opinion in a suit involving the validity of the reissue of the fundamental Marconi patent. The original patent was issued July 13, 1897, and the reissued patent is dated June 4, 1901. The defendant in the suit was the De Forest Wireless Telegraph Company, the complainant being the Marconi Wireless Telegraph Company of America. The opinion is unusually long and discusses almost every phase of the art of wireless telegraphy. Of the 56 claims in the Marconi patent, those in contention were claims 1, 3, 5, 8, 10, and 24. The first part of the opinion discusses the general principles of wireless telegraphy, quotations being given at length from the descriptions in the patents of Marconi and De Forest. It was held that the material differences between the De Forest system and that of the Marconi patents, barring the question relating to elevated conductors, are found in the different construction and operation of the receiving devices, and these two devices are then described in detail.

The main point of the decision relates to the receiving conductor, and in this connection there is considered the work in wireless transmission of Dolbear, Edison, and Kitsee and the publications of Crookes, Lodge, and Popoff. The general conclusion is that if the patent is examined in the light of the facts brought forth in this examination, every element of the claims now in suit is taken from the prior art. The "signalling" and "receiving" instruments are common to the various apparatus from Dolbear, in 1882, to Popoff, in 1895; the Morse key is specifically referred to by Dolbear, Edison, and Kitsee, and is suggested by Lodge; the spark-gap, invented by Hertz, for producing the Hertzian oscillations, is found in Lodge and Popoff; the 1891 Branly coherer, an imperfect electrical contact comprising a tube of filings, and its operation by means of a tapper, are elaborately explained in Lodge's lecture and utilised by Popoff in his experiments, and choking coils are illustrated and described by Popoff. The insulated conductors described and shown as comprising elevated plates suspended on wires were shown in Dolbear, Edison, and Kitsee.

As to the argument of the counsel for the defendant that the said prior disclosures and the imperfect operation of Marconi's apparatus prior to 1898 or 1899, when he introduced various improvements, deprived the original patent of all claim of novelty except for specific improvement on various parts of prior existing complete systems, the Court held that this contention is not well founded, and that the facts stated serve to support the claim for Marconi of a high exercise of inventive ability. No prior existing system was complete, or had been shown or conceived to be commercially operative. A sufficient answer to the attempts to belittle Marconi's great invention, is that with the whole scientific world awakened by the disclosures of Hertz in 1887 to the new and undeveloped possibilities of electric waves, nine years elapsed without a single practical or commercially successful result, and that Marconi was the first to describe and the first to achieve the transmission of defined intelligible signals by means of the Hertzian waves. The exact contribution of Marconi to the art of spark telegraphy may be stated as follows: Maxwell and Crookes promulgated the theory of electrical oscillations by means of a disruptive discharge; Hertz produced these oscillations and described their characteristics; Lodge and Popoff devised apparatus limited to lecture or local experiments or to some impracticable purposes as the observation of thunderstorms. Marconi discovered the possibility of making these disclosures available by transforming these oscillations into definite signals and, availing himself of the means then at hand, combined the abandoned and laboratory apparatus, and by successive experiments reorganised and adapted and developing them into a complete system capable of commercially utilising his discovery. If a later inventor, by the exercise of a discriminating faculty, detects and distinguishes the difficulties, and estimates their proportions and breaks down the barrier, or bridges the interval, or stretches beyond the limitation, by an instrumentality which, in the very facts of its construction and operation, and by the adaptation of its mechanism to the end sought, suggests original and creative design, then, by his contribution of the essential idea in tangible shape, he has invented a new instrumentality, and his monopoly should be sustained.

A considerable portion of the opinion is devoted to the discussion of insulated conductors, this term applying to the aerial wire. The Court held that the weight of argument seems to favour the contention of the complainant that the insulation intended by the patentee was the insulation at the top—the effect of insulation to prevent the oscillations from passing off without operating the transmitting and receiving devices. In the case at bar the functions of the two devices are identical. The original way of transforming the function in Marconi was substantially that of the later way, which is that employed by the defendant. The difference in insulation was not a different way of performance, but an enlargement of scope and increase in the distance of transmission by a greater use of the property of the earth as capacity by means of a continuous physical connection. The Marconi conductors should not be limited to the metallic plates at the top of the vertical wires, but should be construed to cover the wires alone. But whatever interpretation of the term "insulated" be adopted, the decision of the question of infringement rests upon the fact that the Marconi invention in suit is a primary invention, and as such is entitled to a broader range of equivalents, so as to prevent the appropriation of the substance of the invention by a mere change in force accomplishing a mere change in degree

Discussing the Marconi and De Forest receiving devices, it is stated that the defendant's liquid circuit closer or detector could not be used in the Marconi system, being a newly-discovered combination in a newly-evolved class of detectors and covered by its patents. While the defendant's detector is not the equivalent of the "tube containing metallic powder" of claims 8 and 10, it is equivalent of the imperfect electrical contact of claims 1, 3, and 5, because it utilises means identical in function and substantially identical in method with those first employed by Marconi in his primary invention. As to claim 24, covering a tuned conductor, there is no evidence that the defendant uses any tuned conductor, and therefore he does not infringe this claim.

As to claim 1 of the Marconi patent, this is stated to be a new broad claim introduced into the reissued patent which in terms covers every imperfect form of contact in every possible kind of system for producing signals by means of Hertzian oscillations. In view of the limitations imposed upon the Marconi coherer by the disclosures of Branly, Popoff, and Lodge, such a generic claim, much broader than those for the original patent for which it seems to have been substituted, should not be permitted when the effect would be to enlarge the scope of the original invention. In the original patent Marconi limited most of his claim to a combination in the receiver for electrical oscillations, of his coherer, consisting of a tube and powder and means for shaking the powder. But inasmuch as this had been disclosed by prior publications, he applied for the reissue, and now by claim 1 has attempted to cover not merely the coherer of his former claims, or any such coherer in a receiver, or a coherer with means for shaking the powder therein, but every form of imperfect contact device previously disclosed by others, or which might thereafter be discovered, whenever combined with any electrical apparatus using Hertzian oscillations. This claim, if allowed, will apparently cover the prior devices of Lodge and Popoff, the latter of which is a claim to have necessitated the disclaimer and reissue.

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The Court ordered a decree entered dismissing the bill as to claims 1, 8, 10, and 24, and for an injunction and accounting as to claims 3 and 5, the complainant to recover one-half of its costs.

Both the parties to this litigation claim to have secured advantages from the same. The two claims, Nos. 3 and 5, which the Court declared to be valid, and to have been infringed by the De Forest Company, were given in our issue for April 14. For convenience of reference we reproduce them again here:

"3. The combination, in an apparatus for communicating electrical signals, of a spark producer at the transmitting station, an earth connection to one end of the spark producer, an insulated conductor connected to the other end, an imperfect electrical contact at the receiving station, an earth connection to one end of the contact, an insulated conductor connected to the other end, and a circuit through the contact, substantially as and for the purpose described.

"5. The combination, in an apparatus for communicating electrical signals, of a spark producer at the transmitting station, an earth connection to one end of the spark producer, an insulated conductor connected to the other end, an imperfect electrical contact at the receiving station, choking coils connected to each end of the contact, an earth connection to one end of the imperfect contact, an insulated conductor connected to the other end, and a circuit through the coils and contact, substantially as and for the purpose described."

It is claimed by the American Marconi Company that these clauses are quite general enough to cover the use of any form of aerial conductor and grounded connection. On the other hand, the De Forest Company claim a victory because the first claim of the Marconi patent was not sustained. With respect to claims 3 and 5, this company read the decision to mean that any system which does not employ an aerial conductor insulated at the top does not infringe the Marconi patent. Any systems, therefore, which employ other connections to the aerial conductor, and which do not employ an earth connection, are said to be free of infringement. The same company also read the judgment to the effect that other systems which use magnetic detectors or other apparatus for detecting the oscillations which are in imperfect contact type can be freely used. As to the claims declared invalid, Nos. 8 and 10, these were not infringed by the De Forest system, as they were limited to coherers containing metallic powder. The firm also said that claim 24, which was held not to be infringed, was as broad a frame as could possibly be drawn on the Marconi system.

The general impression left on one's mind from the above report of the judgment is that there is opportunity for a good deal more litigation over the wireless telegraph patents. The patents for details which have been issued to various experimenters are numerous, and it will be no easy matter for any company to maintain a complete monoply as far as patent rights are concerned. The commercial side of the question, however, is somewhat simpler as far as this country is concerned, because the Marconi Wireless Telegraph Company have already entered into long-period agreements which give them exclusive rights. For example, they have a contract with Lloyds, under which for 14 years no apparatus except the Marconi can be used to communicate from Lloyds' stations by wireless telegraphy with ships equipped with other than Marconi receiving apparatus. The agreements with the principal shipping companies, and also with the Admiralty and Post Office, are more or less on the same lines, which makes the position extremely difficult for any rival system. This, of course, is the situation in this country only, and in the States the De Forest Company may by their commercial policy be able to secure similar advantages.

## APPOINTMENTS VACANT.

**Borough Electrical Engineer and Tramways Manager**, Southend Town Council. Salary £400 per annum. Applications by May 8. See advertisement in last issue.

**Improver**, Coventry electricity works. Salary £50 per annum. Applications by May 10. See advertisement.

## THE ALTERNATING-CURRENT SERIES MOTOR.*

BY F. CREEDY, STUDENT.

*(Continued from page 593.)*

### Experiments on the Series Motor.

In order to verify the above theory, a series of experiments was undertaken, with the view of showing (*a*) the accuracy of the circle diagram described therein; (*b*) the effect of the number of turns on the field on the performance of the motor, and the fact that there is a certain number of field turns which gives a better power factor than any other; (*c*) the effect of altering the number of turns on the armature; (*d*) the effect of altering the frequency; together with one or two other points of interest in this motor. The motor employed in these experiments was a small bipolar overtype machine, with a double-wound armature having 36 slots and 36 commutator segments. The double winding was intended to improve the commutation (which it did not do), and also to enable one to double the number of armature turns by simply altering the commutator connections. The field magnets were fitted with two coils, having 84 and 104 turns respectively. A connection was tapped off from the middle of the coil having 84 turns, so that 42 turns on the field were also available.

It was found, after some experiment, that the only available way of obtaining a reliable brake test was by using an electric generator as brake. As this machine was not always to be had, it was decided not to take any readings of output while investigating the methods of obtaining good power factor, etc., but to make an independent investigation as to the efficiency afterwards. Accordingly, while observing most of the curves below, readings of current, watts, and speed only were taken, the speed being kept constant in the following way. The pulley was fitted with a brake-strap, which was loaded until approximately the right speed was attained, when the final adjustment of the speed was made by altering the pressure on the brake-strap by hand. In this manner very good circles, such as those shown below, were obtained. A set of experiments was first made in order to show the effect of varying the number of field turns on the power factor, etc. The report of these is shown in Fig. 5.

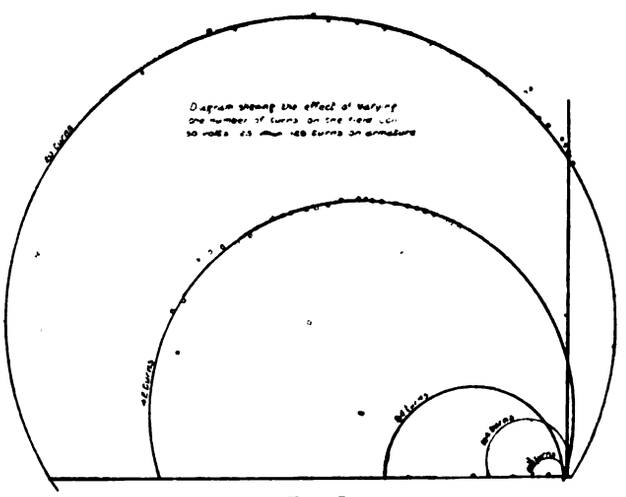

FIG. 5.

These curves were all taken at 25 frequency, and show the *locus* of the current vector as we vary the speed, when we have 188, 104, 84, 42, and 20 turns on the field. The two upper curves were taken at 50 volts, so I have been able to put the points in. The others, however, were taken at a different voltage, so I have been obliged to reduce them to 50 volts before putting them in, and have, therefore, merely indicated the range over which the observations extend. The points, however, lie as closely on the circles as do those shown. The curves show clearly the increase of the power factor, at a given speed, as we decrease the number of turns on the field, and also, of course, the increase in the size of the circle. The range of speed over which the observations extended in all these and the following

* Paper read before the Institution of Electrical Engineers.

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experiments was from 600 to 3,000 revolutions per minute. The curve corresponding to 20 turns, which shows such excellent power factor, was obtained by putting the two field coils in opposition, there being a difference of 20 turns between them. The high power factor is obtained largely at the expense of efficiency.

In the above set of experiments I was unable to reduce the number of field turns below 20, and thereby increase the current taken by the machine, for fear of burning it out. However, after the number of turns on the armature had been doubled, and the armature impedance thereby quadrupled, some further experiments (see Fig. 6) were

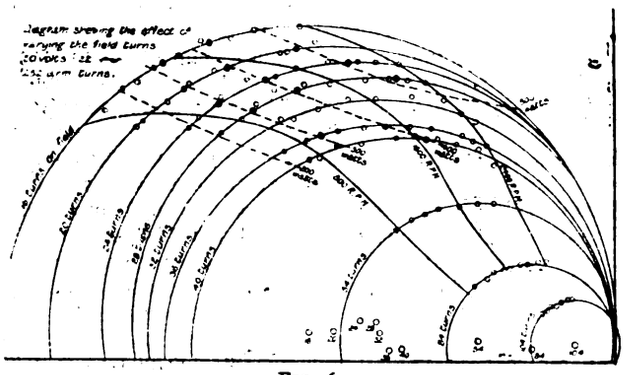

FIG. 6.

made which clearly demonstrate that if we decrease the number of turns below a certain point, the power factor decreases. Thus we have shown experimentally that there is a certain number of turns which gives a maximum power factor, as was shown theoretically above.

In order to verify the construction given in Fig. 2 for the speed, the distance, S P (Fig. 2), is set out in Fig. 7 against the measured speed. This is done in the case of the four circles corresponding to 20, 42, 84, and 104 turns

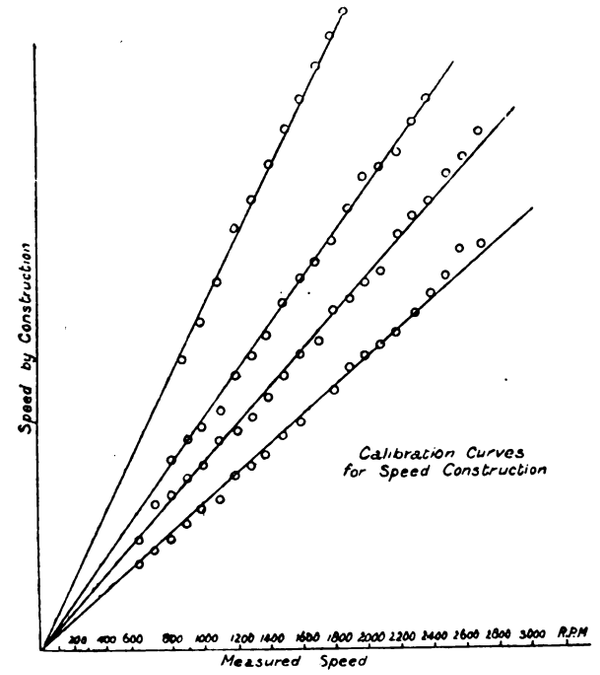


FIG. 7.

respectively. In order to prevent the lines from coinciding, a different scale was taken for S P in each case. From these curves it can be seen how exactly proportional is the line S P to the measured speed. I have no doubt that equally good curves could be obtained from the other circles shown in the paper, but the four given seemed amply sufficient to establish the correctness of the speed construction, so no more were plotted. These curves, together with the large number of experimental circles shown in Figs. 5, 6, 8, and 9, constitute a complete verification of the circle diagram of the series motor, since the fact that the torque is proportional to the square of the current, so long as the magnetic circuit does not approach saturation, is self-evident. From the constructions for torque and speed, and that for the input, which also admits of no doubt, the constructions for output and efficiency follow immediately.

The next series of experiments made was intended to show the effect of varying the frequency on the performance of the motor. The result of these is shown in Fig. 8.

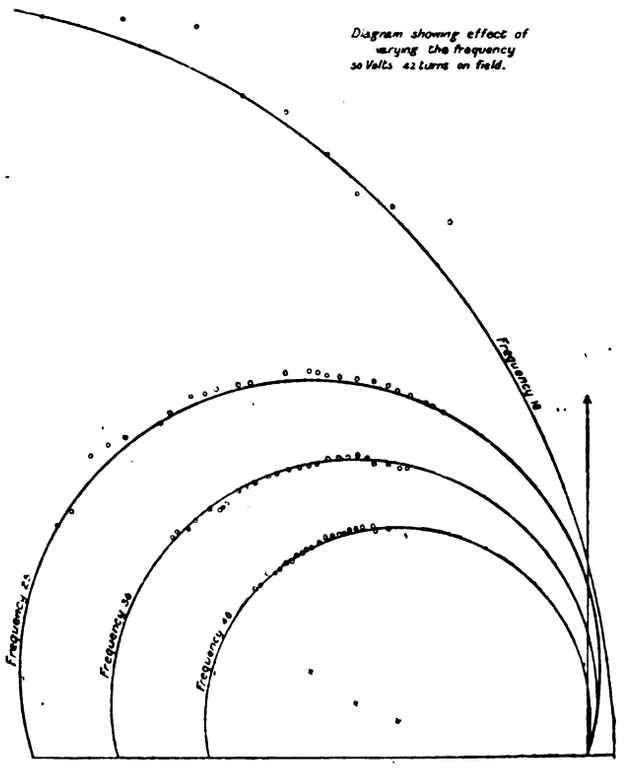


FIG. 8.

The increase of power factor and of the size of the circle with decreasing frequency, which theory leads us to expect, is very well shown. The curves also show that as the frequency gets less, a given change in it produces a greater effect. This, of course, is no more than one would expect. The alteration in both power factor and size of circle, when the frequency is reduced from 25 to 18, is very marked. The curve for 18 frequency was almost the only bad one obtained. It was several times repeated with the same results. The reason why it is so bad, is probably the excessive current taken by the motor.

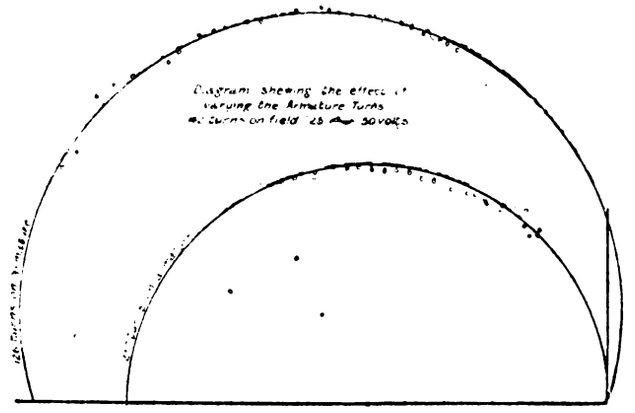


FIG. 9.

In Fig. 9 are given two curves showing the effect of altering the number of turns on the armature.* The improvement in the power factor thereby obtained is clearly shown, and also the decrease in the size of the circle due to the increased armature impedance. In Figs. 10 and 11 are given some curves showing the effect of the number of field turns on the output and efficiency. These were taken simultaneously with those in Fig. 6. Fig. 10 shows three efficiency curves corresponding to 20, 36, and 54 field turns respectively. These show that the efficiency at any given speed rises as the number of field turns increase, thereby agreeing with theory.

* When the number of armature turns is mentioned on the diagrams, the total number of turns is meant, not half this.

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In Fig. 11 I have plotted the output against the number of field turns for various values of the speed. It will be seen that it appears to rise somewhat rapidly from zero to a maximum, and then to gradually decrease again with increasing number of turns. That the output must have a maximum is obvious, for it is zero where there are no turns on the field, and also when there are a great number. It must consequently have a maximum between these two points. The value of $n$ for which this occurs was worked out mathematically, but the expression for it is so complicated that it seemed useless to give it.

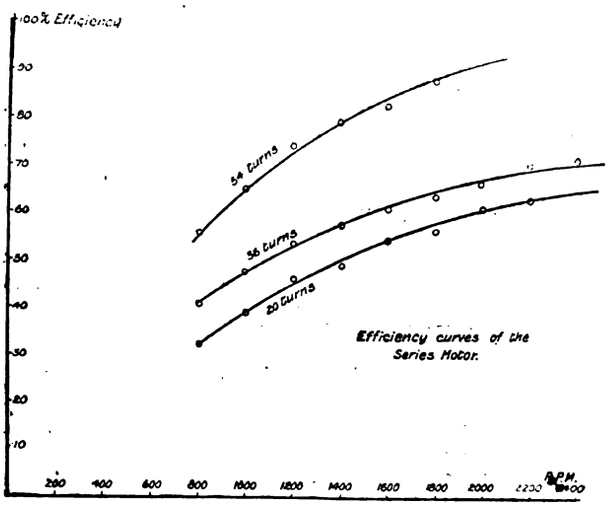


FIG. 10.

In Appendix I. is given a diagram (Fig. 15) showing the various effects of varying the number of field turns in a series motor, while keeping the number of armature turns constant. Although Appendix I. was written after the experiments in Fig. 6 were performed, these latter fortunately enable us to verify this diagram almost completely. In Fig. 6 I have drawn in three lines of constant speed. The similarity in shape between these experimentally determined lines and the theoretical ones in Fig. 15 is very marked. By plotting a series of curves of output against speed, for various numbers of field turns and drawing lines through them corresponding to outputs of 0·2, 0·3, 0·4, and 0·5 kilowatts respectively, I was able to ascertain the points on each circle corresponding to these

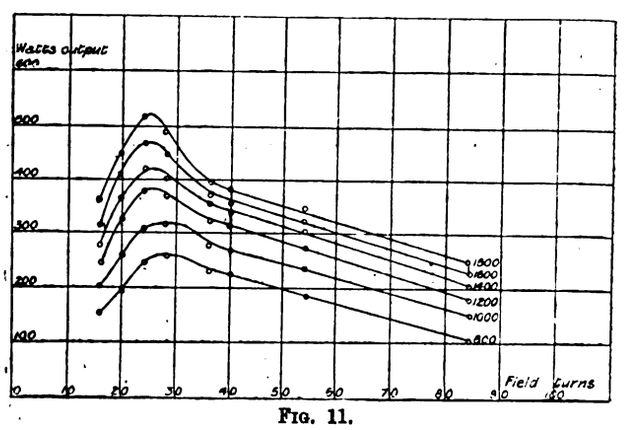


FIG. 11.

outputs. These points are marked in Fig. 6 with a small circle with a cross inside. It may be seen, that if these points do not afford conclusive evidence that the lines of constant output are circles, they at least show that circles, such as are indicated by theory, serve to represent the lines of constant output remarkably well.

(*To be continued.*)

## NOTES ON THE CARE AND MANAGEMENT OF DYNAMOS.

BY W. J. H.

A most important element in the efficiency of dynamos and motors, and one which makes considerable difference to their lifetime, is the care with which they are treated, and the immediate remedy of any fault or irregularity that may appear in them. It requires a certain amount of experience to be able to detect these faults and irregularities as soon as they occur, and also to know the proper steps to be taken to correct them before the damage becomes at all serious or has time to deteriorate the machine. For this purpose, and for the benefit of any readers of the *Electrical Engineer* who may have the care of dynamos and motors, the following notes are written.

In many cases a breakdown or failure in a dynamo may be traced to negligence, or carelessness pure and simple. Dynamo machinery cannot withstand ill-usage and overloading, although motors generally increase their output in proportion to the demand made upon them until a certain limit. If intelligence and commonsense are used, a capable engineer should have no difficulty in looking after an electrical plant, and in keeping it up to its standard of efficiency by a system of regular running, cleanliness, and general care. Of course, the treatment of dynamos in general applies to motors also. A most important point to be noticed is the temperature to which a dynamo attains after a few hours' run; good modern machines rarely increase in temperature more than 40deg. to 45deg. F. above the surrounding temperature of the room in which they are running, after a run of many hours on full load. The parts that are seriously affected by a temperature rise are, of course, the armature and field coils, and any temperature under 130deg. F. is quite harmless to the insulation of these.

Care should be taken that the dynamo is quite rigid on its foundation, and no vibration whatever should be permitted to take place when the dynamo is running. This point should always be kept in mind by the attendant, who should make it his place to tighten up all loose bolts and bearings as soon as any tendency to looseness is apparent. In setting the brushes on the commutator, the points should always be placed diametrically opposite each other, resting very lightly on the commutator. They will probably need moving forward occasionally to maintain this position, and if it is noticed that the points become ragged or rough and uneven, they should be trimmed with a file or scissors.

It is most important that continuous-current machines should be free from sparking at full load. There should be a system of continuous lubrication, and all bearings should run cool. The most satisfactory lubricant to be used for the commutator is vaseline, which should be used sparingly, and wiped carefully off with a non-fibrous rag, in order to leave the least possible amount of lubricant to ensure satisfactory results. If the brushes are made of alloy sheets, lubricating the commutator is not often necessary, as they give excellent results without. It sometimes happens that from inattention, or structural faults, that the surface of the commutator becomes grooved and uneven; the armature should be taken out and turned up lightly in a lathe. With moderate attention the commutator should soon assume a fine dark polish.

When grit or dust gets into the bearings, they should be cleaned by means of thin oil poured into them, which will wash out the dirt. The importance of a perfectly true "run" cannot be over-estimated, and a crooked belt which slides from one side of the pulley to the other is sure to give trouble sooner or later. The joint in a belt should be as smooth and as near the size and shape of the rest of the belt as possible, as the damage done to a dynamo with a belt which "knocks" as it passes over the pulley is incalculable.

In order to run in a satisfactory condition the dynamo should make as little noise as possible. One of the first signs of looseness of bolts or vibration is a loud noise, which means that the dynamo is wearing in some part and needs tightening down, or else it is attributable to loose bearings, or armature or pulley out of balance.

It is frequently the habit of an inexperienced attendant to replace a blown fuse with one of greater capacity, thus inducing overload to the dynamo. Automatic cut-outs are used largely recently, which prevent this occurrence. A dynamo may refuse to start if the contacts be loose or bad, or if a circuit be broken and the residual magnetism be

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diminished. When a motor fails to start or stops, the cause may be a break in the circuit, bad contact, or loss of magnetism or overload.

When handling a dynamo when working the attendant should always see that his hands are dry, and if anything goes wrong he should preserve his equanimity, and keep cool, as presence of mind can often avert catastrophe.

## INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

The meeting of this association to be held in Edinburgh on June 27 and following days will have under consideration a proposal which should attract a large number of associate members and associates. At present the annual conventions are of little service to the assistant engineers in central stations, as they cannot as a rule be absent from their duties while their chiefs are away. It will be seen from the following circular letter that the council wish to arrange additional meetings for the benefit of assistant engineers provided the scheme receives due support:

PRIVILEGES OF MEMBERSHIP.

Dear Sir,—It is felt that associate members and associates are at some disadvantage as compared with members in regard to attendance at the annual convention, it being impossible for an assistant to be absent at the same time as his chief.

The council being desirous of removing this difficulty and of enlarging the scope of the association, has under consideration a scheme for holding either a second convention, or quarterly provincial meetings each year, specially for those who are at present prevented from attending the annual gathering.

Before, however, coming to any decision in the matter, the council is desirous of ascertaining the opinions of those concerned, and particularly as to what extent they will support it, and therefore asks that the attached form may be filled in and returned to the secretary as soon as possible.

Whether the scheme can be carried to a successful issue or not will depend almost entirely upon what proportion of those now eligible for associate membership or associateship make application to join, in view of the proposed extension of the scope of the association.

The matter is, therefore, practically in the hands of those in whose interests the scheme is promulgated.—Yours faithfully,

(Signed) C. MCARTHUR BUTLER, Secretary, I.M.E.A.
Staple-inn-buildings, Holborn, London, W.C.

The questions on the form are five in number, and the engineers in the various municipal supply stations are also asked for any personal observations or suggestions they may wish to offer. The questions read:

1. Are you in favour of a second annual convention, to be held specially for those unable to attend the first?
2. Should such second convention be held at a fixed centre, say London, or in whatever district the first is held?
3. Would you attend such meetings when possible?
4. As an alternative it is suggested that council meetings be held, say, four times a year in different provincial centres, and on each occasion a day be given to reading of papers by associate members and associates, and visits to works in the district. Would you attend such meetings held in your district, and be prepared to support this suggestion?
5. If not already affiliated with the association, will you join it if provision is made for a second convention or provincial meetings?

It seems to us that an all-important question should also be addressed to the chairmen of electricity committees on the question of the expenses incurred by associate members when attending such a convention or meetings. The expenses for a reasonable proportion of the staff should be borne by the department they serve. The views of the chairmen of committees on this point would influence the answers of the assistant engineers to the above question.

## IRON AND STEEL INSTITUTE.

As previously announced, the annual meeting of the institute will be held, by kind permission, at the Institution of Civil Engineers, Great George-street, Westminster, on Thursday and Friday, May 11 and 12, 1905, commencing each day at 10 30 a.m. The following is the programme of proceedings:

THURSDAY, MAY 11.

10.30 a.m.—General meeting of members. The council will present their report for the year 1904. The hon. treasurer will present the statement of accounts for 1904. Scrutineers will be appointed for the examination of the voting papers. Election of officers and council. The retiring president, Andrew Carnegie, Esq., LL.D., will induct into the chair the president-elect, R. A. Hadfield, Esq. The Bessemer Gold Medal for 1905 will be presented to Prof. J. O. Arnold, Sheffield. The award of the Andrew Carnegie Gold Medal and Research Scholarships for 1905 will be announced. The president will deliver his inaugural address. A selection of papers will be read and discussed.

1.30 p.m.—The meeting will be adjourned.

FRIDAY, MAY 12.

10 30 a.m.—General meeting of the members at the Institution of Civil Engineers. A selection of papers will be read and discussed.

7.0 p.m.—Annual dinner of the institute in the Grand Hall of the Hotel Cecil.

The following is a list of papers that are expected to be submitted:

1. "On Experiments on the Fusibility of Blast-Furnace Slags." By O. Boudouard, D.Sc., Carnegie Research Medallist, 1903 (Paris).
2. "On Recent Developments of the Bertrand-Thiel Process." By J. H. Darby (Brymbo) and G. Hatton (Brierley Hill)
3. "On the Application of Dry-Air Blast to the Manufacture of Iron." By James Gayley (New York). Supplement to paper read on Oct. 26, 1904.
4. "On the Effect Produced by Liquid Air Temperature on the Mechanical and Other Properties of Iron." By R. A. Hadfield, president.
5. "On the Cleaning of Blast-Furnace Gas." By Axel Sahlin (London).
6. "On the Failure of an Iron Plate through Fatigue." By S. A. Houghton (London).
7. "On the Continuous Steelmaking Process in Fixed Open-Hearth Furnaces." By S. Surzycki (Czenstochowa, Poland).
8. "On Accidents due to the Asphyxiation of Blast-Furnace Workmen." By B. H. Thwaite (London).
9. "On the Behaviour of the Sulphur in Coke in the Blast Furnace." By Prof. F. Wüst, Ph.D., and P. Wolff (Aachen).

Reports on research work carried out during the past year will be submitted by C. O. Bannister (London), J. Dixon Brunton (Musselburgh), H. C. H. Carpenter (Teddington), J. C. Gardner (Oldbury), G. Dillner and A. F. Enström (Stockholm), E. G. L. Roberts and E. A. Wraight (London), Frank Rogers (Cambridge), and Walter Rosenhain (Birmingham)—Andrew Carnegie Research Scholars.

Members who intend to take part in the discussions will, on notifying such intention to the secretary, have copies of the papers forwarded to them a week in advance, as far as that may be found possible. Visitors' tickets will also be forwarded upon application.

By the courtesy of the Great Western, the Midland, the Caledonian, the London and North-Western, the Great Northern, the Lancashire and Yorkshire, the Great Central, and other railway companies, special arrangements have been made enabling members attending the meeting to obtain return tickets on payment of a single fare and a quarter on production of a certificate of membership, which may be obtained at the institute offices.

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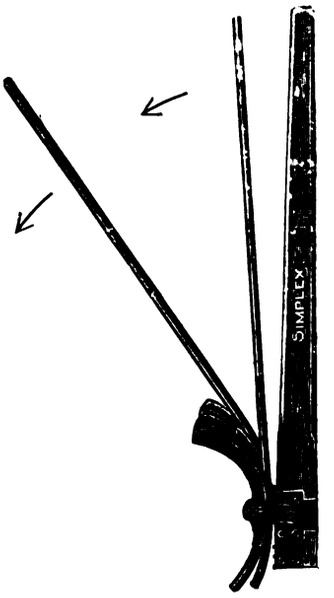
## TRADE NOTICES AND NOVELTIES

### Leakage Indicators.

In view of the new mining regulations, which stipulate that a leakage indicator is to be connected permanently in circuit on the main switchboard, it will, no doubt, interest our readers to know that Messrs. Everett, Edgcumbe, and Co., 87, Victoria-street, Westminster, S.W., have gone very carefully into the question of the best instruments for this purpose, and are now in a position to supply them for all systems, whether direct or alternating current. It need hardly be pointed out that the requirements are somewhat difficult to meet, as it is not only necessary to indicate that a fault has occurred, but also the approximate value of the leakage current, and on which main the leak has taken place. We hope to give a detailed description of these instruments in a later issue.

### Simplex Conduit-Bending Machine.

We illustrate herewith a new conduit-bending machine introduced by the Simplex Steel Conduit Company, Limited, Westinghouse-building, Norfolk-street, Strand, London, W.C.




Simplex Conduit-Bending Machine.

This machine is claimed to be the handiest, most efficient, and cheapest tool for bending tubes on the market. Simplicity and portability are its great advantages, its weight being only 5lb., and there are no loose parts to get lost or out of order. The bender consists of a wooden lever, a hinge link, and a cast bending mould which has two curved grooves of different radii. These grooves together with the corresponding grooves in the end of the lever take conduits up to ¾in. diameter. The method of using the machine is described on a leaflet just issued by the makers.

### High-Tension Apparatus.

The Union Electric Company, Limited, 151, Queen Victoria-street, London, E.C., are about to issue a new edition of their

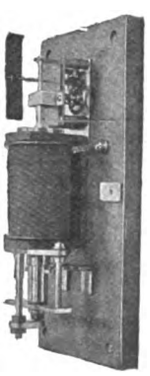


FIG. 1.—Time Relay.

list No. VI. This list (an advance copy of which we have before us) illustrates practically every class of high-tension switchgear for hand and automatic control in both the horn and oil-break types. Some particularly interesting devices for the automatic control of switches are included. The time relay illustrated in Fig. 1 herewith is designed to prevent a momentary short-circuit or overload from opening the high-tension switch immediately. When the time relay has run down in from two to twelve seconds, the release circuit is completed and the switch opened. The device comprises a solenoid acting on an iron core. The movement of this iron core is controlled by a train of wheels connected to an air vane, and when the core has been completely sucked in by the solenoid, the release circuit of the switch is closed. If, however, the circuit through the solenoid is broken owing to the overload not continuing, then the iron core which is connected to the train of wheels through ratchet gear at once falls back to its original position. It is occasionally essential that the time relay shall control the release on ordinary overload, but that on a short-circuit the switch shall be opened immediately; for this purpose the firm supply combined maximum relays, the apparatus consisting of two maximum relays mounted on one insulator. One of these relays is adjusted for slight overload and release through the time relay, the other for heavy overload or short-circuit and immediate release. Fig. 2 illustrates an arrangement of relays for use with the firm's completely automatic oil-break switches to parallel generators or synchronous motors automatically. The great advantage of an apparatus of this description is that it is impossible to parallel otherwise than correctly. By the combination of a pressure relay which fixes the

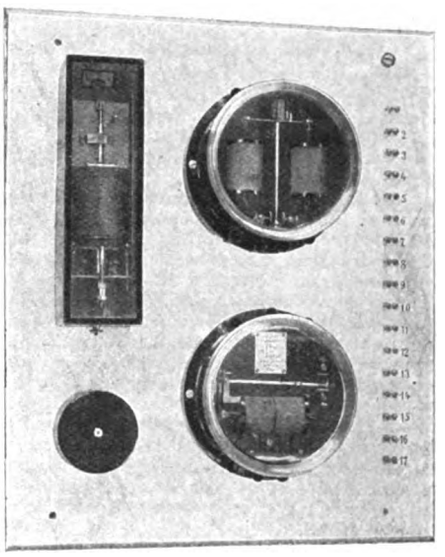


FIG. 2.—Automatic Paralleling Gear.

correct pressure of the incoming machine, a phase relay indicating equality of phase, and a time relay in which the run-off rate (corresponding to the long illumination of the phase lamps) indicates synchronism, the correct moment of synchronism is obtained and the circuit for automatically switching in and out then closed. A small rotary switch is provided for starting the whole apparatus. This is automatically switched out as soon as the main switches have come into action. Only one such gear is necessary, regardless of the number of machines to be dealt with, provided that the pressure transformers and automatic switch-in coils of the respective machines can be connected to it through a four-pole voltmeter change-over switch. The list under notice also includes a large range of high-voltage fuses and some interesting designs in the way of switch pillars and instrument fittings, besides several wiring diagrams and section drawings of standard switchboard designs showing the extreme simplicity of modern high-tension switchgear.

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WESTRUMITE PATENTS.—We have received an illustrated catalogue of the 1905 improvements in Westrumite patents, giving details of Westrumite No. 1, reliable road preserver, dust layer, and disinfectant; Westrumite No. 2, Westrumite asphalt (new patent of great value), a cheap and easily applied durable asphalt road surface. The manufacturers and sole vendors are Hope and Sons, 22, Billiter-street, London, E.C., with works at Hope's Wharf, Millwall, London, E.; Oak-lane Chemical Works, Limehouse, London, E.; Westrumite Works, West Side, Tilbury Docks, Essex; and at Leicester. Since the actions of "Hope and Sons *v.* Westrumite, Limited," and "Westrumite, Limited, *v.* Hope and Sons" were decided by the Chancery Division of the Supreme Court in favour of Westrumite, Limited, Messrs. Hope and Sons have acquired the right to be manufacturers and sole vendors of Westrumite in the United Kingdom. Instructions for use and details with regard to Pynerzone blocks accompany the catalogue. These blocks contain an extract of Norwegian pine, eucalyptus, and thymol in concentrated form, and are useful for disinfecting roads, manholes, sewers, etc.

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# COMPANIES' MEETINGS AND REPORTS.

## CITY OF BIRMINGHAM TRAMWAYS.

The general meeting of this Company was held last week, Mr. Emile Garcke presiding.

The report showed a disposable balance of £60,321, after providing for interest on debentures, dividend on preference shares to Dec. 31, and interim dividend of 5 per cent. on the ordinary shares for the half-year ended June 30, 1904, the net profit being larger by about £3,000 than in the preceding year. The Company carried 54,000,000 of passengers, as against 50 000,000. The balance of £54,000 was proposed to be carried to the reserve fund, which now stands at close upon £300 000. Arrangements have been made for working jointly the various tramways belonging to their Company and to the Birmingham and Midland Tramways Company, the Wolverhampton and District Tramways Company, the Dudley and Stourbridge Electric Traction Company, and the Staffordshire Tramways Company. These companies have agreed to constitute a joint committee, composed of all the directors of the companies concerned. The committee have been working since July 1 last, and for the six months they had been able to effect a reduction in the expenses of about £4,000.

The CHAIRMAN stated that with regard to their relations with the city of Birmingham, an agreement had been effected with the Corporation for the sale of the Company's lines within the district of Balsall Heath, and the Corporation had agreed to purchase the Kyotts Lake depôt. The Company had also consented to the Corporation equipping the horse and steam lines with electric tration during the period of the Company's lease. That was to say, the Company was facilitating the Corporation in their endeavour to electrify the steam lines at the earliest possible date, and, instead of putting the Corporation to the difficulty of waiting until the leases had expired before they were able to enter upon the work of reconstruction, the Company proposed to give them all necessary facilities to enable them to commence the work of reconstruction forthwith. As part of this arrangement the Corporation had given the Company some relief from the heavy charges for permanent way repairs during the remaining part of the lease. One of the greatest difficulties in the way of the Corporation was that the tramways of Birmingham radiated into outside districts whose tramways could not for many years come under the control of the Corporation. In order, therefore, that the public might not be inconvenienced by the changing of cars at the boundaries, the Company and the Corporation were arranging an agreement for mutual running powers. On the subject of motor 'buses the directors were clearly of opinion that the motor omnibuses were not able to compete with electrical or cable tramways, or even with well-designed steam tramways. Motor 'buses, however, were probably preferrable to animal traction, but were not yet sufficiently perfected to enable the directors to say that the whole of their horse omnibuses could be superseded by motor omnibuses. The heavy cost of repair to motor omnibuses and the need for very frequent adjustment of machinery rendered the maintenance of a large service very uncertain; but experiments were being made in view of possibilities.

The report was adopted.

Replying to questions, the CHAIRMAN reminded the audience that only some of the leases expired in 1906, and the leases of the cable line and electric line in Bristol-road continued till 1911. In addition, the Company owned several lines outside the city, consequently there was no question of the Company expiring. A large part of their income would disappear, but the cable and the Bristol-road electric line were practically their best lines, so that their position would not be very seriously modified in 1906. Speaking generally, the directors hoped and believed that the whole of the capital of the Company would become liquid, either by reason of the realisation of properties which would not be required after the leases had expired or by the accumulation of surplus profits. Both these factors would, in the course of time, the directors hoped, make up the capital of the Company.

## PRIMITIVA GAS AND ELECTRIC.

The annual general meeting of the Primitiva Gas and Electric Lighting Company of Buenos Ayres, Limited, was held last week, Mr. H. E. Jones presiding.

In moving the adoption of the report and accounts, the CHAIRMAN said that the results of the past year's working had enabled the directors to recommend a dividend on the ordinary shares of 6 per cent. per annum, an increase of 1 per cent. on the previous year's dividend. The increase of 4½ per cent. in the sales of the Company's gas during the year might not appear to be very large, but it was a fair increase when compared with the results of other gas companies, which generally showed very small increases. This was due to the great saving effected in the consumption of gas by the introduction of the Welsbach burners and mantles. There was, however, a considerable demand for gas cookers and stoves, and in this direction they looked to the present prosperity of the Company being maintained in the future.

The report and accounts were unanimously adopted.

## WEST COAST OF AMERICA TELEGRAPH.

Sir JOHN DENISON-PENDER, presiding at the meeting of the West Coast of America Telegraph Company on Tuesday, stated the increase of receipts from £35,707 to £42,337 was largely due to the introduction of recorder instruments in the place of mirror instruments. The transfer had cost £1,111, and he expected they would have to spend another £200 before that expenditure was completed. Wages had increased £390, and the enlarging of the buildings at Iquique had cost £260. Maintenance of cable and land lines represented £9,203, as compared with £12,155 in 1903. Interest on debts was £6,000, and on income bonds £800, leaving a balance of £7,419. The total at the disposal of the directors was £8,516, which would be disposed of as follows: £6,000 would be placed to reserve (making that fund £10,185), £1,750 to ship reserve (bringing that fund up to £4,000), and £766 would be carried to next year's account.

The report was carried.

## BATH ELECTRIC TRAMS.

The second ordinary general meeting of this Company was held on the 26th ult., Sir Vincent Caillard presiding. Particulars of the report appeared in our last week's issue.

The CHAIRMAN, in moving its adoption, reviewed the progress of the undertaking, and predicted a good result from the Midland Bridge route, now in course of construction, and the Newton St. Loe extension, which has been sanctioned by the Board of Trade. A system of motor 'buses is to be adopted to provide feeders for the trams.

The report was carried unanimously, and Mr. A. A. Campbell Swinton, the retiring director, re-elected.

## RAND CENTRAL ELECTRIC WORKS.

The annual meeting of this Company was held at Winchester House last week, Sir C. Rivers Wilson presiding. Particulars of the report appeared in our last week's issue.

The CHAIRMAN stated that a great scheme was in progress for the formation of a supply of water on the Rand, and when this was carried into force they would be able to obtain their water much cheaper than at present. In view of mining activity on the Rand, and the increasing opportunities of the supply by the Company of electric energy, the prospects were very encouraging, and the directors had great confidence in the future.

The report was adopted.

## BROCKIE-PELL ARC LAMP.

The report for 1904 stated that the sum of £496 had been written off for depreciation of plant, machinery, and tools, and a further amount of £148 expended on new patterns during the year has been charged to revenue account. This left a debit balance of £1,864 on profit and loss account, as against the £2,023 shown in the last account for the 18 months ended Dec. 31, 1903. Despite this result, chiefly attributable to the continued depression of trade and competition, the directors considered that the Company's business is now in a much more promising condition than it was at this time last year.

At the fifth ordinary general meeting held on Tuesday, Mr. H. W. MAYNARD, who presided, first explained the position as regards the directorate. Sir F. Dixon-Hartland and Lord Suffield retired, and Mr. W. Nicolson and Mr. R. Warner succeeded them, but the former gentleman recently died. With regard to the manufacturing work of the Company, he thought there was no doubt that they had been led into taking up one or two lamps that did not come up to anticipations. A considerable change had to be made in them, and that change had been brought about by Mr. Brockie, who had produced the B.E. lamp, on which he (the chairman) did not hesitate to say the future prosperity of the Company largely depended. One firm had ten times repeated their original order for that particular lamp, which had earned golden opinions for its economic qualities. He had been asked whether the directors had any fear of the flame lamp, and he would like to mention that Mr. Brockie had in his mind a flame lamp which he (the chairman) thought would equal anything on the market. Good results were also expected from the Twin lamp. They had good travellers in London, and excellent agencies in Birmingham, Manchester, Newcastle, and Dublin, but it was desirable to spend more money on advertising as soon as finances permitted. The sales of the past year showed a larger number of orders, and something like 4 per cent. higher gross profits than the previous year. Great efforts are being made to dispose of the Company's heavily-rented premises, and with the new lamps, the increasing business in London and in the arc trade generally, with the price at which the Company can manufacture lamps, and with strong hopes of an increase of trade, he was confident of the future and anticipated a very different state of things after another year's working.

The report was adopted.

## BRUSH ELECTRICAL ENGINEERING.

The report for 1904 shows a gross profit of £71,280. General charges, maintenance, interest on debenture stock, and £6,500 carried to depreciation reserve fund absorb £43,200, leaving a balance of net profit of £28 080. The directors recommend a dividend at the rate of 6 per cent. per annum on preference shares for the year, placing £7,000 to general reserve fund, and carrying £3,080 forward. The depreciation reserve fund will then stand at £45,107 and the general reserve fund at £16,450. The sum of £11,508 has been expended on additions to plant and buildings during the year. A considerable proportion of this amount is in respect of a complete plant for rendering wood non-inflammable or fire-resisting, for which a considerable demand has arisen for rolling-stock and other purposes. The Company is engaged upon an important electric supply and tramways undertaking at Bombay, on which the sum of £67,791 had been expended at the end of the year, principally upon account of the construction of the electric supply works. Arrangements are in progress, which it is expected will shortly be completed, for the formation of a separate company to deal with this undertaking, which will secure for the Company important contracts. The general reserve account has been reduced by £11,050, representing the book value of

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the stock of Universal engines. It is proposed, on the other hand, that the sum of £7,000 shall be added out of profits. The Universal engines have not been satisfactory in some sizes, and, their manufacture having been entirely discontinued, the directors have thought it prudent to write off in full the book value of those remaining on hand. The output from the works shows a considerable increase over that for the previous year, and the volume of orders is well maintained. Competition, however, continues to be severe, and the net profits have consequently not increased in proportion to the turnover. Marked progress has been made during the year at Falcon Works in developing new manufactures and in improving existing designs. This work has involved considerable expenditure on drawings, patterns, experiments, etc., the whole of which has been charged against revenue. The demand which has arisen for motor omnibuses has for some time past engaged the attention of the directors. The Company has already built examples of these vehicles, and arrangements are now being made whereby the interests of the Company will receive suitable attention in connection with this important development.

## AUCKLAND ELECTRIC TRAMWAYS.

The seventh ordinary general meeting of this Company was held on Monday, Mr. C. G. Tegetmeier presiding. Particulars of the report appeared in our last week's issue.

The CHAIRMAN announced that the traffic receipts for the first three months of the current year were £3,000 in excess of the receipts for the corresponding period of last year, and the directors were justified in anticipating that at the end of the 12 months they would have a still more satisfactory report to present than they had now the pleasure of laying before the shareholders.

The report was adopted.

## ORIENTAL TELEPHONE AND ELECTRIC.

The eleventh ordinary general meeting of this Company was held at the Great Eastern Hotel, Sir A. Colvin presiding.

The CHAIRMAN stated that the work of underground cabling at several of the stations was proceeding, and that the expenditure would probably necessitate a fresh issue, for which the shareholders would have the first opportunity of subscribing. The Telephone Company of Egypt, in which this Company is largely interested, continues to make good progress.

The report was unanimously adopted.

## NEW COMPANIES REGISTERED.

**British Electrical Device Company, Limited.**—Capital, £500. Object: to carry on the business of manufacturers of and dealers in electric, hydraulic, pneumatic, and steam engines, dynamos, switchboards, switches, pumps, motors; boilers, batteries, cables, wires, telegraph or telephone instruments, etc.

**Gobron Brillie British Motor Company, Limited.** Capital, £30,000. Object: to acquire the business of a manufacturer of and dealer in motorcars carried on by J. Stenbury, to adopt an agreement with the Share and Finance Contract Company, Limited, and to carry on the business of manufacturers and sellers of motorcars, carriages, and other vehicles.

**Barbados Light Railway, Limited.** Capital, £20,000. Object: to acquire the whole or part of the railways, properties, and undertakings now or lately belonging to the Bridgetown and St. Andrew's Railway, Limited, power being taken, in particular, to acquire the benefit of an option or contract of purchase vested in C. J. P. Cave or G. F. Burn referring thereto, and to carry on the business of light railway owners, suppliers of electricity for power or otherwise, rolling-stock manufacturers, builders, contractors, carriers, etc. Registered office: 9, Great George-street, Westminster.

**National Electrical Manufacturers' Association (Incorporated).**—With 500 members, each liable for not more than £1 in the event of winding up. Object: to take over the property of the unincorporated association known as the National Electrical Manufacturers' Association, and to promote and protect the interests of electrical manufacturers and others dealing in or supplying electrical goods in the United Kingdom. The word limited is omitted from the title by license of the Board of Trade. The management is vested in a committee, the first members of which are H. Bevis, T. J. Grainger, P. A. Lundberg, F. H. Nalder, C. S. Northcote, H. Oppenheimer, S. Paterson, and W. Smith. Registered office: 5, Ridler-place, Holland-street, Blackfriars, S.E.

## PERSONAL.

Mr. Ernest Moore, of Sheffield, has been appointed, out of 125 applicants, as chief clerk in the Halifax Corporation tramway offices.

The Belfast Electricity Committee have appointed as station superintendent, at a salary of £4 per week, Mr. Moore, who is assistant manager of the similar department in Manchester.

The Swindon Town Council have abolished the post of shift engineer at the power station, and have appointed the present shift engineer, Mr. F. V. Jordan, station engineer at a salary of £104 per annum.

The Derby Town Council have increased the salary of the electrical engineer, Mr. T. P. Wilmshurst, from £500 to £550 per annum, as from May 1, 1905, and from £550 to £600 per annum, as from May 1, 1906.

We are informed that Mr. Arnold B. Gridley, having accepted an important position on the staff of the Newcastle-upon-Tyne Electric Supply Company, Limited, has severed his connection with the British Electric Traction Company, Limited, with whom he has been for the past four years as secretary of some of its associated electric supply and traction companies. On Friday last Mr. Gridley was presented with a canteen of plate and cutlery by some of the directors and staff. The presentation was made by Mr. Garcke, the managing director of the British Electric Traction Company, Limited.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Edinburgh.**—The Corporation invite tenders for water-tube boilers. Tenders by May 8.

**Tonbridge.**—The Urban District Council require tenders for cables. Tenders by May 29.

**Islington.**—The Borough Council require tenders for coal-conveyors, etc. Tenders by May 24.

**Dublin.**—The Port and Docks Board invite tenders for an electric generating station. Tenders by May 15.

**Cataquoxes (Spain).**—The local light and power company require tenders for electrical plant. Tenders by July 1.

**Johannesburg.**—The time for sending in tenders for this contract (particulars of which appeared in former issues) is May 8 (London).

**Rosario (Argentine).**—The Government require tenders for construction and working of an electric tramway. Tenders by June 30.

**Bury (Lancs.).**—The Guardians invite tenders for electrical installation at the union workhouse. Tenders by 10 a.m. on May 8.

**Cork.**—The Electric Tramways and Lighting Company, Limited, invite tenders for the year's supply of electrical fittings. See advertisement.

**Paris.**—The Colonial Office, 4 bis, Rue Jean-Nicot, require tenders for the supply of lamps and lighting accessories for three years. Tenders by May 23.

**Cheltenham.**—The Corporation invite tenders for the supply of arc lamp carbons for the year ending March 31, 1906. Tenders by May 17. See advertisement.

**Leith.**—The Corporation invite tenders for coal elevating and conveying plant and boiler-house auxiliary plant. Tenders by May 17. See advertisement.

**Cork.**—The Cork Electric Tramways and Lighting Company, Limited, invite tenders for the supply of white wood casing and capping. See advertisement.

**Dartford.**—The Urban District Council invite tenders for the supply and erection of various plant. Tenders by May 24. Full particulars in advertisement columns.

**Liria.**—The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

**Dax (Province of Landes, France).**—The Municipality require tenders for their concession to erect and work electric lighting for 35 years. Tenders to the Mayor by May 14.

**French West Africa.**—The Governor-General of French West Africa, at Dakar, requires tenders for the erection and equipment of a central station at that place. Tenders by May 15.

**Laventhem (Belgium).**—The Municipality require tenders for erection of central station, laying of mains, etc. Particulars (3s. 4d.) may be obtained from the Secretary of the Mayor of that place.

**Kettering.**—The Urban District Council invite tenders for the supply, delivery, and erection of Nernst lamps, posts, etc., for street-lighting within their district. Tenders by May 29. See advertisement.

**Antwerp.**—Tenders will shortly be invited by the Belgian State Railways for the installation of electric light in their local railway station. Specification No. 619 may be obtained from the Government Railways Office, Brussels.

**Paisley.**—The Gas Corporation invite tenders for the following plant: (Contract 5) electric power generating plant, consisting of gas-engines and dynamos; (Contract 6) elevated electric coke conveyors, electric screening plant, coke storage hoppers, etc. Tenders by May 13.

**Switzerland.**—M. R. Vontobel, of Winterthour, and M. Charles Probst, of Lucerne, have obtained a concession for the construction of a narrow-gauge electric railway from Meiringen to Gletsch. The total cost of the enterprise is estimated at £241,600; £19,600 is to be expended on rolling-stock.

**London.**—The London County Council invite tenders for the supply, erection at its generating station, East Greenwich, S.E., and maintenance for a period of 10 years, of a battery of 280 accumulator cells having capacities of 645 ampere-hours at a three-hour discharge rate and of 450 ampere-hours at a one-hour discharge rate. Tenders by May 16. See advertisement in last issue.

**Irvine (Scotland).**—The Corporation invite tenders for the supply and erection of the following plant: (Contract 1) buildings; (Contract 2) power-house plant—(Section A) suction gas plant, gas-engines, and generators; (B) balancers and boosters; (C) battery of accumulators; (D) switchboard; (E) crane; (Contract 3) mains—(Section A) cables, trenches, etc.; (B) converting street lamps; (C) meters. Tenders by May 15.

**London, N.**—Tenders are invited for the road work, platelaying, and paving, etc., required for the construction for electrical traction on the overhead trolley system of the short length, equivalent to about three-fourths of a mile of single track, of authorised tramway in Archway-road, Highgate, between the Archway Tavern and the

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Highgate Archway, in the metropolitan borough of Islington, for the London County Council. Tenders by May 8.

**London, S.E.**—The London County Council invite tenders for the road work and plate-laying required for the construction, for electrical traction on the conduit system, of certain authorised tramways in Blackwall-lane, East Greenwich, and from New Cross to Lewisham, and for the reconstruction, for the same system of electrical traction, of a portion of the existing horse tramways in Woolwich-road, and from Lewisham to Catford. Tenders by 10 a.m. on May 25.

**Heywood.**—The Council invite tenders for (A) Lancashire boiler, feed pump, hot-well, two water-filters, steam feed and blow-off pipes; (B) two 200-kw. steam dynamos, condenser, air and circulating pump, hot-well pump, water-cooling tower, exhaust and circulating pipes, oil separator and pumps; (C) traction switchboard, extensions to lighting board, cable connections, etc.; (D) traction feeders, telephone and test wires, switch pillars. Tenders by May 17. See advertisement.

## RESULTS OF TENDERS.

**Belfast.**—The Council have accepted the tender of Courtenay and Co., at £6,281. 14s. 5d., for the erection of the pump-house in connection with the generating station.

**Belfast.**—It is proposed to order 30 tramway cars from the Brush Company, and, in addition to convert 25 of the best horse cars into electric cars at a cost of £350 for each car.

**Metropolitan Asylums Board.**—The tender of J. W. Gray and Son, of 115, Leadenhall-street, E.C., at £670, for the installation of electric fire-alarms and telephones at the Gore Farm Upper Hospital, has been accepted.

**Generators.**—Johnson and Phillips, Electric Light and Power Works, Old Charlton, report recent orders for 400-kw. traction generator and switchboard extension for the Barking Urban District Council, and 150-kw. and 50-kw. generators for dye works.

**Middlesex Tramways.**—The Light Railways and Tramways Committee have given the work connected with the tramways from Tally Ho! Corner to Woodberry-grove, Ballards-lane, Finchley, and the extension of the tramways from the Edgware-road, Cricklewood, to the Metropolitan Railway Station, Willesden, to C. Ford, contractor, and Dick, Kerr, and Co., Limited, contractors, respectively. The work, which consists of double tracks, wood paved, is to be carried out under schedules and prices, to the satisfaction of Mr. H. T. Wakelam, M.I.C.E., the county engineer.

**Aston Manor.**—The Corporation have received the following tenders for tramway construction:

| | | | |
|---|---|---|---|
| G. Trentham (accepted) | £51,236 | 3 | 9 |
| Dick, Kerr, and Co., Limited | 51 849 | 1 | 10 |
| G. Law | 52 912 | 7 | 6 |
| J. G. White and Co. | 52,357 | 15 | 9 |
| Underwood and Bro. | 53,387 | 7 | 6 |
| Griffiths and Co., Limited | 54,073 | 9 | 6 |
| Graham and Sons | 54,162 | 0 | 0 |
| Krauss and Son | 56,552 | 5 | 0 |
| J. White, jun. | 59,112 | 7 | 7 |
| G. Holloway | 61,572 | 5 | 0 |
| Blackwell and Co., Limited | 61,785 | 12 | 0 |

The prices represent the net amount of tender after deducting the value of old materials.

**Erith (Kent).**—The Urban District Council have received the following tenders for the wiring of their car depôt and workshops:

| | | | |
|---|---|---|---|
| W. Dickinson and Co., Highfield, Bexleyheath (accepted) | £200 | 15 | 6 |
| J. E. Collum and Co., Ipswich | 206 | 15 | 6 |
| A. H. Marshall and Co., Leytonstone | 215 | 10 | 0 |
| Owens Ironmongery Stores, Limited, Erith | 221 | 18 | 6 |
| Cross and Cross, Walsall | 229 | 6 | 0 |
| Barlow and Young, London-street, E.C. | 300 | 0 | 0 |
| J. T. Jarvis and Sons, Erith | 307 | 0 | 0 |
| Private Wire and Telephone Installation Company, Westminster, S.W. | 329 | 18 | 0 |
| Lancashire Electrical Engineering Company, Ashton-under-Lyne | 330 | 0 | 0 |
| D. Hulett and Co., High Holborn, W.C. | 331 | 10 | 6 |
| W. Parker, Gillingham | 350 | 0 | 0 |
| S. E. Haward and Co., Limited, Tunbridge Wells | 361 | 4 | 0 |
| W. H. McKone and Co., Berners-street, W. | 362 | 14 | 0 |
| Dudley Electrical Company, Dudley | 363 | 0 | 0 |
| Star Electrical Engineering Company, Bridgwater | 389 | 17 | 0 |
| Beam Company, Barbican, E.C. | 458 | 0 | 0 |

**Dublin.**—The Corporation have received the following tenders for supply and erection of two electric motors:

| | | | |
|---|---|---|---|
| Aston Bros., Limited, Dublin (Lahmeyer Electrical Company) | £172 | 8 | 0 |
| Vickers, Sons, and Maxim | 178 | 0 | 0 |
| Bruce Peebles and Co. | 185 | 0 | 0 |
| British Westinghouse Electrical and Manufacturing Company, Limited | 196 | 0 | 0 |
| Johnson and Phillips | 197 | 10 | 0 |
| Electric Construction Company, Limited | 198 | 0 | 0 |
| Wm. Coats and Son, Limited (General Electric Company, (1900) Limited) | 210 | 0 | 0 |
| General Electric Company, Limited | 222 | 10 | 0 |
| Industrial Engineering Company | 233 | 6 | 0 |
| Brush Electrical Engineering Company | 236 | 5 | 0 |
| Aston Bros., Limited (Lahmeyer Electrical Company and Orlrey Gear) | 235 | 18 | 0 |
| Lancashire Dynamo Company | 240 | 0 | 0 |
| British Thomson-Houston Company | 270 | 5 | 0 |
| Maschinenfabrik Oerlikon | 276 | 10 | 0 |
| Oerlikon (withdrawn) | 288 | 10 | 0 |

**Derby.**—The Town Council have accepted the following tenders: St. Helens Cable Company, feeder cable £860. 17s. 1d., distributing bitumen cable £438. 12s. 6d.; S. R. Turner and Co., lathe £38. 0s. 6d., pillar drilling machine £34. 2s. 6d.; C. A. Parsons and Co., steam turbine, £3,950; British Thomson-Houston Company, switchboard extension, £287.

**Nuneaton.**—The following tenders have been received for supply and delivery of cables and joint-boxes, for the Electricity Committee:

Vulcanised-bitumen cables.

| | | | |
|---|---|---|---|
| W. F. Dennis and Co.* | £641 | 15 | 6 |
| St. Helens Cable Company | 838 | 10 | 4 |
| Callender's Cable Company | 843 | 0 | 0 |
| British Insulated and Helsby Cables | 904 | 8 | 10 |
| W. T. Glover and Co. | 921 | 6 | 0 |
| Electrical Company, Limited | 776 | 10 | 10 |

Paper cables.

| | | | |
|---|---|---|---|
| W. F. Dennis and Co. | 716 | 2 | 7 |
| St. Helens Cable Company | 910 | 10 | 0 |
| Callender's Cable Company | 843 | 0 | 0 |
| British Insulated and Helsby Cables | 859 | 13 | 7 |
| W. T. Glover and Co. | 869 | 13 | 2 |
| Electrical Company, Limited | 785 | 6 | 8 |
| Johnson and Phillips | 810 | 19 | 7 |
| W. T. Henley's Telegraph Works Company | 895 | 12 | 10 |
| Siemens Bros. and Co. | 869 | 0 | 0 |
| Western Electric Company | 721 | 5 | 0 |
| Ellis and Ward (simplified solid system) | 912 | 9 | 9 |

Joint-boxes.

| | | | |
|---|---|---|---|
| W. F. Dennis and Co. | 134 | 5 | 0 |
| St. Helens Cable Company | 69 | 0 | 0 |
| Callender's Cable Company | 66 | 1 | 0 |
| British Insulated and Helsby Cables | 72 | 0 | 0 |
| W. T. Glover and Co. | 76 | 14 | 0 |
| Electrical Company, Limited | 79 | 10 | 0 |
| Johnson and Phillips | 59 | 17 | 8 |
| W. T. Henley's Telegraph Works Company | 71 | 5 | 0 |
| Siemens Bros. and Co. | 72 | 14 | 0 |
| Western Electric Company | 88 | 0 | 0 |
| Ellis and Ward | 63 | 14 | 0 |
| Rumney and Rumney* | 48 | 8 | 6 |
| Cable Accessories Company | 56 | 3 | 0 |

*Tenders under consideration and likely to be accepted.

**Keighley.**—The Electricity Committee have received the following tenders for a 300-kw. set:

| | |
|---|---|
| T. Parker, Limited, Wolverhampton (Allen) | £1,712 |
| Ditto (Browett) | 1,444 |
| Electric Construction Company, Wolverhampton (Allen) | 1,840 |
| Ditto (Browett) | 1,580 |
| International Electrical Engineering Company (Allen) | 1,740 |
| Ditto (Browett) | 1,472 |
| J. Howden and Co., Glasgow (Parker-Howden) | 1,706 |
| Ditto (Crompton-Howden) | 1,874 |
| Armstrong, Whitworth, and Co. (Allen) | 2,006 |
| J. H. Holmes and Co. (Allen) | 2 060 |
| Ditto (Bellis) | 2,580 |
| Phœnix Dynamo Manufacturing Company, Bradford (Allen) | 1,696 |
| Ditto (Browett) | 1 420 |
| Browett, Lindley, and Co. (Mather and Platt-Browett) | 1,474 |
| Ditto (Parker-Browett) | 1,495 |
| British Westinghouse Company (Allen) | 1,181 |
| Ditto (Parker-Browett) | 1,598 |
| Mather and Platt (Allen) | 1,725 |
| Ditto (Parker-Browett) | 1,430 |
| J. and E. Wood, Bolton (Wood) | 3,125 |
| Greenwood and Batley, Limited (Allen) | 1,786 |
| Ditto (Browett) | 1,540 |
| Lancashire Dynamo and Motor Company (Allen) | 1,879 |
| Ditto (Browett) | 1,551 |
| Dick, Kerr, and Co. (Allen) | 1,961 |
| Davey, Paxman, and Co. (Davey-Paxman) | 1,936 |
| British Electric Plant Company, Alloa, N.B. (Allen) | 1,897 |
| Ditto (Browett) | 1,629 |
| Siemens Bros. and Co. (Allen) | 1,780 |
| Ditto (Bellis) | 1 720 |
| British Thomson-Houston Company (Allen) | 1,965 |
| Ditto (Browett) | 1,681 |
| Bruce Peebles and Co. (Allen) | 1,822 |
| Ditto (Browett) | 1,540 |
| J. Musgrave and Sons (Musgrave) | 1,997 |
| J. Fowler and Co., Leeds (Allen) | 1,778 |
| Ditto (Browett) | 1,507 |
| Royce, Limited (Willans) | 2 326 |
| Galloways, Limited (Galloway-Phœnix) | 1,845 |
| Ditto (Galloway-Parker) | 1 870 |
| Vickers, Sons, and Maxim (Allen) | 1 844 |
| Ditto (Browett) | 1,570 |
| General Electric Company (Allen) | 1 868 |
| Ditto (Browett) | 1,586 |
| Johnson and Phillips (Allen) | 1,756 |
| Ditto (Bellis) | 2 290 |
| Crompton and Co. (Allen) | 1,876 |
| Ditto (Browett) | 1 613 |
| Brush Electrical Engineering Company (Brush) | 1,850 |
| Electrical Company (Allen) | 1,844 |
| Ditto (Bellis) | 2,178 |
| Ditto (Browett) | 1 562 |
| C. A. Parsons and Co. (Parsons) | 2,128 |
| Indiarubber Company (Allen) | 1,896 |
| Ditto (Browett) | 1,637 |

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# BUSINESS NOTES.

## TRACTION.

**Brighton.**—The returns for the Corporation tramways for Easter week show the takings to have exceeded those of last year by more than £400.

**Gloucester.**—The revenue for the first year totals £15,815, and there is a net profit of £273 after making provision for special expenditure.

**Dalkeith.**—The Town Council have provisionally agreed to give their consent to the Edinburgh Suburban Electric Tramways Syndicate's scheme.

**City and South London Electric Railway Co.**—This company announce "great reduction in fares," also abolition of certain restrictions concerning return tickets.

**Maidstone.**—The enquiry by the Light Railway Commissioners into the proposed line between Maidstone and Headcorn has been completed. The Corporation opposed.

**Spain.**—The Grenada and Murcia Tramways Company have received the concession to construct and work the electric tramway from Murcia to Palma. The Malaga Tramways Company propose to construct two lines in Malaga.

**London United Tramways Co.**—A start was made on Monday with the work of construction over Kingston Bridge in connection with the company's scheme of electric tramways for linking Surrey with its existing Middlesex system.

**Chili.**—The Government have decided to grant a concession for constructing and working an electric railway from Valparaiso through the Casablanca and Cura Cavi Valley to Santiago, with a branch to Melifilla. As usual, the material may be imported duty free.

**Bournemouth.**—The Corporation tramway accounts show an excellent result for the past year's working. The total income amounted to £55,333, and the working expenses reached £33,592. After deducting capital charges, etc., there was a net balance of £5,201. The number of passengers carried was over 10 million.

**Birkenhead.**—The special committee appointed to consider whether some system could be devised whereby the ferries and tramways could be worked together with greater advantage to the public, has drawn up a report in which they recommend an experimental issue of reduced through return tickets available over the Higher Tranmere tramway route and the Woodside Ferry, also certain reductions of fares.

**Swansea.**—The first week's traffic on the augmented tramway system shows a large increase, the number of passengers carried being 175,000, compared with 90,000 in the corresponding week of last year. A settlement between the Corporation and the company regarding the price of current and the overhead equipment on the Morriston section seems probable. The new extensions, with the exception of the Port Tennant section, were opened to the public on Saturday morning.

**Metropolitan Electric Tramways, Limited.**—The company have issued an illustrated guide to their service between Edgware and Cricklewood. The various beauty-spots and places of interest are picturesquely shown, which, with the time table attached to the guide, will doubtless render the pamphlet highly popular. The Welsh Harp, the attractions of Hendon, and the old-fashioned town of Edgware are all duly depicted, and now that the long days have come there will doubtless be crowds of passengers anxious to explore the country covered by this line.

**Blagdon and Pensford Light Railway.**—Great interest is being displayed in the endeavour to procure an order for the construction of the Blagdon and Pensford light railway. The work of surveying the proposed route is all but completed, and at a public meeting held last week to support the scheme the following resolution was carried unanimously: "That this meeting is of opinion that the proposed light railway will greatly conduce to the prosperity and trade development of the district, and will greatly assist the agricultural, mining, and other industries, and pledges itself to support the proposed railway by every means in its power."

**Tramways and Light Railway Estates.**—At the sixth annual general meeting of the Tramways and Light Railway Estates Company, Mr. Emile Garcke, who presided, said that the profit was somewhat less than in former years, and was entirely due to the slackness of trade generally, and to the fact that the amount of work carried on by tramway companies in connection with new promotions and the construction of new lines had been very much reduced—so much so that the total fees for the year only amounted to £1,100, instead of £1,400 for the preceding year. Expenses were practically the same, being £815, instead of £835 for the previous year—a difference of £20.

**Northampton.**—Notwithstanding that the electric trams have been running only eight months, and sundry other drawbacks, the year's working of the Corporation trams shows a net profit of nearly £1,000. The account shows fares received £16,469. 5s. 1d., and a few small items making the total receipts £16,869. 8s. The expenditure on working was £9,611. 19s. 1d., leaving a gross profit for the year of £7,257. 8s. 11d. Besides allowing for interest and sinking fund, the committee purpose allocating 100 guineas towards the preliminary expenses of the undertaking and putting by £333. 6s. 8d. for reserve for third party risk. The Corporation and its officers are to be congratulated upon this excellent result.

**Nuneaton Light Railway.**—The promoters of the Nuneaton light railway scheme have given notice of their intention to apply to the Board of Trade for a further extension of time, for one year from the 26th inst., within which to construct the works authorised by the order. The Nuneaton and Chilvers Coton Urban District Council have been approached with a view of their waiving opposition to the application, but so far that authority has not expressed an opinion for or against. Under the original order work should have commenced 12 months ago. The promoters obtained an extension of one year, which expires on the 6th inst., and up to the present nothing has been done towards carrying out the scheme.

**Belfast.**—At the weekly meeting of the Tramways Committee some discussion took place in regard to the harbour tramways on the Queen's Quay. The Lord Mayor, as chairman of the Harbour Trust, explained that a deputation from that Board would wait upon the committee at an early date, and in view of this fact it was decided to postpone this matter also. In response to a letter received from the Municipal Electrical Association, it was decided that Mr. M'Cowen should represent the Corporation at the meeting in June. Mr. Nance reported that he had received the Board of Trade's approval to the portions of the lines which had been relaid, and that there were now 173 cars ordered. He had made a re-examination of the number that would be required when electric traction was started, and he found that they would need 220 cars. The committee will consider this matter.

**Kirkcaldy.**—At the monthly meeting of Kirkcaldy District Committee on Saturday plans for the Wemyss tramway scheme were submitted with information in regard to the mode of construction. Captain Wemyss pointed out that the public roadway was very narrow from Bowhouse almost to East Wemyss, and if the tramways were once laid it would be a very expensive matter for the committee to have the road widened. If the committee were prepared to widen the road at present by 8ft. or 9ft., he would give them the necessary ground free of charge. He understood they had not power to borrow money for that purpose, but should the committee give him a mandate that they would repay the money in a period of about 30 years he would advance the sum required for the purpose. A committee was appointed to look into the whole matter, and report on the advisability of widening the road.

**Potteries Light Railways.**—At a meeting of the Highways Committee of the Stoke Corporation the town clerk reported that he had written the company requesting them to make arrangements for the alteration of the rails to suit the altered roadway levels in Church-street, occasioned by the recent improvements, and that he had received a reply that the company could not agree to the relaying of the tramway as suggested. The clerk was instructed to write the manager again on the matter. The town clerk read a letter from the company in reply to the Council's complaint of obstruction of the highway by cars, and he was instructed to again write the company upon this point also. The regulations proposed to be made by the Board of Trade as regards electric power (overhead trolley system) on the Potteries Light Railways, the North Staffordshire Tramways, and the Potteries Extension Tramways were considered. The committee approved of these, subject to certain suggestions which the town clerk was instructed to lay before the Board. A hackney carriage license has been granted to the tramway company for their motor omnibus. It appears that the Corporation may resort to litigation in connection with the alteration of levels in Church street, but as it is thought that the company are anxious for a concession to enable them to bring their loop from Wolfe-street to the Monument more on the level, a compromise may be arranged.

**Halifax.**—An elaborate statement has been prepared by the tramway officials, showing the receipts for Easter, 1905, and the corresponding results for 1904. A special point is rightly made of the weather, this being a highly important factor in the success of holiday traffic. On Good Friday the receipts amounted to £192. 12s., compared with £174. 2s. 8d. on the same day last year, when the weather was showery. Saturday brought in £440. 12s. 3d., against £388. 6s. 4d. on the corresponding Saturday of 1904, which was a wet day. Sunday's takings also showed an increase—viz., £156. 10s. 1d., in place of £130. 5s. 5d. a year ago. "Fine" is placed opposite Easter Monday and Tuesday both in 1904 and 1905, with the single qualification of "windy" for last Monday. The totals show an advance, for on Monday £549. 10s. was netted, against £458. 7s. 11d. last year, and on Tuesday £498. 3s. 2d. was received, which is considerably more than the £342. 12s. 7d. registered before. Adding these sums together, it is found that with an extended mileage the trams brought in £1,837. 7s. 6d. this year, against £1,493. 14s. 11d. last year, but of this increase £343. 12s. 7d. must be put to the credit of the new Hove Edge to Brighouse, Bailiffe Bridge, and Triangle routes. A line from the borough boundary at the Calder and Hobble Inn to the Stainland and Saddleworth-road, West Vale, is to be constructed with double lines at a cost of £7,291. 15s. A long discussion took place on a resolution moved by Alderman Hey, chairman of the Tramways Committee, authorising the purchase of two motor 'buses at £950 each, as soon as the Corporation is authorised to run such 'buses. It was stated that the 'buses would be used for the Wainstall district. The resolution was passed by 21 votes to 18.

**New York.**—The Rapid Transit Commission has adopted the recommendations made by the Brooklyn Rapid Transit Company for tunnel routes and the application of the Interborough Rapid Transit Company for two additional tracks on the Second-avenue elevated line. The suggestions made to the Rapid Transit Commission by the Brooklyn Rapid Transit Company regarding routes for the Brooklyn extension were all adopted at a meeting of the commission on Tuesday, at which the new routes were incorporated into the proposed system. The offer of the New York City Company to bid for new routes was only for lines in Manhattan and the Bronx. The proposed improvements on the Second-avenue Elevated by the Interborough Company, in general terms, consist of adding two overhead tracks in the Bronx district, from One Hundred and Fiftieth-street to the Harlem River, adding two overhead tracks to the bridge across the Harlem River, and continuing such overhead tracks to One Hundred and Twenty-second.

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street, where they will reach the present grade of the elevated structure. From One Hundred and Twenty-second-street South to First-avenue and Third-street there will be four tracks at the present grade of the Manhattan Railway. At First-avenue and Third-street it is proposed that the centre tracks, to be used for express purposes, shall descend and enter a tunnel which is to be placed in private property to terminate at West and Chambers streets in a loop. Action on this proposition was postponed by the Board. An alliance is announced between New York City railway interests and the New York, New Haven, and Hartford Railroad concerning mutual use of the former's proposed subways. The plan includes the transfer of passengers from New Haven trains at Willis-avenue so that they can take the New York City Company's subway, and thus run into the heart of the city with the privilege of transferring to any of the surface lines of the New York City Company—*Electrical World (N. Y.)*.

**Heywood.**—Terms have now been agreed by committees of the Bury and Rochdale Corporations with Heywood, subject to confirmation by their Councils, for the running of electric trams between these towns. These terms read as follows: (1) Heywood to construct and maintain the track, to electrically equip, and to supply current. (2) Bury and Rochdale to furnish cars and staff sufficient to give a quarter hour's service or as may be mutually agreed upon. (3) Receipts earned upon the section within the borough of Heywood to be handed over to Heywood quarterly. Heywood to pay quarterly 4½d. per car mile run on the section. (4) Bury and Rochdale to repair and maintain in good working condition the overhead equipment. The equipment to be approved and passed by the electrical engineers for Bury and Rochdale. Feeder cables excepted from this clause. (5) The number of cars required to work the whole of the Heywood system will be six; to work the portion from Heap Bridge to Heywood Parish Church four; and Rochdale boundary to Heywood Parish Church two cars. (6) These six cars shall at the end of the tenancy be taken over by Heywood, together with the unpaid debt upon such cars. (7) During the tenancy Heywood shall pay interest and sinking fund upon the whole of the cars on the whole system worked and owned by Bury and Rochdale proportionately to the car miles run upon the Heywood section. Bury and Rochdale to repair and maintain the cars during the tenancy. (8) Heywood to pay rates and taxes on the portion of the undertaking within the borough of Heywood. (9) The tenancy to be for three years certain, subject to six months' notice on either side. (10) Any matters in dispute during the tenancy and which the parties to this agreement may be unable to mutually settle shall be referred to an independent tramways manager to be appointed by the president of the Municipal Tramways Association, whose decision shall be final.

**Leeds.**—The Tramways Committee met on Monday for the purpose of considering a statement prepared by the tramways manager (Mr. Hamilton) as to the revenue and operating expenses for the year ended March 25 (of which we have already given an outline) The total revenue for the year was £298,233. 7s. 5d., which worked out at 10·151. per car mile run, as compared with £280 562. 16s. 3d., or 11·05d. per car mile run in the preceding year. The mileage run was 7,044 838, as compared with 6,091,407 in the previous year, this increase of some 16 per cent probably accounting to a considerable extent for the reduction in the earnings per car mile. Notwithstanding the increase in the mileage, the total expenses for traffic only amounted to £83,005. 12s. 2d., as compared with £79,869. 11s. 1d. in the preceding year, an increase of 4 per cent. only. The cost per car mile, owing to improved traffic arrangements, has been reduced from 3·15d. to 2·82d., which represents a saving in working expenses of over £9,000. General expenses, repairs, and maintenance were about the same as last year, except that there was an increased expenditure in respect of the permanent way of over £8,000. The total working expenses were £161,297. 3s. 7d., leaving a gross profit of £136,936. 3s. 10d. From this there must be deducted fixed charges for interest on capital, £31,691. 10s. 5d.; redemption fund, £28 501. 13s.; income tax and depreciation, £20,743. 0s. 5d.; leaving a surplus of £55,000, which the committee decided to hand over to the Finance Committee. Last year the total working expenses were £148,821. 12s. 5d., and the gross profits £131,741. 3s. 10d. The committee considered the result of the year's working to be highly satisfactory, particularly in view of the fact that trade during the Corporation's past financial year has been much depressed. Though there is a profit of £55,000 to be handed over to the Finance Committee, the ultimate fate of this sum appears to be a matter of some uncertainty until the Finance Committee arrive at a full statement of the financial position of the city, which is reported to be in a somewhat unpleasant position owing to change of party in the Corporation.

**Fatal Accidents.**—An enquiry into the circumstances connected with the death of Mr. William Williams, master of Whiston Workhouse, while travelling on the St. Helens Electric Tramway Company's system, was opened on Saturday. Richard Prescott, contractor, of Dragon's-lane, Whiston, stated that he was travelling on the car with deceased from St. Helens. All went well until they had turned the corner of the bridge in Warrington-road, Rainhill. They were riding on the top of the car, deceased being seated on the left side on the end seat at the back of the car, and witness was facing him. Witness heard a crash, and as he bent forward something struck him on the back of the head and knocked him forward. When he recovered himself he saw deceased falling down the steps of the car. Deceased was terribly injured. They were travelling at an ordinary speed, and he noticed nothing unusual in the running of the car. The standard, which would weigh about half a hundredweight, was torn up. The car travelled about twice its own length after the crash. Witness did not see anything which would lead him to believe there was any negligence on the part of anybody. In witness's opinion, if the standard had been bolted through the roof of the car, it would not have been torn out, but something else would probably have given way. The driver of the car explained that when he heard the crash he stopped the car, for they were travelling slowly down the incline on the straight, after having just turned the curve. Deceased was lying halfway down the steps leading to the top of the car, the trolley pole was lying on the road, and the standard was torn off the car and was leaning upside down over the side rails. In witness's opinion the trolley must have left the wires and caught in the cross wires. In reply to a question, the witness stated that he was warned by Inspector Wallace not to go round the curve more than six miles an hour. Witness added that he did not think any inattention on the part of the conductor had caused the accident. The conductor stated that he held the rope as the car went round the bend. The car travelled 20 yards after he released his hold of the rope up to the accident happening. Replying to a question, witness said his explanation was that the trolley head must have come off the wires and caught in the insulators. After a short retirement, the jury returned a verdict of accidental death, and exonerated the driver and conductor from all blame. Mr. Greer, on behalf of the tramways company, tendered their sympathy with the relatives in the unfortunate accident.

**Folkestone.**—At a meeting of the General Purposes Committee the following letter from the Traction and Power Securities Company, Limited, was read: "As the extended time for the construction of tramways under the Folkestone tramways order will lapse in the course of a comparatively short time, we beg to state that we are disposed to consider with you the question of entering into an agreement with your Corporation to apply next May for a light railways order for the construction of tramways within your borough along such routes as may be mutually agreed upon. We shall be prepared to repay the sums already expended by you not exceeding £1,200, provided you give us your assistance and support before the Light Railway Commissioners, as we understand from Mr. David Cook you may be prepared to do, and that we obtain the order. We are in a very good position financially and technically for carrying out such work, the whole of the materials for which would be of British manufacture. Our share capital amounts to £2,000,000, and we are associated with the British Westinghouse Electric and Manufacturing Company, Limited, whose share and capital loan amounts to £4,712,500. The latter company has supplied most of the plant necessary for the electrification of the Metropolitan and Metropolitan District Railways, and have also executed large contracts for the London County Council, the Admiralty, and the principal cities of the country, including Glasgow, Liverpool, Newcastle, Swansea, Exeter, etc. The best relations have been maintained with all of the above, and we should, of course, aim at maintaining similar relations with the Corporation of Folkestone." Subsequently the committee had an interview with Mr. D. Cook, the company's representative, who explained that as the company desired to work in harmony with the Corporation, he had been authorised to say that the company would pay in cash up to £15,000 for the expense incurred by widening the road at Radnor Park. He added that the gauge would be 3ft. 6in. That was not their choice, but they were hampered in so far that the Dover trams, the Isle of Thanet trams, and the Hastings trams were on a 3ft. 6in. gauge. If it was to be a through system, as it would be in the future, it must be all the same right through. It was decided that the matter should be referred to the Tramways Sub-Committee to deal with it at an early date. Later it was decided that the sub-committee should also take into consideration the advisability of inviting proposals for the construction of tramways in accordance with the Council's order, and when constructed to take a lease of the same.

**St. Helens.**—Labour troubles have dislocated the local tramway system, and the manager, cashier, and other members of the clerical staff have had to quit the desk for the driver's seat on the car. Even so, it has been impracticable to run many cars. St. Helens is largely an industrial centre, and the trade unions have ordered a boycott of the cars, and it is reported that the miners have threatened to wreck the vehicles and throw the drivers and guards into the canal if the cars are run by "outsiders." Several unpleasant incidents have occurred. One car was stoned, and in another the window was smashed by a woman who flung her clog through it. As an instance of the feeling exhibited, it is reported that hundreds of miners walk seven miles daily to go to and return from the pits rather than ride in the cars. On Saturday negotiations were in progress between the directors and the men's representatives in the hope of a settlement being arrived at, but the efforts proved to be in vain, and throughout the day not more than seven or eight cars were running. Early in the morning Councillor Jackson and Secretary Marshall, the men's representatives, paid a visit to Liverpool to confer with Mr. Jacob Atherton and other directors of the tramways company, and to convey to them the strikers' decision not to accept the terms offered them on Friday. The men asked that all drivers starting service should commence at 5d. an hour, with an increase of ½d. per hour at the end of six months, eventually reaching a maximum of 6d., and that conductors should commence at 4d., rise to 4½d. at the expiration of six months, and afterwards receive a maximum wage of 5d. per hour. They also seek a guaranteed average of 60 hours per week in six days; that all spare men shall receive 2s. each day they are not working; that Sundays and holidays, when working, shall be paid at time and quarter rate; that sufficient time be allowed for every journey without infringing upon the Board of Trade regulations; and that drivers and conductors be allowed 15 minutes to sign on, and 10 minutes to be allowed for conductors to pay in. On all points the directors agreed with the exception of the wages question. They proposed that the men's representatives should confer with them at the end of six months in the hope of a settlement being arrived at. In the event of this not being satisfactory, they agreed to the point being settled by arbitration. Subsequently a meeting of the men was held, but they were still firm in their determination not to accept the revised terms. They

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now oppose the question of arbitration on the ground that they have twice offered to submit to arbitration, and it had been refused by the directors.

## LIGHTING AND GENERAL.

**Derby.**—Application is to be made for a loan of £350 for street-lighting.

**Gravesend.**—The Board of Trade have issued a draft order for the extension of the electricity system to Northfleet.

**Belfast.**—It has been decided to extend the electric main from Carlisle-circus to Cliftonville at an outlay of £575.

**Loughborough.**—The electrical engineer has been asked to fully report upon the question of free wiring the better-class houses in the borough.

**Frome.**—Sanction has been obtained to a loan of £6,900 for the purposes of electricity, and £230 for the erection of additional lamps in the town.

**Bridlington.**—The number of fresh applications for electrical energy during the month was 17, bringing the total number of consumers to 110.

**Removal.**—Messrs. Buchan and Hogarth have removed their Edinburgh offices to 16, Rutland-square, the telephone number remaining 2,562 as before.

**Beaconsfield (Cape Colony).**—The Town Council are about to ask Parliament for powers to erect an electricity supply station for public lighting and power supply.

**Erith.**—The Electric Lighting and Tramways Committee has been constituted as follows: Councillors Button, Cannon, Charlesworth, Ling, Palmer, Stebbings, and Turner.

**Chester.**—The recommendations of the Lighting Committee given in our last issue have been adopted with the exception of No. 6, which recommended the establishment of a showroom.

**Globe Telegraph and Trust Co.**—The directors announce a final dividend of 4s. 9d. per share on the ordinary shares, making a total distribution of 5¾ per cent. for the year, carrying forward about £1,600.

**Llandilo.**—The Urban District Council have appointed the following to be an electric light committee: The Chairman, Vice-Chairman, Mr. T. C. Thomas, Mr. Rees Griffiths, Mr. J. Young Davies, and Mr. D. Williams.

**Constantinople.**—A Reuter dispatch says the convention for laying the Kusterji-Constantinople cables has been signed with the German Eastern Telegraph Company. The work of laying the cable will begin shortly.

**Pendlebury.**—The Acme Spinning Company are building at Pendlebury, near Manchester, a mill which will contain about 80,000 spindles, and will cost nearly £100,000. The machinery is to be driven by electricity.

**Reading Exhibition.**—The Reading Electrical Exhibition has proved a great success, both as regards attendance and the excellent variety and interesting character of the contents of the exhibition. A description of the exhibits appeared in our last issue.

**Stafford.**—The Town Council have decided that the price of electricity for power purposes be 2½d. per Board of Trade unit, subject to the following discounts—namely: under 200 Board of Trade units per quarter, 2½ per cent.; over 200, 50 per cent., with a minimum charge of £2 per quarter.

**Swindon.**—At the Tuesday's Council meeting some discussion arose upon recommendation of tenders for wiring consumers' houses. It appears that there were four local tenders, and that the tenders were amended ones and that all quoted the same figures. Finally, the matter was referred back to committee.

**Worksop.**—The income of the electric lighting undertaking last year from all sources was £2,860, paid by 1,985 consumers, and the expenditure was £1,718. This year's profit on the undertaking is stated as £1,142, equal to 4¾d. per cent. on the capital. As compared with last year, the expenditure on electricity has increased by £289 and the income by £623.

**Grays.**—An enquiry has been held into the application of Grays Urban District Council for sanction to borrow £6,000 for purposes of electric lighting. Messrs. W. A. Brown (chairman of the Lighting Committee), W. H. Umfreville, and T. Banks, clerk to the Council (Mr. C. Asplin), surveyor (Mr. A. C. James), and electrical engineer (Mr. E. D. Long) gave evidence.

**Sir Hiram Maxim Electrical Company, Limited.**—Capital, £50,000. Object: to acquire from the Peddie Small-Arms Corporation, Limited, the business and property recently acquired by that company from the Sir Hiram Maxim Electrical and Engineering Company, Limited, to acquire any other concessions, rights, or properties, and to carry on any business connected therewith.

**The Zambesi Bridge.**—It is reported that the bridge at the Victoria Falls will be completely riveted, painted, and finished by the middle of June. Fifty miles of railway north of the Falls were constructed before the material could be taken across the bridge, the locomotives, trucks, rails, sleepers, and other necessaries being carried across the gorge by means of the electric transporter.

**Government Telephones.**—In the House of Commons on Wednesday Lord Stanley moved that a Select Committee be appointed to consider the agreement between the Postmaster-General and the National Telephone Company. There was some opposition to the motion as framed, and, there being an arrangement that no contentious matter should be taken after the Budget resolutions, Lord Stanley withdrew his motion.

**Eastbourne.**—The work of laying the new mains in Seaside and Langney-road is to be proceeded with up to June 9 next, and discontinued the same day until Sept. 20. The Council have accepted an offer of the Underfeed Stokers Company to equip one of the Stirling boilers with a mechanical stoker with a fan for forced draught, a motor to drive the fan, and all work in connection with the erection thereof for a three months' trial free of cost.

**Bradford-on-Avon.**—Messrs. Edwards and Armstrong, electrical engineers, Bristol, propose introducing an electric lighting scheme for the villages of Winsley and Turleigh, if permission can be obtained to lay the cables through or across the streets. The Parish Council have resolved to support the scheme, and to recommend the Rural District Council to do likewise, subject to proper conditions being arranged. The Rural District Council have agreed to support the scheme so far as it is in their power.

**Stock Exchange.**—The Stock Exchange Committee have ordered the undermentioned securities to be quoted in the official list: Measures Bros., Limited, further issue of 25,507 ordinary shares of £1 each fully paid, Nos. 210,001 to 235,507. Applications have been made to the committee to appoint a special settling day in and to grant a quotation to the British Columbia Electric Railway Company, Limited, further issue of £100,000 preferred ordinary stock and £90,000 deferred ordinary stock.

**Huddersfield.**—It has been decided to extend the mains to the Mount, Outlane. The borough electrical engineer in his last report states that the number of consumers in April was 2,085, an increase of 15 on the preceding month, and that the number of lamps connected in April was 142,775, an increase of 571 on the month of March. On March 31 90,441 yards of primary mains and 66,227 secondary had been laid. The Council on Wednesday decided to return their telephone licence to the Postmaster-General.

**London Gazette.**—The last day for receiving proofs in the estate of William Watson and George Huntington, electricians, 83, Battersea-rise, London, is May 13. A receiving order has been made out on creditor's petition in the estate of Harry John Salter, electrical engineer, 235, High Holborn, London. The first meeting in the estate of Arthur Driffell Poulter, printers' and electrical engineer, 22, New Bridge-street, London, will be held at 24, Railway-approach, London Bridge, S.E., on May 12, at 12.30 p.m.

**Lancaster.**—The Electricity Committee have been unable to accede to the request of the Lighting Committee to reduce the price of electricity for street-lighting. They found that when the actual charges had been taken off it only left them a penny and a little over a third per unit for the current used. Compared with 5d. per unit charged to ordinary consumers for lighting purposes, the reduced price of 2½d. per unit charged for current for motors, and 2d. per unit charged to the Tramways Committee, it appears that the amount paid by the Lighting Committee is very moderate.

**Wolsingham.**—The Wolsingham Steelworks have been fitted with electric plant, the main contractors being Messrs. Bruce Peebles and Co., of Edinburgh. The installation consists of three Lancashire boilers, working at 160lb. pressure per square inch, and two high-speed engines by Messrs. W. H. Allen, Son, and Co., together with some 13 motors, ranging from 5 h.p. to 75 h.p. each, and a large number of arc and incandescent lamps. The power and boiler houses are erected in the centre of the works, and are fitted with thoroughly up-to-date water-softening and economising plants, and a 100ft. steel chimney.

**Middlesbrough.**—The engineer's March report shows 76,610 lamps connected and 82,074 units generated against 46,773 lamps connected in April of last year. The coal used was 330 tons, or 9.b. of coal per unit, costing ·48d. per unit, against 200 tons, or 9·81b. per unit, costing ·54d. per unit for the corresponding month of last year. The estimated revenue was £1,021 against £643 last year. The works' cost had been £302, or ·88d. per unit, against £215, or 1·13d. per unit a year ago, showing a reduction this year of ·4d. per unit. The total costs had been £458, or 1·34d. per unit, against £330 last year, equal to 1·73d. per unit, and showing a decrease this year of ·39d. per unit. The estimated profit for the month was £563.

**Southport.**—The gross profit of the Electricity Committee is £14,771, as against £14,573 for the previous year, an increase of £197. The net profit is £3,355, as against £3,616, a decrease of £260. Out of the profits of the past year, in addition to the sum of £2,500 promised in aid of rates, £284 has to be taken to make up the full charge for rates for the year 1904. The sale of current to the Tramways Committee and the company decreased by £300. The expenditure was increased by £468 for additional charges for interest and sinking fund. The income and expenditure for the past four years are as follows: (1902) income £18,493, expenditure £16,811, profit £1,682; (1903) £20,361, £18,576, £1,785; (1904) £22,002, £18,386, £3,616; (1905) £22,593, £19,237, £3,355.

**York.**—The last minutes of the Electricity Committee contained the following statement as regarding finances: gross income, £10,732; ordinary working expenditure, £5,918; extra special charges—viz., erection of offices, £924, making together the sum of £6,842, leaving a net revenue of £3,889. 17s. The amount chargeable for interest and sinking fund has been £6,835, which leaves a net deficit of £2,946 to carry to reserve fund account. The committee have submitted a statement as to the cost of working the destructor for the year ended March 31 last, showing the net amount to be £901, which together with the deficit balance at April 1—viz., £973—makes a total deficit at March 31 last of £1,874. In regard to the above deficiency of £2,946 the committee recommend that the cost of the new offices—viz., £924—be included in and defrayed out of the ensuing year's rates, and that they be authorised to carry over the balance—viz., £2,021—to a suspense account for two years.

**Durham.**—The Durham Collieries Electric Power Company, Limited, are about to supply Hetton Coal Company's collieries. It is proposed to use the current for hauling, pumping, coal-cutting, light

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ing, etc., at the company's extensive collieries at Eppleton, Lyons, and Elemore. The power company will also supply the collieries of the Lambton Collieries, Limited, as well as the estate of the Earl of Durham. The large power station which is being erected at Philadelphia, near Penshaw, will supply at least 12 collieries, and the 15 miles of tramways belonging to the Sunderland District Tramways, Limited, as well as the lighting of the urban districts of Houghton-le-Spring and Hetton-le-Hole, and the district embraced in the area of the Easington Rural Council, owned by the Houghton-le-Spring and District Electric Lighting Company. The contracts have been arranged by Messrs. Harper Bros. and Co., consulting engineers, London, and Messrs. D. Balfour and Son, engineers, Newcastle-on-Tyne. Power will be available by the end of the year.

**Edinburgh.**—The following tariff has been agreed to as from May 15: private electric lighting, 3½d. per unit; public lighting, £10. 15s. per annum for present arc lamp, and £10 per annum for new arc lamps, and motor power 1½d. per unit. On Tuesday the Council considered a recommendation of the Cleaning and Lighting Committee that 1,950 of the present gas lamps for street-lighting should be converted into incandescent gas lamps, at an estimated initial cost of £4,022 and a permanent annual cost of £788. 2s. 6d. Consideration of the matter had been delayed from the last meeting of the Council. Councillor Stevenson, convener of the Electric Lighting Committee, moved as an amendment that of the sum of £4,022 to be placed in the estimate for improved street-lighting, £2 000 should be allocated for the purpose of providing 200 electric arc lamps in suitable thoroughfares throughout the city. Ultimately it was agreed to recommit the subject, on the understanding that Mr. Stevenson should submit his scheme of electric street-lighting to the Cleaning and Lighting Committee, and that afterwards the matter would be determined by the Council.

**Stoke-upon-Trent.**—The electrical engineer in his last monthly report gave the total number of consumers being supplied with electricity at March 31 as 97, including various motors aggregating 44 h.p. The committee having considered the request of the Free Library, Baths, and Museum Committee that the free library and museum should be lighted gratis, regretted they could not accede thereto at present, but undertook to reconsider the matter in the course of 12 months. The chairman has attended the Health Committee regarding the latter's complaint as to the destructor not dealing with the whole of the town's refuse, and has laid before them the engineer's statement of the weight and number of loads of refuse delivered daily during the last 12 weeks. He explained the committee's suggestions as to the supply, and considers that a more regular supply would result therefrom. The borough surveyor's final statement of the cost of the carrying out of the contract for the erection of the electricity and destructor works shows that the work has been completed for £372 less than the accepted tender, and the committee have congratulated him on the very successful and economical erection of the works. The Electricity Committee have now had five or six months' experience in which the works have been in operation, and they are well pleased and satisfied with the progress made, and had every reason to anticipate that in a short time they will be self-sustaining.

**Colchester.**—Sanction has been received to the borrowing of a further sum of £3,495 for electricity purposes. The accounts for the sixth year of working of the electricity undertaking show a gross revenue of £11,432, the working expenditure has been £5,671, leaving a gross profit for the year of £5,761. The amount paid for interest on loans was £1,682, and for redemption £1,693. After allowing for all capital charges a net surplus for the year of £2,432 remains. Private consumers have taken throughout the year 425,229 units, which yielded £7,786—an average price of 4·36d. per unit. Public lamps took 87,373 units, which yielded £871, the average price being 2·39d. per unit. These two items make a total of 513,602 units, yielding £8 657, at an average price of 4·05d. per unit. In addition there are tramways sales amounting to 286,205 units, which yielded £2,265. The price charged for this current was 2d., less 5 per cent., being equal to 1·88d. per unit. These figures would give them a grand total of 779,807 units, generated during the year, which had yielded the sum of £10,922. 19s. 9d., the average price for the whole being 3·27d. A few small items, including £362, being profit on trade account, and £147 for rent, make up a gross revenue of £11,432. 18s. 4d. In addition to the £1,693 paid away during the year as redemption, a sum of £691 has been taken from this year's revenue towards repairs and maintenance of plant, whilst £269 had been paid out of the accumulated reserve for renewals.

**City of London.**—The City of London Electric Lighting Company, Limited, have informed the Court of Common Council that the rate for the supply of electrical energy to all the public buildings of the Corporation will be reduced from April 1 to March 31, 1906, to 2½d. net per Board of Trade unit. The report of Mr. D. J. Ross, the retiring engineer, on the works executed by the public health department states that the number of overhead wires in the City has again greatly increased, in addition to the large number placed underground. In 1904 the number of private owners of overhead lines increased to 117, and of companies to 18, jointly possessing a total estimated number of 39,000 miles of overhead wires in the City, with about 682,900 spans crossing public thoroughfares, compared with 260,000 spans in 1899. The number of overhead-wire owners during the last six years is given as follows: 1899, companies 8, private firms 18; 1900, 11 and 20; 1901, 9 and 64; 1902, 12 and 75; 1903, 17 and 103; 1904, 18 and 117. The engineer says that the value of the enforcement of the by-law by the Corporation requiring proper identification of all overhead wires erected in the City, has been apparent. In the case of about 30 fallen wires reported at various times by the police, whose owners they were unable to ascertain, the inspector of overhead wires, upon being informed of the breakages, was able to identify the owners, and thus to obtain the immediate repair or removal by them of the fallen wire. The Court of Common Council on Thursday agreed to a recommendation of the Streets Committee to light (*a*) Queen Victoria-street and a portion of Queen-street between Queen Victoria street and Cheapside, (*b*) Fleet-street, and (*c*) Lower Thames-street from Fish-street-hill to Billingsgate Market and Monument-street by incandescent gas lamps in lieu of the existing electric arc lamps, on the understanding that the whole be regarded as an experiment, and that the committee proceed no further than the lamps mentioned in their report.

**Power Supply.**—There is nothing like pushing trade if you want to get it. Mr. S. E. Fedden, the general manager and engineer of the Sheffield Corporation electric supply department, has addressed the following business-like circular to likely customers in the town: "As you will probably be overhauling your engines and machinery during the coming holidays, I would draw your attention to the facilities which now exist for driving by electric power off the Corporation mains, and ask you to consider if it still pays you to use engines with their more or less complicated drives and expensive upkeep and attention. The introduction of electric motors greatly simplifies the working of a factory, eliminates much dirt and noise, and frequently sets at liberty valuable space, owing to the comparatively small dimensions of the motors and the ease with which they can be adapted to the peculiarities of buildings and existing arrangements of shafting and machines. The manufacturers of Sheffield have to-day 4,000 h.p. of electric motors connected to the mains of the Corporation electric supply department. These motors vary in size from ¼ h.p. to 120 h.p., and are working machinery of every class employed in the many industries of the city, from the lightest cutlery and silver ware to heavy steel working, general engineering, etc. The rates and charges are amongst the lowest in the country, and, together with the Corporation system of letting out motors on hire, place this cheap and convenient form of power within the reach of every works owner. The general manager will be pleased to submit estimates free for electric driving, and send competent assistants to any address in Sheffield to give information and advice generally on the subject."

**Maidenhead.**—The Thames Conservancy have now consented to accept 1s. per annum as quit rent, instead of £1 as originally asked, in respect of the cable service laid over the bridge at Boulter's Lock, and agreements have been exchanged accordingly. Mr. C. O. Milton, in his monthly report, states that the plant and mains have run well since the last meeting with the exception of an accident to the Castle-hill pilot wire on April 3, which caused a temporary disconnection of the supply. The fault was due to the bad arrangement of the pilot fuse connections, which have given trouble on several occasions. The old type of fuse block has now been removed and the fuses put into a separate iron chamber, and all the other pilot connections will be treated in the same way as soon as possible. This will eliminate the danger altogether. Applications for supply are now again coming in freely, there being about 20 new services to lay. The demand is rising very favourably in the new areas, especially in Maidenhead Court. Mr. Milton again points out the advisability of offering a maximum demand system of charging as an alternative to the flat-rate system at present used, in order to retain the custom of some of the best consumers. The March quarter's accounts show an increase of 35 per cent. on last year. Their total value was about £1 100. The engineer's recommendation to take another pupil into the works, in order that three shifts of electrical men may be run at the works, has been adopted, and the committee will consider his tariff proposals at their next meeting. An extension in Ellington-road is to be proceeded with at once, and an applicant in Taplow village will be informed that the Council intend to include in their next extension scheme that part of the area in which his house is situate. The engineer has been asked for a report showing (1) the cost of the arc lamp pillars and the rental paid by the Council therefor as distinguished from the cost per lamp inclusive of light, lighting, extinguishing, and renewals; and (2) the cost of substituting Messrs. Oliver and Co.'s lamps for those of the British Schuckert Company.

**Hull Telephones.**—The Telephones Committee of the Corporation have had under consideration the agreement entered into by the Postmaster-General for the purchase of the National Telephone Company's undertaking, and have arrived at the opinion that it was not desirable, in the public interest, that such agreement, in its present form, should come into force, and that steps be taken by the Corporation, in connection with other municipalities, to oppose the agreement, in view of the circumstances under which, and the objects for which, the Corporation established their competing system in Hull and took out their license until 1911 only, and the benefits which have resulted therefrom, both to the public and the Government, the committee is strongly of opinion that, in order to enable the Corporation to recoup themselves the capital expenditure incurred, it is only just and equitable that, in case the agreement comes into force, the Postmaster-General should undertake either to purchase the whole of their plant in 1911 or grant a renewal of their license to 1927. An enquiry has been held into a proposal by the Corporation to borrow £20,873 for the purpose of telephonic extension, more especially in the residential portions of the city. Mr. Bennett said that the telephone system had been carried out according to the plan originally submitted to the Local Government Board, although the whole of the loan previously sanctioned had not been expended. The work first undertaken had, however, been completed, and that included the alterations necessary for converting the Trippett baths into a central exchange. The system had also been carried to the villages of Hessle and Cottingham, and also to Beverley. The number of subscribers was at present 1,928. In the first place, they estimated that in the older portion of the city they would get more subscribers than had hitherto been secured; but in the residential districts there were more users than was originally anticipated, these being greatly in excess of the provision made.

**Olympia Electrical Exhibition.**—This exhibition will be held at Olympia from Sept. 25 to Oct. 21, 1905, inclusive, under the auspices of the National Electrical Manufacturers' Association (Incorporated).

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Sir William H. Preece is the president, and a strong executive committee has been at work for some time, of which Mr. Walter Davenport is the secretary. The organising managers, Messrs. F. W. Bridgers and G. D. Smith, have offices at Balfour House, 119-125, Finsbury-pavement, E.C., and they have succeeded in getting together the following very representative preliminary list of exhibitors: E. P. Allam and Co., Arc Lamps Limited, Armorduct Manufacturing Company, W. and T. Avery, Babcock and Wilcox, Berliner Telephone Manufacturing Company, Berry, Skinner, and Co., D. H. Bonnella and Son, G. Braulik, British Accumulator Company, British Electric Plant Company, British Prometheus Company, Bruce Peebles and Co., Brush Electrical Engineering Company, Cory Bros. and Co., Crompton and Co., Crypto Electrical Company, Diesel Engine Company, Durtnall and Pries, Edison and Swan United Electric Light Company, Electric Flashlights Limited, Electric and Ordnance Accessories Company, Electrical Power Storage Company, *Electrical Review*, *Electrical Times*, Elliott Bros., Everett, Edgcumbe, and Co., Ferranti Limited, I. Frankenburg and Sons, Geipel and Lange, General Electric Company, High-Speed Braiding Machine Company, Improved Electric Glow Lamp Company, International Electric Company, J. Keith and Blackman Company, Lahmeyer Electrical Company, Lancashire Dynamo and Motor Company, Langdon-Davies Motor Company, A. P. Lundberg, Linolite Company, Monté Callow and Co., Nalder Bros. and Thompson, New Brotherton Tube Company, Oliver and Co., Pearson Fire-Alarm Limited, Phœnix Dynamo Manufacturing Company, Pope's Electric Lamp Company, Portable Accumulators Limited, Pritchetts and Gold, Rumney and Rumney, P. Santoni and Co., Selig, Sonnenthal, and Co., Siemens Bros. and Co., Simplex Steel Conduit Company, G. Straus and Co., Sunbeam Lamp Company, Tudor Accumulator Company, Dr. H. Traun and Sons, Union Electric Company, Verity's Limited, Western Electric Company, who have engaged space from 100ft. to 1,400ft. each.

**Elgin.**—The special committee appointed to consider as to the introduction of electricity and erecting of a gasometer have reported in favour of electric lighting. As regards the erection of an additional gasometer, the committee consider it advisable to defer erecting a new gasometer, which would save an expenditure of over £4,000, the estimated expense of such gasometer. As regards the introduction of electric lighting into the town, the committee, after making very exhaustive enquiries, point out that in every year since 1896 there has been a considerable increase in the capital invested, number of electric lamps in use, and quantity of electricity used. On looking into the question as to whether electricity pays, the committee find that the average rate of dividend for 103 companies with a capital of over £24,000,000 was 5·03 per cent., and that electric shares are now looked on as gilt-edged securities. Electricity had been successfully introduced into towns of a similar size to Elgin—amongst others: Brechin, population 9,000 (gas 4s. 3d. per 1,000 cubic feet); Montrose, 12 500 (4s. 4d.); Broughty Ferry, 10,000 (3s. 6d.); Dalkeith, 6,835 (4s. 2d.). The committee are of opinion that there is not another town of the same population as Elgin with the same advantages, nor of the same size with so many of the better class of houses and the same class of shops. The town is also compactly built together, which would enable the electric current to be distributed at less than the usual cost. Elgin has already a good water supply and drainage system, the streets and pavements are in good order, and with the installation of electric light it would be thoroughly up-to-date. With these points in view, the committee have made enquiries and have ascertained that a large number of private persons, professional men, and shopkeepers in the town are prepared to use the light in their premises if supplied at a price not exceeding 6d. per Board of Trade unit—the price suggested by the committee. The committee also found that those ratepayers who have private installations will become customers of the Corporation, and that one gentleman who is about to introduce the light for himself will await the decision of the Town Council on the matter before proceeding with his own installation. A number of customers will be obtained for power for driving machinery of various kinds, from rotary brushes to sawmills. A sub-committee who called on the citizens also found a number who are not prepared to take in the electric light at present, either because they are tenants and not proprietors of the properties occupied by them, or for other reasons, but it was found that they were all, nevertheless, in favour of the installation of electricity. In a great number of cases the hope was expressed that the Corporation would themselves introduce the light, and not allow a company to do so. In the list submitted by the sub-committee there are 136 signatures in favour of the introduction of the light, while the owners or occupiers of 106 premises are prepared to use the light. As regards the means of introducing the light, the committee consider that it will be more effectively and more economically done by the Corporation than by a company. Comparing similar installations, it would appear that those laid down by companies are more expensive than those laid down by corporations. This, they say, can be accounted for by the fact that a company has not the same interest to consider economy as a responsible body, and a company expects a good percentage on their outlay while the plant remains in their hands, and a good price when it passes into the hands of a corporation. A corporation is also able to borrow at a low rate of interest, and will therefore be able to sell the light when first produced as cheap as a company, and will much sooner be in a position to reduce the price than if the light was installed by a company. The question of the disposal of the town's refuse is a point of increasing difficulty, and the committee have considered the advisability of disposing of the refuse by means of a destructor, and utilising the destructor so far as possible for the purpose of generating electricity. They find that there has been a great improvement in refuse destructors recently, and that within the last three years 52 combined refuse and electric installations have been laid down in England, while similar installations have lately been completed in Ayr and Port Glasgow with satisfactory results. A few days ago there appeared in the newspapers the description of an installation proposed for Dunfermline. Three systems were there considered—one where the electric power was to be purchased from a company at 1½d. per Board of Trade unit; another where power was to be raised from coal; and a third where a refuse destructor was to be used. The expert called in recommended that the system with the refuse destructor should be adopted. In estimating the value of the Elgin refuse as a power producer, the committee find from statements given by the manufacturers of refuse destructors and from the reports of sanitary inspectors of the towns where destructors have been erected, that over 35 Board of Trade units can be raised per ton of refuse destroyed. In Elgin there are over 10 tons of refuse per day to be disposed of, which at 35 units per ton would give 350 units per day, or 127,750 units per year. Allowing for one-third being lost in storing and transit, and the remaining 85,160 units being sold at 6d. per unit, £2 129 a year would be realised. Taking this calculation in another and perhaps a better way, it would take in Elgin ½d. worth of coal to generate one unit of electricity, and to produce 127,750 units would cost £266. 2s. 11d. Assuming that the cost of a destructor is £3,200, 6½ per cent., or £208, would be required to pay interest and sinking fund, and for this sum of £208, power worth £266 would be obtained, while £100 a year would be saved in the cartage of the refuse. The committee consider that these estimates are quite safe, and are proved by the fact that many towns are generating electricity from refuse where coal is much cheaper than here, and where gas is selling at from 2s to 3s. per 1,000 cubic feet. There are the following special and peculiar reasons why a destructor would be used to advantage in Elgin—viz.: the high price of coal, the amount paid for the carting of the refuse, the more effective disposal of the refuse, and the fact that wherever it is carted it still remains a nuisance. The committee, therefore, recommend that electric light be introduced into Elgin. Consideration of the report has been deferred.

**St. Andrews.**—The Electric Supply Corporation, of which Mr. K. A. Scott-Moncrieff is chief engineer and general manager, have nearly completed their work, and it is anticipated that current will be available within a few weeks. The station in Southfield has been erected by Messrs. Topping, Edinburgh. The contract for the equipment has been in the hands of Messrs. Crompton and Co., Limited. A detailed description just appeared in the *Dundee Advertiser* as follows: "Entering from the east side, there are the offices to the right, while to the left is a storeroom. The entrance passage leads into the engine and dynamo room, where there are three sets of engines and dynamos, and a spiral stair enters into the battery-room. Leading off the engine-room is the boiler-house, adjoining which is what is known as the pump-room. The boilers, which are two in number, are of Babcock and Wilcox patent water-tube marine type, each having a total heating surface of 1,443 square feet. Each boiler is fitted with a Babcock and Wilcock superheater having a heating surface of 332 square feet. They are capable of evaporating 6,000lb. of water per hour from hot feed water, and the superheaters are capable of imparting from 120deg. to 150deg. F. of superheat to the steam. The boilers and superheaters are made for a working pressure of 180lb. per square inch, and an isolating valve has been fitted to each boiler. Each boiler is also provided with a Babcock and Wilcox patent chain-grate mechanical stoker, which is specially adapted for quick steaming. There are two steel chimneys, each 3ft. in diameter and 80ft. in height. In the boiler-room is also a Webster vacuum feed-water heater capable of dealing with 1,200 gallons of feed water per hour, the water being heated with the exhaust steam from the engines. Erected on the roof over the open store is a Doulton water softener capable of softening from 100 to 800 gallons per hour. In the pump-room are three electrically-driven feed pumps, each pump being capable of delivering 600 gallons per hour against a pressure of 180lb., and over the pump-room is a cast-iron feed-water tank with a capacity of 8,000 gallons. There are three dynamos and engines. One is a Crompton-Rosvell steam dynamo, the engine being of the two-crank compound (enclosed) constant thrust type, coupled direct to a Crompton bipolar shunt-wound dynamo. The engine is capable of giving 75 b.h.p. with 180lb. steam pressure, non-condensing, when running at a speed of 560 revolutions per minute, and with the steam superheated to 479deg. F. The dynamo has an output of 104 amperes at 450 to 480 volts. The other two are Crompton-Bellias dynamos, the engines being of the two-crank, compound, enclosed, self-lubricating type, made by Messrs. Bellas and Morcom, Limited, Birmingham, coupled to Crompton multipolar shunt wound dynamos. These two engines are capable of giving 170 b.h.p with 180lb. steam pressure, non-condensing, and run at 450 revolutions per minute, with the steam superheated at about 479deg. F. The dynamos are wound for an output of 250 amperes at 450 to 480 volts. The motor-booster set consists of three multipolar machines, all coupled direct and mounted on one common bedplate, each of the booster dynamos being capable of giving 110 amperes at any voltage from 0 to 80 at a speed of 1,150 revolutions per minute. The motor is wound for coupling on to the 450 to 480 volt circuit. The balance set consists of two multipolar machines directly coupled together, and are capable of dealing with an out-of-balance current of 60 amperes with a voltage on either side of the three-wire system varying from 225 to 240 volts. The battery consists of 230 cells, divided into two equal parts, 115 cells serving each side of the system. The battery has a capacity of 400 ampere-hours. In the engine room is a five-ton overhead hand travelling crane. The switchboard consists of enamelled slate panels mounted on an iron frame, and contains all the usual fittings and instruments for dealing with the three dynamos, balancer, boosters, and battery, and two or three feeders as required. The wiring of the building has been carried out by Messrs. Chancellor and Peterkin, Edinburgh, and the street mains have been laid by the Callender's Cable and Construction Company, Limited, London, and Erith, Kent. The plant at the station has been fitted up under the direction of Mr. R. M. M'Leay, Messrs. Crompton and Co.'s representative, while the whole of the operations have been supervised by Mr. B. G. Drummond, the resident engineer of the Electric Supply Corporation."

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## PROVISIONAL PATENTS, 1905.

APRIL 19.

**8326. An improved switch for electric lighting circuits.** Joseph Hutton, 37, Huntriss-row, Scarborough, Yorks.

**8330. Improvement in automatic switches and circuit breakers.** James Henry Ward, Albert Alexander Godstone, Meyer Hart Godstone, and Harry Scott Nowell, Dutton-street Strang-ways, Manchester.

**8344. Improvements in and in the manufacture of metallic frictional blocks, such as brake-blocks, electrical collector slippers, and the like.** Thomas Ashmore and Phelam McCullough, 10 St. George's-crescent, Liverpool.

**8357. An improved way of administering electricity for medical purposes and apparatus used in connection with same.** William Davenport, 147, Stamford-street, London.

**8391. Improvements in electricity meters.** Joseph Devonport Finney Andrews, 2, Park-avenue, East Sheen, London

**8394 Improvements in or relating to electric motors.** Dr. Max Corsepius, 24, Southampton-buildings, Chancery-lane, London.

**8409. Improvements in selecting devices applicable to party-line telephone systems and the like.** Paul Arnheim, 322, High Holborn, London.

**8410. Improvements relating to electrically-operated selecting and switching devices applicable to party-line telephone and telegraph systems.** Paul Arnheim, 322, High Holborn, London.

**8411. Improvements in and relating to central-battery telephone systems.** Paul Arnheim, 322, High Holborn, London.

APRIL 20.

**8443. Improvements in connection with trolleys of electric tramcars and the like.** Horace Halstead, Archer Johnson, and Samuel Winn, Tower-chambers, Halifax.

**8444. An improved "cut-out" for electric lamps and holders and other purposes.** Archibald Walker and John Manton Walker, Olivet House, Old Conduit-street, Gloucester.

**8511 Improved method of and means for "tuning" Hertzian wave receivers to particular transmitters.** Christian Hülsmeyer, 72, Cannon-street, London. (Complete specification.)

**8541. Improvements in the regulation of electric circuits subject to rapidly fluctuating loads.** Edmund Scott Gustave Rees, Charles Hodgson Iles, and William Armistead, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**8563 Improvements in electric arc lamps with multiple carbons.** William Gamble, 28, New Bridge-street, London.

**8567. Improvements in and relating to systems of electric distribution employing mercury vapour lamps or the like.** The British Thomson-Houston Company, Limited, 83 Cannon-street, London (The General Electric Company, United States) (Complete specification.)

**8568. Improvements in and relating to machines for use in the manufacture of incandescent electric lamps.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**8569. Improvements in and relating to dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**8570. Improvements in and relating to the regulation of the output of electric generators driven at varying speeds** The British Thomson-Houston Company, Limited, Frank Holden, and Alexander Stanley Garfield, 83, Cannon-street, London.

**8571 Improvements relating to systems of electric transmission.** John Dunlop Hilliard, jun., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, April 20, 1904, being date of application in United States). (Complete specification.)

APRIL 22.

**8613. Apparatus for electrical drying of insulation of cables.** George Hinde Nisbett, 65, Chancery-lane, London. (Complete specification.)

**8615. Improvements in electric switches.** Walter F. Jones, Donald G. Macmillan, and Gustave J. Neybergh, 65, Chancery-lane, London. (Date applied for under Patents Act, 1901, Jan. 12, 1905, being date of application in Belgium.) (Complete specification.)

**8631. An improved dry battery.** Fredrick Weatherill, 11, Lowden-road, Herne Hill, London.

**8652. Improvements in plug-boxes and the like for the connection of electric conductors to the main supply cables.** George Arthur Kirk and the Corlett Electrical Engineering Company, Limited, 6, Lord-street, Liverpool.

**8659. Means for protecting electric telegraph lines against the influencing action of alternating-current lines situated in the neighbourhood thereof.** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens-Schuckertwerke G. m. b. H., Germany.) (Complete specification.)

**8663. Improvements in and relating to electro-mechanical block signalling systems for railways and the like.** Attilio Beer, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

APRIL 25.

**8704. Improvements in means for supporting telephone receivers.** Frank Wesley St. John, 52, Chancery-lane, London. (Complete specification.)

**8711. Improvements relating to the distribution of electric energy to apparatus capable of being operated by direct and also by alternating currents.** Benjamin Garver Lamme, the Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, May 3, 1904, being date of application in United States.) (Complete specification.)

**8721. Improvements in processes of preparing nitrogen-oxygen compounds by means of electricity.** Westdeutsche Thomasphosphat-Werke G. m. b. H., 322, High Holborn, London. (Date applied for under Patents Act, 1901, April 7, 1905, being date of application in Germany.) Complete specification.)

**8728. An improved trolley retractor.** Henry M. Love, 1, Queen Victoria-street, London. (Complete specification.)

**8732. Improvements in systems and means for laying electrical wires in conduits.** Guy Moore Gest, 40, Chancery-lane, London. (Complete specification.)

APRIL 26.

**8821a. Telephonograph.** Joseph Skwirsky, 35, Newman-street, Oxford-street, London. (Date applied for under Patents Rule 9, March 20, 1905.)

**8759. Electric distant gas-lighting device.** Adolf Mautz, Blumenstrasse 25, Stuttgart, Germany. (Date applied for under Patents Act, 1901, April 27, 1904, being date of application in Germany.) (Complete specification.)

**8765. Electrical connection for cables to sparking clubs of internal-combustion engines or for other purposes.** Luther Padwick and James McKechnie, care of Vickers, Sons, and Maxim, Limited, Barrow-in-Furness, Lancs.

**8786. Improvements in electric controllers and starting switches.** Daniel Adamson and John Brentnall Duckitt, 17, St. Ann's-square, Manchester.

**8789. Method for safeguarding electric unipolar cells.** Robert Grieson, 32, Waisenhauster, Dresden, Germany. (Complete specification.)

**8822. Improvements in the regulation of electric circuits subject to rapidly fluctuating loads.** Edmund Scott Gustave Rees, Charles Hodgson Isles, and William Armistead, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**8828. Improvements in electric arc lamps.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**8829. Improvements in electric arc lamps.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**8838. Improvements in and relating to apparatus for telegraphic purposes.** Joseph Theodor Szek, 22, Southampton-buildings, Chancery-lane, London.

APRIL 27.

**6959a/04. Improvements in carbons and in the manufacture thereof.** Howard Coppuck Lewis, 83, Cannon-street, London. (The General Electric Company, United States.) (Date applied for under Patents Rule 9, March 22, 1904.)

**7843. Improvements in lifeguards for electrically-driven tramcars, trains, and other vehicles supplied on the overhead or trolley system.** W. T. Skelding and Co., Limited, and Frederic Charles Geary, 189, Wolverhampton-street, Dudley.

**8846. An improved electrical collector trolley-head.** Robert Baron, 10, St. George's-crescent, Liverpool.

**8847. Improvements in apparatus for controlling poles and ropes of electric tramway vehicles.** William James Bowden and James William Cronkshaw, 6, Bank street, Manchester.

**8880. Improvements in wireless telegraph system.** Harry Shoemaker, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**8891. Improvements in and relating to filaments for electric and other lamps.** Ernest Léon Frenot, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, May 7, 1904, being date of application in Belgium.) (Complete specification.)

**8906. Improvements relating to the distribution of electrical energy.** Ernest Rowland Hill, Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London.

**8913. An improved controlling system for electric railways.** Thorsten von Zweigbergk, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**8921. Improvements in electric railway systems.** George Lowe Campbell and William Melvirne Stephens, 4, South street, Finsbury, London. (Complete specification.)

**8931. Improvements relating to points or switches for electric tramways working upon the slot conduit system.** Albert Newman Connett, 322, High Holborn, London. (Complete specification.)

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**8967. Improvements in systems of electrical distribution.** Paul Martyn Lincoln, Westinghouse Patent Bureau, Westinghouse - building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, May 3, 1904, being date of application in United States.) (Complete specification )

APRIL 28.

**8968. An improvement in adjustable brackets for electric lamps.** Arthur John Whitcombe and Maxwell Williams, 31, Harmer-street, Gravesend.

**8972. Improvements in systems of electrical distribution of direct currents by means of vapour rectifiers.** Peter Cooper Hewitt, the Westinghouse Patent Bureau, Westinghouse - building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901 May 13, 1904, being date of application in United States.) (Complete specification.)

**8973. Improvements in vapour electric apparatus.** Peter Cooper Hewitt, the Westinghouse Patent Bureau, Westinghouse - building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, May 13, 1904, being date of application in United States.) (Complete specification.)

**8975. Improvements in automatic telephone exchange systems.** Bernhard Kugelmann, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, April 29, 1904, being date of application in Germany.) (Complete specification.)

**8991. An improved process for insulating electric wires and cables.** La Compagnie Française de l'Amainte du Cap, 7, Southampton - buildings, Chancery - lane, London. (Date applied for under Patents Act, 1901, May 10, 1904, being date of application in France.) (Complete specification.)

**8994. Improvements in electric switches or connectors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States )

**8996. Improvements in electric arc lamps.** Edwin Rudolph Grote and Milton Victor Ely, trading as Foster and Co., Palace-chambers, Westminster, London.

APRIL 29.

**9057. A new or improved electric water-heating apparatus or radiator.** Leonora Binko, trading as the Electric Heating Company, 9, Warwick-court, Gray's-inn, London.

**9064. Improvements in electric switches or circuit breakers.** The British Thomson-Houston Company, Limited, and Edwin Joseph Murphy, 83, Cannon-street, London.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published May 18.*

1904.

**7044. Electro-capillary apparatus.** Armstrong and Orling.

**8910. Push-buttons for closing electrical circuits.** Klein.

**10800. Electric transformers.** Berry.

**10878. Devices for protecting alternating-current electric apparatus.** British Thomson-Houston Company, Limited. (General Electric Company.)

**12737. Electrical motor and speed-control arrangements therefor.** Bentley.

**13543. Electrical switches.** Lundberg and Lundberg.

**14460. Reduction of displacement of phase in electric current circuits.** Johnson. (Badische Anilin und Soda Fabrik.)

**27900. Secondary batteries.** Gardiner.

**28980. Joint-arm applicable for supporting electric lamps.** Nieriker. (Date applied for under International Convention, Oct. 8, 1904.)

1905.

**789. Electric heating of electrically-propelled vehicles.** Union Elektricitäts-Ges. (Date applied for under International Convention, Jan. 16, 1904.)

**923. Electrical measuring instruments.** Conrad. (Date applied for under International Convention, Jan. 20, 1904.)

**3409. Arrangement of multiple switchboards for telephone exchanges.** Siemens Bros. and Co., Limited. (Siemens und Halske Akt.-Ges.)

**3510. Devices for preventing the overcharging of electric cables.** Land und Seekabelwerke Akt.-Ges. (Date applied for under International Convention, March 31, 1904.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ⅞-¾ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 7/16-17/32 |
| British Insulated and Helsby Cables, Ord., 1-100,000 .... | 5 | – | 5¼-6 |
| —— 6 per cent. Cum. Pref., 1-100,000 ..... | 5 | – | 5¾-6 |
| —— 4½ per cent. Mortgage Debentures ..... | 100 | – | 101-104 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. ..... | 100 | – | 100-102 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 ..... | 5 | – | 2¾-3¼ |
| —— 4 per cent. Mortgage Debenture Stock ..... | 100 | – | 91-93 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,751 .. | 2 | – | 1¾-2 |
| —— Non. Cum., 6 per cent. Pref. ..... | 2 | – | 1¾-2 |
| —— 4½ per cent. 1st Debenture Stock ..... | 100 | – | 92-95 |
| —— 4½ per cent. 2nd Debenture Stock ..... | 100 | – | 79-82 |
| Callender's Cable, Debentures ..... | 100 | – | 107-109 |
| —— Ordinary ..... | 5 | – | 10¼-11¼ |
| —— 5 per cent. Pref. ..... | 5 | – | 5¼-5⅝ |
| Crompton and Co. ..... | 5 | – | 2-2¼ |
| —— 5 per cent. Debentures ..... | 100 | – | 96-100 |
| Edison and Swan United, "A" Shares, 1-99,261 ..... | 5 | – | 1-1¼ |
| —— "A" Shares, 01-017,139 ..... | 5 | – | 1⅞-2⅛ |
| —— 5 per cent. Debentures ..... | 100 | – | 85-90 |
| —— 4 per cent. Deb. Stock, Red. ..... | 100 | – | 81-86 |
| Electric Construction, Limited, Nos. 1 to 112,100 ..... | 2 | – | 1-1¼ |
| —— 7 per cent. Cumulative Pref. ..... | 2 | – | 2¼-2½ |
| —— 4 per cent. Perp. 1st Mort. Deb. ..... | 100 | – | 96-99 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 | – | 9¼-10 |
| —— 4 per cent. 1st Mort. Deb. Stock ..... | 100 | – | 97-101 |
| W. T. Henley's Telegraph Works, Ordinary ..... | 5 | – | 11-12 |
| —— 4½ per cent. Preference ..... | 5 | – | 5¼-5⅝ |
| —— 4½ per cent. Debentures ..... | 100 | – | 109-111 |
| India Rubber, Gutta Percha, and Telegraph Works ..... | 10 | – | 16-17 |
| —— 4 per cent. Debentures ..... | 100 | – | 100-103 |
| Parker, Thos., Limited, Ordinary ..... | 10 | – | 10-10¼ |
| Telegraph Construction and Maintenance ..... | 12 | – | 36-38 |
| —— 5 per cent. Bonds ..... | 100 | – | 103-105 |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary ..... | 10 | – | 11¾-12¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 ..... | 10 | – | 10-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 .... | 10 | – | 11-12 |
| —— 4½ per cent. Debenture Stock, Red. ..... | 100 | – | 106-108 |
| Bromley (Kent) Electric Light and Power Co. ..... | 5 | .. | 5¼-5⅝ |
| —— 4½ per cent. 1st Debenture Stock, Red. ..... | 100 | – | 101-104 xd |
| Brompton and Kensington, Ordinary ..... | 5 | – | 9¾-10¼ |
| —— 7 per cent. Preference ..... | 5 | – | 9¾-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 .. | 5 | – | 8⅜ 9⅛ |
| —— Nos. 60,001-80,000 ..... | 5 | – | 7⅜ 8⅛ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. .... | 8 | – | 12¼-13¼ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 105-108 |
| Charing Cross and Strand, 70,001-80,000 ..... | 5 | – | 7¼-8¼ |
| —— 4½ per cent. Cum. Pref. ..... | 5 | – | 5⅜-5⅝ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 5-5¼ |
| —— 40,001-80,000 ..... | 5 | – | 5-5¼ |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 | – | 105-107 |
| Chelsea Electricity Supply ..... | 5 | – | 6¼-7 |
| —— 4½ per cent. Debentures ..... | 100 | – | 109-111 |
| City of London, Ordinary ..... | 10 | – | 11-12 |
| —— 6 per cent. Cumulative Pref. ..... | 10 | – | 13¼-14 |
| —— 5 per cent. Debenture Stock ..... | 100 | – | 125-127 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) .. | 100 | – | 103-105 |
| County of London Electric Supply, Ordinary ..... | 10 | – | 8¾-9¼ |
| —— 6 per cent. Cum. Pref. ..... | 10 | – | 12-12¾ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 102-104 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. ..... | 100 | .. | 111-114 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 .. | 5 | – | 5¾-6¼ |
| —— 6 per cent. Cum. Pref. ..... | 5 | – | 6¼ 6¾ xd |
| —— 4½ per cent. First Mort. Deb. ..... | 100 | – | 106-108 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 2¼-2⅜ |
| —— 5 per cent. Debenture Stock, Red. ..... | 100 | – | 86-91 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 ..... | 5 | – | 5¼-5⅝ |
| —— 4½ per cent. First Deb. Stock, Red. ..... | 100 | – | 101-104 |
| Havana Electricity, Limited, 1-15,000 ..... | 10 | – | 9¼-10¼ |
| Hove Electric Lighting, Limited, Ord., 1-13,000 ..... | 5 | – | 7¼-8 xd |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 100-103 xd |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 ..... | 1 | – | 11/16-13/16 |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | | 12-13 |
| Kensington and Knightsbridge and Notting Hill, 4 per cent Debenture Stock Red .. ..... | 100 | – | 101-103 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9¾-10¼ |
| London Electric, Ordinary ..... | 3 | – | 2¼-2⅝ |
| —— 6 per cent. Pref. ..... | 5 | – | 5¼-5⅝ |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red... | 100 | – | 99-101 |
| Metropolitan Ordinary ..... | 10 | – | 18 19 |
| —— 4½ per cent. First Mortgage Debenture Stock .... | 100 | – | 109-114 |
| —— 4½ per cent. Cum. Pref. ..... | 5 | – | 5¼-5⅝ |
| —— 3½ per cent. Mortgage Debenture, Red. ..... | 100 | – | 97-99 |
| Midland Electric Power Dis., Ld., 4½ p c. 1st Mort. Deb.. | 100 | – | 99-101 |
| Newcastle-upon-Tyne Electric Supply, Ordinary ..... | 5 | – | 98-101 |
| —— Preference ..... | 4 | – | 100-102 |
| Notting Hill Electric Lighting ..... | 10 | – | 14¼-15¼ |
| —— 4 per cent. First Mort. Debs Nos. 1-500 (Reg.) .. | 100 | – | 100-102 |
| Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,310 ..... | 5 | – | 6¼-6⅝ |
| —— 4 per cent. Debenture Stock ..... | 100 | – | 98-100 |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures ..... | 100 | – | 101-104 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 .. | 5 | – | 2⅝-3¼ |
| —— 4 per cent. Debenture Stock ..... | 100 | – | 79-83 |
| South London, Ordinary ..... | | – | 3¾-4¼ |
| South Metropolitan Electric Light and Power Co., Ord... | 1 | .. | ⅞-1 |
| —— 7 per cent. Cum. Pref. ..... | 1 | .. | 1 11/32-1 13/32 |
| —— 4½ per cent. 1st Mort. Deb. ..... | 100 | .. | 105-108 |
| —— Ditto, June, 1904 ..... | | .. | |
| St. James's and Pall Mall, Ordinary, 101-90,000 ..... | 5 | – | 13¼-14⅜ |
| —— 7 per cent. Pref. ..... | 5 | – | 8¼-8⅝ |
| —— 5½ per cent. Deb. ..... | 100 | – | 98-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 ..... | 5 | – | 4 15/16-5 1/16 |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5-5¼ |
| Westminster, Ordinary ..... | 5 | – | 12¼-13¼ |
| —— 5 per cent. Cum. Pref., 110,101-138,251 ..... | 5 | – | 6-6¼ |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 ..... | 5 | – | 5¾-6¼ |
| —— Ord. ..... | 5 | .. | 8¼-8¾ |
| —— Permanent 6 per cent. Debenture Stock, 1888 .. | 100 | – | 140-143 |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 105-107 |
| Barcelona Tramways, Limited, Ord., 1-20,000 ..... | 10 | .. | 11¼-11¾ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 ..... | 10 | .. | 9¾-10¼ |
| —— 5 per cent. Deb., Red., 1-600 ..... | 100 | .. | 99-102 |
| —— 4½ per cent. Red. Deb. Stock ..... | 100 | .. | 96-100 |
| Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606.. | 1 | .. | ⅜-½ |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 ..... | 1 | .. | 15/16-1 1/16xd |
| Belfast Street Tramways, Ord., 1-26,600 ..... | 10 | .. | 10¼-11¼ |
| Blackpool and Fleetwood Tramroad ..... | 10 | – | 13¾-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 ..... | 5 | – | 1-1¼ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 ..... | 5 | – | 3⅜-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 91-98 |
| British Columbia Electric Railway Co., Ord. Def. ..... | 100 | – | 103-106 xd |
| —— Ord Pref. ..... | 100 | – | 100-103 |
| —— Non. Cum. 5 per cent. Pref. ..... | 10 | – | 10¼-10⅜ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each | 40 | – | 103-105 p c xd |
| —— 4½ per cent. Vancouver Power Deb. ..... | 100 | – | 99-102 |
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 | – | 9¼-9⅜ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 ..... | 10 | – | 10⅜-11¼ |
| —— 5 per cent. Perpetual Debenture Stock ..... | 100 | – | 120-122 |
| —— 4½ per cent. 2nd Deb. Stock ..... | 100 | – | 96-98 xd |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Buenos Ayres and Belgrano Tram. Ord., 1-100,000 | 5 | 3½-3¾ |
| —— "A" 6 per cent. Cum. Pf., 1-40,000 | 5 | 5 9/16-5 13/16 |
| —— "B" 6 per cent. Cum. Pf., 1-87,500 | 5 | 5¼-5½ |
| —— 5 per cent. Deb. Stock, Red. | 100 | 107-109 |
| —— Prov. Cert., all paid | 100 | 103 106 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | 97-99 |
| Calcutta Tramways, Limited, 1-102,268 | 5 | 8¼-8½ |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | 106-108 |
| Cape Electric Tramways Nos. 1-480,000 | 1 | 1¼-1½ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | 4¾-5 |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | 99 102 |
| Dalmore Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | 101-103 xd |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | 9½-10 |
| —— 5 per cent. Cum. Pref. | 10 | 11-12 |
| —— 4 per cent. Debentures | 100 | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | 13½-14¼ |
| —— 5 per cent. Pref., Nos. within 1-60,000 | 10 | 15½-16¼ |
| —— 4½ per cent. Mort. Debs., 1-5,000, Red. | 100 | 94-97 |
| Imperial Tramways Ordinary | all | 18-19 |
| —— 5 per cent. Cum. Pref. | all | 14-14¼ |
| —— 4½ per cent. Deb Stock | 100 | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000 | 5 | 2¾-3½ |
| —— 4 per cent. Debenture Stock | 100 | 85-90 |
| Kilmarnock and District Lighting and Traction, Pref. | 5 | 8-8½ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | 10½-10¾ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | 100 103 |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016. | 1 | 3-7/16 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | 1-1 1/16 |
| —— 4½ per cent. Deb. Stock, Red. | 100 | 105-107 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000 | $1,000 | 106-110 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 | 101-104 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 | 103-105 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000 | 5 | ¼-1¼ |

| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Oldham, Ashton, and Hyde Tramway, Ordinary | 10 | 12 |
| —— 5 per cent Cum. Pref. | 10 | 9¾-9¾ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk. | 100 | 105 108 |
| Potteries Electric Traction, Ordinary 20,001-40,00 | 10 | 9 9¼ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | 9¼-10 |
| —— 4½ per cent. Debenture Stock | 100 | 103-107 |
| South Lancashire Electric Traction and Power Company —— £250,000 Ordinary | 1 | 1 |
| —— £101,132 5 per cent. Preference | 1 | |
| —— £597,170 4½ per cent. Debenture Stock | 100 p.c. | 100 p.c. |

## Electric Railways.—

| | | |
|---|---|---|
| Central London, Ordinary | 100 | 92 94 |
| —— 4 per cent. Pref. | 100 | 101-103 |
| —— ,, ,, deferred | 100 | 82-85 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | 111-113 |
| City and South London, Consolidated Ordinary | 100 | 42-43 |
| —— 4 per cent. Debenture Stock | 100 | 107-109 |
| —— 5 per cent. Pref. Stock '91 | 100 | 120-123 |
| —— ,, ,, ,, '96 | 100 | 118-121 |
| —— ,, ,, ,, '01 | 100 | 115-118 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | 10-10¼ |
| —— Ordinary, 1-60,000 | 10 | 3¾-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | — | 99-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | — | 99 -100½ |
| Waterloo and City, Ordinary | 100 | 91-93 |

## Telephones.—

| | | |
|---|---|---|
| National Telephone, Preferred | 100 | 108¼ 109¼ |
| —— Deferred Stock | 100 | 101-103 |
| —— 6 per cent. Cum. First Pref. | 10 | 12¾-13¼ |
| —— 6 per cent. Cum. Second Pref. | 10 | 11¾-12¼ |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | 5¾-5¾ |
| —— 5½ per cent. Deb. Stock, Red. | 100 | 100-102 |
| —— 4 per cent. Deb. Stock, Red. | 100 | 104-106 |
| —— 4 per cent. Prov. Cert. | — | 103¼-105¼ |
| Oriental Telephone and Electric Company | 1 | 1¼-1⅜ |
| —— 6 per cent. Cum. Pref. | 1 | 1 3/16-1 5/16 |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905. | 1904. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Car mile. | Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | April 29 | 1,178 | 1,187 | − 9 | + 5,349h | 19¼ | 19¼ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·14 |
| Ayr Corporation | ,, 23 | 370 | 234 | + 136 | + 760 | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 336,049 | 1·03 | 10·11 | 1,770 | 5 0 |
| Barking Corporation | ,, 1 | 48 | 41 | + 7 | + 305 | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 30 | 1,050 | 1,009 | + 41 | — | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,319,701 | 1·158 | 9·98 | 2,383b | 6·1 |
| Birmingham Corporation | ,, 29 | 435 | 263 | + 172 | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | — | — | — | — | — | 6¼ | 6¼ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 26 | 1,518 | 870 | + 648 | — | 21 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10 94 | — | 4·59 |
| Blackpool Corporation | ,, 27 | 1,946 | 537 | +1,419 | — | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 29 | 781 | 321 | + 463 | — | 16½ | 16½ | Dec. 31 | 32,021 | 2,253,984 | 600,757 | 3·34 | 12·75 | 2,001 | 7·05 |
| Bolton Corporation | ,, 30 | 1,841 | 1,787 | + 54 | + 168 | 38 | 38 | March 31 | 94,161 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·89 |
| Bournemouth Corporation | ,, 26 | 1,577 | 1,018 | + 559 | — | 10·15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 29 | 5,530 | 4,000 | +1,530 | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 30 | 1,0 2 | 814 | + 278 | — h | 9 | 7½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 28 | 5,714 | 4,795 | + 9 8 | — | 51½ | 51½ | Dec. 31g | 253,150 | 44,391,439 | 6,033,528 | — | — | — | — |
| Burnley Corporation | ,, 23 | 1,027 | 937 | + 30 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 30 | 356 | 313 | + 43 | — | 8½ | — | March 31j | 11,574 | 2,556,134 | 282,378 | 1·08 | 9·84 | 1,570 | 7·57 |
| Cardiff Corporation | ,, 22 | 1,255 | 1,245 | + 11 | — | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 29 | 229 | 178 | + 51 | — | — | — | Dec. 31g | 9,987 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 29 | 6,674 | 6 8 0 | − 176 | + 1,837h | 6 | 6 | ,, 31 | 362,471 | 44,953,938 | 1,292,674a | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 30 | 2,..08 | 2,681 | + 127 | — h | 6¼ | 6⅜ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Colchester Corporation | ,, 19 | 182 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 27 | 509 | 434 | + 75 | — | — | — | ,, 31g | 25,657 | 6,353,823 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | ,, 23 | 285 | 222 | + 63 | — | 7·23 | 7·23 | March 31g | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 15 | 187 | 201 | − 14 | — | 4½ | 4½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0 91 | 9 63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | ,, 28 | 159 | 103 | + 55 | — h | 7 | 6¾ | Dec. 31g | 6,231 | 688,905 | 107,164 | 3·88 | 14·09 | 952 | 7·39 |
| Dublin U. T., electric cars | ,, 23 | 4,329 | 4,177 | + 152 | } — | 47 | 46 | ,, 31g | 134,643 | — | 3,429,356 | — | — | — | — h |
| Dublin S. District, Electric | ,, 28 | 1,331 | 1,028 | + 303 | | | | | | | | | | | |
| Dundee City Tramways | ,, 26 | 836 | 745 | + 31 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 29 | 929 | 728 | + 201 | — | 10·77 | 10·75 | March 31 | 34,312 | 12,950,269 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 29 | 15,839 | 13,916 | +2,923 | +35,853h | 145 | 123 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Gloucester Corporation | ,, 26 | 383 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 19 | 2,713 | 2,534 | + 159 | — | 33 | 30½ | March 31 | 68,283 | 16,322,054 | 1,387,885 | 1·0 | 11·79 | 2,069 | 8·77 |
| Huddersfield Corporation | ,, 24 | 1,746 | 1,708 | + 538 | — | 35 | 35 | ,, 31 | 65,545 | 11,893,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | ,, 29 | 2,255 | 2,033 | + 221 | — | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | ,, 29 | 546 | 446 | + 100 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | ,, 26 | 153 | 139 | + 14 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 26 | 272 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 29 | 6,964 | 5,391 | +1,573 | — | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | ,, 22 | 1,951 | — | — | — | 7¼ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | ,, 22 | 10 216 | 10,191 | + 25 | + 6,165 | 103 | 103 | Dec. 31g | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | ,, 30 | 1,694 | 1,553 | + 131 | — h | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — e |
| London County Council | ,, 22 | 12,378 | 10,922 | +1,456 | + 5,761 | 46¼ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | ,, 27 | 148 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 29 | 12 943 | 11,9 8 | +1,015 | + 2,589 | 131¼ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 29 | 125 | 113 | + 12 | — | 2¼ | — | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newcastle-on-Tyne Corptn. | ,, 29 | 3,986 | 3,734 | + 192 | — | 43 | 38½ | ,, 25 | 185,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111b | — |
| Newport (Mon.) Corporation | — | — | — | — | — | 15 | — | — | — | — | — | — | — | — | — |
| Oldham Corporation | ,, 30 | 1 707 | 1 130 | + 577 | + 2,033 | 34½ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 29 | 2,356 | 1,655 | + 700 | — | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·16 | 12·39 | — | — |
| Reading Corporation | ,, 27 | 705 | 588 | + 117 | — | — | — | — | — | — | — | — | — | — | — |
| Rochdale Corporation | ,, 29 | 682 | 120 | + 432 | + 1,811 | 4½ | 4½ | 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 27 | 577 | 436 | + 141 | — | — | — | ,, 31 | 20,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·68 |
| Salford Corporation | ,, 30 | 4,0 3 | 3,957 | + 36 | + 252 | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 29 | 131 | — | — | — | 7¾ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 30 | 5,141 | 4,836 | + 255 | + 465 | 34¼ | — | ,, 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 26 | 1,011 | 911 | + 100 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 26 | 459 | 264 | + 195 | — | 6¼ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 28 | 685 | 504 | + 181 | — | 11¼ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 30 | 1,368 | 1,135 | + 233 | — | 19 51 | 18·48 | ,, 31 | 62,506 | 14,848,958 | 1,433,463 | 1 01 | 10·46 | — | 6·02 |
| Swindon Corporation | ,, 25 | 239 | — | — | — | 3¾ | — | — | — | — | — | — | — | — | — |
| Wallasey U.D.C. | ,, 24 | 846 | 655 | + 191 | — | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·50 |
| Warrington Corporation | ,, 27 | 371 | 303 | + 68 | — | 7¼ | — | — | — | — | — | — | — | — | — |
| West Ham Corporation | ,, 27 | 1,836 | 716 | +1,120 | + 2,326 | 8·62 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 26 | 864 | 550 | + 414 | — | 7¼ | — | ,, 31g | 20,878 | 4,263,066 | 417,335 | — | 12·006 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. e Train mile.
Per mile of single track. c Include rail and tram. d Including depreciation f Including one section of horse traction. g 1903. h Half-year's figures.
Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**Electrical Engineers (R.E.V.).**—The corps held a successful Bohemian concert—the last of the season—at the Caxton Hall on Saturday last, Colonel Crompton, C.B., the commanding officer, occupying the chair.

**The Institution.**—The meeting last week at the Society of Arts was occupied with Mr. A. M. Taylor's paper on "Stand-by Charges and Motor-Load Developments," a report of the discussion on which will appear in our next issue.

**New Marconi Station.**—It is reported that arrangements are in progress for the establishment of a wireless telegraph station at Machrihanish (Argyll) for the transmission of messages by the Marconi system. Ground has been acquired in the vicinity of Losset, but the site has not been finally decided upon. The tower for the dispatch and reception of messages will have an elevation of 400ft.

**Wireless Telegraphy on Lightships.**—Replying to a question in the House by Major Seely as to whether the work of installing wireless telegraphy on the six lightships for life-saving purposes had now been commenced, Mr. Bonar Law, secretary to the Board of Trade, replied that the agreement with the Marconi Company had been finally settled, and the work of installation was being put in hand forthwith.

**Faraday House.**—As a result of the recent scholarship examination the following awards are recommended: to Edward Stanton Ritter, of Cheltenham College, a Maxwell scholarship of 50 guineas, tenable for two years; to Louis Dudley Hooper, of Bournemouth School, and James Ardern Taylor, of Wellingborough Grammar School, exhibitions value 30 guineas, tenable for two years. The following candidates, who distinguished themselves in the above examination, have been awarded special prizes of 20 guineas each: Arthur Lionel Ballard, of Dunheved College; Edgar James Barnes, of Bournemouth School.

**X-Rays.**—A feature of special interest on the concluding day of the Röntgen congress held at Berlin last week was the discussion upon the treatment of cancer by X-rays, as opposed to surgical methods. Prof. Lassar, the well-known authority on skin diseases, advocated the application of X-rays in cases of great suffering, adding that his experience was that they relieved pain. He contended that the rays were greatly superior to the knife for the removal of cancerous growths, and declared that the success achieved by the Röntgen treatment in gangrenous cancer formations was such as the boldest imagination did not dream of a few years ago. In a hundred such cases he had only had three failures.

**Parcel Traffic on Tramways.**—The Manchester Corporation, which recently instituted an elaborate tramways parcels express, have had proceedings instituted against them by Messrs. Sutton and Co., a firm of local carriers, who seek an injunction to restrain the Corporation from conveying, collecting, and delivering goods or parcels by means of road vans, hand carts, or messengers, and acting as general carriers or railway agents. The plaintiffs also seek a declaration that it is unlawful for the Corporation to expend any moneys of the city for such purposes, or to use any buildings, plant, apparatus, or servants belonging to the tramways undertaking otherwise than for the working and using of the tramways. The Corporation will defend the action.

**New Publications.**—We have received a copy of the *Wisconsin Engineer* dated April, which contains articles on "Central-Station Engineering," by Mr. C. H. Williams; "The Public Water Supplies of Wisconsin," by Mr. W. C. Kirchoffer; "The Relations of the Engineer to the Telephone Business," by Mr. A. S. Hibbard; "Desirable Product from the Teacher of Mathematics," by Mr. D. C. Jackson," and "The Physical Properties of Wisconsin Railways." The *Transactions* of the North-East Coast Institution of Engineers and Shipbuilders, dated April, contain Mr. W. R. Cummins's reply to the discussion on "A Comparison of Vertical and Horizontal Tubes in Watertube Boilers," and a paper on "Petrol Motorcars," by Mr. Frank Little, with the discussion thereon.

**Optical Convention.**—We learn from Mr. F. J. Selby, hon. secretary of the Optical Convention, which opens on May 30, that preparations are now approaching completion. In addition to the papers previously announced, a contribution is promised from Lord Rayleigh on "The Polishing of Glass Surfaces," and Prof. Schuster will read a paper on "Spectroscopic Optics." The demonstrations of special apparatus arranged for the afternoons include the following: multiple colour illumination for microscopic objects, by Mr. J. Rheinberg; diffraction apparatus, by Mr. J. Rheinberg; quartz crystals, by Mr. J. Woodward; spectroscopes, by Mr. F. Twyman; and interferometer, by Mr. H Stansfield. The convention has the support of the Mercers', Goldsmiths' and Clothworkers' Companies. The convention is to be held at the Northampton Institute.

**Electrical Contractors' Association.**—The Leeds branch of the Electrical Contractors' Association held their annual meeting on Saturday at the Great Northern Victoria Hotel, Bradford. There was a good attendance of members. The report and balance-sheet were adopted, and the officers for the ensuing year elected. Mr. W. P. Steinthal was elected chairman and Mr. J. H Taylor (Huddersfield) vice-chairman. Mr. E. C. Wallis, who had rendered valuable service as secretary, consented to retain his office for another 12 months. Following the meeting a dinner was held, at which the majority of the members were present, and several guests, amongst the latter being Mr. Rolles and Mr. Allsopp, of the Bradford Corporation electricity department, and Mr. E T. Steinthal, a member of the Central Board of the association. The dinner was succeeded by a smoking concert.

**London Traffic Commission.**—The Royal Commission on London Traffic held sittings in private last week at the Westminster Palace Hotel. The Commissioners are stated to have practically concluded the consideration of their draft report, but apparently they had not finished taking evidence. The witnesses on the first day were Mr. Daniel Duff, manager of the London Road-Car Company, on behalf of omnibus proprietors in London; Mr. A. T. Salisbury Jones, chairman of the London Motor Omnibus Company, Limited; and Mr. A. Campbell Swinton, chairman of the London and District Motor 'Bus Company. Their evidence was chiefly directed to the results that have attended the introduction of motor omnibuses into the streets of the Metropolis in respect of traffic, cost of operation, renewals, repairs, and depreciation. The witnesses on Friday were Mr. C. R. Bellamy, general manager of the Liverpool Corporation tramways, and Mr. J. M. McElroy, general manager of the Manchester Corporation tramways, who attended to supply the Commission with details of tramways working in those cities. It is stated that this really concludes the evidence, and it is anticipated that the report will be presented to Parliament by Whitsuntide.

**Single-Phase Elevator.**—At the fifth annual convention of the Iowa Electrical Association, Mr. L. Sparrow, of St. Louis, read a short paper on the Wagner single-phase elevator and hoisting motor, of which an abstract appears in the *Electrical World* of New York. This motor, which has

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recently been put on the market, behaves, as regards current consumption, very similarly to a shunt direct-current motor, giving a torque in starting in direct proportion to the current used. In elevator service the excess torque and current over the normal in starting is not less than 50 per cent. This excess current, however, falls rapidly as the elevator is accelerated. The polyphase induction elevator motor may require as high as 500 per cent. more than full-load current in starting. This motor makes it possible to give with a single-phase distribution all the kinds of service given by direct current at the present time, and more than are usually feasible with polyphase motors. The new Wagner motor is stated to have a power factor of at least 70 per cent. in starting and 80 to 85 per cent. when running at full speed. The motor in elevator service can be used as an electric brake running as an induction generator if the armature is rotated at a speed in excess of synchronism. The motor is capable of 40 per cent. speed variation, with constant speed at whatever point it may be adjusted, thus making it applicable to ventilating fans and machine shop tool service.

**Wireless Telegraphy.**—Statements in the Press record that another "important discovery" has been made in this field, the achievement being credited to Father Joseph Murgas, pastor of the Catholic church at Wilkesbarre, Pennsylvania, who is stated to have been making experiments for the last seven years. He is reported to have demonstrated that "by conveying musical tones instead of the Morse code he can make communications with almost certain success." For the purpose of his experiments he uses a pole 200ft. high in his rectory yard, and he is stated to have been in constant communication with Scranton, 18 miles away. Operating with two tones only, Father Murgas is stated to exceed the speed obtained by any other system, and he has now almost perfected a complete tone alphabet, the speed of which is limited only by the capacity of the receiver to read the messages, which reminds one of a more familiar system. We are further told that the present cost of this system is not more than one-third the cost of other systems. The report concludes with the information that the transmitting and receiving instruments are the most simple yet devised, and the initial cost is small, because either earth or air current can be used singly or combined. This sounds like progress; but, unfortunately, these admirable systems have a habit of vanishing from the public ken with the same meteoric suddenness as that with which they are heralded.

**Telephone Call Offices.**—The report of Dr. Collingbridge, medical officer of health for the City, should go far to allay the apprehensions of those who feared that the instruments at the public call offices were open to the gravest hygienic objections, it having been suggested that there was especial danger of tuberculosis and diphtheria being communicated by one user to another. With the sanction of the National Telephone Company a number of call offices were selected, the mouthpieces removed, placed in sterilised bottles, and submitted to Dr. Klein for bacteriological examination. As the result of experiments on two guinea-pigs, it was found that the mouthpieces contained no tubercle or diphtheria germs. In all 12 mouthpieces were thus treated. The result was exceedingly satisfactory, as it showed that in none of the mouthpieces were any tubercle bacilli present. The conclusion, therefore, was that there is no real risk in the use of the telephone at public call offices, and that the alarm that had been raised had no foundation in fact. The only precaution advisable was the obvious common-sense one of keeping the mouthpieces clean. The medical officer had for some time been in communication with the Telephone Company with regard to the condition and ventilation of their boxes. They had undertaken to improve the ventilation and to line the boxes with an improved material which would allow of their being thoroughly cleansed, thus doing away with the accumulation of dust.

**Niagara.**—Both Houses of the American Legislature adjourned last week without coming to a decision upon the Niagara Power Bill, which is consequently hung up indefinitely. This result is apparently due to the publicity given to the corrupt practices of the promoters' agents, the *New York World* estimating the amount spent in "persuading legislators to vote for the measure" at £30,000, whilst the *New York Sun* stated that it would be passed at the last moment "if lobbying could buy the needed votes." The feeling of opposition on the part of the public was, however, very strong, and was supported by the Governor of New York State, who apparently wields considerable power in this matter. The promoters were, therefore, unable to force the Bill through. This continuation of the bribery perpetrated in the earlier history of the American side of the Falls cannot well be too strongly deprecated, but at the same time we scarcely think that æsthetic considerations should be allowed to outweigh those of a utilitarian nature. Although the powers proposed to be taken by the promoters are of an extensive character, they are scarcely likely to avail themselves of them to the full unless there is a corresponding market, in which case economic considerations would probably justify such a course. There is still the question of payment for the water thus taken to generate energy. It is notorious that as the result of bribes, huge concessions were given away in connection with previous American schemes for utilising the Falls, instead of a reasonable charge being made, as is done by the Dominion Government. We do not know the precise terms of the present Bill, but a tax, at once adequate and reasonable, is only what the circumstances of the case demand and the value of such a concession merits.

**Local Sections.**—Elsewhere in this issue will be found an interesting suggestion for the extension of the good which the local sections of the Institution of Electrical Engineers have already performed. Until these sections were organised it was, as a rule, only the heads of firms who were able to attend with any degree of regularity the meetings of the parent Institution. Their presence at the London meetings rendered the same more interesting than they have been during the past year or two. With the formation of the local sections the number of papers read and discussed each year has increased, but what is much more important is that the number of electrical engineers who have been able to take part in the discussions or to listen to them is very much larger. The social intercourse after the meeting between the engineers engaged in the local firms is also a most valuable feature of the meeting. It is now suggested by a contributor that these local sections should undertake the distribution of standard technical literature to the members. This could be organised much in the same way as a lending library, and the membership fee should be made to cover all but the postage expenses. The junior members of the profession naturally find it impossible to buy for themselves a complete set of standard works on electrical engineering, or to subscribe to even one technical journal from each country interested in electrical manufacturing. In this respect the London members have the advantage of the library in Victoria-street, and the proposal to render the volumes in this library accessible to country members needs careful consideration. In our opinion the value of a library is largely

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reduced if once books are lent out. Thus, while our correspondent's suggestion is a most valuable one, we think the books which should be circulated should be duplicate copies of standard works specially obtained for the purpose. Further, in connection with every local section there should be arranged a room in which, during certain nights in the week, the technical journals from foreign countries, as well as the English ones, could be read by members. This room would also afford a meeting place for electrical engineers, and would extend the opportunities for that mutual assistance which members can render to each other.

**Engineering Standards Committee.**—We have received reports Nos. 20 and 21, which respectively deal with "British standard screw threads" and "British standard pipe threads." The committee recommend that the Whitworth form of thread be adopted on all screws of ¼in. diameter and above, having either Whitworth or British standard fine pitches. The committee also recommend that all screw threads made in accordance with the sizes given in Table I. be known as "British standard Whitworth screw threads (B.S.W.)," those in Table II. as "British standard fine screw threads (B.S.F.)," and those in Table III. as "British Association screw threads (B.A)." The retention of the pitches originally devised by Sir Joseph Whitworth is advocated. To meet the wide-spread desire for a series of finer pitches to supplement those of Sir Joseph Whitworth, the committee have prepared a table of fine pitches of ¼in. to 6in. diameter. For odd sizes the committee recommend the adoption of the pitch and depth of thread for the size immediately preceding the required one. The pitches given in Table II. for sizes up to and including screw threads of 1in. diameter are based on the formula $P = \frac{\sqrt[3]{d^2}}{10}$, P equalling the pitch of thread in inches and $d$ the full diameter of thread in inches. For those sizes above 1in. diameter up to and including screw threads of 6in. diameter the pitches in Table II. are based on the formula $P = \frac{\sqrt[3]{d^5}}{10}$. The Committee on Screw Threads and Limit Gauges are at present engaged how best to secure satisfactory interchangeability between male and female screws. Report No. 21 contains recommendations regarding the form of pipe threads, a definition of the Whitworth thread, sizes of tubes, couplers, etc. The committee also recommend that a complete set of standard male screw gauges be made in accordance with the specified tables, and that they be deposited with some recognised authority, such as the Board of Trade or the National Physical Laboratory, for reference. These two reports are published at 2s. 6d. each, and can be obtained from the offices of the committee or from any bookseller.

**Association of Tramway and Light Railway Officials.**—The ninth general meeting of this association was held at Bristol last week under the presidency of Mr. H. England, manager of the Wakefield Light Railways Company. The members present hailed from London, Birmingham, Norwich, Darlington, Brierley Hill, Wolverhampton, Rossendale, Worcester, Wakefield, etc. Mr. Charles Challenger, the traffic manager of the Bristol Tramways Company, in welcoming the members of the association on behalf of the directors of the company, alluded to the great expansion of the Bristol system, which during last year carried the population almost three times each week. The route length to-day was about 30 miles, and it was not the company's fault that there was not double that length of route. Bristol was amongst the first two or three tramway companies in this country to operate horse cars, and was the first to run electric cars under the Board of Trade rules. Referring to the great engineering work done by Sir George White and his brother, Mr. Samuel White, the speaker said that their achievements in Bristol alone would have placed them in the front rank of electric tramway organisers, but the marks of their genius in this respect had been impressed upon many towns in this kingdom. The London United Tramways, on account of the formidable obstacles of various kinds to be overcome, stood out as a monument to their and Mr. Clifton Robinson's genius, tact, and enterprise. In conclusion, he outlined the provision made by the company for old employés, which, starting with a provident fund, had now developed into a pension scheme, whereby an annuity was secured to employés at the age of 65 without any contribution from them. Mr. Sydney E. Smith, the assistant traffic manager, also read a paper on the system, in which he reviewed its technical aspects. Mr. Conaty offered congratulations on the pension fund, which was a step in the right direction, though he was afraid that all tramway concerns could not afford it. New members having been elected and the report and accounts adopted, the president and Mr. Conaty were elected to represent the association at a conference upon the desirability of amalgamating the Municipal Tramways Association, the Tramways and Light Railways Association, and this association.

**Electricity on a German Warship.**—The liner "Preussen," which was launched from the Vulkan shipyards in Stettin, Germany, at the end of 1903, and which at the present moment is at anchor at Swinemünde, is to be put into service and will be attached to the Baltic marine station this month. It has three screws, and is about 400ft. in length, 70ft. in breadth, and 25ft. in draught, with a displacement of 13,200 tons. It develops a speed of 18 knots, the capacity of her engines being 16,000 h.p. The vessel is fitted with a belt armour of 225mm. and an armoured deck of 75mm. thickness. Her artillery equipment comprises four quick-charging guns of 12in. gauge, 14 7in. quick-charging guns, and 12 of 3½in. gauge, 12 1½in. machine guns, and eight machine rifles, in addition to six torpedo-launching tubes. Her crew consists of 697 men. All the internal rooms as well as the upper deck are lighted by electric glow lamps. For use in connection with the scouting service in action or, generally speaking, whenever the enemy is close by, as also for signalling to a distance, there are used four large projectors of 61 million normal candle-power each. Electromotors are being used extensively for such purposes as conveying ammunition from the ammunition stores to the guns, moving the rotating armoured gun-turrets, handling coal, lowering or hauling the large boats, operating the machine tools and refrigerating plant, as well as for driving the numerous fans of different sizes, which are installed in all the compartments of the ship. The whole of the apparatus used for the transmission of orders from one part of the ship to another, as well as for mutual communication between different places—*i.e.*, the telegraphs controlling the rudder, engines, boilers, artillery, and torpedo rooms—the optical signalling apparatus for the transmission of orders and intelligence from ship to ship or from land to ship, the telephone and alarm plant, the medical outfit of the infirmaries, and instruments for indicating the depth, etc., are operated by electricity. The whole of the above machinery and apparatus has been constructed by the Siemens-Schuckert Works, which syndicate also installed the two central stations supplying the current for their operation as well as the one required for the "Telefunken" wireless telegraph apparatus. These central stations contain an aggregate of four turbo-dynamos of

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65 kw. each in addition to a storage battery, intended to serve as reserve.

**Personal.**—Mr. W. A. Chamen, late chief engineer to the Glasgow Corporation electricity department, was entertained to dinner at the Grosvenor Restaurant, Glasgow, on the evening of Thursday, the 4th inst., by members of the electrical profession in the neighbourhood and the staff of the electricity department. Ex-Bailie D. M. Stevenson presided over a large company, covers being set for considerably over 200. Several scientific bodies, including the Institution of Electrical Engineers, were represented. The Chairman, in proposing the toast of the guest, recalled the early history of the electricity undertaking, which was originally a very small affair under the wing of the gas department. Mr. Chamen promptly realised the desirability of forming the electricity undertaking into a distinct department, and since the separation had been accomplished it had developed by leaps and bounds. Although their late chief engineer did come from south of the Tweed, the credentials with which he came gained the confidence of the committee, and he immediately justified this confidence by formulating a scheme for a large power station at Port Dundas, another power station being opened shortly afterwards at St. Andrew's Cross. The result was that the annual output had increased from some 26,000 to 17,000,000 units, and the revenue from £3C,000 to £180,000. He (the speaker) had never known an official who managed to get along as Mr. Chamen had done—he pleased the contractors, the Corporation, and the consumers, and in his presence difficulties disappeared. Mr. Thomas Wright, chairman of the Electrical Contractors' Association, supported the toast, which was received with acclamation. Mr. Chamen, in returning thanks, said that the friendly relations which had always existed between him and the staff were due to a very simple circumstance. He explained, amid laughter, that whenever any problem arose he had called in his assistants, who all expressed their ideas, and then he said what he thought should be done, which was done, and that was all. It had given him the greatest pleasure to see that Mr. Lackie was to take his place as chief engineer, with Mr. Page as chief assistant. He might add that a great deal of rubbish had been talked about Englishmen not being liked in Scotland; his experience had been that the alleged prejudice was a myth.

**Electrification of Trunk Lines.**—An illustrated lecture on the "Application of Electricity to Heavy-Freight and Trunk-Line Railways" was recently delivered by Mr. J. H. Hallberg before the Electrical Engineering Society of Columbia, and an account of same appears in the *Electrical Review* of New York. The lecturer described in detail all electric systems which have been proposed and tried for trunk-line service, and a number of lantern slides illustrating the 15,000-volt single-phase railway developments carried on by the Oerlikon Electric Company, of Zürich, Switzerland, under the direction of Mr. Emil Huber, were the subject of an interesting description and discussion. After describing the Oerlikon system, the electrical equipment for the New York Central Railroad (now being manufactured by the General Electric Company), and the Siemens and Halske locomotive used for the high-speed electric railway tests between Marienfelde and Zossen, an interesting discussion ensued upon the single-phase to polyphase electric railway system lately invented by the lecturer. The important feature of this system is that it is possible to build very powerful locomotives which can be operated with only one contact wire delivering high-voltage single-phase current to the locomotive. The current is converted on the locomotive by means of a motor-generator set into polyphase currents suitable for the polyphase induction motors, which are mounted on the driving axles. As all generating and transforming apparatus are of the alternating-current type, no commutators are required, and the use of induction motors on the locomotive eliminates altogether the use of commutators for any of the main generating or driving machines for this system. Subsequently the various forms of construction for overhead contact wires for high-speed trunk-line railways were considered, and the general opinion was that it would be preferable to make contact on the top of the contact wire, as suggested by Mr. Huber, of the Oerlikon Company, instead of using the ordinary catenary suspension, which makes it necessary to collect current from the underside of the contact wire. The lecturer agreed with Mr. C. O. Mailloux and Mr. Damon in that nothing less than 15,000 volts should be used for heavy trunk-line traction, and that the use of more than one wire for each track would be prohibitive. Mr. Hallberg also commented favourably upon Mr. Mailloux's suggestion to generate current at about 15,000 volts, which could be distributed directly to the contact wire wherever necessary, instead of generating current at a low voltage and then stepping up to a very high voltage for the transmission lines and again reducing the pressure at sub-stations for the contact wire. Where large amounts of power are generated, as for a large trunk-line railway system, it would perhaps be more economical to generate and distribute directly to the contact wire through high-potential transmission lines without the use of sub-stations.

**Grinding of High-Speed Commutators** — An article on this subject appears in the *Electrical World* of New York from the pen of Mr. O. H. Crossen. The author points out that an objection raised against the use of rotary converters on 60-cycle alternating-current systems is based on the troubles encountered at the commutator. While the design of the commutator for a low-voltage 25 cycle converter is comparatively free from difficulty, the problem becomes more complex with increase of either the frequency or the E.M.F. For very high frequencies and voltages the designer is forced to use an extremely large number of commutator segments, or to accept a high difference of potential between adjacent segments; to use very thin segments or to resort to high peripheral speeds. It is evident that any of these extremes would prove detrimental to the sparkless operation of the commutator, and with 60 cycle rotary converters for railway work a compromise design must be adopted, a large number of thin segments being used upon a commutator having a high peripheral speed. Even with a commutator of the best construction, sparkless performance will not be obtained unless the bearing surface of the mica and segments be kept perfectly true. Any slight roughness of the surface, due to difference in height of the mica and the segments, will cause under the brush a spark which will burn the segments and thus increase the roughness, so that the effect is cumulative. Continued operation of a roughened surface will soon result in the necessity for the use of a turning tool to prevent the sparking. The most common method for smoothing a commutator involves the frequent use of sand-paper. The author believes this method to be inadequate, since it merely postpones the trouble for a day or two at the most, and it causes the rapid wearing away of the commutator. Experience indicates that it is impossible to obtain good results from the use of sand-paper upon a commutator having a peripheral velocity as high as 4,600ft. per minute. Excellent results have been obtained, however, by using the brushes themselves for grinding the commutator. For this purpose the machine should be driven by some external means, as, for

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example, by the small starting motor on its shaft, and its field circuit should be open, so that no E.M.F. is generated at the commutator. A thin film of light engine oil should then be applied to the commutator with a cloth. Within from three to five minutes the surface of the commutator will be ground smooth, due to the cutting of the brushes. The grinding being completed, the oil should be removed, and a little gasoline applied with a cloth to thoroughly clean the commutator and brushes. Care should be exercised to remove all oil from the underside of the brushes, for any oil which finds its way to the commutator during operation is liable to become carbonised and cause trouble. Mr. Crossen states that commutators may be kept in practically perfect condition if they are ground in this manner whenever sparking begins to appear. Some commutators will require this treatment after a run of 20 hours, but with others the process need not be so frequent.

**Rare Earths in Electric Illuminants.**—A paper was recently read before the Engineers' Society of Western Pennsylvania, by Mr. M. C. Beebe, upon "The Use of Rare Earths in Electric Illuminants." The author commenced by discussing the wide field for a filament that would supersede the carbon type in both arc and incandescent lamps, for though carbon is practically infusible, the temperature at which it operates in the incandescent lamp causes vaporisation. He then described the properties of the various rare earths, with special reference to a combination of zirconium and yttria earths. Experiments indicate that the yttria earths of the greatest atomic weight give the most satisfactory result in glowers. Further on Mr. Beebe dealt with the possibilities of self-starting filaments. Many oxides will conduct at room temperature. A mixture of iron and tin oxides, about 70 iron to 30 tin, will start without preliminary heating and withstands rather a high temperature. There are many other similar combinations, likewise other possibilities exist; such as carbides, silicides and borides, operated either in vacuum or gases. A Nernst glower may be made to conduct current at low temperatures by running it for a short time in a rarefied atmosphere containing a carbon gas. If to a globe in which a glower is operating in a good vacuum an amount of hydro-carbon gas is admitted sufficient to lower the vacuum even less than a millimetre, the potential difference across the terminals of the glower will decrease rather rapidly, and in the space of a few minutes, or even seconds, the glower will have become a conductor when cold; in other words, self-starting. The author then detailed an experiment in support of this theory. A glower was mounted in a glass bulb and in the axis of a carbon filament of a helical shape. The bulb was exhausted well and sealed off. The carbon filament was used four or five times to start the glower, alternating current being employed. After the glower had run a few hours it was noted that it was changing colour at its terminals. The discoloration gradually crept toward the centre, and after about 24 hours the glower could then be started without preliminary heating. Apparently, enough of the carbon filament was oxidised during the short time it was in use to give a slight quantity of free carbon monoxide in the bulb, the source of oxygen being the glower itself. It is uncertain whether this gas was effective in reducing some of the glower material to its metallic form, or whether a conducting carbide was formed by the action of the carbon gas upon the glower materials. The author prefers the former reason, because it is noticeable that the darkened portion at the negative end of direct-current glowers is of higher conductivity than the glower proper, and it seems quite likely that this deposit is a metal separated out by electrolytic action. Metallic zirconium, for example, withstands very high temperatures in the open air without oxidising, and its melting and vaporising points where air is excluded are doubtless very high. The author concludes with the statement that there is a broad electrical field still open for the rare earths, and considers them well worthy of further research.

**Electrolytic Dissociation.**—A summary of Mr. Louis Kahlenberg's recent investigations bearing on the theory of electrolytic dissociation appears in the *Journal* of the Chemical Society. The author made experimental observations in connection with the properties of aqueous and non-aqueous solutions, and the results lead him to the conclusion that the theories of solution and electrolytic association are untenable. He remarks that no general agreement between the values of electrolytic dissociation as calculated from the conductivity, and from the vapour pressure, boiling point, or freezing point, has ever been established. Whereas Arrhenius's theory requires that the molecular conductivity shall always increase with dilution, cases are known where it diminishes or remains practically constant. The Nernst-Thomson rule, which ascribes the cause of dissociation to the high specific inductive capacity of the solvent, is not confirmed by later experiments. The additive properties of solutions of electrolytes, which are frequently regarded as evidence in favour of the dissociation theory, really form no argument, for in the case of pure liquids additive relationships are known to exist—for example, in the case of molecular volume and of molecular refractive power. The theory refers the colours of solutions, say, of copper, nickel, and cobalt salts, to the ions, but non-conducting benzene solutions of the oleates of these metals are also blue, green, and red respectively, and the red cobalt solution turns blue on heating, just like the aqueous solutions. Instantaneous reactions cannot be ascribed to ions, for non-conducting benzene solutions of hydrochloric acid and of copper oleate precipitate copper chloride practically instantaneously. The behaviour of acids towards metals in non-aqueous solutions is not in accord with the assumption that the substances owe their characteristic properties to hydrogen ions, for non-conducting solutions of trichloroacetic acid in allylthiocarbimide attack dry magnesium rapidly and decompose the dry alkali carbonates. Thermal data offer difficulties also, and the fact that Ostwald's dilution law holds good for certain organic acids in aqueous solutions is not of general significance. The essential electrolytes do not fit in with the law of mass action in aqueous solution, and in non-aqueous solvents it has yet to be shown that the mass action law is applicable. These and other facts lead the author to conclude that Arrhenius's dissociation theory is useless and misleading. An acceptable theory of solution must not differentiate between the processes of solution and chemical action. A careful consideration of facts shows that these are "identical in character, and chemical compounds are merely the cleavage pieces of solutions placed under special stress or duress represented by the so-called purifying processes." The process of solution thus represents the general case of interaction of substances, union resulting when the specific attraction between them is, under the existing conditions, sufficient to cause a fusion or blending of their masses. In the further investigation of solutions, the most concentrated should receive first consideration, the dilute solutions only appearing as limiting cases. By means of vapour pressure, freezing point, and conductivity measurements carried out systematically on these lines, it should be possible to elaborate a theory of solutions on the basis of chemical affinity acting between solvent and solute.

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## BRITISH-MADE TELEPHONES.

### Visit to the General Electric Company's Salford Works.

A considerable amount of correspondence has appeared in our columns this year on the question of British-made telephones, and we have noticed that this correspondence has spread to the daily Press. As is usual in all telephone discussions, the relative merits of imported telephones and those manufactured in this country have not been compared at normal temperature. We are not concerned with the trade interests involved, but wish in this article to give a fair idea of the state of development to which one English firm has brought the manufacture of telephones. The subject is one which borders on the fiscal question, as the Free Trade policy of the country, combined with other considerations, hampers the English manufacturer. We do not refer in this respect to the cheaper grades of telephones used so largely for domestic purposes, or to those instruments employed in offices and factories for interconnection between the different departments. It is in the manufacture of the highest class of instruments and of the exchange apparatus used in public switch-rooms that the English maker has been handicapped. For instance, until

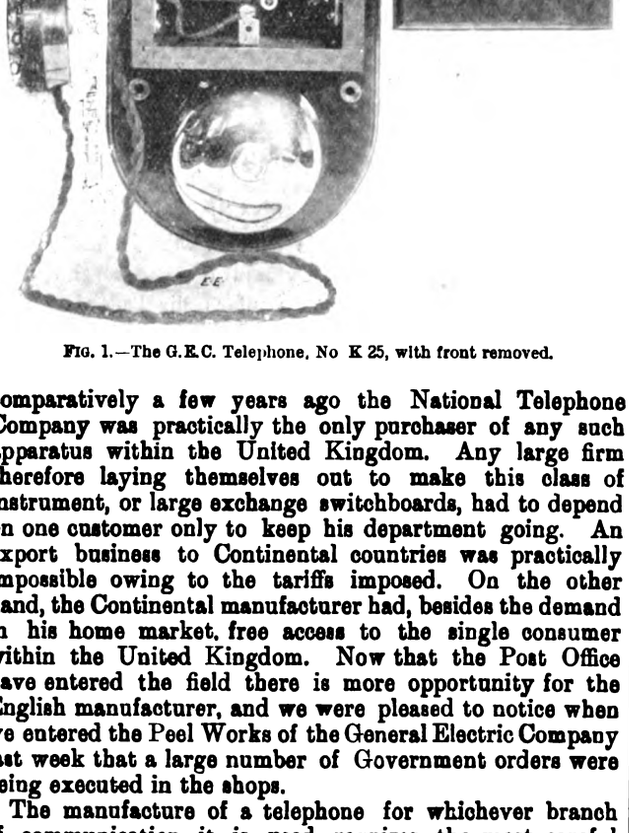

FIG. 1.—The G.E.C. Telephone, No K 25, with front removed.

comparatively a few years ago the National Telephone Company was practically the only purchaser of any such apparatus within the United Kingdom. Any large firm therefore laying themselves out to make this class of instrument, or large exchange switchboards, had to depend on one customer only to keep his department going. An export business to Continental countries was practically impossible owing to the tariffs imposed. On the other hand, the Continental manufacturer had, besides the demand in his home market, free access to the single consumer within the United Kingdom. Now that the Post Office have entered the field there is more opportunity for the English manufacturer, and we were pleased to notice when we entered the Peel Works of the General Electric Company last week that a large number of Government orders were being executed in the shops.

The manufacture of a telephone for whichever branch of communication it is used requires the most careful design, and the detail work involved surpasses that in any other branch in electrical engineering. Coupled with the need of careful design to procure satisfactory working, there is also the question that the instruments have to be produced at rates which will allow of them competing with the manufacturer in other countries where labour is cheaper. This fact gave special interest to the inspection we made of the above works, and we noted with pleasure the numerous labour-saving devices and special tools which have been introduced into the manufacturing process. The number of instruments actually going through the shops was a striking proof that these labour-saving devices and automatic tools have enabled the company to successfully compete on commercial lines in the manufacture of telephones and accessory apparatus. Thus the average output for this the largest department of the Peel Works for the last three years has been as follows: telephone apparatus, 32,500; electric bells, 91,000; electrical indicators, 17,800; switches, 15,000; telegraphic apparatus, 11,250: telephone annunciators and small switchboards, 510; large switchboards, 115. Large as these figures are, the present year promises to show a much greater turnover than the average for the past three years. Thus we saw in course of manufacture for the Post Office a series of instruments forming part of orders for 1,200 central battery type of wall telephones, 5,000 extension magneto bells, and 10,000 Bell receivers. Out of the 1,750 hands now employed at the works, about 1,100 are engaged exclusively in the telephone and telegraph departments. The growth of demand has rendered it necessary to extend the space for

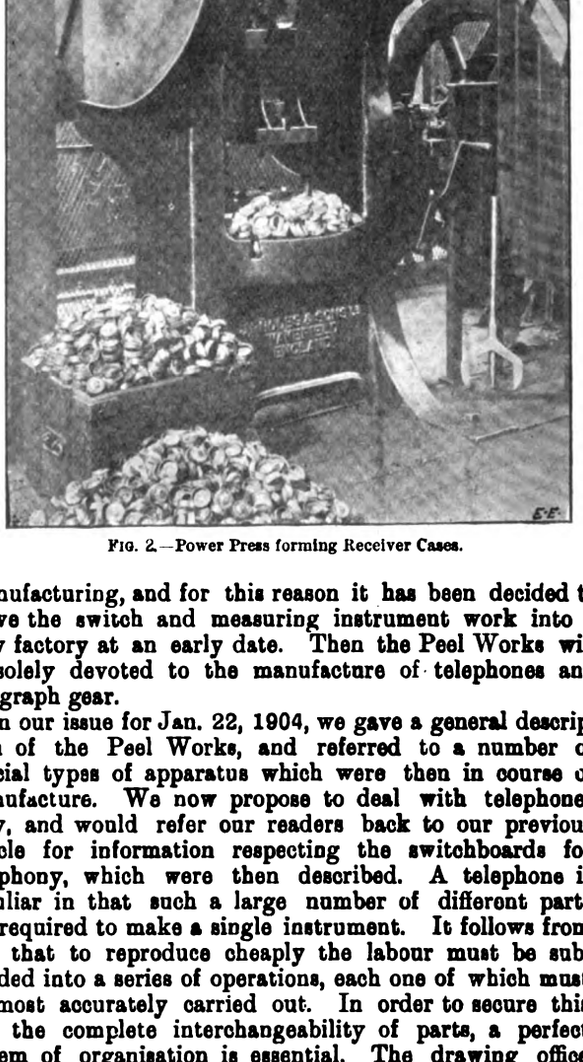

FIG. 2.—Power Press forming Receiver Cases.

manufacturing, and for this reason it has been decided to move the switch and measuring instrument work into a new factory at an early date. Then the Peel Works will be solely devoted to the manufacture of telephones and telegraph gear.

In our issue for Jan. 22, 1904, we gave a general description of the Peel Works, and referred to a number of special types of apparatus which were then in course of manufacture. We now propose to deal with telephones only, and would refer our readers back to our previous article for information respecting the switchboards for telephony, which were then described. A telephone is peculiar in that such a large number of different parts are required to make a single instrument. It follows from this that to reproduce cheaply the labour must be subdivided into a series of operations, each one of which must be most accurately carried out. In order to secure this and the complete interchangeability of parts, a perfect system of organisation is essential. The drawing office department holds the key of the whole position in this respect. We had an opportunity of inspecting a number of working drawings, and were pleased to note that every detail of any instrument is drawn out and dimensioned in a way which affords an easy means of locating any incipient

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errors. The groups of detailed parts required to build up each element of the complete telephone are kept together, and a special system of numbering adopted. By means of this the parts are easily identified in the store where they

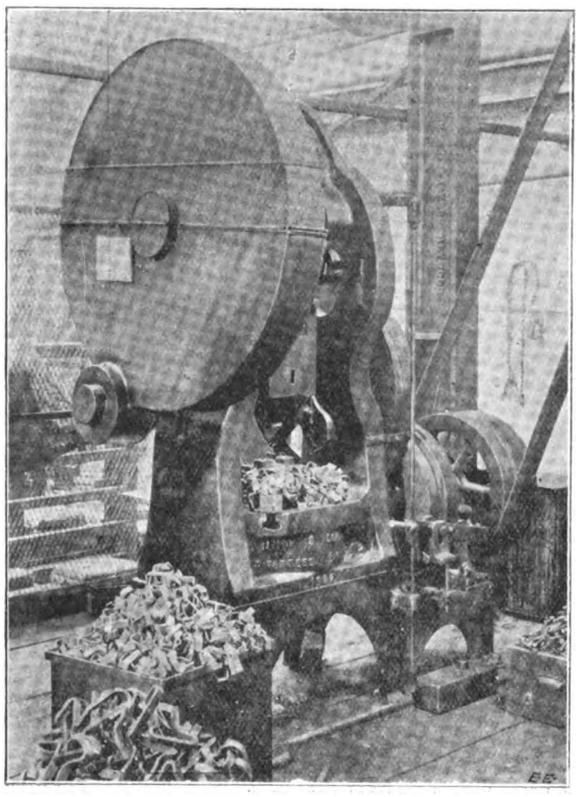

FIG. 3.—Power Press bending Magnets for Telephones.

are collected as manufactured, and from which they are issued to the assembling departments.

We could not attempt in the space at our disposal to describe in detail even a single instrument of one special type, but we propose to draw attention to a few special features in the process of manufacture which struck us as being the outcome of extended experience both of the practical requirements from a telephone and extended experience in the manufacture of the same. The instrument illustrated in Fig. 1 is the K 25 type, which has been produced this year for use in factories and offices. In our illustration we show this instrument with the front cover removed. It will be seen that there are no hinge connections whatever with this instrument, and that the cover is secured by the two screws. These screws also serve to make definite metallic connections with the receiver. The screws are not loose, but held in position by the spring connections to the receiver. The whole of the moving connections inside this telephone are arranged so as to give a good rubbing contact every time the receiver is taken off the hook or replaced. The induction coil used in the instrument is of the Post

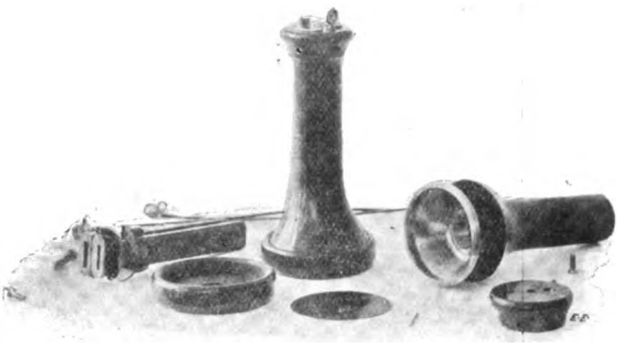

FIG. 5.—Standard Bell Receiver and Parts.

Office pattern, having a resistance of one ohm in the primary and 25 ohms in the secondary. It must be remembered in this connection that the instrument is one which is intended to meet a very large demand by being sold at a low price. The bell has a 25-ohm winding, and the receiver, which is of the watch type, has coils of 30 ohms resistance.

This watch type of receiver is worthy of special mention. We show in Fig. 2 one of the power presses in which the receiver cases are made. These cases are pressed out o sheet brass by means of a series of dies, which dish the flat sheet and mould it into the final shape by a series of interesting operations. The case is given an exterior lip, which is then threaded in a machine so as to receive the ebonite ear-piece. Some 4,000 of these receivers were passing through the power pressing department at the time of our visit. The finished product is a good example of what can be done by the department, as the accuracy obtained is excellent. In the same department we also

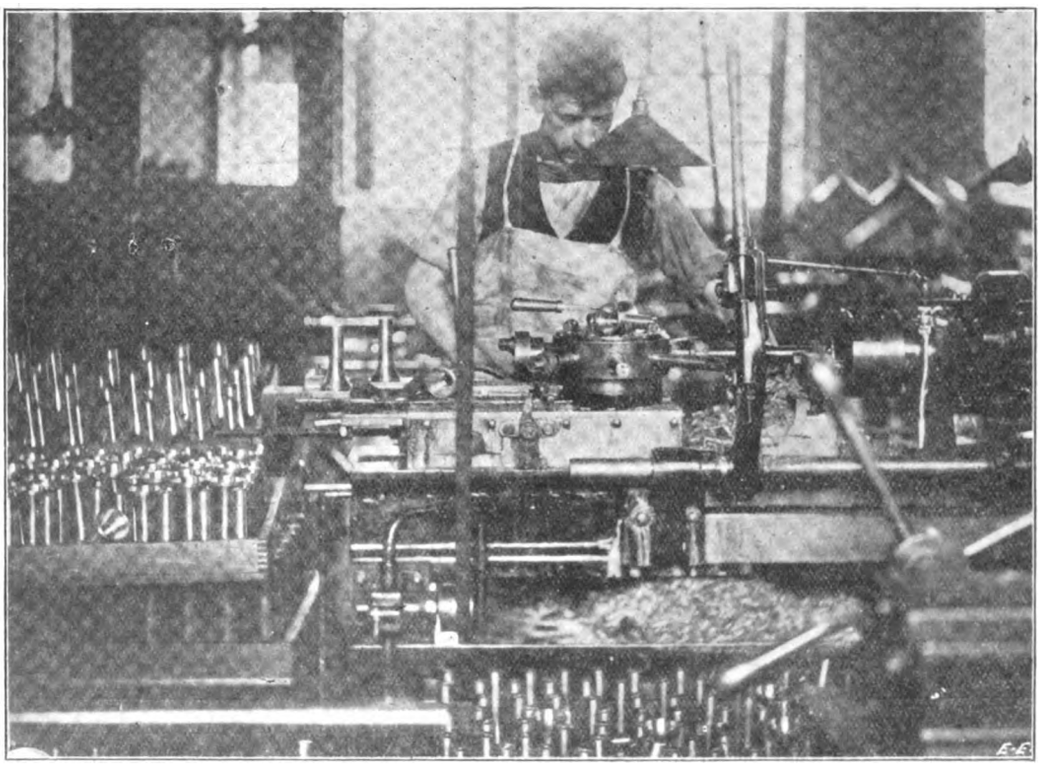

FIG. 4.—Turret Lathe machining the Brass Cases for Standard Bell Receivers.

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saw a power press bending the magnets required for the various types of telephones. Fig. 3 is a view of this press, the magnets which are seen on the floor being those required for the table type of magneto instrument. With this type the magnets form the framework of the instrument.

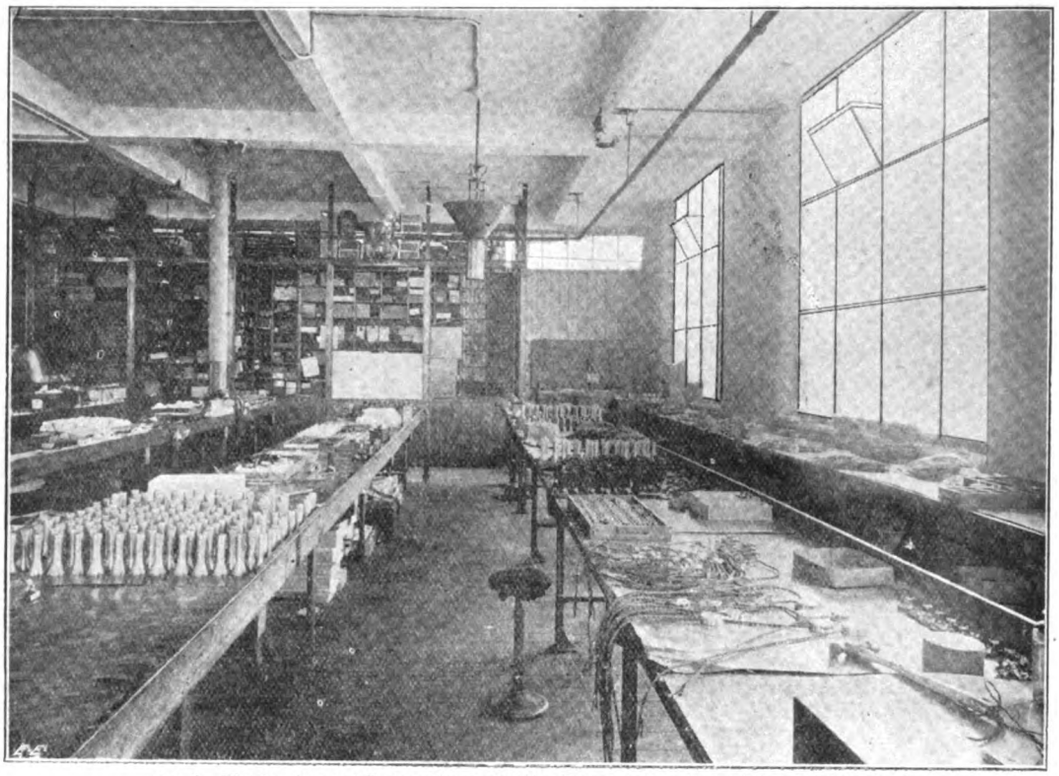

FIG. 6.—The Receiver and Transmitter Assembling Department, with Sub-Stores in background.

Another standard instrument which is being turned out in very large quantities is the Bell type of receiver. In the early days of telephony ebonite cases were used for these receivers, but the ebonite has been found unsuitable in view of the rough usage to which the receivers are sometimes subjected. This is got over by using a brass case as the foundation of the instrument to give the necessary mechanical strength. The machining of these brass cases is now carried out on a special turret lathe with tools which have been designed for the purpose. In Fig. 4 this lathe is shown at work, but to properly appreciate the various operations a full description of each tool would be needed. The brass casting is provided with an extension piece which is gripped in the chuck of the lathe. A number of tools are then brought successively into operation, which bore, turn, and screw the inside of the case. The outside is machined by a special tool with a cutting edge the full length of the case. The outside thread on which the ebonite ear-piece is screwed is then formed, and, lastly, the case is divided from the extension piece by which it has been held. The net result is that the brass casting is finished all over accurately to gauge in an exceedingly short space of time. In Fig. 5 we show an enlarged view of this case, and also of the numerous other

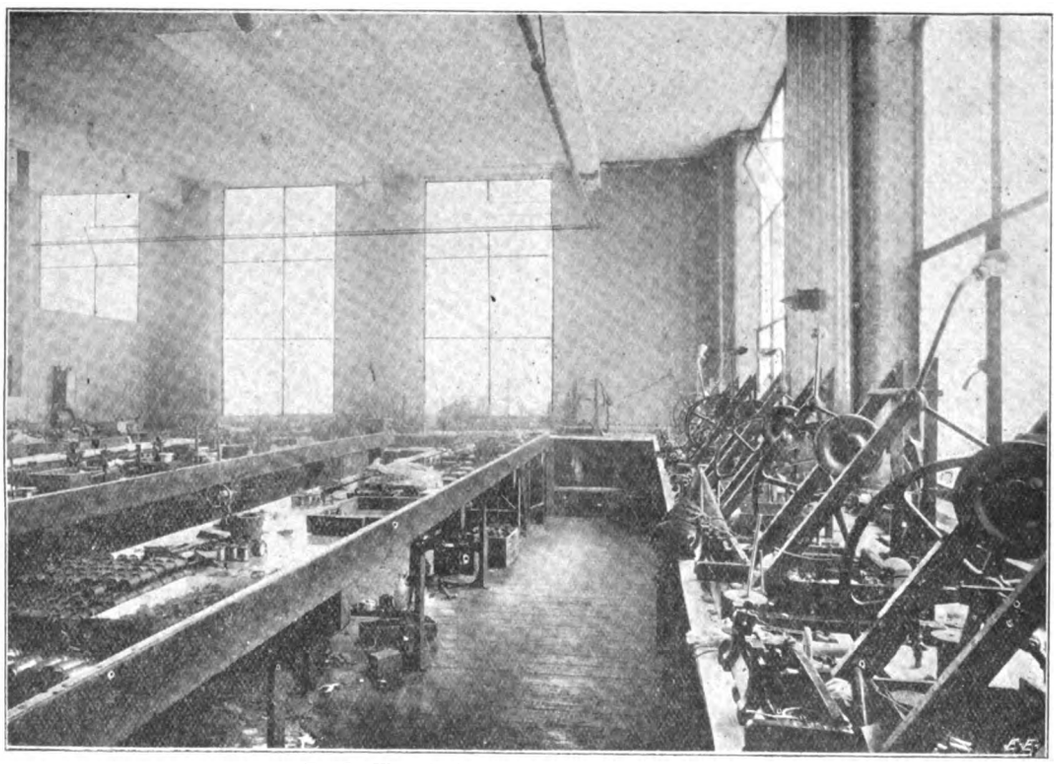

FIG. 7.—View of a Corner in the Coil-Winding Department.

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parts which go to make up a complete Bell telephone receiver. The ebonite sheath for the case is also shown. The ebonite from which the ear-piece is made is of special high-grade material, which is exceedingly tough and able to withstand

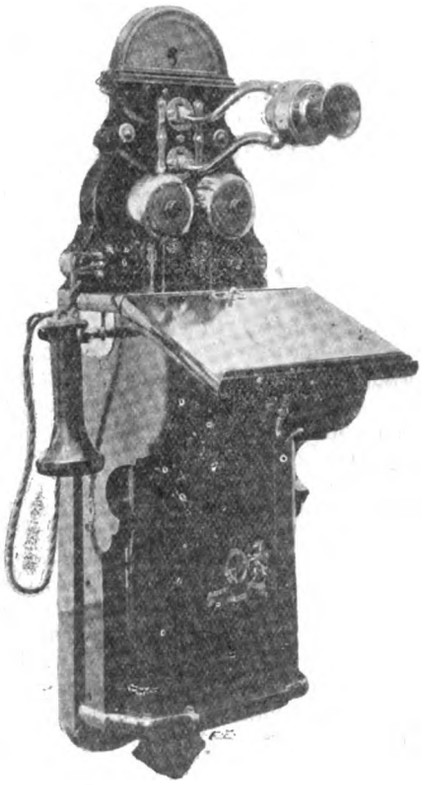

FIG. 8.—Central Battery Type of Wall Telephone made for the Post Office.

rough treatment. As mentioned above, some 10,000 of these receivers were going through the shops at the time of our visit.

In Fig. 6 a view is given of the shop in which the telephone transmitters and receivers are put together. At the back of the department there is to be seen a sub-store from which the materials are issued. In connection with this issuing of parts the firm have an interesting system which facilitates the counting of the materials. A large number of trays are used, each designed to hold in a single layer a definite number of the particular parts in question. The trays thus serve not only as a means of conveniently storing the parts, but also as a check on the number received from the workshop or issued to the assembling department. The workmen in the latter thus receive each day a certain number of trays, the contents of which can be ascertained at a glance. The system affords also a ready check on the operatives, as any damaged material could not be thrown to waste without the fact being noted when the trays are returned to the store after any process has been completed.

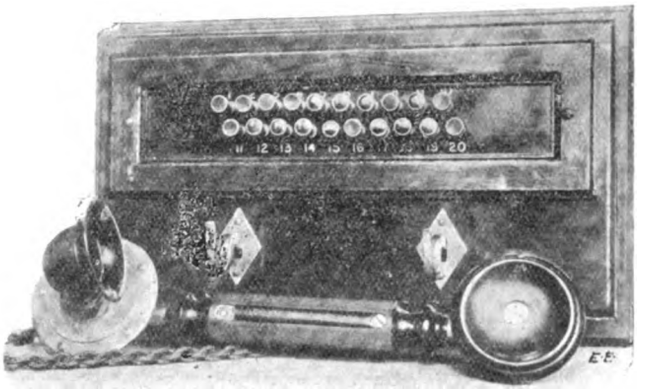

FIG. 9.—The G.E.C. Self-Restoring Intercommunication Telephone.

In Fig. 7 a view of the coil-winding shop is given. The weekly output from this department is in the region of 10,000 coils, all of which are tested both for insulation resistance and circuit resistance before they are passed from the department into the stores. Even these tests are supplemented by others with the same object when the coils have been placed in the completed instrument. An adjoining department which was visited is devoted entirely to the making and braiding of telephone cords.

Perhaps the highest-grade instrument which was going through the shop at the time of our visit was the Post Office central battery signalling wall set, which we illustrate in Fig. 8. The instrument is so designed that a magneto call can be added if desired. An interesting feature in this instrument is the movable transmitter, the vertical height of which can be varied by 6in. As will be seen, the transmitter is carried by two parallel links placed vertically one above the other, and hinged at the one end to the transmitter and at the other to the telephone case. These

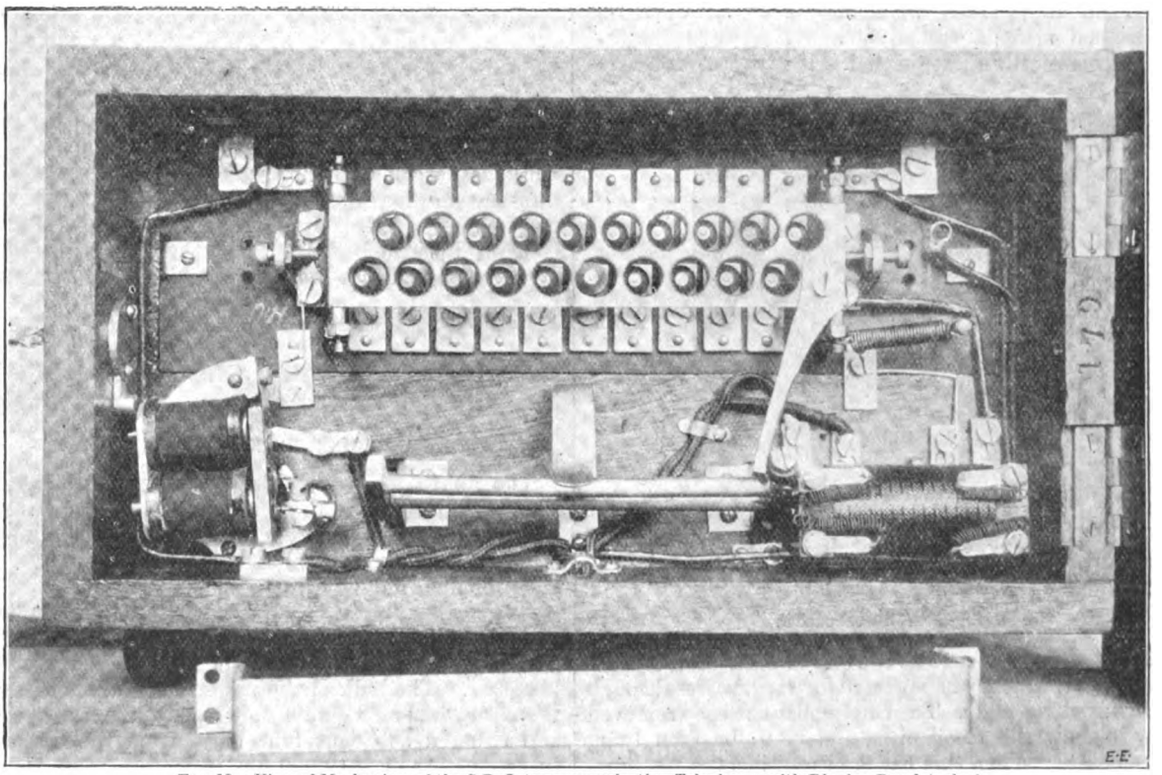

FIG. 10.—View of Mechanism of the S.R. Intercommunication Telephone, with Ringing Bar detached.

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links, which allow of the transmitter being moved up and down, also serve as the connections respectively to and from the same. The finish of this instrument is remarkable, both the metal-work and the wood case showing excellent workmanship.

The self-replacing intercommunication telephone which we illustrate in Figs. 9 and 10 is not new, but we believe that the ingenious self-replacing device is not well known amongst electrical engineers. In Fig. 10 an illustration of this is given which will enable the details to be followed.

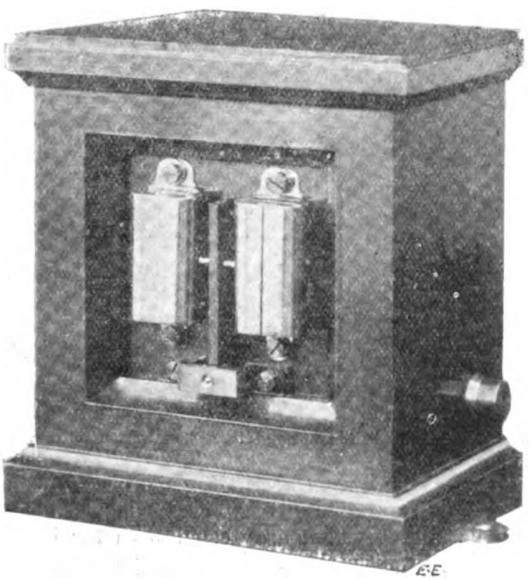

FIG. 11.—Front View of Visual Sounder for Post Office.

The feature of the instrument is the push-button line selector. When one of the buttons seen in Fig. 9 is pressed in, it connects the battery to the line for ringing purposes. When the pressure on the button is removed it does not regain its original position, but, after disconnecting the battery, keeps the instrument connected with the line wanted. When the conversation is completed and the hand combination telephone replaced, the button is released, and all is ready for a new call. If, when one call has been made, a second button is pressed, the first line is automatically disconnected. It will be seen from

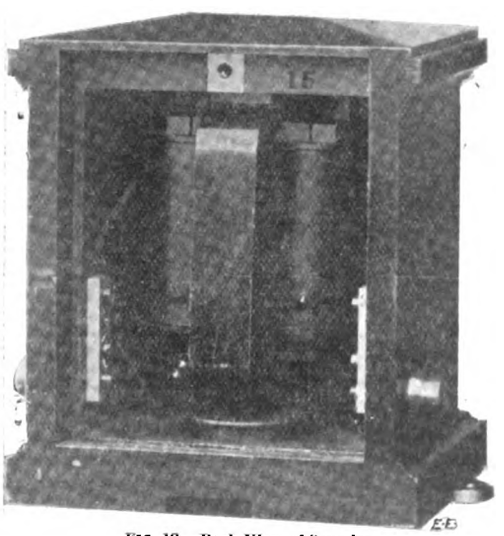

FIG. 12.—Back View of Sounder.

Fig. 10 that there is a cone at the end of each of the push-button spindles, which, when pressed forward, passes through a hole in a rocking plate. The ringing bar has been removed in order to show the mechanism, and is to be seen lying under the case. When this bar is in position, the platinum points at the front of the cone make connnection with it for ringing. On the return stroke of the push button the under side of the cone engages of the face of the rocking plate, and connection is made for speaking. The holes in this plate are countersunk from the back, so that if a second push button is pressed it moves the plate sufficiently to let the edge of the first cone slide down the countersunk surface and break contact. The long finger secured from one end of the rocking plate moves the same, and disconnects the line when the telephone is again hung on the hooks. With this arrangement, unless there is carelessness in pressing two buttons simultaneously, it is impossible to get more than one connection made at the same time. While this does not necessarily mean secrecy, it goes farther in that direction than the ordinary type of sliding contact switch, and it gives at the same time an automatic clearing at the end of each message.

Before leaving the references to special instruments, we would refer briefly to the new telegraph sounder (Fig. 11), which we saw both completed and in course of manufacture for the General Post Office. The advantage of the new type is that it can be read either by sight or sound, and it can be worked on most lines without the interposition of a relay. The resistance of the coils of this instrument is as high as 4,500 ohms. In the same department we notice a new indicator for the same department for showing the exact instant at which an engaged trunk line is set free. The indicator depended for its signalling on an electro-magnetic holding up a disc. Here, again, the details in workmanship were a credit to the department in which the instrument was being made.

We have not referred in detail to a large number of the departments visited, nor even to the woodworking shops, in which the seasoned woods of various kinds are handled. It suffices, perhaps, to say that in this, as elsewhere in the factory, machines for the reproduction of parts in quantities are extensively employed. All the holes are drilled in the wood cases and other parts of the telephone before the wood is polished and delivered to the assembling departments. This being done accurately with jigs and templates, there is little margin for personal error when the instruments are being put together. Before any instrument however small is allowed to leave the works it is subjected to two tests, first by the foreman under whose supervision it was put together, and then in the independent testing department. A casual inspection of this latter department would leave some doubt as to the mental condition of the staff.

It remains to be said that the General Electric Company first commenced to make telephones in 1888, and the department has grown year by year since then. The manufacturing is carried out under the supervision of Mr. A. Brooker, as works manager, and his assistant-managers, Mr. A. Trafford and Mr. G. C. Vyle. Mr. P. P. Kipping has taken up the commercial management of the telephone, telegraph, and signalling departments of the company. He and Mr. Brooker kindly showed us the works last week, and our thanks are due to them for the information given above. Last, but by no means least, we must mention Mr. Max Byng, who, as director of the General Electric Company, had the courage to start the department, and has been responsible for its success.

## THE BLAST-FURNACE GAS-POWER PLANT AT THE ILSEDER IRON AND STEEL WORKS.

BY G. HOOGHWINKEL, MIEE, MIME.

The above plant may be considered, perhaps, the first successful installation of its kind on a large and commercial basis. As may be seen from the illustrations, the plant has been designed on a liberal scale, and it has been the writer's good fortune to have been connected with it.

At the time the furnace plant consisted of four furnaces, producing 220 tons of pig iron per diem each, which give off enough gas to supply about 15,000 e.h.p. for outside purposes. The bulk of the power had to be transmitted to the steelworks at Peine belonging to the same company, and situated at about four miles from the Ilseder blast furnaces. As over 12,000 h.p. in motors were required at Peine, a liberal amount of surplus gas had to be provided, and, therefore, the steam-driven blowers were replaced by gas-driven ones. Formerly the steam was supplied by gas fired boilers, but the amount of gas required was found to be about four times as much as when used direct in the gas-engines. The gas-driven blower shown in the illustration is actually installed at the Nieder-Rhine Steelworks,

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and is identical with the two installed at the Ilseder furnaces. These two blowers required about 500 h.p. each. The engine-house, as shown in the illustrations, contains six sets of 1,000 h.p. to 1,200 h.p. each, but there is room for four more.

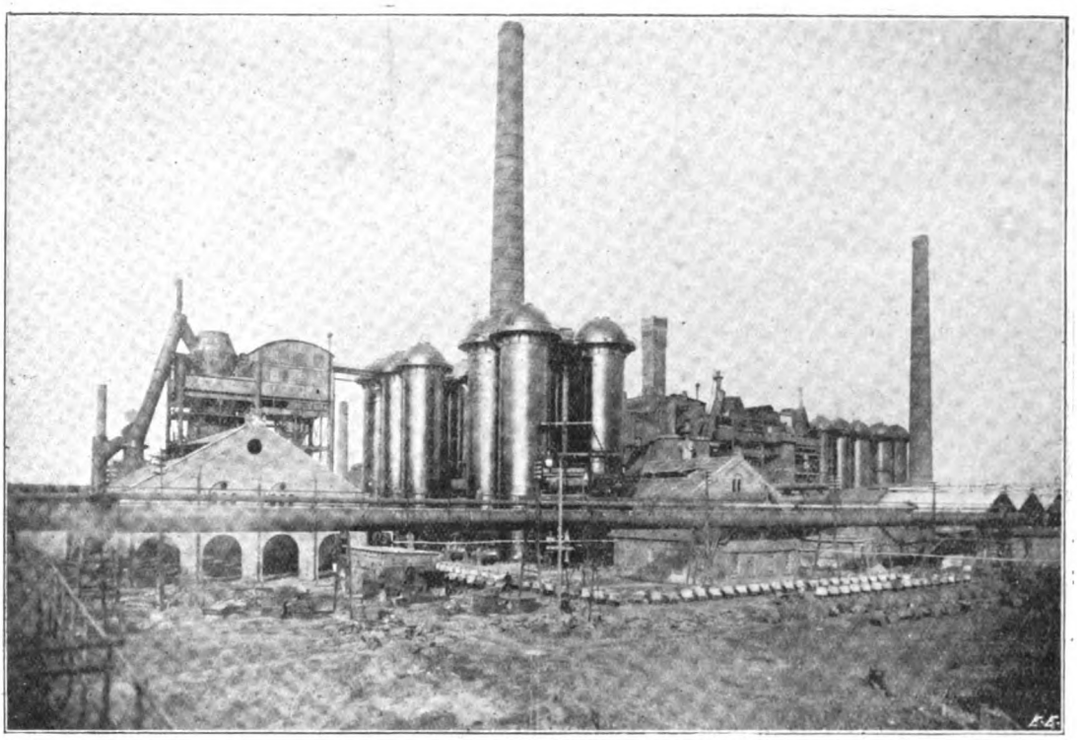

FIG. 1.—The Blast Furnaces at Ilseder (Westphalia).

Before reaching the gas-engines the gas is cleansed and cooled. The Ilseder blast-furnace gas plant being one of the first installations of its kind, the cleaning of the gases has not been carried so far as is now generally being recog-

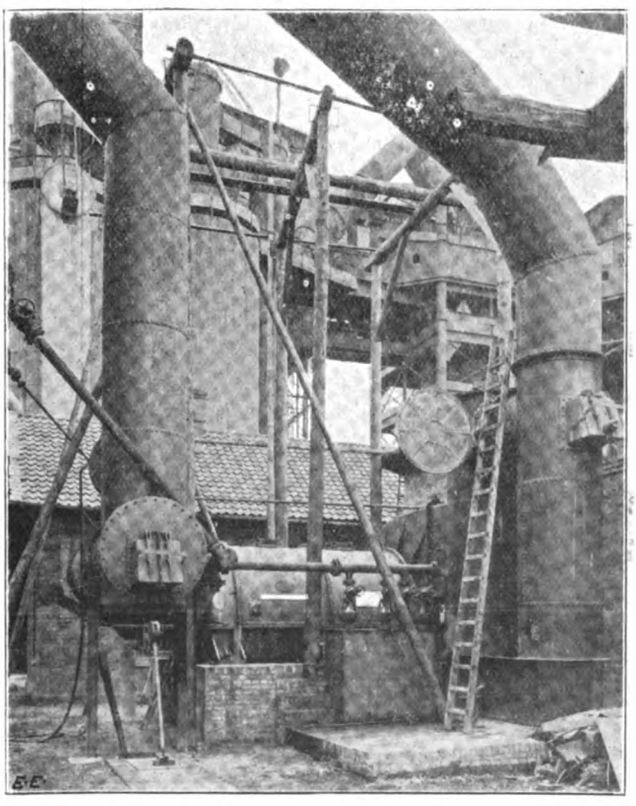

FIG. 2.—The Theisen Gas-Washing Plant at the Ilseder Blast Furnaces.

nised as desirable. That, however, with these imperfectly cleaned gases such good results have been obtained is a proof of the thorough construction of the gas-engines used. The cleaning relies mostly on two rotary washing plants of the Theissen type and a long gas-main. These Theissen exhaust washers consist mainly of a triple-concentric drum revolving at some 300 revolutions, in which the hot gases are thrown against the outside cover, which is continually cooled by trickling water. In this way the gases and the water are efficiently mixed, while at the same time the fan draws the gases from the furnace caps. These washers deal with 25,000 cubic feet of gas per minute, and require only 110 h.p., while the water consumption is about 50 gallons per minute. The relatively small dimensions of the cleaning plant can easily be seen from the photograph. The power station consists of two bays 147ft. by 214ft. long and 56ft. high, spanned by a 25-ton travelling crane.

The gas-engines are of the Oechelhauser type on the two-cycle principle, two separate engines each with one power cylinder driving one dynamo, one on each side. These engines are exceedingly simple in design, although from the photographs this does not show off sufficiently owing to the many rods and separate pump. There are no valves, thus removing the principal cause of trouble of a gas-engine working with blast-furnace gas. The cylinder is open on both sides, another simplifying feature. Of course, the separate pump has the disadvantage of a slightly lower efficiency for the whole engine, as the power to drive it requires about 10 per cent. of the output. However, the total efficiency is only about 3 to 4 per cent. lower than other four-cycle engines, but the increased simplicity is so all-important in blast-furnace works that this disadvantage is not to be regarded at all. These engines are so well balanced in the parts that the coefficient of angular velocity variation is as low as 1/350 with a flywheel of only 25 tons combined with the dynamo rotor. The speed is 125 revolutions. Each engine has its own exhaust carried outside the station, as may be seen from the photograph.

The dynamos are of the flywheel type and of the well-known Siemens design, while the switchboard is a model of roomy and simple construction, as is shown in the photograph of the high-tension switchroom. Some of the power is used at the furnaces for chargers and lifts, cranes and trams, but the bulk of the power is required for their own steelworks and rolling mills, situated at a distance of about four miles from the blast furnaces. This power supply may be divided into three separate classes:

1. The Bessemer steelworks—requiring power for blowers for the converters, mixers, blowers and ventilators, fans for the furnaces, pumps for the hydraulic compressors, casting machines, and other auxiliary machines.

2. The rolling mills—requiring power for the mills, the

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rolling trains or rollers, the hot saw, the shears, the presses, the pumps for the hydraulic compressors.

3. Tools and machines for various purposes—cranes, locomotives, boiler feed pumps, lifts, transmissions, etc.

use continuous-current motors for the mills, rollers, cranes, and Bessemer converters, and alternating-current motors for all the other machinery. The total supply for power purposes was about 12,500 h.p.

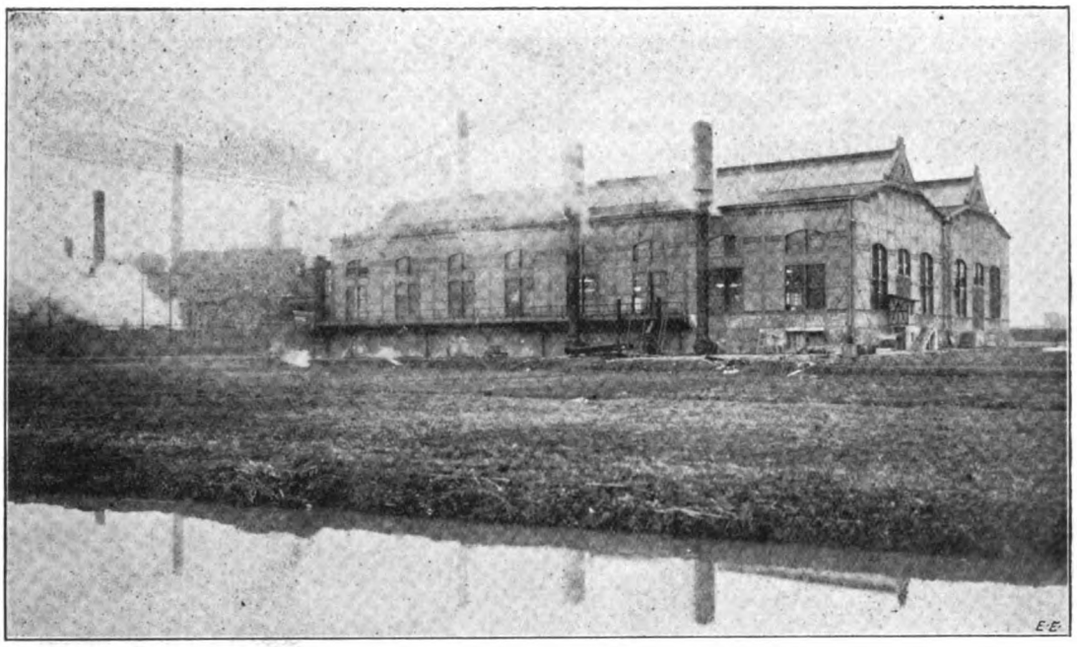

FIG. 3.—Exterior View of Ilseder Power Station, with Gas-Driven Plant.

It was, of course, thought desirable to apply the electric power on the same system as it is transmitted from the power station, at 10,000 volts 50 periods alternating current. Alternating-current motors are preferable on many points, and for nearly all the machines in the steelworks, except those where variable speed and heavy starting efforts are required. We are now, however, going in the right direction to adapt the alternating-current motor even to those requirements, but at the time the installation under review was designed it was decided to

The reason for adopting continuous current for the rolling mills was that, in order to overcome the huge starting efforts when the ingots are introduced in the mill, a heavy flywheel was mounted on the motor shaft. The duty of these flywheels was to give off energy at times of overload, and this can, of course, only be attained by a lowering of the motor speed. If the flywheel is not to have a too heavy weight (owing to the slow speed), speed reductions of 10 to 20 per cent. are required, and this is impossible with alternating-current motors, unless auto-

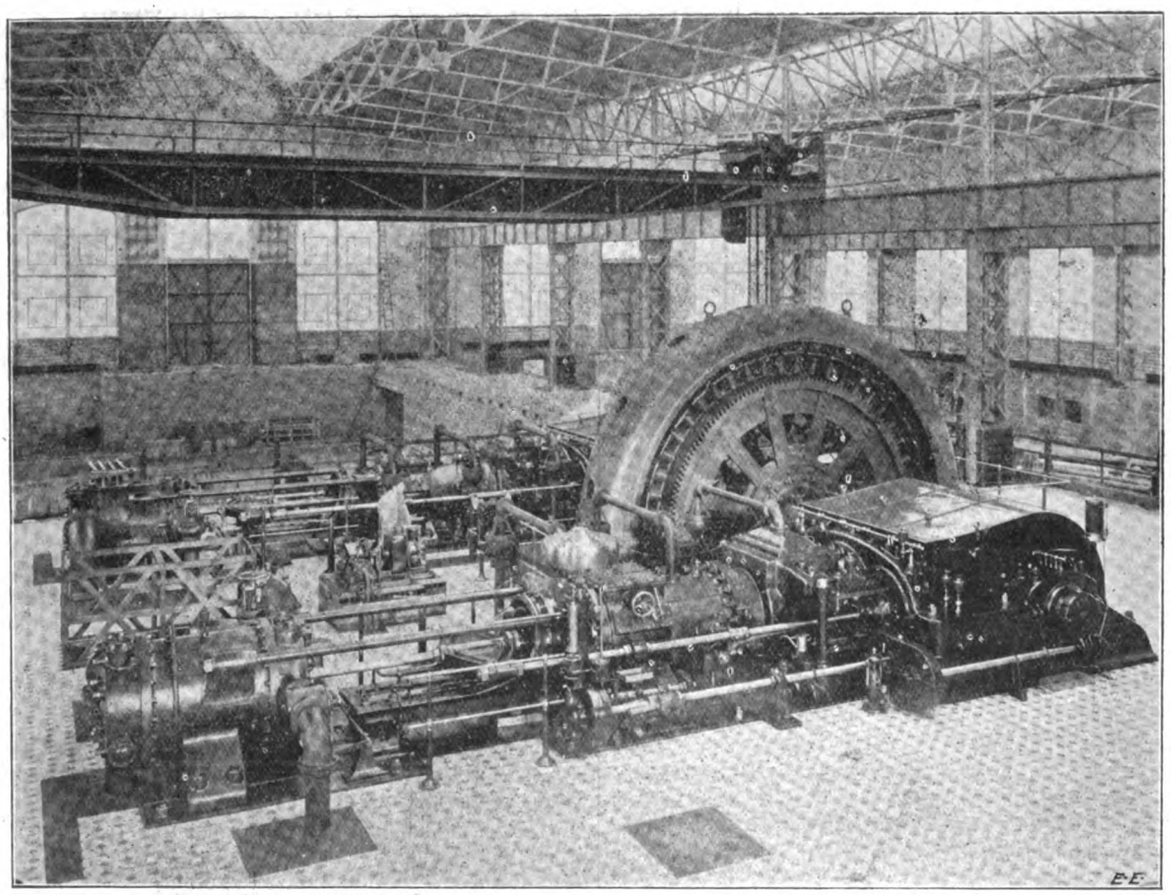

FIG. 4.—Inside of Power Station, showing Oechelhauser 1,000-h.p. 125 revs. Gas-Engine coupled to 10,000-volt Dynamo.

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matic resistances are inserted in the rotor circuit in order to increase the slip. This cannot be calculated beforehand, but must be adjusted on site, which is inconvenient and costly; besides, the resistances have the effect of lowering the efficiency considerably. The smaller and high-speed machines, however, are all driven by alternating-current motors, as the flywheels may be made heavier in proportion to the speed; and these small motors permit a greater slip.

batteries of the sub-stations. An additional advantage of the compound continuous-current motor for rolling mills was that these motors may be regulated for several fundamental speeds, required by the rolling of various materials and sizes, by regulating the shunt for each speed. Alternating-current motors would have required huge resistances in the rotor circuit, which would reduce the torque almost in the same proportion to the speed (20 to 30 per cent.).

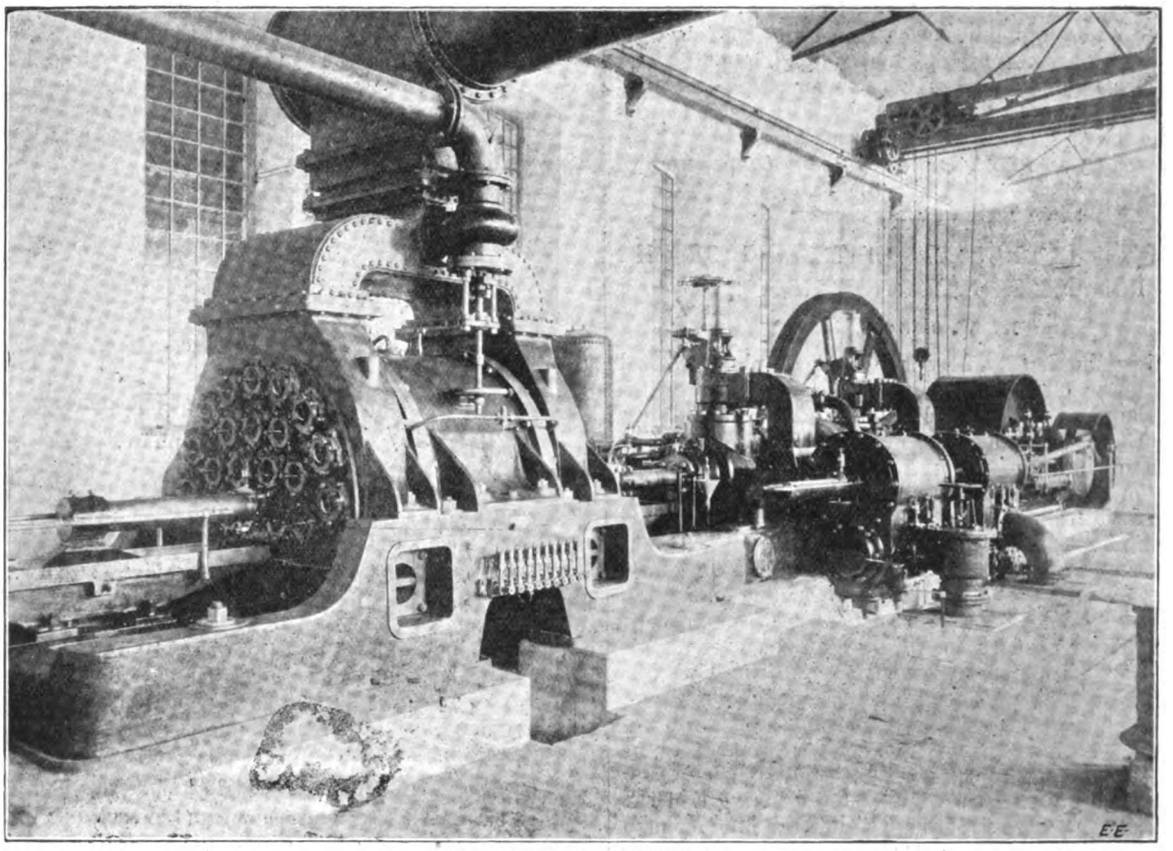

FIG. 5.—Gas-Driven Blowing Engine.

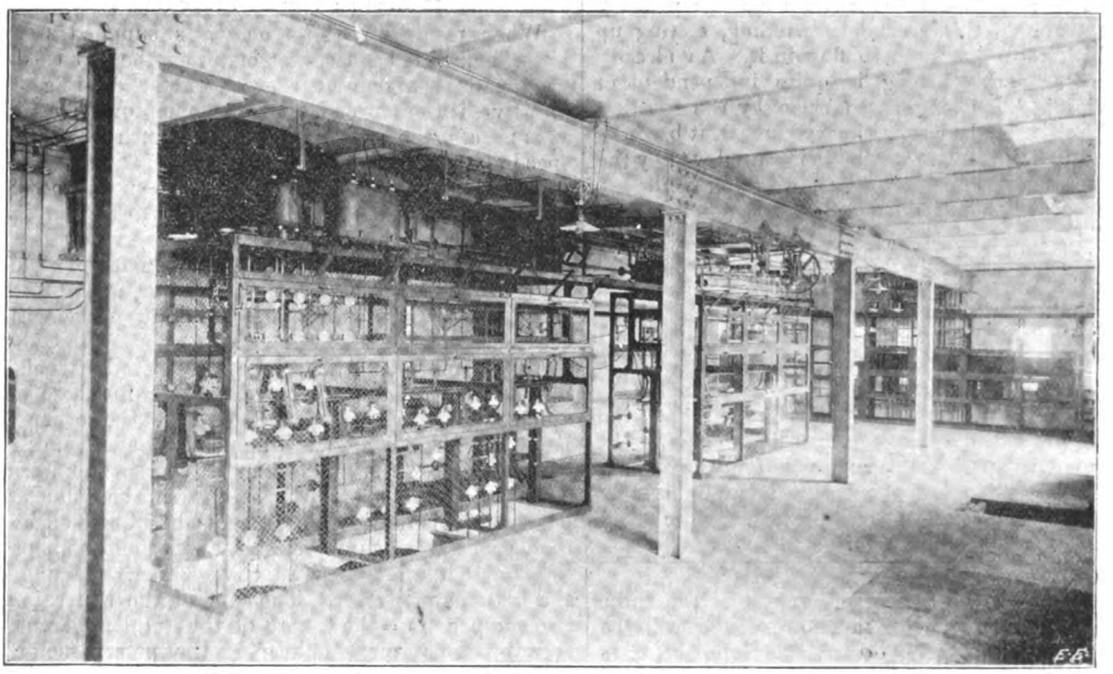

FIG. 6.—The Back of the 10,000-volt Switchboard.

Another disadvantage of the alternating-current motors for the rolling mills are the huge irregularities at the power station which would react on the gas-engines. Some motors require 2,000 h.p. at full load, so the effect may be imagined, and the power station would have had to be much larger. Now the much smaller variations are taken up in the

The high-tension alternating current supplies two sub-stations situated near the centres of supply (*vid* the cogging mills), one containing three 800-kw. rotaries and two 500-kw. transformers (10,000 volts to 500 volts), and a battery of 1,660 ampere-hours capacity; while the other sub-station contains five 800-kw. rotaries, two 800-kw.

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transformers, and a battery of 2,200 ampere-hours capacity. The main conductors to the various shops are laid as cables to avoid short-circuits and a clumsy superstructure, and as a 500-volt supply for power is taken as a standard all conductors are kept out of reach.

The lighting of the shops is taken from the main high-tension three-phase supply, twice transformed down, once in the sub-stations and once in each shop. The offices and dwellings are lighted by continuous current from the sub-stations. The savings introduced by the extensive utilisation of the waste gases from the furnaces at Ilseve, have effected a reduction in production costs of 6s. per ton of pig made.

## NOTES ON THE THEORY AND TESTING OF THE POLYPHASE INDUCTION MOTOR.

BY W. ROGERS.

As an introduction it will not be out of place to deal briefly with the elementary side of this subject, notwithstanding the fact that it is well understood by all readers of this journal. The polyphase induction motor consists of two separate windings—viz., the primary or stator, and the secondary or rotor. The primary winding receives a polyphase current from a source of supply: it is, therefore, strictly speaking, an armature. The secondary winding has no connection with the supply circuit, being magnetised by induction from the primary. Although either the primary or secondary circuits may form the revolving part, it is usual to keep the primary circuit stationary, as it avoids exposing the high-voltage winding to the strains which accompany rotation. When the primary winding, which is made up of coils connected up in groups overlapping each other, is energised by a polyphase current, a rotating magnetic field is set up, which gives rise to a series of alternating E.M.F.'s in the windings. The current supplied to the primary may be divided into two parts: (1) that part representing energy usefully expended or absorbed in heating; (2) the part employed in magnetising, and which is known as the magnetising current. The secondary may be either wound with coils or built up by inserting copper bars in the slots forming the rotor core and connecting the extremities of the parallel conductors together, forming a short-circuited secondary. The magnetic fields set up by the primary current pass through this secondary winding, setting up E.M.F.'s, which cause currents to flow in it. As already stated, this secondary winding is quite independent of the supply circuit, but being acted upon by the rotating magnetic field, generated by the primary current, it becomes the seat of induced currents, rotation being produced by the reaction between these currents and the rotating field.

The no-load speed of an induction motor is equal to the number of alternations of the supply current ÷ number of poles. Should the rotor by any means be made to run at its actual synchronous speed, it would cease to be acted on inductively, and would exert no turning effort. This difference between the no-load speed and the synchronous speed is known as the slip, and is expressed as a percentage of the maximum speed. As the load on a motor is increased the slip also increases, in order that the motor may run with a greater turning effort. In fact, a drop in speed is necessary for developing any torque, and this may be proved quite clearly as follows: The speed of the rotating magnetic field of an induction motor $= \frac{\text{number of alternations of supply}}{\text{number of poles}}$ and may be assumed to be almost constant. If the rotor and the rotating field run at the same speed, they will be stationary with regard to each other; therefore, the lines of force due to the rotating field cannot cut the conductors of the rotor, and so give rise to induced currents in it, which are necessary for a torque It will thus be seen that any increase in the difference in speed of the rotating field and the rotor, caused by load being thrown on, gives rise to an increased torque, and the greater the difference in speed between the field and rotor the greater will be the rate of cutting the field by the rotor, which will result in an increase in the E.M.F.'s set up in it, and thus an increase in the secondary current and torque. For any load thrown on a motor (within the limits of its load) the rotor speed will continue to fall, and the E.M.F.'s induced in the rotor will continue to increase, until the torque delivered is sufficient for the motor to carry that particular load.

The current taken by an induction motor of given output and voltage depends upon the number of phases, power factor, and efficiency, the currents taken by a single, two-phase, or three-phase motor being found by using the following formulæ. The amperes per terminal at line voltage, V, required to develop horse-power, H, in a motor having an apparent efficiency, $\eta$,

$$= \frac{746 \times H}{\eta \times V} \text{ for single-phase.}$$

$$= \frac{746 \times H}{\eta \times V} \times \tfrac{1}{2} \text{ for two-phase.}$$

$$= \frac{746 \times H}{\eta \times V} \times \frac{1}{\sqrt{3}} \text{ for three-phase.}$$

The line current per phase in a three-phase motor

$$= \sqrt{3} \times \text{current in one phase.}$$

Current per phase in any motor

$$= \frac{\text{H.P.} \times 746}{\text{Efficiency} \times \cos\phi \times \text{line volts} \times \text{number of phases}}.$$

The watts input are the same for a single, two, or three phase motor of given output, but the input current depends upon the number of phases.

For example, take the case of a 10-h.p motor, 200 volts, efficiency = ·85 and power factor = ·8. Then true watts = 10 × 746 ÷ ·85 = 8,776, and apparent watts = 8,775 ÷ ·8 = 10,970.

With a single-phase winding line, current

$$= 10{,}970 \div 200 = 54{\cdot}85 \text{ amperes.}$$

With two-phase (four wires), current in each line

$$= 10{,}970 \div (200 \times 2) = 27{\cdot}4 \text{ amperes.}$$

With a three-phase winding, with 200 volts between lines, line current

$$= 10{,}970 \div (200 \times \sqrt{3}) = 31{\cdot}7 \text{ amperes.}$$

As the line current = $\sqrt{3}$ × phase current, then the phase current

$$= 10{,}970 \div (3 \times 200) = 18{\cdot}3 \text{ amperes.}$$

When measuring the true watts supplied to a three-phase motor, if the two-wattmeter method is used it will be found that one of the wattmeter readings will be negative, if the power factor of the motor be less than ·5, as is usually the case when it is run much below its rated speed at reduced voltage.

The true power supplied to a motor = useful power given out on motor shaft + iron, copper, and friction losses. Also apparent power supplied = primary amperes × volts. Power factor = true power ÷ apparent power. The apparent power is always greater than the true power, owing to the fact that the primary currents are not in phase with their E.M.F.'s.

The primary current may be considered as being made up of two currents, one current being in phase with the applied voltage, giving true energy, the other current lagging 90deg. behind the applied voltage, being wattless and giving no energy. The first current is known as the energy component, and the second as the inductive component. This inductive component has a bad effect on the regulation of the supply circuit, and should be kept as low as possible if a motor is to have a large starting torque and high power factor. The sum of the squares of these two components = the square of the total apparent input, and the importance of keeping the power factor of an induction motor as high as possible may be shown in a very simple way. Suppose a motor has a power factor of 90 per cent., then the inductive component of the current

$$= \sqrt{\text{total current}^2 - \text{energy component}^2}$$

$$= \sqrt{100^2 - 90^2} = 43{\cdot}6.$$

That is to say, that with a power factor of 90 per cent., the portion of the current that is lagging 90deg. behind the E.M.F. is equal to 43·6 per cent. of the total current.

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The inductive component in an induction motor depends upon the magnetising current and also upon the magnetic leakage, and in practice it is usual to express the inductive component and the magnetising current as a percentage of the total primary current, magnetic leakage being expressed as a percentage of the magnetic flux due to the primary current. If the magnetising current is 30 per cent. and magnetic leakage is 12 per cent., this will give an inductive component of 42 per cent. of the total primary current, which corresponds nearly to a power factor of 90 per cent.

When an induction motor is running on full load, a low leakage and a high magnetising current will give the same power factor as a high leakage and low magnetising current, but when the motor runs at half load the percentage magnetising current is nearly doubled, while the magnetic leakage is halved. It will, therefore, be seen that it is necessary to have a small magnetising current when a high power factor is required. From what has already been stated above, it follows that the power factor is the ratio of the energy component to the total apparent input, and if the power factor and apparent input are known, the values of the inductive and energy components can be easily obtained. A large inductive component means a low power factor, which may be raised by increasing the energy component, but if the inductive component is kept at its same value, the efficiency is not much improved. When starting an induction motor the energy component may be taken as a measure of the torque, but a large consumption of power at starting does not necessarily mean a large starting torque. We shall now consider some methods of starting up and regulating the speed of an induction motor. Although it is possible to start a polyphase motor by simply connecting it to the supply mains, it is not advisable to do so except in the case of motors of small size. If large motors were started in this manner, it would result in large currents being drawn from the supply, which would interfere with other parts of the system, and also do injury to the motors themselves.

The following gives a brief review of the methods at present in use :

*Method I.*—The motor is connected directly to the supply mains, which method is, as already stated, only suitable for small machines. When a motor is just starting, the rotating magetic field rotates at a very high speed relatively to the rotor, consequently the E.M.F. induced in the rotor will be high, which will result in large induced currents being set up in it for reasons already given in the commencement of this article. At starting, the induction motor may be considered as a transformer having a large air-gap in its magnetic circuit, as it takes a large wattless current from the supply to produce a magnetic field in the air-gap. The large current taken at starting of an induction motor is, therefore, similar to the high magnetising current taken by a transformer having insufficient iron in its core, and, as will be readily understood, the effects mentioned above will be greatly increased in large motors. The evil effects of the large currents taken by motors at starting may be considered as follows : The large wattless current taken from the supply causes a large voltage drop in the generator, owing to its demagnetising action on the generator field. It also tends to demagnetise the motor field, decreasing the magnetic flux and increasing the leakage between the primary and secondary windings.

*Method II.*—This method employs a variable resistance in the secondary circuit. The insertion of a non-inductive resistance in the rotor circuit at starting is a very simple and effective method of preventing excessive currents and the demagnetising effect on the motor field, at the same time increasing the torque, the torque being directly proportional to the rotor resistance at starting and inversely proportional when running at normal loads. When a wide variation in speed is desired, this method requires a large number of contacts on the rheostat, which then becomes complicated and cumbersome.

There is another method, due to Mr. Fisher-Hinnen, in which the resistance is cut out automatically as the speed rises, and the following explanation will show how this is brought about. Now, at starting the frequency of the rotor and stator currents is the same, but as the speed rises the frequency of the rotor currents falls off, being only a small fraction of the frequency of the stator currents, when the rotor is running at full speed. In each of the rotor circuits a high non-inductive resistance is inserted, which is shunted by a reactance coil, C, having a small ohmic resistance, but a high coefficient of self-induction, L. The reactance, R, of this coil depends upon the frequency of the E.M.F. Now, the frequency is proportional to the slip, and the slip varies with the speed, the slip being at its maximum at starting, falling to nearly zero at normal speed. It will, therefore, be seen that any variation in speed varies the reactance, which also falls from a maximum to nearly zero. The impedance of the rotor circuit = resistance + reactance in series. Joint resistance $= \frac{C R^2}{C^2 + R^2}$ and joint reactance $= \frac{C^2 R}{C^2 + R^2}$.

At starting the reactance, R, is at its maximum, therefore the joint resistance is also a maximum. As the speed rises and the frequency in the rotor circuit decreases, the apparent resistance of the reactance coil diminishes, the ohmic resistance being then shunted by an apparent resistance, which is constantly falling in value until the motor reaches its full speed, when the joint resistance is nearly zero, because the reactance is nearly zero. This device enables an induction motor to start up under load with a small current, automatically increasing its speed till the normal speed is reached. Fig. 1 shows connections for

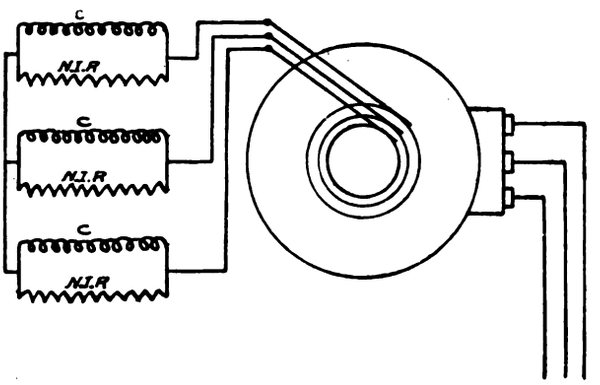


FIG. 1.

this method. C and R are resistances and reactances in parallel. This starter is always in circuit, and the only bad effect this has on the running of the motor is to cause a slight increase in the slip and a small decrease in the power factor.

Another method employs an auto-transformer to vary the voltage supplied to the motor. An auto-transformer consists of a coil of wire wound on an iron core and connected across the supply mains. The coil has a large number of turns and several tappings, so that different voltages may be supplied to the motor. The auto-transformer permits large currents at low voltage to be supplied to the motor, while a small current at high voltage is taken from the mains, and when the motor has reached its full speed it may be cut out of circuit. This method requires no slip-rings on the motor, and a short-circuited rotor may be employed. Satisfactory working of an auto-transformer is only obtained when it is employed to start up the motor for which it was designed. Fig. 2 shows the connections of an auto-starter for two-phase motors.

Another method of varying the speed is to wind the stator in such a way that it is possible to alter the number of poles. By halving the number of poles the synchronous speed is doubled, the slip remaining the same as before for any given load. A great disadvantage of this method is the large number of cable connections which it involves, and for this reason it is not often met with in present-day practice.

Having briefly described the different methods of varying the speed, it will be interesting to further consider the speed, and its relation to the torque exerted, also the conditions on which both depend. We have already seen that when load is thrown on a motor, its speed will continue to fall, and the E.M.F.'s induced in the rotor circuits will

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continue to increase until the torque developed is sufficient to run the motor at that particular load. By further increasing the load, the speed will continue to fall and the torque increase, until finally zero speed is reached, and if the different speeds and their corresponding values of torque are plotted, the resultant curve should be a straight line, as $E^1$ (Fig. 3). It will be found, however, that an actual speed-torque curve takes the form of $E^2$, owing to

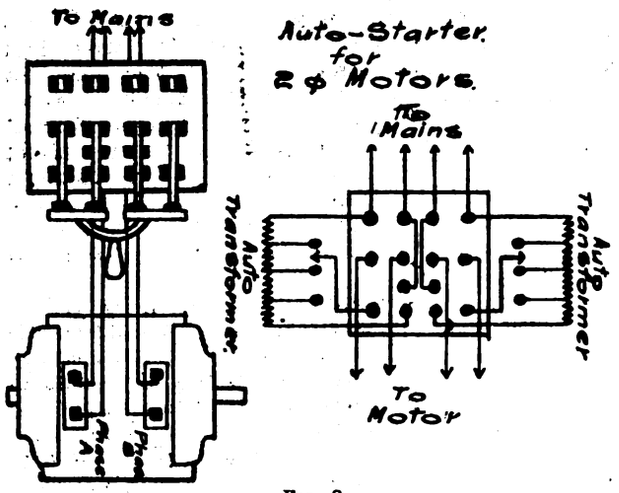


FIG. 2.

the following reasons: A certain part of the voltage impressed on the primary winding supplies the C R loss in it due to its resistance, and if the impressed voltage is kept constant the counter E.M.F. of the primary will diminish as the C R drop increases, and the magnetic field required will also be diminished. Therefore to generate the required induced currents in the rotor the speed must drop more than is shown in curve $E^1$—that is to say, the speed-torque curve is curved, and not a straight line.

leakage and a low secondary resistance the speed-torque curve assumes the shape of $E^3$ (Fig. 3). It will be seen that the torque increases as the speed falls, until its value reaches a certain maximum, and if the speed continues to fall through a further increase in load after this point is reached, the torque will gradually fall until the motor stops. A motor must, therefore, have its rated load below this point, which is known as the pulling-out point. The

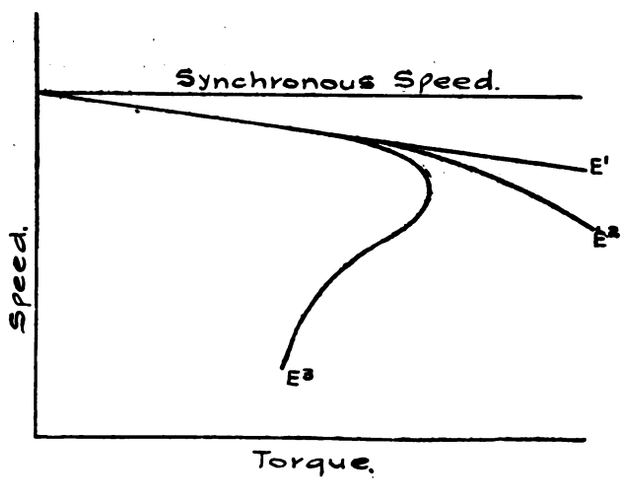


FIG. 3.

speed-torque curve is of the greatest importance, as on it depends the starting torque and speed regulation of the motor. At this point it will be necessary to take into account the effect of the secondary resistance on the speed curve; any increase in the secondary resistance requires a proportionate increase in the slip if the torque is to be kept constant, because an increased resistance in the rotor circuit requires a higher E.M.F. to drive through it the induced currents necessary for that particular torque. If

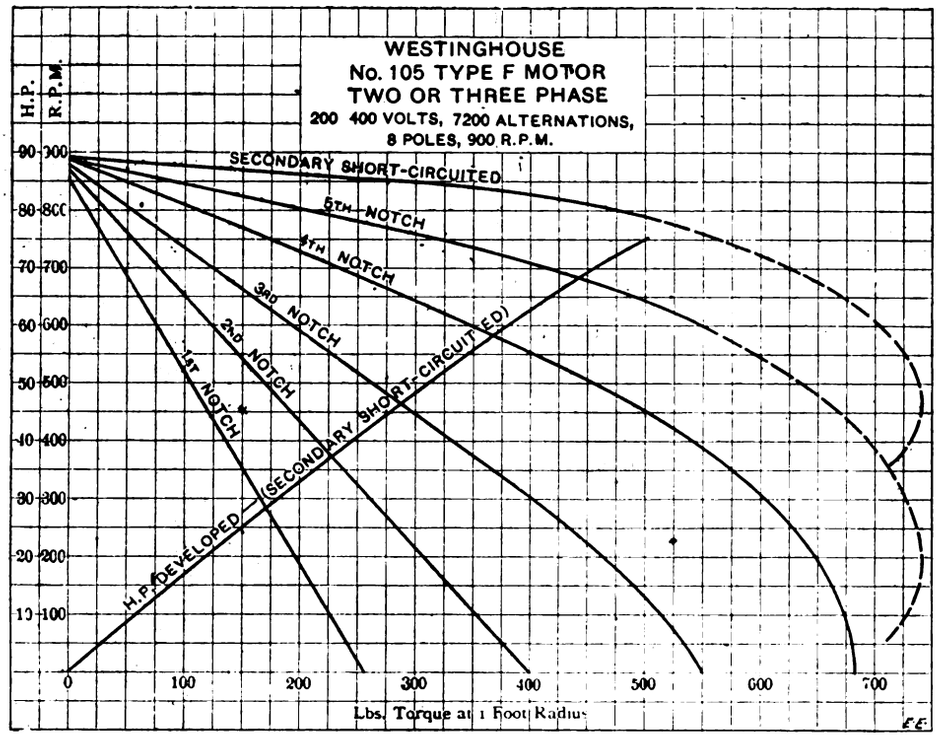


FIG. 4.

The E.M.F.'s generated in the secondary by the induction of the primary have to drive the currents through the secondary, not only against its resistance, but also against local E.M.F.'s due to the stray magnetic fields set up by the fields due to the primary and secondary currents being opposed to each other. These local E.M.F.'s due to magnetic leakage depend upon the frequency of the secondary currents, and vary with the drop in speed, reaching their highest value at zero speed, and cause a further drop in speed for any required torque. With large magnetic

the slip with a given torque is 5 per cent. it would be 10 per cent. if the secondary resistance was doubled, provided the primary voltage and frequency are kept constant.

The effects which different resistances in the secondary circuit have on the speed-torque curve may be considered as follows: Suppose in case (*a*) secondary resistance is small; (*b*) secondary resistance is doubled. The torque is the same in each case, but in case *b* the slip for a given torque is doubled. In case *c* secondary resistance is again

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doubled, the starting torque is increased, but the slip is rather large, being double its value in case *b*. Case D slip is again doubled, which causes a large increase in the torque at starting, but it falls off rapidly as the speed increases. So far as a large starting torque is concerned, case D is the best for starting. For running, case A gives least drop in speed for a given increase in torque. From the point of view of primary current consumed, case A takes the largest current at start, but gives a low torque. Case B takes less current than A and gives a higher torque. Case C takes less current than *b*. Case D takes less current than C, and gives a maximum torque at the start. It will therefore be seen that when a resistance is introduced into the secondary circuit, each value of the resistance will have its own particular speed curve.

In Fig. 4 is shown a series of speed-torque curves, corresponding to different secondary resistances, of a Westinghouse variable-speed induction motor, and it will be seen that the speed at any torque given by any particular value of controller resistance is smaller than when the controller resistance is cut out and the secondary short-circuited. When this motor is run with a resistance in the secondary and develops a definite torque, the horse-power output will vary directly as the speed. The power factor, current, and power taken by the motor depend upon the torque developed, and are practically the same, independent of the speed, and the torque developed at any given slip is proportional to the square of the impressed E.M.F.

*(To be continued.)*

## STREET-LIGHTING IN THE CITY OF LONDON.

As was announced in our issue of last week, the Court of Common Council have decided to experiment on a large scale on the replacement of electric street-lighting by incandescent gas lamps. From the report of the Streets Committee we take the following figures as to the streets in which this experimental gas lighting is to be carried out:

| Street and new light. | Initial cost. | Annual saving. |
|---|---|---|
| Queen Victoria-street and part of Queen-street (45 high-pressure gas lamps)..... | £1,376 5 0 | £224 0 0 |
| Fleet-street (34 incandescent gas lamps)..... | 120 0 0 | 111 0 0 |
| Lower Thames-street, from Fish-street-hill to Billingsgate and Monument-street (33 high-pressure incandescent gas lamps) ... | 446 0 0 | 28 11 0 |

In these three streets the number of arc lamps now in use are respectively 27, 12, and 8.

It will be seen from these figures that a considerable outlay is to be incurred in order to secure a comparatively small annual saving. For instance, in the case of Queen Victoria-street the annual saving is only 16 4 per cent. on the first cost of installation. This leaves only a small percentage for depreciation after interest and sinking fund charges have been met. It is, however, with the general question of gas *versus* electricity for street-lighting that we have to deal, and we propose to show that the conditions in the city of London are exceptional, and that the comparisons made by the common councillors were unfair to the electric light. In the first place, any comparison of cost is quite valueless unless the cost is expressed as a function of the illumination produced It is even then most unfair to compare this figure for the new high-pressure gas lamps with that for the existing arc lamps in the City.

To make this point clear it is necessary to consider the past history of the street-lighting contracts. When the City of London Electric Lighting Company was formed, contracts were taken over under which a charge of £26 per annum was the agreed price for arc lamps to be supplied and maintained by the company. These arc lamps have to be kept alight from one hour after sunset to one hour before sunrise. Under the agreement also the company was bound to keep a separate plant for street-lighting, so that that portion only of their undertaking might, if desired, be separately acquired by the Corporation. In the early part of 1891, when this agreement was entered into, the price charged—*i.e.*, £26—per arc lamp was considered low, and the agreement was looked upon as a concession to the Corporation. We may also say that at the time when the present lamps were erected they were as good as any that could be obtained in the market. Unfortunately, litigation occurred over the company's concessions, and it was finally ruled by the House of Lords on Aug. 8, 1903, that two out of the three agreements held by the company were invalidated because certain of the common councillors who had voted for these held shares in the pioneer company. Since that date the street-lighting has been continued as though these two agreements were in force, and at the same price and subject to the same fines for any defects in the working of the lamps. Under the circumstances it is not a matter of surprise that the company have not replaced the arc lamps, which are now quite out of date, with others which would have rendered the present experiment with gas unnecessary.

This fact is partially admitted by the Streets Committee by the fact that they have asked for prices for electric lighting with new lamps. They have also been advised by their electrical inspector that the street-lighting could be done more cheaply with modern arc lamps than by gas. It was at the end of March that the subject of improving the electric lighting was first broached. Both the companies supplying electricity were then written to and asked for a quotation for an improved system of street-lighting. When, however, the Streets Committee were asked for more details as to what was required, the companies were informed that the electrical engineer of the Corporation was preparing a specification for the improved arc lighting, which would be forwarded in due course. This communication passed at the end of April. It seems curious, therefore, that without waiting for this specification to be issued, or for the tenders from the two companies in question, the councillors should have decided last week to spend nearly £2,000 in experimenting on gas lighting. The decision to do so must obviously have been arrived at without any comparative figures of costs, as it is absurd to compare old rates for electric lighting with the charges for a new system of incandescent gas lighting. It remains to be seen how far the real motive in the present movement is a desire to get the cheapest illuminant, and how far its object is to determine the present contract or contracts for the electric lighting of the streets. It will be obvious from the above that the decision come to last week has no bearing on the comparative merits of the two illuminants. Unless this is made clear to the councillors in other towns, it may lead others to a wrong conclusion on the street-lighting question. As to the actual cost with the two systems, reliable figures can be obtained from the quarterly reports of the city engineer of Westminster (Mr. J. W. Bradley) on street-lighting. These reports clearly show from trials in the streets extending over two or three years that the arc light is the cheapest illuminant when all the factors entering into the cost are considered. Even then the arc lighting at Westminster is not carried out with lamps of the most modern flame type. If a comparison is needed between the two rival systems as far as lighting is concerned, it can be obtained by a visit to the Mansion House-circus, where there are a few arc lamps of the flame type erected on the old lamp columns. We trust that the Corporation when spending some £2,000 on experimental gas lighting will also vote the much smaller sum which would enable the arc lighting in Queen Victoria-street, Fleet-street, and Lower Thames-street to be brought up to date. If this is done, we do not fear the result of the extensive competitive trials which would then be possible.

ELECTRICAL COMPANY'S PUBLICATIONS.—Recent publications issued by the Electrical Company, Limited, 121-125, Charing Cross-road, London, W.C., include three prints illustrating respectively three 75-kw. continuous-current generating sets driven by gas-engines at Limerick Corporation electricity works, two of four 240-kw. synchronous motor-generators supplied to the Corporation of Sunderland, and one of three 720-kw. three-phase alternators supplied to the same Corporation; also a leaflet describing the advertising twinkling socket already noticed in our columns, a pamphlet entitled "How to make Electric Light Cheaper than Incandescent Gas," and another on "Electrically-Driven Winding Engines," which we hope to make the subject of a separate notice in an early issue.

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THE
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### TO CORRESPONDENTS.

*All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

*All communications intended for the Editor should be addressed* C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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## THE CITY AND ELECTRIC LIGHTING.

There is jubilation in the streets of Ascalon—otherwise among those interested in the gas industry, and, like many another jubilation, seems warranted till fully investigated. The City Fathers, true to the versatility that has attended most of their dealings with electrical matters, have made another change. There is a lost art in modern civilisation—the art of remembrance. Memory now has reached its limits if it has extended over the space of nine days, and to extend over that limited period of time it must be exercised on something of the nature of the weird or the wonderful. The history of the City's connection with electrical matters is such a reiteration of change and shuffle that few retain the faintest perception of it. The early history is a case of "first she would and then she wouldn't"—procrastination and change through several revolving years. Then all seemed settled, agreements were made, but subsequently some of these agreements were held legally to be illegal. Meanwhile the lighting of certain streets was *un fait accompli*, and till now has continued as if the agreements were valid and in force. No one cared to test the matter of removal, and what was continued to be. The lapse of time and the march of improvements rendered possible both in electric and in gas lighting better things than existed when the original arc lamps were installed to replace the older form of gas lamps.

At the present moment we have not the slightest evidence that the City Fathers have made the comparison of improved electric lamps with improved gas lamps. All the evidence we possess is to the effect that comparison has been made of the best modern gas systems with the old, antiquated, out-of-date electric lamps, and it is to this comparison that all published figures relate. We ask if that is the position to be taken by those who control the affairs of the first city in the Empire? We ask if the men who do such a thing can have the faintest conception of business matters? And when we are told they are among the chief business men in the city of London, we open our eyes in wonderment. If what we have suggested above is correct, there is absolutely no moral to be drawn in favour of gas if this replacement be carried out, unless it be an unsatisfactory one. The position, to say the least of it, is peculiar. Negotiations were commenced with the electric light authority, and it was understood a specification was to be issued upon which new prices could be tendered, but, so far as we can gather, no such specification was issued, and therefore no new tender could be made. To put forward an estimated annual saving is a most misleading process unless other information be given as well; and to put this forward when one part of the expenditure is in accord with an old agreement, and not necessarily in accord with what might be done at the present moment, is still worse.

We are far from saying that the present system of lighting is all that can be desired. It is not. Progress has been made, and the results of that progress should be utilised. But—and here is one of the greatest difficulties to be encountered—the conditions of the case have been such as practically prohibit the utilisation of more modern lamps. Assume an agreement made now, that agreement should not preclude the adoption of improvements, but rather attempt to accelerate them. Is it possible to have an agreement at once variable and binding—that is, binding as regards replacement and variable as regards apparatus and price? An improved piece of apparatus should mean decrease of cost, and should be adopted, the consumer getting a benefit, but an agreement should not be so stringent as to compel the use

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over a term of years of a particular piece of apparatus which, while excellent at the time, might be soon superseded. The present proposal is to supersede seventy-four arc lamps by one hundred and twelve gas lamps, and, as our contemporary the *Journal of Gas Lighting, etc.*, puts it, saving "at present prices three hundred and sixty-three pounds a year." We have indicated that the facts are altogether different, and that the question of saving "over present prices" has not been considered—it is the new gas against the old electric. Hence the lesson our contemporary would have us learn is fallacious. It says: "Herein we have the application to the municipal service of a fundamental principle of modern industrial practice—the abandonment of the existing for the new, if the new can produce an economy showing upon the outlay involved a balance of profit." This principle is certainly not modern, and cannot truly be applied in this case. The comparisons should be made with equivalent modern developments, and if this be done electricity will not be found wanting.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### "STAND-BY CHARGES, ETC."

SIR,—With your permission I should like to comment further on two points which were raised at the discussion of my paper on Thursday. The first point—a very pertinent one—was raised, I think, by Mr. Sparks, and I regret to have overlooked it in replying. Mr. Sparks asked why, in column 2 of Table A, I had taken works cost at 0·7d., whereas in column 3 I had reduced it to 0 45d. The reason is that with a motor load which clashes with the lighting load we cannot get rid of "peak" conditions in the working of the plant, and my Fig. 7 and the tables on pp. 26 and 27 show that under such conditions the boiler and other stand-by losses will never attain their minimum.

On the other hand, with the "restricted hour" load superposed on the "interest-paying" motor and lighting loads, the "peak" is less prominent (in contrast to the valleys) on the daily load curve, and the generating charges are reduced *below* what they would be with the interest-paying motor load alone, and, of course, still further below those with the lighting load alone.

The "restricted hours'" system is, I understand, in use at St. Pancras, and also by the County of Durham Company. Perhaps Mr. Baynes or Mr. Esslemont, though unable to take part in the discussion, may be willing to give us, through your columns, some indication of its success in either place.

The other point on which I should like to make a few remarks is the question raised by Mr. Jeckell. The figures given us by Mr. Jeckell were most interesting, but, unfortunately for the electric motor, they prove my figure of one unit per B H.P. hour to be only too near the truth where the motor is a small one and is working at a quarter of its rated load. Your readers shall judge for themselves. The following figures were given us by Mr. Jeckell:

| | |
|---|---|
| Revenue derived from motors | £4,385 |
| Units sold for motors | 854,543 |

Hence

| | |
|---|---|
| Average price per unit | 1·23d. |
| Total H.P. of motors | 905 |
| Units sold per H.P. installed per annum | 944 |
| Average cost per H.P. installed per annum | £4. 16s. 10d. |
| Number of hours of working per annum | 2,500 |

$$\text{Hence cost per B.H.P. per hour} = \frac{£4{,}385 \times 240}{905 \text{ H.P.} \times 2{,}500 \text{ hours}} = 0{\cdot}46\text{d.}$$

$$\text{Now energy per B.H.P. per hour} = \frac{\text{pence per B H.P. hour}}{\text{pence per unit}} = \frac{0{\cdot}46}{1{\cdot}23} = 0{\cdot}38 \text{ unit per B.H.P.}$$

The above result looks very plausible, and none would welcome it more than the writer, but it goes against the principle of the conservation of energy. Where, then, is the "nigger"? Simply that, as pointed out in my reply, Mr. Jeckell multiplies the *rated* H P. of his motors by the hours of running, and calls this the B H.P. hours.

To get the B.H.P. hours *developed*, this figure should be multiplied by the ratio of the average H.P. developed to the rated H.P. of the motor.

For instance, at Coventry, units sold per H.P. installed per quarter = 236, whereas with my Class I. motor (see p. 3) units sold per H.P. installed and developed per quarter = 585. Hence

$$905 \text{ H.P. for } 2{,}500 \text{ hours} \times \frac{236}{585} \text{ units} = 913{,}000 \text{ B.H.P. hours,}$$

whereas Mr. Jeckell has taken 2,260,000 B.H.P. hours.

Hence, also, 0·38 unit per nominal H.P. hour $\times \frac{585}{236}$ = 0 94 unit per B.H.P. hour, which is near enough to my figure to suit most people.

With reference to my Table C, it may be some consolation to Mr. Jeckell to be able to inform the gasman that the 1·37d. there given represents the cost of four hours' working and not of one hour, because it refers to a motor working on the average at a quarter of its rated load (my Class II.).—Yours, etc., A. M. TAYLOR.

### DIVERSITY FACTOR.

SIR,—As this question of diversity factor is one of the greatest importance, and my extension of the ordinary meaning of load factor has evidently been misunderstood, I beg leave to further trespass on your columns.

Mr. Tapper's remarks, and more especially Mr. Arthur Wright's communicated remarks, bear out in a striking way my own deductions (p. 18 of paper). The Glasgow motors, we are told, develop 60 kw. occasionally. Hence, taking a one-hour cycle, the energy consumption with a 100 per cent. "load factor" (in the sense I have taken it) would be 60 units per car.

But we know that for each unit consumed on the car we ought to do a car mile. Therefore, if the "load factor" were 100 per cent., we should cover 60 miles in that hour. But it is found in practice that, including all stops, we only cover, say, eight miles per hour = 8 0 units.

Hence the load factor (over a one-hour cycle) is only $\frac{8}{60} \times 100$ per cent. = 13·3 per cent. And the diversity factor is the reciprocal of the load factor, or $\frac{60}{8} = 7{\cdot}5$, which is almost exactly what Messrs. Wright and Tapper make it.

Similarly, with very intermittent work, such as lifts, etc., the diversity factor may easily reach values of 10, 15, or even 20, but the load factor goes down in proportion.

In spite of this, as I have shown in my paper, the station load factor (over the same cycle) may be quite high, because it is the product of the (cyclic) load factor and the diversity factor.—Yours, etc., A. M. TAYLOR.

## PERSONAL.

The Right Hon. Lord George Hamilton, P.C., M.P., and Mr. William H. Brown have been elected directors of the Metropolitan District Railway Company.

Mr. Charles James Cater-Scott (chairman of the London and India Docks Company) has been elected a director and appointed chairman of the London United Tramways (1901), Limited, Mr. Charles T. Yerkes having resigned the chairmanship in order to enable him to devote more of his time to the Metropolitan District Railway Company. Mr. William H. Brown has also been elected a director of the London United Tramway Company.

The engineer and manager of the Wellington Electric Light and Power Company, Limited (Mr. G. S. Maben) is visiting England.

Mr. Hilliard Stephens, A.M.I.E.E., A.M.I.M.E., of 39, Victoria-street, has been appointed sole London agent for the Asphaltic Limestone Concrete Company, Limited, for the sale of bitumen, box compounds, and asphalt. Mr. Stephens has also been appointed agent to Messrs. A. and J. Main and Co., Limited, structural engineers, Glasgow and London.

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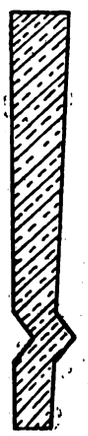
## INSTITUTION OF ELECTRICAL ENGINEERS.

### Students' Visit to Leeds.

The annual Easter excursion of the Students' Section of the Institution of Electrical Engineers was made this year to the Leeds district during the week May 1 to May 6. The journey down to Leeds was, however, broken at Loughborough in order to visit the Falcon Works of the Brush Electrical Engineering Company.

THE BRUSH ELECTRICAL ENGINEERING COMPANY.

As the manufactures of this firm are so well known in the electrical world, only a few notes of the most striking points of interest will be given. The company have under the Parsons patents perfected a type of steam-turbine which they are now making in several standard sizes. In the stationary field system of the turbo-dynamos a continuous iron surface is presented to the armature, as in the case of the stator of an induction motor. As is usual when this type of field magnet is adopted, compensating windings carrying the load current are placed across from one pole to the next so as to oppose the distorting action of the armature current, and thus facilitate sparkless commutation. In some machines a compressed stranded conductor has been used in the armature, and the commutator bars, besides being secured by the usual shrunk-on steel rings, are stamped (as shown in sketch) with small V niches, so that the bars are keyed, as



it were, into one another. With turbo-alternators the revolving-field type, again with a continuous iron surface, has been adopted, the magnetising coils being distributed over several slots, and the end bends securely held in slots cut in the massive brass end cheeks. Besides the above, the party saw under construction a 1,000-kw. inductor type alternator for the Leicester Corporation, a car body entirely of steel for the District Railway, and a 100-kw. transformer built especially for electric furnace work, giving on the secondary 12,500 amperes at eight volts. The controller and rheostat shop was also visited. The company in their controllers have adopted the multiple-coil type of magnetic blow-out, and for rheostats cast-iron grids are greatly used.

On Tuesday morning the party visited

THE LEEDS COPPER COMPANY'S WORKS AT HUNSLET

This company buys ordinary blister copper at a purity of about 96 per cent., and by refining and electrolysis turns out a pure material having properties both electrical and mechanical unobtainable, it is claimed, by any other mode of manufacture. The method of electrolytic refining is based upon the Elmore process, which has, however, been much improved and perfected by the present company. As the cost of power is of primary importance in the process, all the usual accessories have been installed in the power-house to attain an economical use of the fuel, which is a cheap small coal obtained from neighbouring collieries. In the engine-house four depositing sets of 170 kw. each have been installed, although two sets are sufficient for the works as they are at present. In this way a continuance of supply for depositing day and night is insured. The dynamos are of the Brown-Boveri make, and generate at 110 volts. They are belt-driven from Bollinkx cross-compound slow-speed engines. The first stage in the production of the electrolytic copper is the treatment in the refining furnaces, by which means all arsenic and many other impurities are removed, leaving 99½ per cent. pure copper, which is cast into triangular-shaped bars about 13ft. long to form anodes in the electrolytic bath. The second stage is the depositing. The electrolytic tubes are formed upon an iron mandril which has been thoroughly coated with blacklead. The cathodes are kept in continual rotation and are burnished by agate stones fixed in wooden clamps, these making one complete journey along the tank (a distance of 13ft.) every half-hour. When the deposit is completed it is removed from the iron mandril by placing in a lathe and "squeezing" the copper between friction rollers, after which the mandril is easily withdrawn on the draw bench. The copper tube is then annealed by heating to a dull red and quenching in a bath of dilute acid. It is then ready for drawing to any diameter and thickness in lengths up to 70ft. Before leaving the works all tubes are tested up to a pressure of 1,000lb. to the square inch, and for carrying out bursting tests a hydraulic intensifier has been installed giving pressures up to 26cwt. to the square inch.

Besides the manufacture of copper tubes by this process, the company also make a speciality of copper coatings on cast-iron cylinders, such as are used by calico printers and in hydraulic machinery of all kinds. They also manufacture drawn brass tubes in large quantities, but before passing to this part of the business, which does not involve the use of the electrolytic bath, a word must be said about that all-important part of the latter—namely, the electrolyte itself. The success of the depositing depends to a large extent upon the continual purity of the electrolyte, and in appreciating this fact the company have installed an up-to-date liquor shop in which the stale liquor is concentrated and a fresh and pure supply of copper sulphate crystals obtained. Owing to what we may call the "inefficiency" of the electrolytic bath, it is always found that the amount of copper *in the solution* grows as the solution is in use, so that there is a continual manufacture of copper sulphate. Further, because of the percentage of free acid used in the baths, it is found impossible to obtain good crystals from the liquor as it leaves the vats, so that before it is evaporated it is passed through a tank containing free copper, and into which hot air and steam are blown. In this way more copper sulphate is formed and the liquor loses its acid. It is then evaporated and led into cooling tanks, where pure copper sulphate crystals collect upon lead strips suspended in the liquor. The surplus copper sulphate crystals obtained as above form a valuable by-product.

Coming now to the manufacture of brass tubes, these are first cast in cast-iron moulds about 4ft. long, with cores made up of hay and loam pressed on to a metal shaft and baked. The cast tubes are then annealed by heating in a furnace and allowed to cool in air alone, not, as with copper, by quenching. They are then bored smooth in a special vertical machine, after which they are prepared for drawing in the same way as with the copper tubes.

As regards the mechanical properties attained by the electrolytic refining, we may state that the average maximum stress sustained by 12 samples taken at random from stock and tested by Mr. Thomas Nash, of Sheffield, was 17·4 tons per square inch, the numbers varying between 14·3 and 22·6. The figure given by Lineham as an average for ordinary copper is 13 tons per square inch.

On Tuesday afternoon the students visited the works of

MESSRS. GREENWOOD AND BATLEY, LIMITED.

This firm are the English licensees of the De Laval patents. The De Laval turbine with its helical reduction gear and its twin dynamos is too well known to require description here. Two sets have been installed in the power house and supply current for lighting and power, electric driving having been adopted throughout the works. Among the many manufactures of this firm, the one of chief interest was, perhaps, their electric brougham. It is equipped with a fairly small battery, capable of running the car 30 miles only, as the radius of travel of such a conveyance is, as a rule, not very

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great. Two motors with double helical reduction gear are used, each motor having two armatures and two separate field windings. By this means a system of control is obtained in which a rheostat is only used on the first contact to cut down the initial rush of current. On the first and second control positions all the field windings and the armatures are in series, on the third position the field windings are first put in parallel, on the fourth position the armatures are put in parallel and the fields are both in series, whilst on the highest position the field windings are again placed in parallel. Another interesting feature is that the current is not broken on the copper contacts of the controller drum, but by a special carbon contact fitted with a magnetic blow-out device, actuated automatically from the controller drum. One reverse speed is provided, and the supply is shut off altogether by a plug which can only be inserted or withdrawn when the controller is in the stop position.

On Wednesday morning a visit was paid to the Midland Engine Works of

MESSRS. J. AND H. MCLAREN.

This firm makes a speciality of traction engines, more especially for agricultural purposes. Their engines for driving dynamos have a direct electrical interest. Electric driving has been, with a few exceptions, adopted throughout these works.

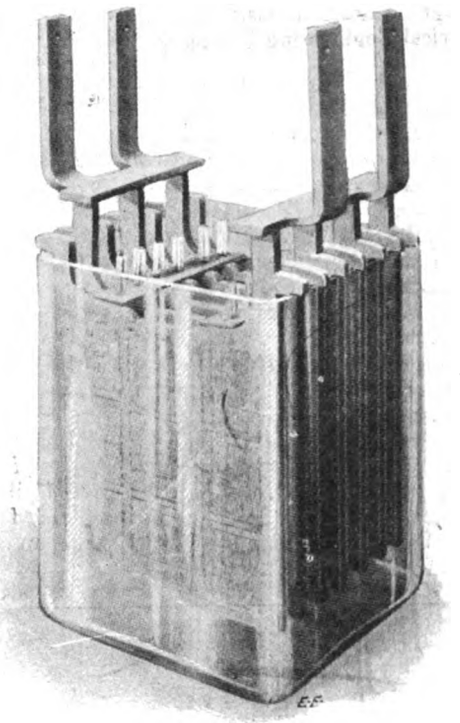
*(To be continued.)*

## THE BIJUR STORAGE BATTERY.

[COMMUNICATED]

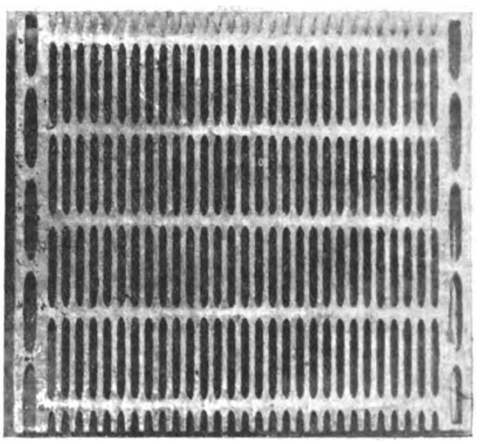
As a result of several years' work on the part of Mr. Joseph Bijur, of New York, a new form of storage battery plate has been produced, which, while retaining the well-tried electro-chemical combination of lead and sulphuric acid, differs radically in design, construction, and results from forms hitherto known in the storage battery art. With the collaboration of Dr. J. S. C. Wells, of Columbia University, in the earlier stages of the work, Mr. Bijur set out to produce a storage battery plate according to an ideal design which should be both mechanically and chemically perfect. This design embodied a rigid structure, freedom from tendency to distortion, perfect acid diffusion, active material incapable of being displaced, high specific capacity, high rates of charge and discharge, high efficiency, good regulation and freedom from "sulphation," buckling, or any other destructive action, save ordinary and unavoidable wear and tear. These characteristics could only exist in a form of plate made up of small, finely sub-divided structures, each free to expand unrestrainedly and firmly welded to a strong supporting and conducting grid. The active portions decided on as most advantageous could not be produced at commercial cost by any known method, whereupon Mr. Bijur set to work to produce these crudely, following this up by devising automatic machinery by which these parts are now made with great uniformity and at low cost. By no method of metal working then existing was it possible to commercially weld together two elements, of which one was a heavy solid form and the other of very fine thin parts. It was, therefore, necessary to devise a new method of metal welding which, after much patient work, in the face of seemingly insuperable difficulties was successfully accomplished, and for the carrying out of which on a commercial scale an entire line of machinery was constructed on original lines. The requisite quality and uniformity of oxide next received attention, with the result that, to secure the desired effects, a new process of formation was devised by which great toughness, porosity, and other desirable qualities could be imparted to the oxide layer, the whole process being perfectly reliable and at all times under the control of the operator.

The Bijur plates are composed of multiples of pure lead structures in the shape of gratings or "grills." These are welded to and in one piece with a stiff frame made of lead and antimony only. The weld goes clear through the plates, and is produced without the use of tin, solder flux, or any extraneous material whatsoever. The frame merges into the grill without joint. At each end of the grill a space is provided for its elongation by expansion, and provision is made for expansion sidewise. The result is a plate having the stiffness, strength, and inoxidisable support of the alloy grid, rigidly held active parts, yet complete provision for their expansion without the setting up of any strains that could produce buckling. The grills are composed of a multitude of minute openings or cells, open through from face to face. When in the untreated metallic



Bijur Storage Battery.

state these grills are very open structures, having a large number of component ribbons running in the vertical direction, supported by heavier cross members running horizontally, which serve as conductors, and give lateral stiffness. During the formation process, part of the metallic lead is converted into oxide, which, by reason of the large increase in volume, nearly fills the openings. The ribbons on the positive elements have a large amount of metal left as a reserve for the oxidation which is attendant on the normal action of every storage battery.



Grill "Unformed"—Bijur Storage Battery.

When the oxide is formed in the rectangular cells, it assumes a slightly elliptical shape, which, expanding into the rectangular containing space, produces a locking in that is so positive that nothing short of destruction of the plate can dislodge it. At the same time, even when the oxidation is carried to the point of apparently completely filling the cells, the tendency of the ellipse to grow larger along both its axes ensures the presence of a minute slot through the centre of the oxide mass, which allows the flow of electrolyte to take place freely through it. The resultant

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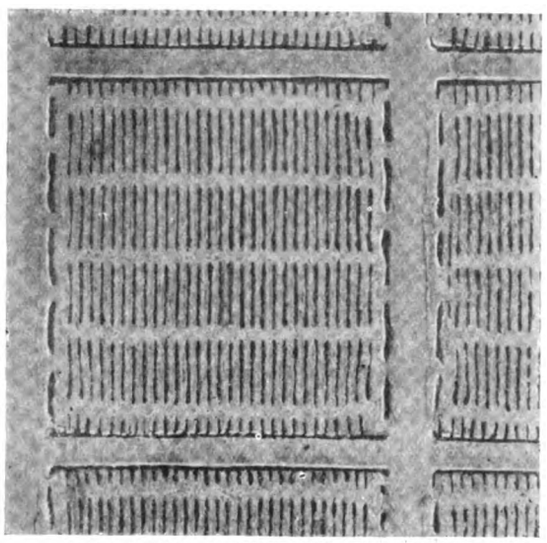
oxidised plate, therefore, is rigid, the grills are firmly held, they expand without producing strains, each particle of oxide is firmly pressed against the lead from which it is grown, and the entire plate is open through and through to circulation and diffusion of the electrolyte. Owing to the character of the design and the structure of the oxide formed, the plates possess several features hitherto unattained in battery practice. "Buckling" cannot take place, and, so far, repeated attempts to intentionally produce distortion have failed. Also, since the perfect diffusion through the plate prevents high acid concentration in the pores, deleterious sulphation does not take place even when an effort is made to produce it.

One of the important advantages gained by this form of design, is that in a plate of given dimensions 20 per cent. greater capacity can be obtained with about 10 per cent. more reserve lead than in any form of plate hitherto constructed. The fine sub-division of the oxide into small masses, combined with the fact that the surfaces of the plates are composed of ribbon edge, precludes the possibility of blistering or shrinkage that is liable to occur when plates contain oxides in large masses. The makers claim that owing to the rapid acid diffusion full charge may be given the batteries at a voltage of 2·4 to 2 5 volts instead of 2 7 volts per cell, as is usually required. This low charging voltage results in increase of efficiency, and reduces the size of boosters required to charge. The structure of the plate forms a conducting network to all parts, ensuring equality of action all over its surface, and this, together with the facility for escape of gas without dislodging active material, favours the ability to stand very high rates of charge and overcharge without marked deterioration.



Section of "Formed" Plate—Bijur Storage Battery.

In short, since storage battery plates can be calculated out scientifically and then constructed in exact accordance with the design, the series of developments and inventions of Mr. Bijur places the manufacture of storage batteries on the same basis as that of dynamo-electric machinery. These processes permit of any suitable forms of active parts and supporting framework being united into one integral structure at a low cost of production and without the introduction of any foreign substances. Such being the case, an improvement in storage batteries may be expected similar to that which took place in dynamo construction after the laws of magnetic circuit and magnetic constants had been explained by Hopkinson, and applied by the engineering fraternity.

The General Storage Battery Company, which is now putting elements on this type on the market under the name of the Bijur "High-Duty" battery, has recently equipped a factory at Boonton, N.J., with special automatic machinery for the cheap and rapid production of storage batteries, where, by reason of an abundant and cheap hydraulic power and the automatic machinery used, storage batteries of the highest grade can be produced, it is claimed, for a lower cost per kilowatt-hour capacity than is possible anywhere else in the country. The company has also developed a new and complete line of automatic regulating boosters, end cell switches, and other auxiliary apparatus for all classes of central-station work and power plants, descriptions of which will appear later. It may be said, however, that all of these devices differ as radically from the present known types, as does the Bijur "High Duty" battery from the conventional storage battery electrodes, and the improvement in methods and degree of regulation represents a marked advance in storage battery engineering.

## TESLA PATENT ON WIRELESS TRANSMISSION OF ELECTRICAL SIGNALS.

An U.S.A. patent was issued on April 18 to Mr. Nikola Tesla for "The Art of Transmitting Electrical Energy through the Natural Mediums." We are indebted to the *Electrical World* for the abstract of this patent given below:

In the preamble it is stated that experiments and observations have tended to confirm the opinion held by the majority of scientific men, that the earth, owing to its immense extent, does not behave in the manner of a conductor of limited dimensions with respect to electrical disturbances, but much like a vast reservoir or ocean, which, while it may be locally disturbed by commotion of some kind, remains unresponsive and quiescent in a large part or as a whole. The inventor states he has discovered that notwithstanding its vast dimensions and contrary to all observations heretofore made, the terrestrial globe may in a large part or as a whole behave toward disturbances impressed upon it in the same manner as a conductor of limited size.

In the course of certain investigations he noted unsuspected behaviour of sensitive instruments, which he discovered to be due to the character of electrical waves produced in the earth by lightning discharges, and which had nodal regions following at definite distances the shifting source of the disturbances. From data obtained in a large number of observations on a maxima and minima of these waves, their length was found to vary approximately from 25m. to 70m., and these results and certain theoretical deductions led to the conclusion that waves of this kind may be propagated in all directions over the globe, and that they may be of still more widely differing lengths, the extreme limit being imposed by the physical dimensions and properties of the earth. By means of gradual improvements in the generation of electrical oscillations, electrical movements were finally reached not only approximating, but, as shown in many comparative tests and measurements, actually surpassing those of lightning discharges; and by means of this apparatus it was found possible to reproduce whenever desired phenomena in the earth the same or similar to those due to such discharges.

For example, by the use of such a generator of stationary waves and receiving apparatus properly placed and adjusted in any other locality, however remote, it is practicable to transmit intelligible signals or to control or actuate at will any one or all of such apparatus for many other important and valuable purposes, as for indicating wherever desired the correct time of an observatory, or for ascertaining the relative position of a body or distance of the same with reference to a given point, or for determining the course of a moving object, such as a vessel at sea, the distance traversed by the same or its speed, or for producing many other useful effects at a distance dependent on the intensity, wave-length, direction or velocity of movement, or other feature or property of disturbances of this character.

In the accompanying figure is represented diagrammatically the generator which produces stationary waves in the earth, and an apparatus situated in a remote locality for recording the effects of these waves. The generator consists of a primary coil forming part of a transformer and consisting generally of a few turns of a stout cable of inappreciable resistance, the ends of which are connected to the terminals of a source of powerful electrical oscillations, this generally being a condenser charged to a high potential and discharged in rapid succession through the primary. *C* is a spiral-wound secondary coil within the primary, one end being connected to ground and the other

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to an elevated terminal, *E*. The resistance of the secondary system should be as small as practicable, its self-induction as large as possible, and the ground should be made with great care. The total length of the conductor from the ground-plate to the elevator terminal, *E*, should be equal to one-fourth of the wave-length of the electrical disturbance or to that length multiplied by an odd number. The relation being observed, the terminal, *E*, will be made to coincide with the points of maxima pressure in the secondary or excited circuit, and the greatest flow of electricity will take place in the same to permit free oscillation. The inductive connection between the primary and scondary should not be very intimate as in ordinary transformers, and this is accomplished by the spiral form given to coil *C*. With this arrangement it has been possible to produce an electrical movement thousands of times greater than the initial, and activity of rates of flow have been produced measured by many tens of thousands of horse-power. The powerful electrical oscillations being communicated to the ground cause corresponding vibrations to be propagated to distant parts of the globe, whence they are reflected, and by interference with the outgoing vibrations produce stationary waves, the crests and hollows of which lie in parallel circles, relative to which the ground-plate may be considered to be the pole—that is to say, the terrestrial conductor is tuned into resonance with the oscillations impressed upon it, just like a wire. A number of facts ascertained clearly show that the movements of electricity through the system follow certain laws

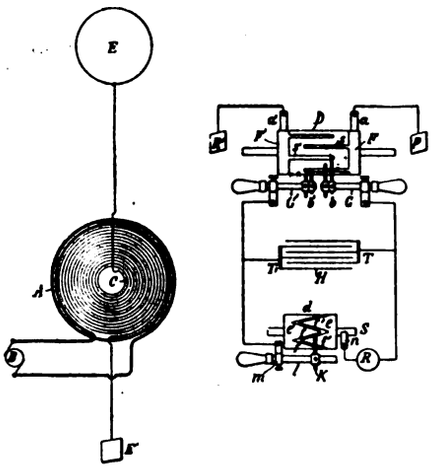


Diagram of Tesla Wireless Signal Apparatus.

with merely mathematical rigour. For the present it is sufficient to state that the planet behaves like a perfectly smooth or polished conductor of inappreciable resistance, with capacity and self-induction uniformly distributed along the axis of symmetry of wave propagation, and transmitting slow electrical oscillations without sensible distortion and attenuation.

Three additional requirements seem to be essential to the establishment of the resonant condition, as follows: First, the earth's diameter passing through the pole should be an odd multiple of the quarter wave-length—that is, of the ratio between the velocity of light and four times the frequency of the currents. Second, the frequency should be smaller than 20,000 per second. The lowest frequency would appear to be six per second, in which case there will be but one load at or near the ground-plate, and paradoxical as it may seem, the effect will increase with the distance, and will be greatest in a region diametrically opposite the transmitter. With oscillations still slower, the earth, strictly speaking, will not resonate, but simply acts as a capacity, and the variations of potential will be more or less uniform over its entire surface. Third, the main essential requirement is that, irrespective of frequency, the wave train will continue for a certain interval of time, which is estimated at not less than one-twelfth, or 0 08484 of a second, and which is taken in passing to and returning from the region diametrically opposite the pole over the earth's surface with a mean velocity of about 471,240 km. per second.

Fig. 2 shows a device for detecting the presence of the waves. It consists of a cylinder, *D*, of insulating material, which is moved at a uniform rate of speed by clockwork and other suitable motor power, and is provided with two metal rings, *F F*, upon which bear brushes, *A A'*, connected to terminal plates. From the rings, *F F*, extend narrow metallic segments, *S S'*, which by rotation of the cylinder, *D*, are brought alternately into contact with double brushes, *b b'*, carried by and in contact with conducting holders, *H H'*, supported in the metal bearings, *G G'*. The latter are connected to the terminals, *T T'*, of a condenser, *H*, and are capable of angular displacement as ordinary brush supports. The object of two brushes in the holder is to vary at will the duration of the electrical contact with the terminal plates and the condenser. To the latter is connected a receiver, *R*, and a device, *d*, performing the duty of closing the receiving circuit at predetermined intervals of time, and charging the restored energy through the receiver.

The receiver consists of a cylinder made partly of conducting and partly of insulating material, which is rotated at a desired rate of speed by any suitable means. The conducting part, *e*, is in electrical connection with the shaft, *S*, upon which slides a brush, *K*, capable of longitudinal adjustment in the metallic support, *m*. Another brush, *n*, is arranged to bear upon a shaft, *S*. It will be seen that whenever one of the segments, *F*, comes in contact with the brush, *K*, the circuit, including the receiver, *R*, is completed, and the condenser discharged through the same. By suitable adjustment the circuit may be made to open and close in rapid succession and remain open or closed during such intervals of time as may be necessary.

The terminal plates, *P P'*, through which the electrical energy is conveyed to the brushes, *A A'*, may be at a considerable distance from each other in the ground or one in the ground and the other in the air, preferably at some height. In the latter case the location of the apparatus must be determined with reference to the position of the stationary waves. If both plates be connected to earth, the points of connection must be selected with reference to the differences of potential which it is desired to secure. In receiving the speed of rotation of the cylinder, *D*, is varied until it is in synchronism with the alternate impulses of the distant generator; the brushes being properly adjusted, electrical charges of the same sign will be conveyed to each of the terminals of the condenser, and with each fresh impulse it will be charged to a higher potential. In this manner the energy of any number of separate impulses may be accumulated and discharged through the receiver, *R*. Thus a relatively great amount of energy may be accumulated and the receiver need not be very sensitive. It being possible to shift the nodal and ventral regions of the waves at will from the sending station, the regions of maximum and minimum effect may be made to coincide with any receiving station or stations.

By impressing upon the earth two or more oscillations of different wave-length, a resonant stationary wave may be made to travel slowly over the globe. If the nodal and ventral regions are maintained in a fixed position, the speed of a vessel carrying receiving apparatus may be exactly computed from observations of the maximum and minimum regions successively traversed. In any region at the surface the wave-length can be ascertained from certain rules of geometry, and, conversely, knowing the wave-length, the distance from the source can be readily calculated. Thus the distance of one point from another, the altitude and longitude, the hour, etc., may be obtained from the observation of such stationary waves. With several generators, preferably generating different wave-lengths, installed in selected localities, the entire globe could be sub-divided in different zones of electrical activity, and important data could be at once obtained by similar calculations or readings from suitably graduated instruments.

"EXCELLO" ARC LAMPS.—The Union Electric Company, Limited, 151, Queen Victoria-street, London, E.C., have just issued a new descriptive pamphlet and price-list of their "Excello" arc lamps. We have several times referred to the excellent results obtained with this type of lamp, and the comprehensive description of its properties and advantages now published should prove welcome.

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## TRADE NOTICES AND NOVELTIES.

### Nodon Rectifiers.

A new pamphlet on the "Nodon" patent electric valve has been issued by Mr. H. Snowdon, Balfour House, Finsbury-pavement, London, E.C. This valve has been designed to transform alternating current into continuous current without the aid of moving machinery, its action being electrolytic. The results of some independent tests of the apparatus are included.

### The "Telaupad."

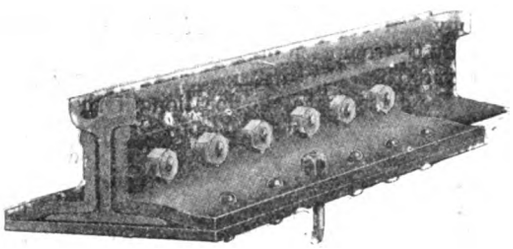
Some particulars are to hand of the "telaupad" or receiver cushion, a mechanical invention of British manufacture introduced by the Telaupad Syndicate, Limited, 10, Coleman-street, London, E.C., for overcoming the objectionable super-resonance and excessive buzzing noise so annoying to users of the telephone. The telaupad is a simple pneumatic contrivance which can be attached to the receiver in a few seconds, and has already been largely adopted.

### Impact Testing Machine.

Messrs. W. and T. Avery, Limited, Soho Foundry, Birmingham, have sent us a description of their patent Impact testing machine for testing material required to stand "shock." The principle of the apparatus is very simple. A pendulum weight is raised to a certain height and allowed to swing and strike the test piece, fracturing it in one blow, and the number of foot-pounds of energy which the test piece has absorbed is automatically registered on the indicating quadrant.

### Booth's Rail Joint.

We illustrate herewith a rail joint, chair, and sleeper combined, which has been patented by Mr. H. Booth, 84, Parkside-road, Sheffield. It is claimed that this joint ensures increased grip to head of rails when cars are passing over it,



gives double the ordinary bearing surface where most needed, and freedom from vibratory shocks, jolting, or hammering, and is cheap to construct. The joint is to be tried, we understand, by the Sheffield Corporation.

### Return-Current Circuit Breaker.

Messrs. Ernest F. Moy, Limited, Greenland-place, Camden Town, London, N.W., are introducing a return-current single-pole circuit breaker for continuous-current circuits up to 600 volts. This breaker is arranged to open on an actual reversal of current only. It will not open on "no current" or on any overload, and as its action is quite independent of 'bus-bar pressure it may be relied upon to disconnect a faulty generator at a definite return current of 20 per cent. of its rated capacity, although the station pressure may have fallen considerably. Illustrated particulars of its construction are contained in a circular just issued by the makers.

### Catalogues Received.

ELECTRICAL DRILLS AND GRINDERS.—A pamphlet which we have received from the Cincinnati Electrical Tool Company, Cincinnati, Ohio, U.S.A., contains illustrations and particulars of this firm's portable electrical drills and grinders for direct current.

LIGHT RAILWAY ROLLING-STOCK.—From Messrs. Dick, Kerr, and Co., Limited, Abchurch-yard, Cannon-street, London, E.C., we have received a copy of their latest work on light railway rolling-stock engineering. This contains illustrations and particulars of a large variety of tipping and other wagons, small steam locomotives, etc., for portable and light railways.

CELLS AND CARBON BRUSHES.—A number of illustrated circulars are to hand from the Atlas Carbon and Battery Company, Limited, Ewer-street, Union-street, London, S.E. They deal respectively with the firm's "Dania" dry cells for motorcars, etc., "Atlas" perfect porous pots for Leclanché batteries, "Atlas" carbon brushes, and the "Atlas" new central zinc battery.

SWITCHBOARD APPARATUS.—A postcard from Messrs. Cecil Hodges and Co., Balfour House, Finsbury-pavement, London, E.C., illustrates their central-station type of moving-coil instrument and a heavy traction switch. We understand the firm have a large amount of work in hand, including the switchboard for the King's Sanatorium in Sussex.

## STEPNEY ELECTRICITY ACCOUNTS.

The following is an abstract of the electric lighting revenue account for the 12 months ended March 31, 1905, taken from the accounts just issued by the metropolitan borough of Stepney.

| Dr. REVENUE ACCOUNT. | £ | s. | d. |
|---|---|---|---|
| Fuel, oil, waste, water, and stores | 8,729 | 10 | 1 |
| Wages at generating station | 1,768 | 18 | 6 |
| Repairs and maintenance of buildings and plant | 841 | 11 | 1 |
| Distribution of electricity | 752 | 16 | 11 |
| Attending and repairs to public lamps | 1,619 | 5 | 6 |
| Rates and taxes | 1,073 | 19 | 3 |
| Management expenses, salaries, etc. | 2,159 | 14 | 3 |
| Legal expenses | 239 | 8 | 2 |
| Special charges—insurance, etc. | 98 | 15 | 6 |
| | 17,288 | 17 | 3 |
| Balance carried to net revenue account | 14,837 | 1 | 5 |
| | £32,125 | 18 | 8 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| Sale of current for private lighting | 23,863 | 3 | 1 |
| Sale of current for public lighting and power | 6,276 | 3 | 1 |
| Rent of meters, etc., on consumers' premises | 243 | 6 | 8 |
| Profit on work done for customers | 13 | 9 | 6 |
| Attending and repairs to public lamps | 1,619 | 5 | 6 |
| Rents receivable | 110 | 10 | 10 |
| | £32,125 | 18 | 8 |

## FORTHCOMING EVENTS.

FRIDAY, MAY 12.

**Iron and Steel Institute.**—At 10.30 a.m., annual meeting continued; at 7 p.m., annual dinner at Hotel Cecil.

**Physical Society.**—At 8 p.m., "A Simple Method of Determining the Radiation Constant, suitable for a Laboratory Experiment," by Dr. A. D. Denning; "A Bolometer for the Absolute Measurement of Radiation," by Prof. H. L. Callendar; and "The Resistance of a Conductor the Measure of the Current Flowing through it," by Mr. W. A. Price.

SATURDAY, MAY 13.

**Birmingham Electric Club.**—At 7.30 p.m., "Cheap Electrica Energy for Power Purposes," by Mr. J. A. Jeckell (provisional).

**Junior Institution of Engineers.**—Visit to Dorking water, gas, and electricity works.

MONDAY, MAY 15.

**Society of Arts.**—At 8 p.m., Cantor lecture (I.) "The Uses of Electricity in Mines," by Mr. H. W. Ravenshaw.

WEDNESDAY, MAY 17.

**Royal Meteorological Society.**—At 4 p.m., "Measurement of Evaporation," by Mr. Richard Strachan, and "Logarithmic Slide-Rule for Reducing Readings of the Barometer to Sea-Level," by Mr. John Ball.

**Institution of Electrical Engineers (Students' Section).**—At 7.30 p.m. annual general meeting.

**Electro-Harmonic Society.**—At 4.30 p.m., annual general meeting (9*d*, Victoria-street).

THURSDAY, MAY 18.

**Royal Institution.**—At 5 p.m., "Flame," by Sir James Dewar.

**Faraday Society.**—At 8 p.m., "An Application to Electrolytes of the Hydrate Theory of Solutions," by Dr. T. M. Lowry.

SATURDAY, MAY 20.

**Rugby Engineering Society.**—Visit to the Lots-road power station at Chelsea.

**Incorporated Municipal Electrical Association.**—June 27-30, annual convention.

## APPOINTMENTS VACANT.

**Town Electrical Engineer,** Municipality of East London, South Africa. Salary, £500 per annum. Applications by May 18. See advertisement.

**Electricians** (2) with commercial knowledge. See advertisements.

**Assistant** to take charge under mains superintendent. Wages, 50s. per week. See advertisement.

**Assistant Engineer,** Middlesex County Asylum, Napsbury, St. Albans, Herts. Wages, 35s. weekly and house on the estate. Applications by May 20. See advertisement.

**Assistant Electrical Engineer,** Oban. Wages, £70. Applications by May 15.

**General Manager,** Johannesburg, £2,000; Station Engineer, £1,000, with house. Applications to Mordey and Dawbarn, 82, Victoria-street, Westminster.

**Shift Engineer,** Manchester. Wages, £150. Applications by May 22.

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# THE ALTERNATING-CURRENT SERIES MOTOR.*

BY F. CREEDY, STUDENT.

*(Continued from page 635.)*

## COMMUTATION.

With the object of endeavouring to throw some light on the commutation of the alternating-current series motor, and the various other actions going on in it, a number of experiments relating to this subject were made with the aid of a Duddell high-frequency oscillograph, the curves being photographed on a falling plate. Many of the results shown below could obviously not be obtained on any instrument which records, not a single wave, but the mean of several. For instance, in the motor examined no two commutation curves are exactly alike. A number of experiments was first made by the author, in conjunction with Messrs. R. S Dahl and H. M. Lyons. In order to remedy some omissions in these, some further experiments were made later on by the author. As, during these experiments, the motor was fitted with very wide brushes, covering rather more than three segments, the experiments on commutation were repeated, as, owing to the long time of commutation, much better curves were obtained on the falling plate. In the discussion given below I have confined myself almost entirely to this latter series of experiments.

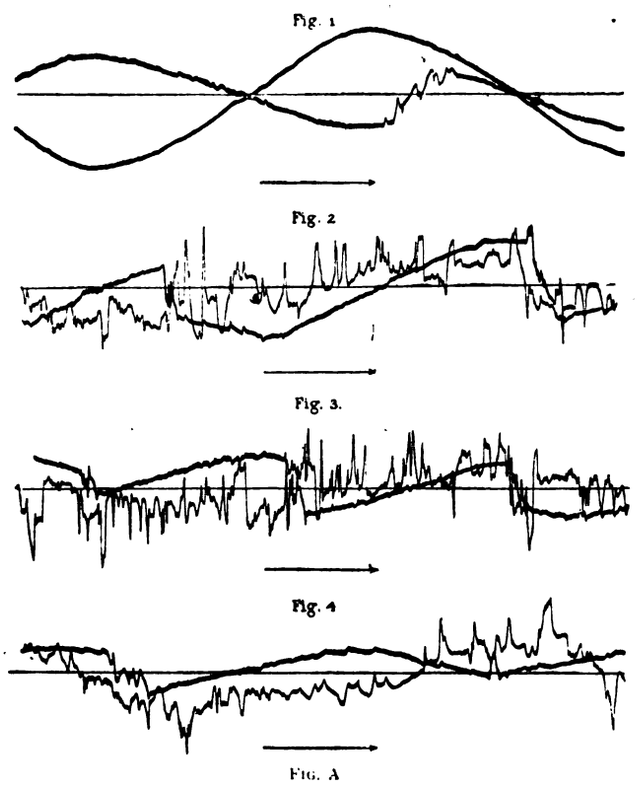


FIG. A

In observing the commutation curve of the motor the following method was made use of: the machine was fitted with two slip-rings, which were fixed on a piece of fibre and mounted on the commutator. One of these slip-rings was joined to a commutator segment, from which one of the armature connections had been unsoldered. This armature connection was then joined to the other slip-ring, and the brushes rubbing on these rings connected by means of a low resistance which served as a shunt for the oscillograph.

In Fig. A are shown a number of the commutation curves of the series motor obtained by the aid of this arrangement. Curve 1, consisting of a curve of main current and of current in the armature coil, contains a very good example of the kind of commutation curve which is found in this motor. As it was thought that the ripples in the current during commutation might be due to the irregularities in the E.M.F. induced in the short-circuited coil by the main flux, a search coil of one turn was wound round the pole-tip (as shown in Fig. 12) as near to the armature as was practicable. Since the brushes are on the neutral line, the E.M.F. induced in this coil, due to the variation of the main flux, will be nearly the same as that induced in the coil under the brush. Curves 2, 3, and 4 (Fig. A) show the current in the armature coil, and the E M.F. in the search coil parallel to it. Curve 2 was taken under the following conditions: main current, 20 amperes; speed, 1,000 revolutions per minute; frequency, $26\frac{2}{3}$ Curve 3 was taken under the same conditions, but at 2,000 revolutions per minute. Curve 4 was taken with main current, 17 amperes; speed, 1,000 revolutions per minute; frequency, 23. Resistance in circuit with the

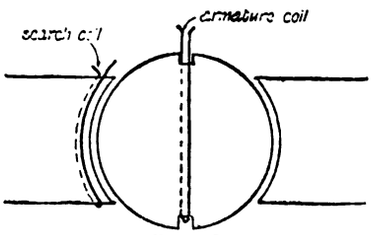


FIG. 12.

coil under observation = 0 3 ohms. In the first three curves shown the generator used was a Wenstrom rotary converter.

In order to eliminate any possible disturbance due to the slots, commutator, etc, of this machine, in Curve 4 and all those succeeding a bipolar Gramme machine, fitted with slip-rings and driven by a Westinghouse motor, was employed as generator. As this machine, of course, had a smooth ring armature, the effect of both slots and commutator were thus got rid of. Curve 4 was taken to show the effect, if any, on the shape of the commutation curve of putting resistance in the armature coil. As may be seen, there is no appreciable effect. These four curves, if examined closely, seem to give us the cause of the oscillation in the E.M.F. curve. In all of them we may notice that there are small ripples in the current curves. These ripples are bound to cause corresponding ones in the E.M.F. curves, and, in fact, we notice that there does exist a ripple in the current curve corresponding to each of the principal ripples in the E M.F. curve. This is especially marked in Curve 2. In order to show that very small ripples in a curve of current or flux are capable of producing enormous oscillations in the E M.F. curve, I give in Fig. 13 a curve of the E.M.F. induced in the search coil, and underneath it a curve which is the graph of the integral of the E M.F. curve, and is consequently proportional to the flux producing it. This curve was drawn by means of an integraph,

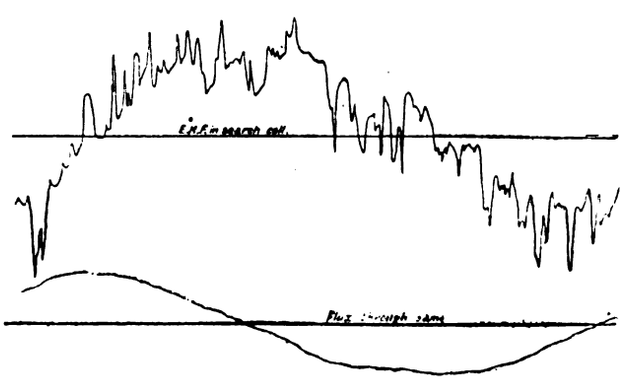

FIG. 13.

the use of which renders the drawing of these flux curves extremely easy, as it is only necessary to draw a point over the curve to be integrated, while a pen draws the integral curve. This method—viz, observing the E.M.F. in an oscillograph, and then integrating it mechanically—appears to be the only one by means of which curves of the instantaneous flux passing through a coil may be obtained.

The fact that the ripples in the current and E.M.F. curves do not in all cases exactly correspond is probably due to the fact that the current curves shown in Fig. A do not represent the total current flowing round the field, but merely that flowing through one coil of the armature. A

* Paper read before the Institution of Electrical Engineers.

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difficulty in the way of the above explanation, I must admit, is caused by Curve 1. This does show the current which passes through the field, and it shows no sign of any ripple. But how account for the undubitable correspondence between the current and E.M.F. curves if we reject the above?

A curve of E.M.F. in the search coil and of armature current was also taken with a direct current through the motor. It showed the same irregular ripples in the E.M.F. curve. Thus these cannot be connected with the fact that the motor is an alternating-current one. Curve 4 also shows us another interesting point. One of the commutations in it takes place at the point where the current is zero. We see that as soon as commutation begins there is a sudden peak in the current, and this in spite of the fact there were 0·3 ohms in series with the coil under observation. I could reproduce, were it worth while, half a dozen different curves all showing this peak whenever commutation occurs while the current is zero. The cause of this is fairly obvious. If the current at all resembles a sine wave, its greatest rate of change occurs at the moment when it

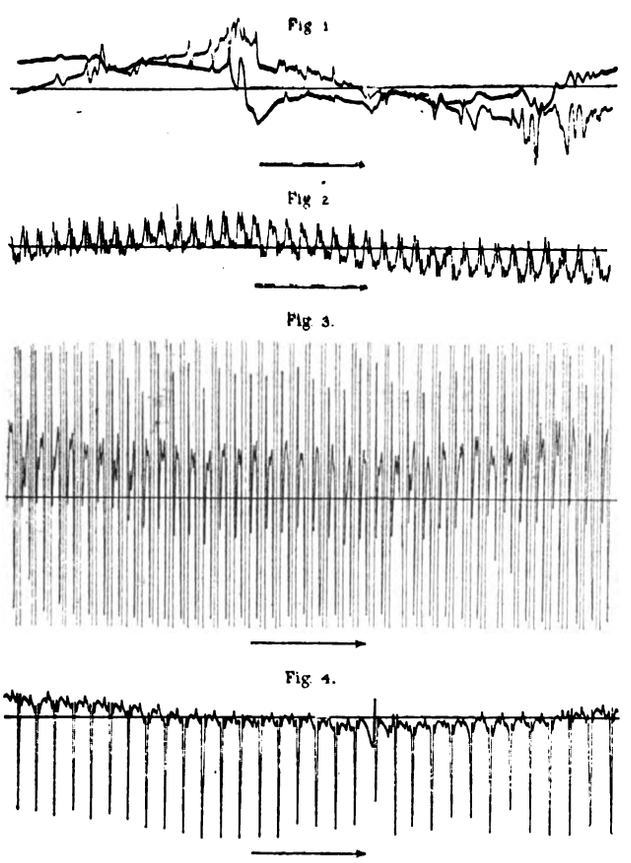


FIG B.

reverses, and consequently the E.M.F. induced in the short-circuited coil will be greatest at this moment.

From the nature of the ripples in the current curves they appear to be due to variations of the brush contact or some such cause. We should therefore expect that both they and the oscillations in the E.M.F. curve would disappear at standstill. This was tried and found to be the case, both being nearly sine curves. In order to make quite sure that the ripples in the E.M.F. wave were not due to the slots, the motor was driven externally and the brushes lifted. The E.M.F. curve was again found quite regular and devoid of ripples. The brushes were then put down, but were not connected to any external circuit. The result is shown in Curve 1, Fig. B. It may be seen that the peaks in the E.M.F. wave have reappeared, so that it seems as if some, at any rate, of the irregularity is due to the variation of the current in the short-circuited coil.

In order to endeavour to throw some further light on these variations, some experiments were made on a direct-current Westinghouse motor with laminated poles. A search coil of 13 turns was wound on the pole within $\frac{1}{8}$in. of the armature, and the E.M.F. in it was observed: (1) With the motor running light. The result is shown in Curve 2, Fig. B. It is, of course, very similar to that obtained by Dr. Thornton and described in his paper on "Eddy Currents." It contains a slow wave due to the eccentricity of the armature, which was very noticeable in this machine, and a ripple, due primarily, I think, to the slots. Most of these ripples have two peaks, though some have three. (2) With the motor running light, but the brushes moved over so as to produce heavy sparking. The same ripples are noticeable, but one of the hollows in each seems to be exaggerated into a peak of large amplitude in the other direction, while one of the peaks is correspondingly exaggerated. Thus the E.M.F. makes a complete alternation between the main parts of each ripple. (3) In order to find out whether the ripples in the two curves mentioned above are due to the slots or not, the Westinghouse motor was separately excited, run up to full speed, then shut down, the brushes lifted, and the plate taken while the motor continued to run on account of its inertia. The result is shown in Curve 4, Fig. B. The curve is very similar to Curve 2, but smaller. This is not due to a decrease of speed, for a comparison of the frequency of the ripples in the two cases shows that the speed was much the same in both. It still contains very sharp peaks, similar to those in Curve 3, but all on one side of the zero line.

Thus it would appear that the armature current in some way reinforces these ripples and also damps out the sharp peaks shown in Curve 4. A confirmation of this view may be found in the fact that Dr. Thornton found that these ripples were smaller (in fact, he could not observe them at all) when the brushes were in the neutral position than when they were displaced. This certainly suggests the reinforcement of the ripples by the armature current. This may, perhaps, be explained by the action of the armature current on the fringe issuing from the pole-tip.

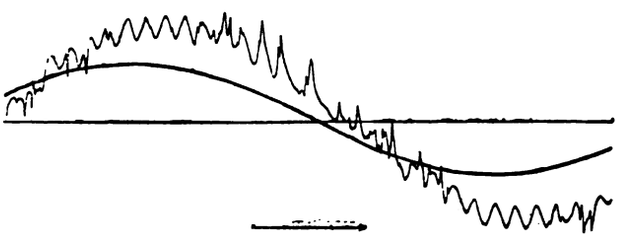

FIG. 14.

To sum up: The fact that we get the irregular-shaped E.M.F.'s shown in Fig. A with direct current as well as with alternating current, and that no such E.M.F. occurs in the Westinghouse motor, justifies us, I think, in inferring that it is peculiar to the motor experimented on. Moreover, the experiments described above definitely show that it is due to some action taking place at the commutator. It must be, I think, due to the fact that in order to get the current density in the brush low enough I was obliged to use brushes of very large area, and thus, the brush-holders being intended for much smaller brushes, the pressure was insufficient and the contact uncertain.

In Fig. 14 are shown curves of main current and counter E.M.F. in the series motor. The motor was driven externally, and the field excited with alternating current. This current and the E.M.F. across the brushes (which were open-circuited except for the oscillograph connections) were then observed on the oscillograph. These curves show very clearly that lag of the counter E.M.F. behind the current which I mentioned in Part 1. The ripples in the counter E.M.F. curve I am inclined to put down to the fact that the brush sometimes short-circuits three and sometimes four segments. When three only are short-circuited, there are more turns on the armature active than when four are short-circuited. When these curves were taken the motor was running approximately in synchronism, and it may be seen that there are about 36 ripples per period—the number of the slots and of the commutator segments. The above curves show something of the actions going on in an alternating-current series motor, but they afford no indication as to how to obtain good commutation. I found, however, that by using a very low current density in the brush, and moderately hard carbons (not too hard), I was able to get perfectly satis-

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factory commutation in the motor I used with all frequencies up to 35, currents up to 30, and speeds up to 3,000. The irregular-shaped E.M.F.'s shown in Fig. A did not seem to affect the commutation.

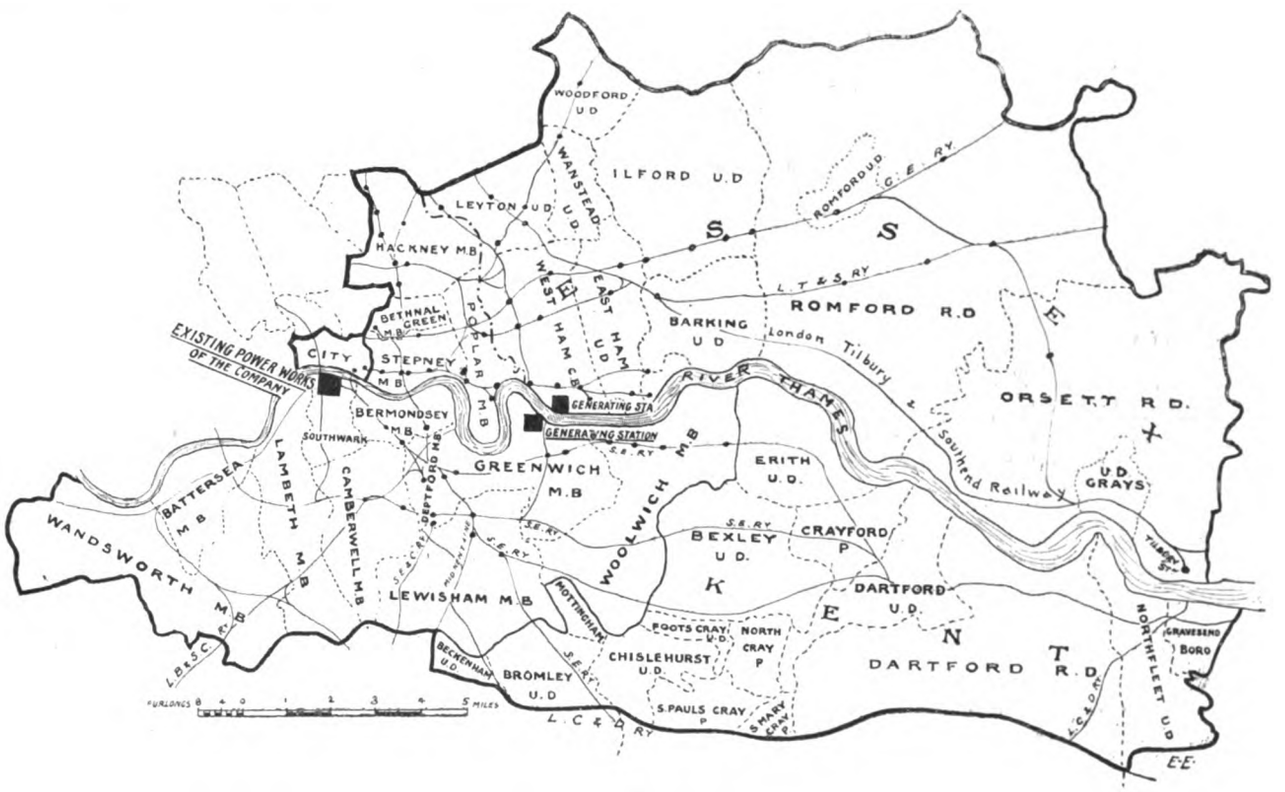
In conclusion, I wish to express my thanks to Prof. Ayrton and Mr. Mather, who have given me every possible assistance in carrying out the above series of experiments, to Mr. W. Cramp, and to the Crypto Works Company, the builders of the experimental motor. I wish also to express my thanks to those second and third year students of the Central Technical College who have assisted me in the above experiments, most of which required three observers. This assistance I have received from Messrs. Montgomrey, Halse, Austin, Webber, Hanson, Gordon, Deakin, Harper, Tanaka, and Strickland.

*(To be continued.)*

## LONDON POWER BILLS.

The committee of the House of Lords presided over by Lord Camperdown resumed on Tuesday the hearing of evidence on the nine Bills which have been promoted to deal with the supply of electric power in and around London. The two Bills now under consideration are the East London and Lower Thames Electric Power Bill and the City of London Electric Lighting Company (Extension of Powers) Bill. It was agreed to take these two as one measure, as they are both promoted by the City of London Electric Lighting Company. We give herewith a map to show the area over which powers are sought for the supply of electricity in bulk. It will be seen by comparing this with the map reproduced on p. 412 in our issue of March 24, that it is practically the industrial area in the Administrative County of London and District Electric Power Bill. The chief difference lies in the fact that Hampstead, St. Pancras, and East London are not included in the northern portion of the area. In introducing the Bill, Mr. Balfour Browne claimed that under the present scheme a supply of power could be quickly given and quite as economically as by the rival company. He explained that the company now had in their Bankside station plant capable of producing 22,000 kw. It was proposed to supplement this by installing at once five turbines of 5,000 kw. each and new boilers. The space at their disposal would enable 55,000 kw. of plant to be installed. The company also had scheduled areas for generating stations in West Ham and Greenwich respectively. He urged that the company ought to receive preference over one which had not previously done any work in the district. The company did not seek powers to compete with the existing companies, but wished to supply municipal undertakers in bulk.

Evidence was given by Mr. Frank Bailey on the engineering part of the scheme, and Mr. H. F. Parshall supported the same. He said from his knowledge of the station at Bankside the company could give an adequate supply of electricity more quickly and more cheaply than a new company could. Evidence was then brought to show the financial position of the company, and that it could promptly raise the extra capital required.




Map of the Proposed Area for Power Supply of the City of London Electric Lighting Company under their Extension of Powers Bill.

# LEGAL INTELLIGENCE.

## TELEPHONIC INTERCOMMUNICATION.

In the King's Bench Division last week Mr. Justice Buckley heard the action brought by the Swansea Corporation against the National Telephone Company, Limited, claiming a declaration that the defendants were bound to connect the telephone junction lines laid by the Corporation with the central switchboard in the National Company's exchange at Swansea.

Before a license was granted to the Corporation in 1902 to provide a system of public telephones in the Swansea area, the defendants worked a telephone system in the area, and their license was extended to 1920. The Corporation asked the defendant company to provide them with facilities for intercommunication; but differences arose between the parties as to the nature of the work to be carried out, and also as to how the costs were to be borne, defendants contending that the costs should be paid by the Corporation.

His Lordship held that the Corporation were entitled to relief. As this was the first case of the kind in the company's history, his Lordship said he would put his judgment into writing, and deliver it at a later date.

## TRAMCAR ACCIDENT.

At the Manchester Assizes last week, before Mr. Justice Bray and a common jury, the Salford Corporation were sued by Mrs. Esom for damages for personal injury.

The case for the plaintiff was that on Oct. 8, which was a Saturday, and a day on which a football match was being played, she, with a child, got upon a Salford Corporation tramcar at a "request" stop, to go to Weaste. She placed the child upon the step of the car and was getting on herself when, before she had obtained a secure footing, the car was started. She fell into the street, and suffered injuries for which she was medically attended.

It was admitted that in consequence of the football match the cars on that day were very crowded. Mrs. Esom said that before she got upon the car three passengers got off.

The case for the Corporation was that the car did not stop where the plaintiff joined it, but that it slowed down because there was

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funeral procession in front of it. The plaintiff was anxious to get home, and he suggested that she thought the car was stopping, and mounted the step. He submitted that it had not been proved that the Corporation servants in charge of the car had been guilty of negligence.

The driver and guard stated that the car did not stop at the spot where the accident happened. No passengers left the car at that point. Similar evidence was given by an inspector.

A tramway inspector said the cars were very crowded at the time the accident happened. He had directed passengers to leave other cars, but he did not remove any passenger from this particular car. There were passengers on the step.

The plaintiff's counsel contended that if the Corporation of Salford made extra profits by carrying extra passengers, they must adopt increased safeguards to prevent overcrowding. It was clearly negligent conduct on the part of the Corporation if they placed themselves in the position of being overmastered by people who boarded the cars at the stopping-places.

The jury gave a verdict for the plaintiff, and awarded her £50 damages. The foreman said he had been requested by his fellows to say that in their opinion the Corporation had overcrowded the car, and had not taken proper precautions to protect the passengers.

Judgment was entered for £50 and costs.

# COMPANIES' MEETINGS AND REPORTS

## GREAT NORTHERN TELEGRAPH OF COPENHAGEN.

The general meeting of this Company was held at Copenhagen on the 29th ult.

Commodore E. SUENSON, the chairman and managing director, announced that the general state of the cables in 1904 has been satisfactory, although interruptions have been unusually frequent. The closing of the cables between Vladivostock and Nagasaki naturally rendered the Vladivostock route useless for all traffic between Europe and the Far East transiting Russia, but the Company has fortunately been able to substitute the alternative route *via* Peking-Kiachta-Irkutsk. The Russian Government has exercised no control whatever over the traffic transiting Russia, and will prevent accumulation of traffic in future by increasing the number of wires between St. Petersburg and Irkutsk. In order to accelerate the transmission over the Company's lines in Europe, not only of the above-mentioned traffic, but also of the whole Russian terminal traffic, the directors have, with the consent of the Imperial Government, established a service at the central station at St. Petersburg for direct working with Great Britain, Sweden, and Denmark, which has also benefited the transmission of telegrams between Russia and France. He then reviewed at length the position of matters in the Far East as affected by the Russo-Japanese campaign, which had naturally caused a dislocation of the commercial traffic, although the increase in the political and Press traffic has been enormous. However sad the causes which have created this huge traffic, financially the year has been unique in the annals of the Company. The directors were prepared for a decrease of £120,000 as a result of the considerable tariff reductions introduced by the London conference in 1903, and had the fortunes of war been different, the decrease would have been heavier still. Instead of this, however, traffic receipts have increased by more than £100,000, and, adding to this the profit from investments in other telegraph undertakings, etc., a total net revenue has been obtained which exceeds that of the hitherto most successful year, 1900, by about £28,900, although the expenditure has considerably increased on account of the expensive establishment at St. Petersburg, the maintenance of the third cable steamer, and the extra expenses necessitated by the transmission of the heavy traffic. Without having in the least altered their views of the position of the Company and its future as expressed in the reports of the preceding years, the directors are able, thanks to the unique results of the year under review, to propose the distribution of a dividend of 12½ per cent., together with a quite exceptional bonus of 11½ per cent., making in all 24 per cent., of which 5 per cent. has already been paid. In order to make this distribution to the shareholders, it has been necessary to place but a very moderate amount to the reserve and dividend equalisation funds. The latter has, however, also been credited with interest at the rate of 4 per cent., thus becoming a kind of savings fund for the benefit of the shareholders. It was proposed to increase by 50 per cent. the amount set aside for the pension fund of the staff, whose numbers have been increased in about the same proportion during the last five years. Dealing with the prolonged negotiations with the British and Danish Governments relating to the laying of the cable which is to connect the Faroe Islands and Iceland with the telegraph system of the world, he stated that, notwithstanding disappointments in regard to Government support, the directors have undertaken to carry it out before Oct. 1, 1906, conditionally upon the prolongation of the Anglo-Danish concessions of the Company until 1925.

## EASTERN EXTENSION, AUSTRALASIA, ETC., TELEGRAPH.

The half-yearly meeting of this Company was held last week under the presidency of Sir John Wolfe Barry. Particulars of the report appeared in our issue of the 28th ult.

The CHAIRMAN, after reviewing the financial position, alluded to references in the Press to a German-Dutch company, which was formed a short time ago under subsidies from the German and Dutch Governments for establishing German-Dutch cables in the Pacific Ocean and between the Netherlands, India, and China. The main object of this Company was to enable Germany and Holland to communicate with their possessions in the Far East independently of the British cables. The Eastern Extension, etc., Company had now come to a satisfactory working arrangement with the German-Dutch company, by which the interests of the former were safeguarded. The cable sections between the Celebes, the Carolines, and Guam, where the German-Dutch system joins the American cable systems, were laid last month, and the section between the Carolines and China is expected to be laid before the end of the current year. Regarding the Pacific Cable Conference, the directors understood that the long-deferred meeting of the Pacific Cable Conference may take place this month, when the effect upon the Pacific cable of the agreements entered into by certain of the Australian States with the Company and other questions arising out of the partnership will presumably be considered.

The Marquis of TWEEDDALE seconded the adoption of the report.

In reply to a shareholder, the CHAIRMAN stated that the reason why the directors did not propose a larger dividend was that they thought it prudent to build up a good reserve fund.

The report was then unanimously agreed to.

Sir A. J. L. Cappel and Sir J. D. Pender were re-elected directors, and a vote of thanks was unanimously accorded the directors.

## WOKING ELECTRIC SUPPLY.

The annual meeting of this Company was held at Woking, Mr. J. Ashby presiding. Particulars of the report appeared in our issue of the 28th ult.

The CHAIRMAN, in moving the adoption of the report, intimated that it was the policy of the Board to build up a solid reserve. The Board of Trade had just granted a provisional order for extending their operations to adjoining districts. As further plant was required the shareholders would be invited to subscribe to a fresh issue. He concluded by eulogising the work of the staff.

The report was unanimously adopted.

## KALGOORLIE ELECTRIC POWER.

The sixth ordinary general meeting of this Company was held last week at Winchester House under the presidency of Mr. Roger W. Wallace, K.C., the chairman of the Company. Particulars of the report appeared in our issue of the 28th ult.

The CHAIRMAN, in moving the adoption of the report and accounts, reviewed the financial position at length, and then outlined the prospects. They had made some favourable contracts during the past few months for the disposal of their power, and they had settled outstanding differences in the way of claims for not taking current. A rather difficult negotiation, which he had been conducting for some time, was with the tramway company, and they had now come to an agreement that was satisfactory to themselves and the tramway company, and he believed it would work well for both parties. The negotiations had been very arduous, and the result was practically this: that they charged the tramway company a fair price for the electricity, and, in conjunction with them, would manage the tramway lines, so that they could see that the electrical load was properly distributed. This would be of very great benefit to them in the working of the Company, as they would have exactly what was required from time to time for carrying out the work. There would be a joint committee of management for the working of the tramway, and this Company would receive the receipts and hand back to the tramway company their proportion of the takings. The arrangement was to run the tramways on a car-mile basis. Should the cost of the electricity delivered to them be cheaper, the tramway company would get 50 per cent. of the benefit, and this Company would get 50 per cent. A further result of this agreement was that practically the whole of their load was now taken up. The contracts, which would commence about August—many of which they had not had any benefit from at present—would make it necessary to consider how they could increase their plant. It would therefore not, in the future, be a question of utilising the plant they had, but of how much it should be increased.

The report was unanimously adopted.

## CALCUTTA ELECTRIC SUPPLY CORPORATION.

The eighth annual meeting was held last week at Salisbury House, Colonel A. J. Filgate presiding. Particulars of the report appeared in our issue of the 28th ult.

In moving the adoption of the report the CHAIRMAN stated that everything pointed to continued prosperity and to a growing business for a considerable time. The Company at the date of formation were granted a license for the supply of electricity under the Act of the Government of Bengal then in force, and they had had three new licenses granted to them for extensions of their area on the Calcutta side of the Hooghly. Since then a new Electricity Act had been passed by the Government of India. The Government officials suggested that it would be desirable to grant the Company a consolidated license under the new Act in supersession of their present licenses. A draft of the license which the Government were prepared to give them had been received, and, while it did not in any way damage them, in one important particular it placed them in a better position. The new license provided for the right to acquire their property at the end of the first 21 years on the same terms as the present licenses, and further provided the right to purchase on the same terms after the completion of each subsequent period of 10 years, so that the license would be a continuing one, and these new conditions were decidedly more favourable to the Company than those of the existing licenses.

The report was unanimously adopted.

A resolution was subsequently passed empowering the Board to arrange with the Government of Bengal and the Municipality of Calcutta and all other necessary authorities for the surrender of the

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Company's existing licenses under the Indian Electricity Acts, and for the grant of a new license or licenses in exchange therefor.

## SOUTH STAFFORDSHIRE TRAMWAYS.

The report for the half-year ended Dec. 31 last, to be submitted at the meeting on the 22nd inst., states that the total revenue for the half-year amounted to £1,257. After deducting all expenses chargeable to revenue, there remains a profit of £653, which, added to the amount of £7 brought forward from the last account, gives an available balance of £670. The directors recommend a dividend of 1s. 8d. per share on the preference shares for the half-year, leaving to be carried forward £37. A settlement has now been arrived at with the South Staffordshire Tramways (Lessee) Company, Limited, with regard to the repayments for reconstruction under the terms of the lease, which is embodied in the draft agreement, and will be submitted for confirmation to the shareholders at the extraordinary general meeting to be held on the 22nd inst. The amount to be repaid for the work already carried out in respect of which that company claims £18,500 has been fixed at £11,500. Negotiations are still pending with the Corporation of Dudley regarding the purchase of the lines within their area.

## WELSBACH INCANDESCENT GAS.

The report for the year ended March 31 states that the net profit of the whole undertaking, including the dividend for the year 1903-1904 upon the Company's holding in the Austrian company, amounts (before deduction of debenture interest) to £94,010. To this has to be added £7,123 carried over from last year, making, in all, £101,134. With regard to the Company's investment in the Austrian company, the Board report that the serious difficulties in carrying out the arrangements for the separation of the "A" (gas) and "B" (electric) undertakings of the Austrian company, referred to at the last annual meeting, have been overcome, and that the necessary sanction of the Austrian Government to the separation has been obtained. As a result, Baron Auer von Welsbach has resumed the part interest in the osmium electric light which was vested in the "B" undertaking, the "B" shares have been formally cancelled, and the "B" undertaking as part of the Austrian company has ceased to exist. The whole control of the Austrian company is therefore now in the hands of the "A" shareholders. The past trading losses of the "B" undertaking have been repaid, with interest, and the Austrian company is under no future liability in connection with the osmium light.

## WESTERN TELEGRAPH.

The report for the half-year ended Dec. 31 states that the revenue amounted to £248,265, and the working expenses to £105,547. After providing for debenture interest and sinking fund and income tax there mains a balance of £123,831, to which is added the sum brought forward, making a total of £128,270. Interim dividends amounting to £62,379 have been paid, and after transferring £60,000 to the general reserve fund and £2,000 to the maintenance ships' reserve fund there remains a balance of £3,891, which is carried forward.

## NEW COMPANIES REGISTERED.

**Electro-Chemical Industries, Limited.**—Registered in Guernsey with a capital of £300,000. Object: to acquire and develop inventions, patent rights, etc., relating to electricity and chemistry.

### Liens Registered.

**Indian Electric Supply and Traction Company, Limited.**—A trust deed, dated April 20, 1905, securing £125,000 "construction" debenture stock has been registered. The company covenants, when Cawnpore undertaking is completed, to execute a mortgage thereof in favour of trustees in accordance with Indian law, with power to previously execute in England a charge on such undertaking, to be merged in the Indian mortgage when created. Trustees: F. L. Harris, M.P., 4, Green-street Park-lane, W.; and E. E. Bird, 58, Cadogan-place, S.W.

**South Metropolitan Electric Light and Power Company, Limited.**—Issue on April 18 of £15,000 debentures, part of a series created July 3, 1900, and May 16, 1904, to secure not more than the paid-up capital for the time being. Property charged: the company's undertaking and property, present and future, including uncalled capital. The debentures are issued to the trustees as further security for debenture stock covered by trust deeds of Aug. 3, 1900, and June, 1904. Trustees: H. R. Beeton, 18 Austinfriars, E.C.; and W. R. Davies, 10, Moorgate-street, E.C. Total amount previously issued of same series, £173,292.

**Electrolytic Alkali Company, Limited (Middlewich).**—Issue on April 13 of £3,150 debentures, part of a series created July 9, 1904, to secure £50,000, charged on the company's undertaking and property, including uncalled capital. Trustees: Liverpool Mortgage Insurance Company, Limited, 6, Castle-street, Liverpool. Total amount previously issued of same series, £17,500.

**Electric Ignition Company, Limited (Birmingham).**—A trust deed, dated April 10, 1905, and a debenture of even date, securing £2,000, have been registered. Property charged (by debenture): the company's undertaking and property, present and future, including uncalled capital, but excluding unissued capital. (By trust deed): manufactory and premises known as the Royal Wellington Works in Sampson-road, Birmingham, and the goodwill of the company's business. Holder: H. Lewis, Langleigh, Olton, Warwickshire. Trustees: F. Lewis and J. W. Lewis, Dominion Works, Upper Dean-street, Birmingham.

**W. T. Glover and Co., Limited.**—Issue on April 6 of £1,000 second mortgage debentures, part of a series created March 27, 1902, to secure £100,000, charged on the company's undertaking and property, present and future, including uncalled capital, subject to £100,000 first mortgage stock. No trustees. Total amount previously of same series, £99,000. A mortage or charge, dated April 6, 1905, to recover £16,100 (being, as to £1,000, part thereof an additional security with above-mentioned debentures), has been registered. Property charged: £80,000 second debentures (part of the said series of £100,000), issued to the Manchester and County Bank, Limited, and all moneys recoverable thereunder, subject to the rights of the said bank. Trustee: C. Cooper, 33, Princess-street, Manchester.

**Eastern Telegraph Company, Limited.**—A mortgage or charge, dated April 5, 1905, to secure £10,000 debenture stock, ranking *pari passu* with previous issues, amounting to £1,897,704, has been registered. Property charged: the company's undertaking and revenue. Holder: F. R. de Levanté, 141, Hill-street, Peckham, S.E.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Tonbridge.**—The Urban District Council require tenders for cables. Tenders by May 29.

**Ashton-under-Lyne.**—The Corporation invite tenders for six tramcars. Tenders by May 23.

**Llandudno.**—The Corporation invite tenders for switchboard extensions. Tenders by May 22.

**Darlington.**—The Corporation invite tenders for two storage batteries. Tenders by May 23.

**Islington.**—The Borough Council require tenders for coal-conveyors, etc. Tenders by May 24.

**Dublin.**—The Port and Docks Board invite tenders for an electric generating station. Tenders by May 15.

**Cataquexes (Spain).**—The local light and power company require tenders for electrical plant. Tenders by July 1.

**St. Pancras.**—The Borough Council invite tenders for the supply of arc lamp carbons for 12 months. Tenders by May 23. See advertisement.

**Glasgow.**—The Trustees of the Clyde Navigation invite tenders for electric arc-light installation for the outer basin of Clydebank Dock. Tenders by May 22.

**Paris.**—The Colonial Office, 4 bis, Rue Jean-Nicot, require tenders for the supply of lamps and lighting accessories for three years. Tenders by May 23.

**Cork.**—The Electric Tramways and Lighting Company, Limited, invite tenders for the year's supply of electrical fittings. See advertisement in last issue.

**St. Marylebone.**—Tenders are invited for the annual supplies in the electricity department. Tenders by May 28. Full particulars in advertisement columns.

**Dartford.**—The Urban District Council invite tenders for the supply and erection of various plant. Tenders by May 24. See advertisement in last issue.

**Edinburgh.**—Tenders are invited for extension of switchboard panel at McDonald-road electricity supply station. Tenders by May 30. See advertisement.

**Cheltenham.**—The Corporation invite tenders for the supply of arc lamp carbons for the year ending March 31, 1906. Tenders by May 17. See advertisement in last issue.

**Leith.**—The Corporation invite tenders for coal elevating and conveying plant and boiler-house auxiliary plant. Tenders by May 17. See advertisement in last issue.

**Cork.**—The Cork Electric Tramways and Lighting Company, Limited, invite tenders for the supply of white wood casing and capping. See advertisement in last issue.

**Liria.**—The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

**Dax (Province of Landes, France).**—The Municipality require tenders for their concession to erect and work electric lighting for 35 years. Tenders to the Mayor by May 14.

**French West Africa.**—The Governor-General of French West Africa, at Dakar, requires tenders for the erection and equipment of a central station at that place. Tenders by May 15.

**Laventhem (Belgium).**—The Municipality require tenders for erection of central station, laying of mains, etc. Particulars (5s. 4d.) may be obtained from the Secretary of the Mayor of that place.

**Kettering.**—The Urban District Council invite tenders for the supply, delivery, and erection of Nernst lamps, posts, etc., for street-lighting within their district. Tenders by May 29. See advertisement in last issue.

**Burslem.**—The Corporation invite tenders for wiring the town hall, markets, baths, gymnasium, and Wedgwood Institute, and also for the supply of house service fuses and meters. Tenders by May 30. See advertisement.

**Stalybridge.**—The Stalybridge, Hyde, Mossley, and Dukinfield Tramway and Electricity Board require tenders for the supply, delivery and erection at the Stalybridge sub-station of a 400-kw. motor-generator, together with the necessary switchgear for same.

**Paisley.**—The Gas Corporation invite tenders for the following plant: (Contract 5) electric power generating plant, consisting o

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gas-engines and dynamos; (Contract 6) elevated electric coke conveyors, electric screening plant, coke storage hoppers, etc. Tenders by May 13.

**Switzerland.**—M. R. Vontobel, of Winterthour, and M. Charles Probst, of Lucerne, have obtained a concession for the construction of a narrow-gauge electric railway from Meiringen to Gletsch. The total cost of the enterprise is estimated at £241,600; £19,600 is to be expended on rolling-stock.

**London.**—The London County Council invite tenders for the supply, erection at its generating station, East Greenwich, S.E., and maintenance for a period of 10 years, of a battery of 280 accumulator cells having capacities of 645 ampere-hours at a three-hour discharge rate and of 480 ampere-hours at a one-hour discharge rate. Tenders by May 16.

**Irvine (Scotland).**—The Corporation invite tenders for the supply and erection of the following plant: (Contract 1) buildings; (Contract 2) power-house plant—(Section A) suction gas plant, gas-engines, and generators; (B) balancers and boosters; (C) battery of accumulators; (D) switchboard; (E) crane; (Contract 3) mains—(Section A) cables, trenches, etc.; (B) converting street lamps; (C) meters. Tenders by May 15.

**Bangour (Scotland).**—The District Lunacy Board invite tenders for the following works: (1) building in boiler economisers, etc.; (2) building in chimney stalk; (3) building in steam and electric cable trenches; (4) steam boilers; (5) engines and dynamos; (6) economisers and piping; (7) overhead travelling cranes; (8) accumulators; (9) switchboard and connections; (10) main cables and branches. Tenders by May 27.

**London, S.E.**—The London County Council invite tenders for the road work and plate-laying required for the construction, for electrical traction on the conduit system, of certain authorised tramways in Blackwall-lane, East Greenwich, and from New Cross to Lewisham, and for the reconstruction, for the same system of electrical traction, of a portion of the existing horse tramways in Woolwich-road, and from Lewisham to Catford. Tenders by 10 a.m. on May 23.

**Heywood.**—The Council invite tenders for (A) Lancashire boiler, feed pump, hot-well, two water-filters, steam feed and blow-off pipes; (B) two 200-kw. steam dynamos, condenser, air and circulating pump, hot-well pump, water-cooling tower, exhaust and circulating pipes, oil separator and pumps; (C) traction switchboard, extensions to lighting board, cable connections, etc.; (D) traction feeders, telephone and test wires, switch pillars. Tenders by May 17. See advertisement in last issue.

## RESULTS OF TENDERS.

**Lowestoft.**—The Town Council have accepted the tender of W. J. Brooke and Co. for the supply of eight arc lamp posts at £10. 10s. each.

**Ramsgate.**—The tender of J. W. Woodhall and Son, Ramsgate, at £3,655, has been accepted for the construction of the new electric power station at Whitehall

**Govan.**—The tender of the Lancashire Dynamo and Motor Company, Trafford Park, Manchester, has been accepted for the supply of motors for all sizes above 3 h.p.

**Aberdeen.**—The Council have accepted the tender of W. H. Bailey and Co., Albion Works, Salford, Manchester, for the supply of one surface condenser, with air pump, oil separator, etc.

**Southampton.**—The Tramways Committee recommend the Council to accept the tender of Messrs. Griffiths, London, at £1,711, for relaying the Portswood-road section of the tramways.

**Bournemouth.**—The British Electric Equipment Company, 11, Queen Victoria street, E.C., have obtained the contract for the Christchurch tramways extension (overhead section) at £4,205.

**Bournemouth.**—The Town Council have accepted the tender of the British Electric Equipment Company, 11, Queen Victoria-street, E.C., at £4,315. 6s., for steel poles, overhead line, section boxes, etc., for the tramways.

**Cardiff.**—The Corporation have accepted the following tenders: British Westinghouse Company, main switchboard, £1,768. 4s.; Yates and Thom, pipes, £1,789; Horsfield and Co., superheaters, £442; General Electric Company, motor-generators, £4,955. 18s.

**Buenos Ayres.**—Messrs. J. G. White and Co., 22A, College-hill, Cannon-street, London, E.C., have been awarded the contract for the construction of the rural tramways. The work comprises supply and erection of 35 miles of overhead equipment, supplying and laying the necessary cables, supply of about 100 cars and equipments, and the erection and equipment of a power house with 2,000 kw. The amount of the contract is approximately £250,000.

**Mexborough.**—The National Electric Construction Company have secured the tramway contract for Mexborough, Rawmarsh, and Swinton. This contract includes the building of the generating station, car-sheds, generating plant, cars, permanent way, and cables; also feeders and distributors for lighting Swinton and Rawmarsh. The same firm have also secured the contract for the laying of permanent way, feeders, and cars for the Torquay tramways. Total amount in all approximate £300,000.

**Wigan.**—The Corporation have accepted the following tenders for (Section A) steam dynamo and accessories; (B) steam and water piping, ejector condenser, and motor-driven centrifugal pump; (C) paper and lead covered cables, dry-core telephone cables, paper and lead covered cables (twin service), and vulcanised rubber cables: (A) Dick, Kerr, and Co., Limited, Albert-square, Manchester, £3,695. 10s. (B) Tickle Bros., Vulcan Foundry, Wigan, £742. (C) Johnson and Phillips, Old Charlton, Kent, paper and service cables, £1,023 and £176; British Insulated and Helsby Cables, Limited, Blackfriars, Manchester, telephone cable £74, rubber cable £464.

**South Africa.**—The *British and South African Export Gazett* mentions the following contracts: The A.E.G. Electrical Company of South Africa have in hand an order for the auxiliary plant for the Pretoria electric installation. Two orders each for a 30-h.p. motor for the Village Deep and the New Modderfontein mines respectively have been placed with the British Westinghouse Electric and Manufacturing Company through C. C. George and Co., Johannesburg. Messrs. Ingram and Kemp, Birmingham, have in hand an order for the supply of electrical fittings for the new city hall, Cape Town. The contract for the supply of the electrical pumping machinery for the Kroonstad water-supply scheme has been given to Messrs. Hubert Davies and Spain, Johannesburg. A powerful electric lift has just been installed at the new premises of Mr. J. Garlick, Cape Town. The makers are R. Waygood and Co., London, S.E. Messrs. Hubert Davies and Spain, Johannesburg, have secured the concession for installing and working electric tramways at Bloemfontein, and will shortly be placing orders for the necessary machinery, etc. An order for an additional alternator for the King William's Town installation has been placed with the Electric Construction Company, and orders for four transformers have likewise been given out.

**Engines.**—Messrs. Browett, Lindley, and Co., Patricroft, report the following recent orders: Industrial Engineering Company, Limited, Hyde (for the Shelton Iron and Steel Company, Limited), one 150-kw. engine; Newport Corporation, one 300-kw. steam dynamo, also one 200-kw. steam balancer, including dynamos by the General Electric Company, Limited; Bruce Peebles and Co., Limited (for the Canadian Electric Tramways), one 250-kw. engine; the General Electric Company, Limited, the jet condensing plant for the King's Lynn Corporation; J. Birch and Co., London (for mill lighting in India), one 50-kw. set, including dynamo by J. P. Hall and Co., Limited; Witting, Eborall, and Co., London (for mill lighting in India), one 50-kw. engine; British Thomson-Houston Company, Limited (for the Hoylake Urban District Council's electricity works), one 250-kw. engine; J. H. Holmes and Co., Newcastle-on-Tyne (for Brookes and Doxey, Limited), a tandem compound engine; Fernhurst Spinning Company, Limited, Oldham, one 1,400-i.h.p. three-crank, triple-expansion vertical Corliss engine for driving their mill by ropes; Phœnix Dynamo Manufacturing Company, Limited, Bradford, one 300-kw. engine for the Keighley Corporation; one 85-kw. engine for coupling to a three-phase generator for a large Bradford mill; also an engine for coupling to a dynamo for the West Riding County Council.

# BUSINESS NOTES.

## TRACTION.

**Cheshunt.**—The tramway order is still under consideration by the Board of Trade with reference to proposed alterations in the financial clauses.

**Lancs. and Yorks Railway.**—A fire occurred last Saturday evening on one of the electric trains running between Liverpool and Southport, but no casualties occurred.

**Leeds.**—The Tramway Committee have decided to recommend the Council to allocate £55 000 of the tramway profits to the relief of the rates, as compared with £52,000 a year ago.

**Heywood.**—The terms given in our last week's issue for the running of cars between this town and Bury and Rochdale have been approved by the respective Tramways Committees.

**Maidstone-Headcorn.**—The enquiry into the project of a light railway between these places has been completed, but the Commissioners may visit the route again before giving their decision.

**Mansfield Light Railways.**—The Board of Trade have sanctioned an extension of time for six months for the construction of the lines authorised by the Mansfield and District light railways order.

**Folkestone.**—The Corporation have apparently decided that a sub-committee shall proceed with the negotiations with the Traction and Power Securities Company and Lord Radnor in reference to the construction of a tramway system.

**Edinburgh.**—Under the Private Legislation Procedure (Scotland) Act a provisional order has now been lodged by which it is sought to incorporate the Edinburgh Suburban Electric Tramways Company, empowering them to construct several electric lines.

**York.**—The local branch of the Independent Labour Party has issued a manifesto supporting the Corporation in the deadlock which has occurred in the negotiations between the Corporation and the company for the purchase of the latter's undertaking.

**Coventry Electric Tramway Co.**—The Hon. Arthur G. Brand, M.P., presided at the meeting of this company and moved the adoption of the report, which stated that the net earnings for the year were £3,410, being a decrease of £1,232 from the year 1902. The report was adopted.

**London United Tramways Co.**—The Unopposed Bills Committee of the House of Commons have passed the Bill of this company seeking an extension of two years in respect of the construction of tramways in Croydon and Wimbledon authorised under previous Acts. It had been found impossible to carry out the work in the limited time specified in those Acts.

**Lampeter-to-New Quay.**—The promoters of the proposed light railway to connect Lampeter, Aberayron, and New Quay are doing their utmost to secure the success of the project they have in hand, and at the next meeting of the Cardiganshire County Council a motion will be brought forward asking the County Council to grant a sum of £30.000 towards the project.

**Cape Electric Tramways.**—Another meeting of this company is to be held on the 23rd inst. It is a sequel to the gathering held some

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little time back. At that meeting, it will be remembered, Mr. Parrish was removed from the Board after a poll had been taken. Mr. Parrish then intimated that he would requisition another meeting, so that the directors would have definite instructions from the shareholders not to buy or re-lease the Consolidated undertaking. The directors state that they are in entire accord with this resolution.

**Dundee.**—It is reported that a company is considering the question of starting a motor 'bus service in Dundee and district. The proposal is to run vehicles of the type so familiar in London. The route favoured in the first instance is towards the east, connecting the city with Broughty Ferry, Monifieth, and Carnoustie, and then probably Birkhill and several of the villages along Perth road. It is thought that the capital necessary to establish a rapid service in the Broughty direction would not be heavy—not more than about £12,000.

**London County Council.**—The Camberwell Borough Council has appointed the Mayor and Councillor A. T. Moore, with the town clerk and borough engineer, to give evidence in support of the County Council's Bill for carrying the trams over Blackfriars Bridge. The Borough Council have also decided to support the County Council in the latter's endeavour to obtain enlarged powers in reference to the laying of temporary rails. The Stepney Borough Council have also agreed to support the Council's scheme for carrying the trams over Blackfriars Bridge.

**Burton-on-Trent.**—The report relating to the tramways for the year ending March 31 last was issued at the meeting on Wednesday. The amount expended on capital account reached the sum of £86,012. 13s. 11d. The number of passengers carried was 3,878,269, and the traffic receipts per car mile were 9·21d. The maximum number of passengers carried any one day was 24,885, and the receipts £125. 4s. The gross revenue account for the year showed a surplus of income over expenditure of £5,160. 19s. 5d., of which £4,604. 0s. 7d. was absorbed in repayment of debt and interest, leaving a balance of £556. 18s. 10d., which it was proposed to carry to the repairs and renewal fund.

**Aberdeen.**—At the meeting of the Tramways Committee last week a letter was read from the Aberdeen Suburban Tramway Company intimating the acceptance of the Corporation's terms as to running powers for another year. It was resolved to lodge a petition against the Great North of Scotland Railway Company's provisional order for the running of motor 'buses in connection with their trains. The new Guild-street bridge having now been taken over by the Streets and Roads Committee, instruction was given that intimation should be made to the Board of Trade, requesting the inspector to go over the tramway line and pass it, with a view of traffic being commenced at as early a date as possible.

**Liverpool.**—We learn from Mr. C. R. Bellamy, the general manager of the Corporation tramways, that in the annual report for 1904 certain figures were transposed through a printer's error. The main items in this connection, correctly rendered, are as follows, the figures referring to 1902, 1903, and 1904 respectively: total capital expenditure to end of year, £1,832 977, £1,863 485, and £1,916 257; revenue, £517,935, £544,720, £557,888; operating costs, £339,810, £341,463, £367,845; percentage of operating costs to total revenue, 65 per cent., 62·6 per cent., 65·9 per cent.; gross profits, £178,124, £203,256, £190,043; interest and sinking fund, £102,627, £107,014; £108,717; balance, £75,497, £96,242, £54,217.

**Bury.**—The Corporation have adopted the following report of the Tramways Committee: "That the committee are of the opinion that it is desirable the existing tramways in Bolton-road should be extended along that road to the boundary of the borough of Bolton and of the township of Ainsworth, and therefore reques: the Council's instructions in the matter," and "that the Council be requested, in the event of their deciding to proceed with the Bolton-road extension, to direct whether or not powers shall at the same time be sought to extend the Fairfield section to the boundary of the borough of Bury on Rochdale Old-road, and also for the extension of the Limefield section to the boundary of the borough on Walmersley-road."

**Birmingham.**—An accident took place on Saturday morning on the Small Heath electric tram route. The trolley wire broke at the corner of Hill-street and Station-street, and in its fall it struck Frank Keisler, of 95, Coventry-road, Hay Hills, causing injuries which were subsequently treated at the Queen's Hospital. At the time of the accident an electric car was proceeding round the corner at the junction of Hurst-street, Hill-street, and Station-street. The upper deck of the car was well laden with passengers, and, as the terminus was near, all were preparing to get off. Keisler had, in fact, just stepped off the footboard when the wire snapped, and it caught him on the forehead, inflicting a wound over the left eye and an injury also to the nose.

**Bordeaux Tramways.**—The directors of the Compagnie Française des Tramways Electriques et Omnibus de Bordeaux have declared a dividend for the half-year ended Dec. 31, 1904, of 6fr. on registered shares by endorsement on certificate, and 5 85fr. on bearer shares against coupon No. 7. The company also announces that 211 shares have been drawn for repayment at 298fr. per share, the holders also receiving a dividend share (action de Jouissance). The registered certificates, coupons, and drawn shares can be deposited with the Comptoir National d'Escompte de Paris (London agency), 52, Threadneedle-street, E.C., for payment at the current rate of exchange of the day, where a list of the shares drawn for redemption can be seen on application.

**Gloucester.**—The first annual report of the Gloucester Light Railways Committee and an analytical statement of operating expenditure and income from April 29, 1904, to March 31, 1905, has been issued. The result of the 11 months' working shows that the revenue amounted to £13,908. 8s. 2d., and the operating expenses to £9,741. 14s. 11d., showing a gross profit of £4,166. 13s. 3d. to carry to net revenue account. The total receipts amount to 7·43d. per car mile and total operating charges to 5·20d. per car mile. The cars have run 449,320 miles and have carried 3,546,852 passengers during the 11 months, the traffic earnings per car mile being 7·22d. There were no serious casualties. The undertaking has taken energy to the extent of £2,831. 0s. 7d. from the electricity department of the Corporation, contributed to the rates £226. 18s. 5d., and effected a considerable saving in road maintenance.

**Glasgow.**—At the enquiry into the Corporation's Tramways Consolidation Bill, which seeks, among other things, power to extend the lines and to carry parcels, opposition was offered by the railway companies, who contended that if the Corporation were empowered to carry parcels, it would convert what had hitherto been a tramway into a light railway. The proposal to extend the Corporation system to Barrhead has been dropped. At a meeting of the Town Council, the convener of the Tramways Committee stated that negotiations with the County Council of Renfrew had been broken off. Decisions have been given in regard to several proposals for extensions of the Glasgow tramways. The Commissioners found that a case had not been made out for the extension of the system from Maryhill into the county of Dumbarton to Canniesburn, but they sanctioned the extension as far as Garscube Bridge, which is the municipal boundary. They also sanctioned two important extensions into Lanarkshire, on the east of the city, from Barrachnie to Baillieston, and from Tollcross to Uddingston.

**Aston.**—In submitting the report of the Public Works Committee Alderman W. Evans mentioned the steps which they were taking concerning the future working of the tramways. The committee had passed two resolutions, which they asked the Council to approve of. The first resolution read: "That the town clerk be instructed to make application to the City of Birmingham Tramways Company for a statement of accounts showing the result of the working of the tramways within the borough, the subject of the agreement of June 9, 1903." Alderman Evans added that they wished to see what the trading profit had been for the past year before they could be prepared to negotiate or to do anything with Birmingham. The second resolution was: "Resolved that a committee of three, consisting of the Mayor, Alderman Evans, and Alderman Smith, be deputed to see the B.E.T. Company with a view to ascertaining what arrangements they are prepared to make if the Council released them from the terms of their agreement of June 9, 1903, and also, if thought desirable, to see the Corporation of Birmingham and ascertain what terms that body are prepared to offer, if the Council would grant them a lease of their tramlines within the borough for a period of 21 years." This, remarked Alderman Evans, ought to satisfy everyone of them that the committee were doing all they could to bring about an amicable working arrangement with Birmingham in the interests of the people of Aston. The report was adopted.

**Belfast.**—At the meeting of the Tramways Committee last week a letter was read from the British Electric Traction Company as to the supply of current for the Cavehill and Whitewell tramways, stating that, having carefully considered the Corporation's offer, they were now prepared to take current from the Corporation at a flat rate of 1½d. per unit, and they wished to know at what time the current would be supplied. After some conversation between the electrical engineer and the members it was resolved that no alteration could be made in the conditions upon which the first offer had been tendered to the company. The next business was taken up, which was the surveyor's report in regard to the progress of the work of reconstruction. He stated that there were 14 miles of the track completed, five miles at present under construction, and several miles ready for traffic. The general manager, in his report, intimated that he had received a letter from the makers of the tramcars, from which he expected to have the first car in Belfast upon Thursday next. After that the cars would be delivered at the rate of so many every week, and the whole of them would be there by September next. In order that he might have a sufficient number to commence the full service, he asked permission to transform in their own workshops 50 of the old cars into electric cars, which would bring the total available up to 220. This was agreed to after some discussion. Mr. Nance reported that the track was now completed on the Shore-road and on the Lisburn-road as far as Balmoral, and it was intended to deal with the Malone-road immediately. A councillor suggested that a letter should be written to the National Telephone Company pointing out that the latter had not yet removed all the wires that must necessarily be removed along the tracks. In answer to questions, the electrical engineer said it would be most dangerous to run the electric cars where these telephone wires were allowed to remain. It was decided to write to the company.

**Plymouth.**—It is reported that friction has arisen between the Corporation and the Plymouth, Stonehouse, and Devonport Tramways Company. A few years ago the Corporation, under an agreement with the company, reconstructed and electrically equipped the tramway from Derry's Clock to the borough boundary at the Palace Theatre, and leased it to the company on payment of a rental calculated at 11 per cent. on the capital outlay. At that time the company had the sole use of the line, the Theatre Royal being the terminus for all the Corporation trams. Subsequently, however, the Corporation made the Palace Theatre the terminus for the Prince Rock cars, and more recently for the Peverell Park cars also. This has greatly increased the traffic over the Union-street line, and the company complain strongly of the inconvenience which has resulted to their service, and the unfairness of the competition they have now to meet. Under the agreement, the company take from the Corporation electric current for the working of their cars between Derry's Clock and the Palace Theatre, and they complain of the charge as excessive. Another matter of difference is the assessment of the tramway undertaking. In addition to the rental charge, the company have been called upon by the Corporation to pay the full rates on the property. While they had the exclusive use of the line the company paid the rates without question, but since the Corporation have been running their cars over the line the company have

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objected to pay the rates, and considerable arrears, amounting to several hundred pounds, have accumulated. Efforts to arrive at an amicable settlement have not so far met with much success, and the Tramways Committee at a special meeting reviewed the whole position. It was reported to them that the Plymouth, Stonehouse, and Devonport Tramways Company had failed to make the payments due to the Corporation under Section 35 of the Plymouth, Stonehouse, and Devonport Tramways Act, 1900, within the time limited by the Act of Parliament, and the committee thereupon decided to recommend: "That notice in writing be given to the Plymouth, Stonehouse, and Devonport Company determining forthwith all the rights conferred on the company by Section 35 of the said Act, and that all other necessary proceedings be taken to recover payment of the sum due."

**Southampton.**—A good deal of discussion ensued at the last meeting of the Town Council over the clause in the Tramway Committee's report embodying the report of the general manager. In the course of the report, it was stated that the relay of the track in parts of Lodge-road was proposed to be proceeded with immediately, the idea being to relay the portion of single track between Stag Gates and the first loop, and to work on down Lodge-road by sections, relaying those parts which were extremely defective and dangerous, and leaving any considerable length which would not require attention this year. New 7in. rails with welded joints were to be used. It was proposed to take in hand and repair forthwith such short lengths of the rest of the track as were in the worst condition. The general manager expressed the opinion that if the track in High-street were taken in hand as soon as possible, it might be made to last several years longer. The same remarks applied to the Avenue and the rest of the Shirley-road which had not been reconstructed. With regard to the Portswood-road track between St. Denys-road and Avenue-road, he considered it should be relaid throughout. As the energies of the staff would be fully engaged in every other part of the town effecting sectional relays, the general manager proposed, if it were decided that Portswood-road should be reconstructed, to advertise immediately for tenders for carrying out the work. It was desirable to do so at once, because two valuable months had already gone, and with regard to new rails, the mills were now somewhat slack, though they would probably be busy in about six weeks' time. He proposed to adopt a new method of getting rid of rail corrugation, and the apparatus would be made in their own workshop. The manager is unable to give a reliable estimate, as it is not yet known to what extent the reconstruction of the track has deteriorated till the setts, etc., have been stripped. The manager's report proceeds: "That this expenditure is needed I am convinced, and, further, if the deterioration had been taken in hand 12 months ago, it could have been checked with possibly half the present expenditure, while if the work is not done now it will very likely cost double next year to effect the same result. The electrical equipment of the cars and overhead work being in a high state of efficiency will help us a great deal, and if the committee will only give me a free hand, a similar state of affairs in other directions will be obtained. I have several proposals to make for dealing with rail corrugation, but it will be necessary to bring the road surface into better condition before these are tried. As you are aware, meetings of tramways engineers are being held at various places to deal with this vital question." The report was eventually adopted.

**Reading.**—The report of Mr. W. Binns, general manager of the Corporation tramways, for the past year states that the total receipts from all sources amounted to £33 573. 4s. 10d., and the total working expenses to £18 892. 9s. 8d., leaving a gross profit of £14,130. 15s. 2d. Interest and sinking fund absorb £11,757. 0s. 2d., leaving a net profit on the year's working of £2,923. 15s., which, with a balance of £618 10s. 4d. brought forward from last year, leaves £3,542. 5s. 4d. available for appropriation. Mr. Binns recommended that this be placed to a reserve or renewals fund account, to meet the heavier items of expenditure which will arise as time goes on, consequent on the depreciation of the equipment. Mr. Binns added: "As I have pointed out on previous occasions, some municipalities have unwisely put what they termed profits to the relief of the rates, without first building up a reserve fund for depreciation and renewals, and their subsequent experience has proved that the policy was financially unsound. I am hopeful that with steadily increasing traffic and increased revenue from other sources, still better results may be obtained during the coming year." The number of miles run by the cars was 872 426, and the traffic receipts per car mile amounted to 8·98d., or ·97d. per passenger carried. The total traffic receipts amounted to £32,650. 10s. 1d. Mr. Binns stated that if the Corporation had obtained the large bogie cars for use during the summer months, the receipts would have been better, but the summer was almost over when they were delivered. By slightly increasing the speed of the cars the time taken on the various journeys can be reduced, and arrangements have been made for some time past for carrying this improvement into effect, but until the public were well accustomed to the higher speeds of the electric cars, compared to the old horse cars, Mr. Binns thought it inadvisable to make any alteration, but he thinks that the service may now be accelerated without danger. In the autumn the parcel system was commenced, and is developing, a sum of about £140 having been obtained from this source during the past few months. The consumption of electric current per car mile was 1·02 units, which which is well below the average of most tramway systems; 1,020,400 units have been generated during the year, the works costs per unit being ·74d, as against ·85d. during the first 8½ months of electric traction—from July 22, 1903, to March 31, 1904. The permanent way has been carefully inspected and defects remedied as soon as they were observed, but the paving of the permanent way, where lava setts have been laid, is causing considerable expense. The permanent way in Duke-street, parts of Caversham-road, King-street, and Bridge-street has already been relaid, and other parts of the track where lava setts are laid will have to be repaved in the near future. The report was adopted.

## LIGHTING AND GENERAL.

**West Hartlepool.**—Sanction has been received to the borrowing of £2 200 for the provision of additional plant.

**Swanage.**—The National Telephone Company are just connecting the various places in the town with the local exchange.

**Southampton.**—The head telegraph office at Southampton will soon be transferred to the new premises erected near the docks.

**Wednesbury.**—The electrical main in Walsall-street is to be extended a distance of 370 yards down Spring Head at an estimated cost of £96.

**Islington.**—The Borough Council have decided to borrow £15,500 for electric lighting extensions. Details of the scheme appeared in our issue of April 28.

**Bills.**—The Andover Lighting and Power Bill and the South Wales Electrical Power Distribution Company's Bill have been read a third time in the House of Commons.

**Swansea Telephones.**—The telephone manager's last report shows that there are 1,171 lines and instruments working, 1,034 subscribers on the books, and 178 orders in hand.

**Manchester.**—The Corporation have placed an order with Ferranti Limited for the supply of continuous-current switchgear for the Dickinson-street generating station.

**Winchester.**—An attractive electrical exhibition has been held at the St. John's Rooms under the auspices of the Winchester Electric Light and Power Company, Limited.

**Stockport Telephones.**—The Stockport tradesmen have joined in the protest against the purchase of the National Telephone Company's concern on the terms of the provisional agreement.

**St. Annes.**—The output at the electricity works for the year ending March 31 totalled 589 500 units, an increase of 105,518 units. The number of consumers had increased by 72, and was now 321.

**Colne.**—An application of the National Telephone Company, asking for permission to lay underground conduits along the public highways in Colne, has been referred to the borough surveyor for report.

**Sale of Plant.**—The Aldershot Urban District Council have for sale 24 Watson penny prepayment meters calibrated for a 210-volt circuit with energy at 6d. per unit. Details in another column.

**Brighton.**—An enquiry was held on the 11th inst. into the Town Council's application for sanction to borrow £11,617 for purposes of the Council's telephonic undertaking. The undertaking shows a profit of £413 for the past year.

**County of London Electric Supply Co.**—The sales in the London district during the quarter ended March 31 are estimated to realise about £41,895, which compares with £37,925 for the corresponding period of last year.

**South Africa.**—An immediate increase in the electrical equipment of the General Electric Power Company, Limited, Brakpan, Transvaal, has been decided upon. The Vryheid (Natal) Local Board have decided to instal an electric light service, and orders for the material required will shortly be forthcoming. Two 400-b.h.p. electric motors are to be installed in each 220-stamp mill of 1,350lb. stamps at the Angelo and Cason gold mines. The *British South African Export Gazette*, to which we are indebted for the above items, also mentions forthcoming developments in Krugersdorp electric lighting, and an increased demand for electric motors in the Transvaal and Natal for mining and manufacturing purposes.

**Stock Exchange.**—The Stock Exchange Committee have ordered the undermentioned securities to be quoted in the official list: Electric Lighting and Traction Company of Australia further issue of £70,000 5 per cent. first debenture stock, and Primitiva Gas and Electric Lighting Company of Buenos Ayres further issue of £55,000 4 per cent. first debentures of £100 each, Nos. 4,451 to 5,000. Applications have been made to the committee to allow the following securities to be quoted in the official list: Baker-street and Waterloo Railway Company's £500,000 4 per cent. debenture stock, in lieu of the Speyer Bros.' scrip certificates now quoted; British Electric Traction Company's further issue of £448,653 5 per cent. perpetual debenture stock, and £158,623 4½ per cent. second debenture stock; Consolidated Electrical Company's 110,000 ordinary shares of £1 each, fully paid; County of London Electric Supply Company's £250,000 4½ per cent. second debenture stock, in lieu of the provisional certificates now quoted, together with a further issue of £150,000 4½ per cent. second debenture stock; Rosario Electric Company's 12,000 6 per cent. cumulative preference shares of £5 each, fully paid.

**Fulham.**—At a recent Council meeting a resolution was passed consenting to the erection of temporary poles in Queensmill-road to carry overhead wires for fire-alarm purposes as required by the London County Council. Since then a letter has been received from the Postmaster-General pointing out that in view of his statutory powers, he would be unable to accept a condition limiting the use of poles to any specific purpose, nor would he be justified in agreeing to the erection of temporary poles, a condition which would be equivalent to an undertaking to remove the poles at the request of the Council at any time. As an alternative to this condition he would not object to the Council reserving a power to withdraw their consent at, say, three months' notice. This would safeguard the Postmaster-General's right of appeal and preserve a principle to which he is obliged to attach great importance. The Council propose to consent to the placing of an overhead telegraphic line on the understanding that the Postmaster-General is to make good any damage which may be done in the placing or maintenance of the line, the Borough Council reserving power to withdraw such consent at three months' notice. The Electricity Committee have recommended that the alterations to the rectifier room at the electricity works be carried out by the borough surveyor by direct labour at a cost of £250.

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**Barrow.**—The electrical engineer is sending circulars to all consumers of electricity informing them that the meter readers will in future wear badges, and requesting that no person without such badge be allowed to examine the metors.

**Wood Green.**—The Urban District Council complain about the above-ground telegraph lines on the south side of Lordship-lane. It is contended that they had spent money in beautifying the district, and now these ugly poles would spoil their efforts.

**Cheltenham.**—The process of wiping off the electricity deficit will take a rate of 2d. in the £ for 10 years. Last year's expenditure amounted to £15 364, and was below the estimate. For the present year it is estimated that £9,246 will be required.

**Agency.**—Mr. C. R. Heap, 47, Victoria-street, S.W., has been appointed sole agent for London and 11 adjacent counties for the direct and alternating current motors and dynamos and starting switches manufactured by Messrs. Hodgson, Wright, and Wood, of Halifax.

**Bishop's Stortford.**—The promoters of the Bishop's Stortford electric lighting order having agreed to the insertion of a clause for the protection of the interests of the county in regard to bridges and approaches, the Herts County Council's opposition to the order has been withdrawn.

**Newcastle.**—The Newcastle and District Electric Lighting Company on Tuesday decided that on and after July 1, 1905, the price of electricity for lighting should be 4½d. per Board of Trade unit, with an allowance of 1d. per unit on accounts paid monthly as at present, making the price 3½d. per unit net.

**Macclesfield.**—Mr. Woodward has undertaken to formulate a scheme of electricity for the borough. The following sub-committee has been appointed to report on suitable sites for a generating station: The Mayor, Alderman Brocklehurst, Councillors Cameron, W. R. Brown, Isherwood, Clayton, and Bailey.

**Worthing.**—It is proposed to apply for sanction to a loan of £3,000 for extension of plant, mains, etc., required to enable the electric light works to deal with the demands of next winter. These include an additional boiler with steam and water pipes at an estimated cost of £860, and extensions of feeder and of distributing mains.

**New Zealand.**—The Auckland Council are considering a proposal by Mr. P. M. Hansen, managing director of the electric tramways company, for the supply of current for public street-lighting. Mr. R. D. D. McLean is installing an electric power plant for his Maraekakaho sheep station. The Westinghouse Company have obtained the contract.

**Ayr.**—Thirteen new consumers were connected during April, making a total of 866; 344 lamps were connected (total, 37,050), and one motor (total, 32). The units generated during the month were 86,948 (total for the year, 1,250,526). The units generated for the corresponding period last year amounted to 1,179,158. There is thus an increase of 71,368 units.

**East Molesey.**—The District Council have approved plans from the Twickenham and Teddington Electric Supply Company for the laying of their cables in 20 roads in the district, subject to the work being completed within three months from the date of its commencement, and to a schedule of prices being agreed for the reinstatement of the footpaths by the Council.

**West Bromwich.**—The Town Council have approved a report with respect to the proposed purchase of the National Telephone Company's system by the Government, and recommended the adoption of a resolution expressing the opinion that such a transaction could not be effected on terms which would permit of the provision of a permanently cheap and effective service, and strongly urging adherence to the policy embodied in the Telegraphs (Telephones) Act, 1899.

**Dublin.**—The Corporation at their last meeting discussed and passed the following resolution: "That report No. 60, together with the letter from Messrs. Robert Hammond and Son, be referred back to the Lighting Committee, the committee to confer with Mr. Robert Hammond regarding the amendment of the existing agreement suggested in the letter from Messrs. Hammond and Son, and to report thereon to the next ordinary meeting of the Council."

**Nelson.**—The price of current for lighting and motive power has been reduced as from April 1 as follows: For lighting—up to 1,000 units per annum, 4d. per unit; up to 3,000 units per annum, 3¾d. per unit; up to 5,000 units per annum, 3½d. per unit; up to 8,000 units per annum, 3¼d. per unit; over 8,000 units per annum, 3d. per unit. For motive power—for the first hour, 2½d. per unit; and for every subsequent hour 1½d. per unit. All these charges are subject to 5 per cent. discount in all cases for prompt payment.

**Morley.**—The borough electrical engineer, Mr. J. E. Ellis, in his last report gives the output from the electricity works during the month ending March 31 as 13,993 units, which compared with 13,722 in the corresponding period last year shows an increase of 271 units. The quantity consumed by meter was 9,812 units, as compared with 8,703 the same period of last year, being an increase of 1,109 units. There were 296 lamps connected during the month and 26 disconnected, the total number of lamps connected to date being 12 571.

**Hastings.**—In order to locate faults in the distributing network at Warrior-square, four disconnecting boxes are to be placed in the square at an estimated cost of £80, to be defrayed out of the loan of £4,500 sanctioned for new mains. The high-tension feeder between the works and the sub-station at the hospital is to be extended at a cost of £380. In his last report, which has been adopted by the Council, Mr. Fergusson, electric light engineer, mentions that, owing to the reorganisation of the electric lighting department, Mr. Glass has been placed in charge of the public lighting department at an increased salary.

**Stockton.**—Over 34,900 lamps were connected during the quarter, and applications have been received for 60 more. The units sold numbered 178,930, against 135,560 in the corresponding quarter of last year. At the last Town Council meeting Mr. Tomkins, chairman of the Electricity Committee, said that the cost of production had been cut down in every item, with the result that the committee were able to allow the following substantial discount to consumers of electricity for business purposes: 2½ per cent. on accounts of between £100 and £200 per annum, 5 per cent. between £200 and £300, and 10 per cent. £300 and upwards.

**Arc Works Club.**—This football club (Messrs. Crompton and Co., Limited, Chelmsford) report a very successful season, with the following results: The first eleven are champions of the Chelmsford and District League, having won the cup and medals. The reserve team are champions of the second division of the Chelmsford and District League, and also receive medals. The first eleven are joint holders with Halstead in the North Essex League. The result of the matches played during the season is as under: Arc Works First, played 25, won 20, lost 3, drawn 2, goals for 118 against 39; Arc Works Second, played 17, won 12, lost 2, drawn 3, goals for 54 against 23.

**Burton-upon-Trent.**—An enquiry has been held into the application of the Town Council to borrow £16 165 for electric light extension, and to replace £6,000 excess of expenditure already incurred on behalf of the electric lighting. The electricity accounts show a total income of £9,791, against £8 962 last year, an increase of £729. The total expenditure, including the surplus, has been £9,791, against £8 962, and the surplus is only £357, as compared with £1,197, a decrease of £840, but this year £303 will be contributed to a sinking fund (reserve) contribution, and this was absent from the sheet last year. The increased income is due to the tramways, which paid £1,337 more for power than in the previous year, and motors also took about £200 more than last year. Against these increases, however, there was a fall of £585 in the sale of current for lighting.

**Worcester.**—Alderman Millington's suggestion regarding the sale of the electricity works was mentioned at the last Council meeting. It was said that such an event would set at liberty a very considerable sum of money—something like £100 000—and that would cover the outlay upon the sewerage works, which would mean a considerable saving in the rates. Others thought that as there was a new engineer it would not be fair to entertain such a proposal until they saw whether he could make the concern pay. It was stated that no doubt the Electricity Committee would take Alderman Millington's suggestion into consideration, but it was hoped that they would not adopt it. It is now 10 years since the works were opened, and the total expenditure to Dec. 31 last amounted to £123 950, but repayments had been set on one side, amounting to £20,850, so that at that date the net capital was £103,100. There has been an annual loss of £428 since the works opened.

**Canterbury.**—The receipts of the electric light undertaking for the year amounted to £6,925, the works costs and loan repayment and interest to £6,720, leaving a balance of £205, representing the net profits of the year's work. The balance brought forward from last year was £911, but the costs of the renewal of the accumulators amounted to £570, which reduced the balance to £341, and left £546 to be carried forward. Although there was an increase of 11½ per cent. on the total amount of current sold to private consumers during the year, the work has been done at 7 per cent. less cost in coal than the previous year. The increase in private lighting consumers was equal to 1,885 8 c.p. lamps, or an increase of 10 per cent. The reduction in price of current of 1d. per unit made a difference of £776 in the year's revenue. Had the price not been reduced the net profit would have been £981. During the year a new battery of accumulators was bought at a cost of £570, and partly paid for out of the previous year's profits.

**Hammersmith.**—At the last meeting of the Board of Guardians a letter was read from the Local Government Board, stating that with regard to the electric lighting, etc., of the new workhouse and infirmary, the questions involved, such as the propriety of accepting a lower tender than that provisionally accepted and the necessity or otherwise for incurring the proposed large expenditure on the transforming scheme, were matters which the Guardians should investigate with the view of ascertaining whether the scheme could not be carried out at a less cost than that proposed; also further stating it did not appear to the Board any advantage would result from their receiving the proposed deputation from the Guardians. The Chairman said that the Guardians having now received the schedule in connection with the electric lighting they had resolved to give an opportunity to the whole of the firms who had sent in tenders on the previous occasion, and that they would consider the same on the 17th inst. This mistake, therefore, had been rectified. The proposition was agreed to.

**Portsmouth.**—An enquiry has been held into the application of the Corporation for sanction to borrow £21,835 for the purpose of extending the municipal telephone system and £8,000 for extensions at the electric light works. Mr. W. S. Foale, the superintending engineer at the electric lighting works, said the net profit on the year's working for 1903 had been £3,000, and £4,000 in the following year, while the reserve fund amounted to £11,725. Mr. Hammond Etherton, the deputy town clerk, said it was intended to bring the present number of telephone lines up to 3,000. The principal items were £5,194 for a new underground route to Stamshaw and North End, which was to be a cable of 312 pairs, and of three new sections of the multiple switchboard at the central exchange room for 960 new lines—640 at once and 320 as the necessity arose—for which £2,134 was required. The other amounts were for work at Gosport, a switch-room at Porchester, etc. The system had been working since March 1, 1903, and the first year's profit was £1,233. 18s. 10d., while last year the amount of profit on the year's working was £1,969. 9s. 8d., of which £614 had been paid over to the suspense account.

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**Durham.**—Amongst the various matters which were brought before the County Council, but had to be postponed owing to the lateness of the hour when they were reached, was a report of the Electricity Supply Committee, which contained the following resolution: "That the Durham County Council hereby resolve to promote a Bill in Parliament having for its object the establishment of a system of electrical services for the county of Durham." There was also a paragraph relating to the Houghton-le-Spring and District electric lighting provisional order, as follows: "The Board of Trade, dated 6th inst., have granted the Houghton-le-Spring and District electric lighting order and have not been able to insert the clause submitted for the protection of the Durham County Council. We think the practice of a paid Government official having power to supersede and ignore the collective opinion of a large representative body like the Durham County Council upon questions immediately touching the welfare and working of the county is fraught with the greatest danger to public interest. It appears reasonable to assume that whilst a county council are actually engaged in developing a county scheme of electric service for the convenience and welfare of all, that it is the obvious duty of the Board of Trade not to hamper and well nigh render impossible the evolution of such a scheme by handing over to private companies a monopoly over large portions of the county for nearly half a century to come. It amounts to the removal of the administration in a very important sense from our representative assembly in Durham to a Government office in London, and should not be allowed to pass without protest."

## PROVISIONAL PATENTS, 1905.

MAY 1.

**9101. Improvements relating to electrical connections.** Philip Henry Jones, 25, Allesley Old-road, Coventry. (Complete specification.)

**9107. New or improved method of constructing or manufacturing electric traction cells, accumulators, and electric storage or secondary batteries.** Georges Schauli, 173, Fleet-street, London.

**9110. Improvements in the distribution of electricity.** Andrew Sweet, Butleigh, Friern-lane, Whetstone, London.

**9113. Improvements in dynamo-electric machinery by means of which a constant voltage may be produced at varying speeds.** John Herbert St. Hill Mawdsley, Norfolk House, Norfolk-street, Strand, London.

**9120. An electric periodical switch.** Armand Frey, 41, Rominterstr., Berlin, Germany. (Date applied for under Patents Act, 1901, Aug. 3, 1904, being date of application in Germany.) (Complete specification.)

**9134. Improvements in and connected with the charging and discharging of secondary batteries applicable to electric train-lighting installations.** J. Stone and Co., Limited, and John Robert Quain, 77, Chancery-lane, London.

MAY 2.

**13736a/04. Improvements in apparatus suitable for detecting electrical oscillations.** John Ambrose Fleming, 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Rule 9, June 17, 1904.)

**9161. Watertight electric lamp for motorcars.** Charles Edward Clark, 395, Summer-lane, Birmingham.

**9162. Improvements in trolley collectors or the like.** Samuel Feather, George Robert Feather, Herbert Henry Feather, Edward Earnshaw Feather, and John William Astley, Moses Gate Brassworks, near Bolton.

**9181. An improved electric light candle fitting.** Hugo Hirst and John Hillery Collings, 71, Queen Victoria-street, London.

**9203. Improved method of electrically operating hydraulic apparatus for opening and closing bulkhead doors of ships and the like.** Edmond Meyer Tudor Boddam, 23, Savernake-road, London.

**9216. Apparatus for purification of water by electrical means.** James Slough Zerbe, 81, High Holborn, London. (Date applied for under Patents Act, 1901, May 2, 1904, being date of application in United States.) (Complete specification.)

**9219. Improvements in coherers.** Guiseppe Magini, 52, Chancery-lane, London. (Date applied for under Patents Act, 1901, May 8 1904 being date of application in Italy.) (Complete specification.)

**9257. Improvements in and means for the electrical regulation of the speed of internal-combustion engines.** Marquis Albert de Dion and Georges Bouton, 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Dec. 23, 1904, being date of application in France.) (Complete specification.)

MAY 3.

**9274. An improved device for preventing accidents through the breakage or dislocation of overhead electric wires.** George Porritt, 6, Finkle-street, Stockton-on-Tees.

**9279. Improvements in apparatus for controlling the supply of energy from alternating-current generators to alternating-current motors.** Arthur Pemberton Wood, 34, Castle-street, Liverpool.

**9296. Improved trolley wheel for use in electric traction.** Firth Bamforth, 51, Deansgate-arcade, Manchester.

**9303. An improved electric switch or protective circuit breaker.** Louis Rutledge Gleason, 420, Uxbridge-road, Shepherd's Bush, London.

**9344. New or improved electric current meter.** Jacob Kruyswijk, 77, Chancery-lane, London. (Date applied for under Patents Act, 1901, May 5, 1904, being date of application in Germany.) (Complete specification.)

**9346. Improved construction of electric accumulator for small arms.** Alexander Elias Dakhyl and Antonio Galanti, 173, Fleet-street, London.

**9347. Improvements in sytems of control for magnetic clutch speed-changing gears, applicable more especially to self-propelled vehicles.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

MAY 4.

**9363. An electromagnetic release for photographic shutters.** Francis Noel Gasquoine, St. Oswalds, Upper Bangor, North Wales.

**9401. Improvements in electric contact devices.** James John Walker, 17, London-road, Wembley, Middlesex.

**9405. Improvements in electromagnetic switch-operating mechanism.** Frederick Theodore Kitt, 52, Chancery-lane, London. (Complete specification.)

**9430. Improvements in electrical switches or circuit breakers.** The British Thomson-Houston Company, Limited, and Edwin Joseph Murphy, 83, Cannon-street, London.

**9431. Improvements in vapour electric apparatus.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**9439. Improvements in fireproof casings and covers for electric conductors.** Henry Redmayne Romney, 65, Chancery-lane, London. (Complete specification.)

**9447. Improvements in the electrolytic refining of copper.** The Metals Corporation, Limited, and Sherard Cowper-Coles, 70, Chancery-lane, London.

**9448. Improvements in and relating to the electrolytic deposition of metals.** Sherard Osborn Cowper-Coles, 70, Chancery-lane, London.

**9455. Combined kerbstone and electric wire conduit.** Patrick John Donohue, 40, Chancery-lane, London. (Complete specification.)

MAY 5.

**9467. An improved method for equalising electrical power when the power required is of an intermittent or variable character.** Rudolf Braun, 4, St. Ann's-square, Manchester. (Complete specification.)

**9475. Improved door for electric switchboard.** John McAllister, 3, St. Joseph's-terrace, Marlborough-park North, Belfast.

**9479. Improvements relating to the electric lighting of railway carriages and other vehicles.** The Electric and Ordnance Accessories Company, Limited, and Robert Frederick Hall, 24, Temple-row, Birmingham.

**9481 Improvements in or relating to electrically illuminated signs or advertising devices.** Percy Beresford Wright Kershaw, 57, Chancery-lane, London.

**9489. Improvements in or connected with dynamo-electric generators and motors.** William Wright Howe, 71, Albion-street, Leeds.

**9501. Improvements in or relating to incandescent electric lamps.** Norman Scholefield Tennant, 50, Wellington-street, Leeds.

**9508. Improvements in skates or collectors for electrically-driven vehicles operated by any surface-contact stud system.** Robert Brown, 16, Great George-street, Westminster.

**9522. Improvements in electric resistance furnaces.** James Francis Bottomley and Arthur Paget, 55, Chancery-lane, London.

**9542. Means for automatically operating the points of slot-conduit electric tramways.** William Arthur Lawrance, 4, South-street, Finsbury, London.

**9543. Improvements in or connected with primary batteries.** Richard Joseph Crowley and Arthur William Macleod, 4, South-street, Finsbury, London.

MAY 6.

**9565. Apparatus for making and breaking electric circuits.** Frank Smith, 51, Deansgate-arcade, Manchester.

**9577. A portable hand electric battery.** Benjamin Seacombe, 170, Knutsford-road, Warrington, Lancs.

**9584. Improvements in or relating to terminals or connectors for electrical conductors.** Athelstane Corderoy and John Frederick Pannell, 111, Hatton-garden, London.

**9602. Improvements in electricity meters.** Stanley Matthews, 4, South-street, Finsbury, London.

**9607. Improved method of and means or apparatus for controlling electric switches and like apparatus in electric current distributing systems.** Guy Carey Fricker, 46, Lincoln's-inn-fields, London.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published May 25.*

1904.

**9518. Hangers or ears for overhead electric trolley wires.** Richardson, Heap, Heap, Bailey, Brierley, and Billington.

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**9969. Electrically-driven coal whips or hoists.** Wilhelmi.

**10070. Regulating sockets or switches for electric lighting, heating, or power purposes.** Bogia.

**10080. System and apparatus used therein for the distribution of electrical energy over a large subdivided area.** Tanner.

**10081. Electric meters.** Venner.

**10461. Multiple electric switch rheostats.** British Thomson-Houston Company, Limited. (General Electric Company.)

**11368. Electric switches suitable for use in connection with telephonic apparatus and for other purposes.** Graham.

**11930. Alternating-current electric motors.** British Thomson-Houston Company, Limited. (General Electric Company.)

**12192. Brush-holders for dynamo-electric machines.** British Thomson-Houston Company, Limited. (General Electric Company.)

**12340. Electric cut-outs, switches, and the like.** British Thomson-Houston Company, Limited, and Cubitt.

**12373. Electrical maximum demand indicator.** Nalder Bros and Thompson, Limited. (White.)

**12970. Small dynamos and motors.** Wright.

**13624. Brush gear specially applicable to commutators of the internal ring type for dynamos and electric motors.** Maclean.

**13862. Electric arc lamps.** British Thomson-Houston Company, Limited. (Allgemeine Elektricitäts-Ges.)

**14071. Apparatus for raising, supporting, and lowering of electric arc lamps.** Berry and Skinner.

**14733. Electric arc lamps.** Carolan. (General Electric Company.)

**14734. Electric arc lamps.** Carolan. (General Electric Company.)

**14735. Electric arc lamps.** Carolan. (General Electric Company.)

**14740. Electric meters.** British Thomson-Houston Company, Limited. (General Electric Company.)

**14770. Electric light reflectors.** Hirst and Collings.

**15034. Electric arc lamps.** Crompton and Co., Limited, and Hodgson.

**21131. Automatic electric switching devices applicable to flash advertising signs and the like.** Percy Benson Harrison Seabrook, Henry Herbert Parkes Seabrook, and Leonard Kingsill Job.

**21846. Electric switches.** Cameron.

**22000. Electric motors.** Jigouzo. (Date applied for under International Convention, Oct. 21, 1903.)

**23399. Electric switches or cut-outs for disconnecting conductors in case of breakage.** Ellor and Ellor.

**23716. Devices for preventing sparking at the commutators and like contact devices of electric motors.** Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, Nov. 2, 1903.)

**23991. Magnetic suspensions for the moving parts of measuring instruments.** Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, Nov. 6, 1903.)

**25643. Space telegraphy.** Stone. (Date applied for under International Convention, Nov. 25, 1903.)

**25846. Space telegraphy.** Stone. (Date applied for under International Convention, Nov. 25, 1903.)

**27199. Method of accelerating the excitation of dynamo-electric machines.** Siemens Bros. and Co., Limited. (Siemens-Schuckertwerke G. m. b. H.)

**28393. Electric current governors or electromagnetic switches.** Boult. (Richards.)

**29014. Electric switches.** Longden.

**29401. Pendant electric fixtures.** Lake. (Bradshaw, Keough, Keough, and Keough.)

**29532. Electrical signalling apparatus.** Holmes. (Date applied for under International Convention, March 19, 1904.)

1905.

**493. Electromagnets for use in electric meters.** Blathy.

**1681. Insulators for electric conductors.** Marconi's Wireless Telegraph Company, Limited, and Turnbull.

**3371. Mechanism for actuating electrical clocks.** Schönberg.

**4062. Sparking plugs operating with magneto-electricity for gas or oil engines.** Rene.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ¾-⅞ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 7/16-17/32 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | – | 5¼-6 |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | – | 5¼-6 |
| —— 4½ per cent. Mortgage Debentures | 100 | – | 102-105 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 100-102 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | – | 2¾-3¼ |
| —— 4 per cent. Mortgage Debenture Stock | 100 | – | 91-93 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,751 | 2 | – | ¼-⅜ |
| —— Non. Cum., 6 per cent. Pref. | 2 | – | 1½-2 |
| —— 4½ per cent. 1st Debenture Stock | 100 | – | 92-95 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | – | 79-82 |
| Callender's Cable, Debentures | 100 | – | 107-109 |
| —— Ordinary | 5 | – | 10¼-11¼ |
| —— 5 per cent. Pref. | 5 | – | 5⅞ 5⅞ |
| Crompton and Co. | 3 | – | 2-2¼ |
| —— 5 per cent. Debentures | 100 | – | 95-100 |
| Edison and Swan United, "A" Shares, 1-99,261 | 5 | – | 1-1¼ |
| —— "A" Shares, 01-017,139 | 5 | – | 1¾-2¼ |
| —— 5 per cent. Debentures | 100 | – | 85 90 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 82-87 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | – | ¾-1¼ |
| —— 7 per cent. Cumulative Pref. | 2 | – | 2¼-2¾ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | – | 95-99 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | – | 9¼-10 |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | – | 97-101 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | – | 11-12 |
| —— 4½ per cent. Preference | 5 | – | 5¼-5⅜ |
| —— 4½ per cent. Debentures | 100 | – | 109-111 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | – | 16-17 |
| —— 4 per cent. Debentures | 100 | – | 100-103 |
| Parker, Thos., Limited, Ordinary | 10 | – | 10-10¼ |
| Telegraph Construction and Maintenance | 12 | – | 35 37 |
| —— 5 per cent. Bonds | 100 | – | 103-105 |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary | 10 | – | 11¾-12¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | – | 10-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | – | 11-12 |
| —— 4½ per cent. Debenture Stock, Red. | 100 | – | 106-108 |
| Bromley (Kent) Electric Light and Power Co. | 5 | .. | 5¼-5⅝ |
| —— 4½ per cent. 1st Debenture Stock, Red. | 100 | – | 101-104 xd |
| Brompton and Kensington, Ordinary | 5 | – | 9¼-10¼ |
| —— 7 per cent. Preference | 5 | – | 9¼-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 | 5 | – | 8¾ 9¼ |
| —— Nos. 60,001-80,000 | 5 | – | 7¾ 8¼ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | – | 12¼-13¼ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 105-108 |
| Charing Cross and Strand, 70,001-80,000 | 5 | – | 7¼-8¼ |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5⅝-5⅞ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 5-5¼ |
| —— 40,001-80,000 | 5 | .. | 5-5¼ |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | – | 105-107 |
| Chelsea Electricity Supply | 5 | – | 6¼-7 |
| —— 4½ per cent. Debentures | 100 | – | 109-111 |
| City of London, Ordinary | 10 | – | 11-12 |
| —— 6 per cent. Cumulative Pref. | 10 | – | 13¾-14¼ |
| —— 5 per cent. Debenture Stock | 100 | – | 125-127 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | – | 103-105 |
| County of London Electric Supply, Ordinary | 10 | – | 8¾ 9¼ |
| —— 6 per cent. Cum. Pref. | 10 | – | 12-12¼ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Red. | 100 | – | 102-104 xd |
| —— 4½ per cent. 2nd Debentures Prov. Certs. | 100 | .. | 111-114 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | – | 5¾-6¼ |
| —— 6 per cent. Cum. Pref. | 5 | – | 6⅛ 6⅜ xd |
| —— 4½ per cent. First Mort. Deb. | 100 | – | 107-109 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 2¼-2⅜ |
| —— 5 per cent. Debenture Stock, Red. | 100 | – | 86-91 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | – | 5¼-5⅜ |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | – | 101-104 |
| Havana Electricity, Limited, 1-15,000 | 10 | – | 9¼-10¼ |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | – | 7¼-8 |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 100-103 xd |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 | 1 | – | ⅜-½ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | | 12-13 |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red | 100 | – | 101-103 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9¾-10¼ |
| London Electric, Ordinary | 3 | – | 2¼-2½ |
| —— 6 per cent. Pref. | 5 | – | 5¼-5⅜ |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | – | 99-101 |
| Metropolitan Ordinary | 10 | – | 18-19 |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | – | 109-114 |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5¼-5⅜ |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | – | 97-99 |
| Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb. | 100 | – | 99-101 p.c. |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | – | 98-101 |
| —— Preference | 4 | – | 100-102 |
| Notting Hill Electric Lighting | 10 | – | 14¼-15¼ |
| —— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.) | 100 | – | 100-102 |
| Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,310 | 5 | – | 6¼-6¾ |
| —— 4 per cent. Debenture Stock | 100 | – | 98-100 |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures | 100 | – | 101-104 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 | – | 2¾-3¼ |
| —— 4 per cent. Debenture Stock | 100 | – | 79-83 |
| South London, Ordinary | | – | 3¾-4¼ |
| South Metropolitan Electric Light and Power Co., Ord. | 1 | .. | 13/16-15/16 |
| —— 7 per cent. Cum. Pref. | 1 | .. | 1 11/32-1 13/32 |
| —— 4½ per cent. 1st Mort. Deb. | 100 | .. | 105 108 |
| —— Ditto, June, 1904 | | .. | |
| St. James's and Pall Mall, Ordinary, 101-90,000 | 5 | – | 14-15 |
| —— 7 per cent. Pref. | 5 | – | 8¼-8¾ |
| —— 3½ per cent. Deb. | 100 | – | 98-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | – | 4¼-5¼ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5-5¼ |
| Westminster, Ordinary | 5 | – | 12-13 |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | – | 5-5¼ |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 | 5 | – | 5¼-5¾ |
| —— Ord. | 5 | .. | 8¼-8¾ |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | – | 140-143 |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 105-107 |
| Barcelona Tramways, Limited, Ord., 1-20,000 | 10 | .. | 11¼-11⅝ xd |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 | 10 | .. | 9¾-10¼ |
| —— 5 per cent. Deb., Red., 1-600 | 100 | .. | 99-102 |
| —— 4½ per cent. Red. Deb. Stock | 100 | .. | 96-100 |
| Bath Elec. Tramways, Ld, Pref. Ord. Shs., 75,001-150,606 | 1 | .. | ⅜-½ |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 | 1 | .. | 15/16-1 1/16xd |
| Belfast Street Tramways, Ord., 1-26,600 | 10 | .. | 10¼-11¼ |
| Blackpool and Fleetwood Tramroad | 10 | – | 13¾-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | – | 1-1¼ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | – | 3¾-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 91-93 |
| British Columbia Electric Railway Co., Ord. Def. | 100 | – | 103-106 xd |
| —— Ord Pref. | 100 | – | 100-103 |
| —— Non. Cum. 5 per cent. Pref. | 10 | – | 10¼-10¾ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 | – | 103-105 p c xd |
| —— 4½ per cent. Vancouver Power Deb. | 100 | – | 99-102 |
| British Electric Traction Ord. 1-500,000 & 60,001-80,000 | 10 | – | 9¼-9⅝ |
| —— 6 per cent. Cm. Pt., 30,001-60,000 | 10 | – | 10¾-11¼ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | – | 121-123 |
| —— 4½ per cent. 2nd Deb. Stock | 100 | – | 96-98 xd |

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| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| | £ | | £ |
| Buenos Ayres and Belgrano Tram. Ord., 1-100,000 | 5 | – | 3¼ 3¾ |
| —— "A" 6 per cents. Cm. Pf., 1-40,000 | 5 | | 5 9/16-5 13/16 |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | – | 5¼-5¾ |
| —— 5 per cent. Deb. Stock, Red. | 100 | – | 107-109 |
| —— Prov. Cert., all paid | 100 | – | 103-106 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | – | 97-99 |
| Calcutta Tramways, Limited, 1-102,265 | 5 | .. | 8¼-8½ |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | .. | 107-109 |
| Cape Electric Tramways Nos. 1-480,000 | 1 | – | 1¼-1½ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | – | 4¾-5¼ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | – | 99-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | | 101-103 xd |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | | 9¼-10 |
| —— 5 per cent. Cum. Pref. | 10 | – | 11-12 |
| —— 4 per cent. Debentures | 100 | – | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-50,000 | 10 | – | 13¼-14¼ |
| —— 5 per cent. Pref., Nos. within 1-50,000 | 10 | – | 15¼-16¼ |
| —— 5½ per cent. Mort. Debs., 1-5,000, Red. | 100 | – | 94-97 |
| Imperial Tramways Ordinary | all | – | 18-19 |
| —— 5 per cent. Cum. Pref. | all | – | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 | – | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 50,001-60,000 | 5 | | 2¾-3¼ |
| —— 4 per cent. Debenture Stock | 100 | – | 85-90 |
| Kilkenmuster and District Lighting and Traction, Pref. | 5 | – | 8-8½ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | – | 10-10¼ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | – | 99-102 |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 | .. | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016 | 1 | .. | 11/32-13/32 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | .. | 1-1 1/16 |
| —— 4½ per cent. Deb. Stock, Red. | 100 | .. | 105-107 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000 | $1,000 | .. | 105-110 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1938, 1-600 | 100 | .. | 101-104 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 | .. | 103-105 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 54,001-74,000 | 5 | – | ¼-1½ |

| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| | £ | | £ |
| Oldham, Ashton, and Hyde Tramway, Ordinary | 10 | | 18 |
| —— 6 per cent Cum. Pref. | 10 | – | 8½-9½ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk. | 100 | – | 105 108 |
| Potteries Electric Traction, Ordinary 20,001-40,00 | 10 | – | 9 9¼ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | – | 9¼ 9¾ |
| —— 4½ per cent. Debenture Stock | 100 | – | 103-107 |
| South Lancashire Electric Traction and Power Company | | | |
| —— £350,000 Ordinary | 1 | | 1 |
| —— £101,152 5 per cent. Preference | 1 | | |
| —— £897,170 4½ per cent. Debenture Stock | 100 p.c. | – | 100 p.c. |

## Electric Railways.—

| | | | |
|---|---|---|---|
| Central London, Ordinary | 100 | – | 91-95 |
| —— 4 per cent. Pref. | 100 | – | 101-103 |
| —— " " deferred | 100 | – | 82-85 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | – | 110-112 |
| City and South London, Consolidated Ordinary | 100 | – | 42-43 |
| —— 4 per cent. Debenture Stock | 100 | – | 107-109 |
| —— 5 per cent. Pref. Stock '91 | 100 | – | 120-123 |
| —— " " " '96 | 100 | – | 118-121 |
| —— " " " '01 | 100 | – | 115-116 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | – | 10-10¼ |
| —— Ordinary, 1-50,000 | 10 | – | 3¼-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | – | – | 99-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | – | – | 100-101¼ |
| Waterloo and City, Ordinary | 100 | – | 91-93 |

## Telephones.—

| | | | |
|---|---|---|---|
| National Telephone, Preferred | 100 | .. | 108 109 |
| —— Deferred Stock | 100 | – | 101-103 |
| —— 6 per cent. Cum. First Pref. | 10 | – | 12¼-13¼ |
| —— 6 per cent. Cum. Second Pref. | 10 | – | 11¼-12¼ |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | – | 5¼-5⅝ |
| —— 5½ per cent. Deb. Stock, Red. | 100 | – | 100-102 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 104-106 |
| —— 4 per cent. Prov. Cert. | – | .. | 103¼-105¼ |
| Oriental Telephone and Electric Company | 1 | – | 1¼-1⅜ |
| —— 6 per cent. Cum. Pref. | 1 | .. | 1 5/16-1 5/16 |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905. | 1904. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | April29 | 1,178 | 1,187 | – 9 | + 5,349h | 19¼ | 19¼ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·14 |
| Ayr Corporation | May 6 | 228 | 205 | + 23 | + 733 | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 316,049 | 1·03 | 10·11 | 1,770 | 5 0 |
| Barking Corporation | — | — | — | — | — | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 7 | 1,040 | 980 | + 60 | — | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,319,701 | 1·158 | 9·98 | 2,383b | 6·1 |
| Birmingham Corporation | ,, 6 | 342 | 258 | + 84 | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | — | — | — | — | — | 6¼ | 6¼ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 3 | 803 | 856 | – 53 | + 135 | 24 | 23 | — | — | — | — | — | — | — | — |
| Blackpool Corporation | ,, 4 | 564 | 552 | + 12 | + 251 | 17½ | 17½ | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10 94 | — | 4·59 |
| Blackpool-Fleetwood Trams. | ,, 6 | 342 | 320 | + 22 | + 48 | 16½ | 16½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Bolton Corporation | ,, 7 | 1,914 | 1,698 | + 216 | + 335 | 38 | 38 | Dec. 31 | 32,021 | 2,253,984 | 600,757 | 3·34 | 12·75 | 2,001 | 7·05 |
| Bournemouth Corporation | April26 | 1,577 | 1,018 | + 559 | — | 10·15 | 10½ | March 31 | 94,151 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·89 |
| Bradford Corporation | May 6 | 4,024 | 5,565 | – 1,542 | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 7 | 944 | 785 | + 158 | + 352h | 9 | 7½ | — | — | — | — | — | — | — | — |
| Bristol Tramways Company | ,, 5 | 4,675 | 4,942 | – 267 | — | 51½ | 51½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Burnley Corporation | ,, 5 | 1,053 | 984 | + 69 | — | 10·60 | 10 | Dec. 31g | 253,150 | 44,391,439 | 6,033,528 | — | — | — | — |
| Burton Corporation | ,, 7 | 305 | 307 | – 2 | — | 8½ | — | — | — | — | — | — | — | — | — |
| Cardiff Corporation | ,, 6 | 1,905 | 1,920 | – 15 | + 23 | — | — | March 31j | 11,574 | 2,556,134 | 282,378 | 1·08 | 9·84 | 1,570 | 7·57 |
| Carlisle Tramways Company | ,, 6 | 219 | 183 | + 21 | – 316 | — | — | — | — | — | — | — | — | — | — |
| Central London Railway | April29 | 6,674 | 6 8 0 | – 176 | + 1,827h | 6 | 6 | Dec. 31g | 9,987 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| City & South London Railway | ,, 30 | 2, 08 | 2,681 | + 127 | — h | 6½ | 6⅝ | ,, 31 | 362,471 | 44,953,938 | 1,292,674a | 1·87 | 64·87 | 58,229 | 35·60 |
| Colchester Corporation | May 3 | 183 | — | — | — | 7 | — | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 4 | 462 | 483 | – 21 | + 283 | — | — | — | — | — | — | — | — | — | — |
| Darwen Corporation | ,, 5 | 216 | 234 | – 18 | + 34 | 7·23 | 7·23 | ,, 31g | 25,657 | 6,353,323 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Dover Corporation | April15 | 187 | 201 | – 14 | — | 4½ | 4½ | March 31g | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·56 |
| Dublin & Lucan Electric Ry. | ,, 28 | 159 | 103 | + 56 | — h | 7 | 6½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0·91 | 9 63 | 2,503 | — |
| Dublin U. T., electric cars | May 5 | 3,949 | 4,033 | – 84 | } — | 47 | 46 | Dec. 31g | 6,291 | 888,905 | 107,164 | 3·88 | 14·09 | 952 | 7·39 |
| Dublin S. District, Electric | ,, 5 | 958 | 952 | – 34 | | | | ,, 31g | 134,643 | — | 3,429,356 | — | — | — | — h |
| Dundee City Tramways | ,, 3 | 844 | 861 | – 17 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 6 | 763 | 719 | + 29 | — | 10·77 | 10·75 | March 31 | 34,312 | 12,950,269 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 6 | 15,116 | 14,242 | + 874 | +37,733h | 145 | 123 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Gloucester Corporation | ,, 3 | 279 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 3 | 3,392 | 2,749 | + 543 | — | 33 | 30½ | March 31 | 68,283 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,079 | 8·77 |
| Huddersfield Corporation | ,, 6 | 1,193 | 1,184 | – 24 | — | 35 | 35 | ,, 31 | 65,545 | 11,893,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | ,, 6 | 2,048 | 2,037 | + 11 | + 44 | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | April29 | 546 | 446 | + 100 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | May 3 | 105 | 141 | – 35 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 3 | 209 | 212 | – 3 | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 8 | 5,461 | 5,484 | – 23 | + 1,249 | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | April12 | 1,951 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | ,, 29 | 10,832 | 10,072 | + 820 | + 7,098 | 103 | 103 | Dec. 31g | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | May 7 | 1,575 | 1,594 | – 19 | – 1,156h | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — a |
| London County Council | April29 | 14,262 | 10,684 | +3,578 | + 9,338 | 46½ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | May 4 | 110 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 6 | 11,947 | 11,602 | + 345 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 6 | 125 | 108 | + 17 | + 58 | 2¾ | — | — | — | — | — | — | — | — | — |
| Newcastle-on-Tyne Corptn. | ,, 6 | 3,506 | 3,646 | – 140 | — | 45 | 38½ | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newport (Mon.) Corporation | — | — | — | — | — | 15 | — | ,, 25 | 185,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111b | |
| Oldham Corporation | ,, 7 | 1 565 | 1 089 | + 477 | + 2,555 | 34½ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 6 | 1,769 | 1,703 | + 65 | – 503 | 29 | 29 | ,, 31 | 94,448 | 18,204,426 | 1,828,193 | 1·16 | 12·39 | — | — |
| Reading Corporation | April27 | 705 | 588 | + 117 | — | — | — | — | — | — | — | — | — | — | — |
| Rochdale Corporation | ,, 29 | 582 | 120 | + 462 | + 1,811 | 4½ | 4½ | 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | — |
| Rotherham Corporation | May 4 | 366 | 440 | – 74 | — | — | — | ,, 31 | 20,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·68 |
| Salford Corporation | ,, 8 | 4,120 | 3,685 | + 435 | + 687 | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 6 | 88 | — | — | — | 7¾ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 7 | 4,639 | 4,279 | + 360 | + 339 | 34½ | — | ,, 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 3 | 817 | 910 | – 33 | – 278 | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 3 | 305 | 273 | + 32 | + 107 | 6¼ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 5 | 472 | 528 | – 56 | + 36 | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | April30 | 1,368 | 1,135 | + 233 | — | 19·51 | 18·48 | ,, 31 | 62,506 | 14,848,958 | 1,433,463 | 1·01 | 10·46 | — | 6 02 |
| Swindon Corporation | May 3 | 176 | — | — | — | 3½ | — | — | — | — | — | — | — | — | — |
| Wallasey U.D.C. | ,, 6 | 736 | 669 | + 67 | + 204 | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·50 |
| Warrington Corporation | ,, 4 | 317 | 297 | + 20 | + 88 | 7½ | — | — | — | — | — | — | — | — | — |
| West Ham Corporation | ,, 4 | 1,449 | 742 | + 707 | + 3,032 | 8·62 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 3 | 657 | 577 | + 120 | — | 7½ | — | ,, 31g | 20,878 | 4,263,066 | 417,335 | — | 12·006 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1905. h Half-year's figures.
Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**Royal Institution.**—On Thursday, May 25, at five o'clock, Prof. J. A. Fleming will deliver the first of three lectures on "Electromagnetic Waves." These are the Tyndall lectures. The Friday evening discourse for May 26 will be delivered by Prof. J. W. Brühl on "The Development of Spectro-Chemistry," and on June 9 Sir William White will lecture on "Submarine Navigation."

**New Electric Lighting Regulations.**—After considering the various observations on the drafts of the revised regulations, the Board of Trade have decided to issue four sets of regulations to meet the following cases of electric lighting undertakings owned by (1) local authorities in the provinces; (2) a company in the provinces or in the city of London; (3) a company in any part of London except the City; and (4) a local authority in London.

**Royal Society.**—The following, among others, were last week elected as Fellows: Prof. William Arthur Bone, lecturer on chemistry, Manchester; Prof. William Henry Dines, meteorologist, London; Prof. Martin Onslow Forster, assistant professor of chemistry, Royal College of Science, London; Frederick Gowland Hopkins, reader in chemical physiology, Cambridge; George William Lamplugh, district geologist on the Geological Survey, Ireland; and George F. C. Searle, senior demonstrator in Cavendish Laboratory, Cambridge.

**Engineering Standards Committee.**—We have received a copy of Report No. 13 (published by Messrs. Crosby Lockwood and Son, at 2s. 6d.), which deals with the standard specification for structural steel for shipbuilding. The committees which dealt with No. 13 were composed of representatives of the Admiralty, Board of Trade, Lloyd's Register, Iron and Steel Institute, North-East Coast Institution of Engineers and Shipbuilders, British Corporation for the Survey and Registry of Shipping, Bureau Veritas, Steel Ingot Makers' Association, and other bodies. The report deals with the process of manufacture, testing and inspection, branding, makers' certificate, rejected material, etc.

**Manchester Section.**—The report of the committee for the fifth session records that the attendance at the meetings has been well maintained, the average number present being about 180. Nine papers were presented, and a large proportion of the members participated in the discussions. The fourth annual dinner was a most successful function, over 200 members and visitors being present. The membership of all grades aggregates 764, a substantial advance on the 549 of last year. Great success has attended the formation of the Students' Section, the membership of which numbers 306. Eight meetings were held, and a similar number of visits paid by the juniors. The chairman of the section for 1905-6 is Mr. S. L. Pearce, and the vice-chairman Mr. T. L. Miller. In conclusion, the committee express the hope that the members will assist them in every way possible to still further increase the usefulness of the section.

**Electric Lighting in Auckland (N.Z.).**—The Corporation is again considering the substitution of electricity for gas in connection with street-lighting, this course being recommended by their engineer. The electric tramways company has made definite proposals for the supply of current, and the Corporation have referred the matter to committee. The inhabitants appear to be decidedly in favour of the new illuminant. Great improvements have been and are being effected throughout the colony by the erection of electric tramways and the installation of electric light, but in the present instance a question of finance appears to be the obstacle. We do not gather that the Auckland coffers are in a particularly bad way, and the Corporation have presumably been guided by motives of prudence in refraining hitherto from exercising the powers obtained in 1891 and again in 1900. This policy is certainly preferable to improvident expenditure, but it is to be hoped that the Auckland councillors will not be ultra-cautious in their methods.

**The Telephone Transfer.**—In the House of Commons on Tuesday Sir H. Campbell-Bannerman, in asking what the order of business would be, said that the first order of the day—the appointment of the committee on the telephone agreement—had only been announced the previous night, and considerable objection had been taken to it. He hoped, therefore, it might be postponed. In reply, Mr. Balfour stated that he should be happy to meet the wishes of the right hon. gentleman as far as possible, although time was rather of the essence of the matter. There was a general wish on both sides that the committee should report, and that before the end of the session the Government should be in a position to find a day for the discussion of the report. He should be prepared to postpone the motion for the appointment of the committee until Monday next, and he hoped that the debate would not assume undue proportions, but that the House would assist the Government to carry through the appointment of the committee, which had been nominated in deference to the general wish of the House.

**Underground Telegraphs.**—The Associated Chambers of Commerce of the United Kingdom recently forwarded to the Postmaster-General a memorial urging the importance in the interests of trade and commerce of all trunk telegraphic wires being laid underground, so as to obviate the delays caused by storms breaking down the overhead wires. The Postmaster-General has replied that last year £150,000 was spent on the underground line to the North, and with the assent of the Treasury he has included the same amount in the estimates for the current financial year. With that amount he will be able to complete the underground line from London to Glasgow and to begin underground lines to the east and to the west from London. In conclusion, he expresses his appreciation of the importance of underground trunk telegraphs, giving this information as evidence of the importance attached by him to the provision of underground trunk telegraphs, and he is of opinion that Parliament could not be asked to sanction a larger expenditure, and that his department could not economically proceed with greater rapidity.

**Electric Tramway and Railway Exhibition.**—The third International Electric Tramway and Railway Exhibition will be held at the Royal Agricultural Hall, London, from Monday, July 3, to Friday, July 14. The exhibitors who have already secured space exceed 150. The exhibits will comprise many interesting designs not shown at the earlier exhibitions, and will include several systems of surface-contact tramways, new types of tramway cars, motor omnibuses, and a great variety of small appliances for car equipment, overhead work, and track construction. It is expected that demonstrations of several new processes and apparatus will be carried out at the exhibition. More than 80 town councils will appoint official deputations to visit the exhibition, and it is expected that every important tramway will be represented. The Municipal Tramway Association and other tramway and scientific bodies will hold conferences at the exhibition, which is likely to form a centre of the greatest interest to all concerned in such matters. A few good stands are still available, and intending exhibitors should make early application to the *Tramway and Railway World*, Amberley House, Norfolk-street, Strand.

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**Electrolytic Method for Separating Ores.**—At the recent meeting of the American Electro-Chemical Society, Prof. L. I. Blake presented a paper upon the Blake-Morscher electrostatic separator, of which an abstract appears in the *Electrical World* of New York. The author prefaced his description with the statement that where there is a mechanical mixture of two kinds of crushed materials with different electric conductivities, and this mixture is brought into contact with an electrostatically charged surface, the two different materials will get a different charge in the same time. If, for instance, one material is a conductor, and the other a non-conductor, the latter will remain uncharged, while the former gets a charge. As soon as this takes place the charged particles only are repelled from the charged surface, so that in this way a separation of the conducting and non-conducting materials is accomplished. This is the fundamental idea on which the electrostatic separator is based. To carry out the process in practice it is necessary first to crush the ore; secondly, to dry it thoroughly; thirdly, to feed it in a suitable manner to the charged surface; and, fourthly, to collect and remove the separated materials. The voltage required is 350,000, and is furnished by a special electrostatic machine, acting, not by friction, but by induction. The leakage in the electrostatic separator is considerable, but notwithstanding this, the total power required for a separator treating 12 tons in 24 hours is not more than 1 h.p.

**Testing Incandescent Lamps.**—At the annual convention of the Iowa Electrical Association, Prof. L. B. Spinney, of Iowa State College, read a paper, abstracted in the *Electrical World* of New York, on the lamp-testing work of that institution, which has for a number of years made a practice of testing at cost incandescent lamps sent to it by central stations of the State. Tests of mean horizontal candle-power and watt consumption are made at the rate of 4s. per dozen. Recently the department of electrical engineering has added to its equipment a Matthews integrating photometer, which will enable it to make tests of mean spherical candle-power quickly and cheaply. The author explained the principle of the Matthews photometer, which records simultaneously the candle-power from 11 different angles, and integrates the results so that a reading is obtained directly of the mean spherical candle-power. Incidentally, he called attention to how illogical is the present method of rating lamps by horizontal candle-power. This rating had been adopted mainly because of the difficulties involved in the past in making a test for mean spherical candle-power, but the only true measure of the efficiency of a lamp was the watts per mean spherical candle-power, and the proposer considered it probable that in the near future this, rather than horizontal candle-power, will be the basis of rating of all illuminants. Tests are to be made at the college to show the difference between ratio of horizontal candle-power and spherical candle-power with different kinds of filaments.

**Telephonic Intercommunication.**—An interesting judgment was delivered last week by Mr. Justice Buckley upon the question of intercommunication between the National Telephone Company's system and that of any competitor licensed by the Postmaster-General. The cause of action arose under Section 3, Sub-section 5, of the Telegraph Act of 1899, which provides, *inter alia*, that when the license of an existing system shall be extended in respect of any exchange area for a period of eight years, the proprietor shall, at the request of the new licensee, afford all proper facilities for the transmission of telephone messages over both systems, provided that the licensee requiring intercommunication shall afford similar facilities. In September, 1902, the Postmaster-General granted a license to the Swansea Corporation, at the same time extending the company's license. In January, 1904, the Corporation, having satisfied the Postmaster-General that they had obtained the requisite number of subscribers, requested the company to afford intercommunication. The company, however, raised objections. They had a central exchange at Swansea and some dozen subsidiary exchanges, and they required that the Corporation should provide junction circuits to connect directly the plaintiff's exchange at Swansea and the company's exchange there, and with nine subsidiary exchanges and also junction circuits to connect the Mumbles and Morriston exchanges. The Corporation argued that this was contrary to the spirit of the Act, and his lordship upheld their contention, deciding that the Corporation were entitled to be afforded all facilities for restricted intercommunication as provided by the Act. We are glad to see that the statute has been interpreted upon comprehensive lines, as it is not difficult to imagine the obstruction to progress that might arise from the company carrying their stipulations to an extreme.

**The Rating of Machinery.**—The Machinery Users Association direct attention to the important question of the rating of machinery and its effect upon electrical undertakings. At a recent conference of the London County Council and delegates from the various metropolitan boroughs the following resolutions were formulated: (*a*) "That in the case of premises where the assessable value is enhanced by the presence of plant and machinery essentially necessary to the business carried on, and which it is intended should remain attached to the premises so long as they are used for the purposes of the business, such enhanced value unless already covered by the rent paid by the occupier shall be taken into account." (*b*) "That having due regard to necessary modifications in special cases, 10 per cent. of the capital value of rateable machinery shall be taken as the average percentage for gross value." (*c*) "That the maximum deduction of one-third should not be allowed as a matter of course, but the amount should vary between one-third and one-sixth, according to the proportion of machinery included in the assessment." If effect be given to these by the rating authorities of London, the rateable value of electrical undertakings will be appreciably increased, because machinery that is now considered as belonging to the occupier, and for which a certain proportion of the receipts is at present deducted as representing interest and trade profit on the capital he has invested, will no longer be allowed. While the question is comparatively new to users of machinery in London, it has agitated the minds of provincial manufacturers for many years, and at the present time the association, which was formed for the purpose of resisting the imposition of a tax upon machinery, is contesting it before a divisional court on behalf of the manufacturers of Leeds, and the result is naturally awaited with great interest. We observe that the association is being backed by a strong committee, and all sections of the manufacturing and industrial community who are threatened with additional taxation would do well to rally to its banner.

**Lighting in New York.**—The investigation into the lighting conditions of New York has come to a curious pass, the Legislature having declined to receive the committee's report. This report made the following recommendations: that (1) the price of current for heat, light, and power purposes in the boroughs of Manhattan and Brooklyn, and in part of the borough of Bronx, should be fixed at a maximum of 5d. per kilowatt-hour of current actually consumed, and that provision should be made for inspection to secure accurate metering; (2) the price of arc

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lamps for street-lighting in the city of New York should be fixed at £20 per lamp per year for single lamps of 2,000 c.p., consuming 450 watts at the arc, and that the price of twin arc lamps, consuming 250 watts each at the arc, should be fixed at £13 each per year; and (3) the city of New York be given authority to utilise water power, now owned or hereafter acquired by it, for the purpose of generating electric current for the use of the municipality, provided that no additional water shall be used for said purpose that would otherwise by required by the city. It is also recommended that provision should be made for the creation of a commission, the members of which should be appointed by the Governor with the consent of the Senate, to be paid by the State, and to have general supervision of all persons and corporations having authority to lay or erect and maintain wires and pipes for the purpose of furnishing gas or electricity for light, heat, or power, with power to investigate and ascertain the character of the service and reasonableness of charges and the methods employed in manufacture and distribution and in the maintenance of works and distributing systems and to enforce the provisions of law applicable thereto; to prescribe methods of keeping accounts; to examine the corporations under its supervision; to require annual reports; and other powers. There are four Bills proposed to carry into effect the lighting recommendations. The first fixes the price of gas, the second provides for inspection of meters, the third the rates for electricity, and the fourth creates a State lighting commission.

**General Electric Company.**—The thirteenth annual report of this American company, for the year ending Jan. 31, 1905, shows a profit of some £1,350,000 after deducting all expenses and making allowances for depreciation, losses, and patent account. This, however, is subject to a further deduction of £150,000 on revaluing the assets of the Stanley Electric Manufacturing Company and other acquired interests. During the year a sum of about £750,000 was paid in dividends, the net surplus for the year being £455,000. Added to a surplus from the previous year of £1,460,000, there was a total surplus at Jan. 31 last of some £1,915,000. The company's sales for the year totalled £8,000,000, representing a diminution of 6 per cent. as compared with the previous year. Among the important orders secured by the company are contracts with the New York Central Railroad Company for 30 90-ton electric locomotives, 40,000 kw. capacity of steam-turbines, and the entire switchboard plants for the Mount Morris and Yonkers power stations; contracts with the Public Service Corporation of New Jersey, for steam-turbines and rotary converters; contracts with the Interborough Rapid Transit Company of New York, for additional control equipments and motors for operation of the subway trains; contracts for car equipments with the New York City Railway Company, the Philadelphia Rapid Transit Company, the Chicago Union Traction Company, and other traction and street railway companies; contracts for generators to develop water power in 10 States, Mexico, and other countries; contracts for 154 steam-turbines. On Feb. 1, 1905, the company had sold a total of 289 Curtis turbines capable of generating in daily operation from 450,000 kw. to 500,000 kw. The company has sold a large number of these turbines to various customers in Canada, Europe, South America. Japan, New Zealand, Mexico, and other parts of the world, The total number of cars equipped with the Sprague-General Electric control system on Jan. 31, 1905, was 2,997 cars, as against 2,595 cars the year previous. About £400,000, exclusive of the cost of patterns, special tools, etc., was expended upon sites, erection of new buildings, extensions to existing buildings, and additional machinery.

**The Tesla Patents.**—The series of American patents generally known as the fundamental Tesla patents, which have played such a conspicuous part in the electrical industry during the two last decades, expired on the 4th of this month. Mr. B. A. Behrend takes the opportunity of paying a tribute to Tesla's work in an article contributed to the *Electrical World* of New York. The genius of Tesla has been instrumental in stimulating, if not in creating, a wonderful industry—wonderful in magnitude, and wonderful in the ingenuity of the apparatus used in the accomplishing of the transmission of power over long distances. After discussing the evolution of scientific principles and the patent system, the author deals with the personal achievements of Tesla, the ingenious inventor who, by a "sort of glorified common sense and unfailing intuition, picked his way through puzzling mazes of complicated phenomena, and protected himself from the pitfalls and the alluring by-paths ensnaring smaller intellects." With Tesla, in America and in Europe, worked a host of capable and ingenious engineers, and their work, vivified by the ingenuity of Tesla's inventions, has become one of the greatest monuments of engineering achievement crowning the work of the nineteenth century. Turning to Tesla's remarkable paper, entitled "A New System of Alternate-Current Motors and Transformers," read at the meeting of the American Institute of Electrical Engineers in New York on May 16, 1888, the author remarks that this paper, even when considered in the light of previous discoveries and knowledge, is one of the most brilliant pieces of engineering thought, teeming with suggestions and ideas, animated with an intuition of the highest order, and giving an exposition of the working of the induction motor in a manner which resembles the methods pursued in the "Experimental Researches on Electricity" of the great master, Michael Faraday. While stating, however, that for 17 years the Tesla patents have formed the nucleus of the electrical industry, Mr. Behrend points out that these patents do not represent the only valuable ideas on the subject of polyphase alternating-current systems. He predicts that the expiry of the patents, aided by vigorous competition, will give the electrical industry a new stimulus.

**Pneumatic Dispatch.**—A Select Committee of the House of Commons commenced on Tuesday the consideration of the Metropolitan Pneumatic Dispatch Bill. Sir Henry Aubrey Fletcher presided. The Bill is opposed by the London County Council, a number of borough councils, and electric supply and railway companies. Mr. Balfour Browne, K.C., in explaining the Bill to the committee, said the promoters proposed to establish a system of pneumatic transport within the administrative county of London for the dispatch of parcels, goods, and messages. The scheme was to lay down 95 miles of double 12in. tubes, with 172 stations. The system proposed to be used is that known as the Batcheller. Electric power is conveyed to motors at the several stations, where the current operates air compressors. The scheme has the personal and financial support of Messrs. Barclay and Bevan (of Barclay, Bevan, and Co., bankers), Smith's Union Bank, Mr. Parr (of Parr's Bank), Mr. Hoare (of the Bank of England), Mr. J. Pierpont Morgan, and a great number of others. The capital of the company would be four millions sterling. There would be one charge for collection, transmission, and delivery of parcels in the tube area, which practically covered the whole administrative county of London. For the transmission of the parcels they would require 30,000,000 Board of Trade units of electricity per annum. The rate of transmission would be very rapid. On the

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average 30 miles an hour would be the rate at which the carriers would pass from one place to another, but, if necessary, that rate could be accelerated up to 50 miles an hour. From the stations the parcels would be delivered by tricycles and vans, but the distance in London would never exceed three-quarters of a mile. The "tubes" would cost £1,057,350, the cables for carrying the current £105,000, the plant and stations £805,508, and the carriers (12,000 in number) £48,000. They hoped to carry 80 million parcels per annum. Within the administrative county the average charge would be 3·1d. per parcel, and for parcels going outside London 4·132d. There will now be an opportunity for the merits of the project to be fully discussed. If the system can accomplish anything like what is claimed for it—and it appears to have done so abroad—there is little doubt but that it would prove of great utility.

**Iron and Steel Institute.**—In the course of his presidential address last week, Mr. R. H. Hadfield gave a comprehensive review of the history of this institute, and also of the industrial outlook. One of the branches he touched upon was electrometallurgy, which, as he remarked, makers of iron and steel cannot ignore. After alluding to the work of the commission appointed by the Canadian Government, and that of M. Héroult on behalf of the French Electrometallurgical Company of Froges and La Praz, he dealt with "electric steel," in connection with which he did not think there was special virtue in the electrometallurgical process. It was necessary to look to the quality of the product in order to see whether this steel could show superiority over ordinary kinds. Whether the cost of production was lower than that of older systems remained to be proved; the energy must be generated at low cost, or it certainly would not compete with existing methods. When electric energy could be produced more cheaply—and the time, he thought, might not be far distant—there would perhaps be a different state of affairs; and the process of electric smelting might become a commercial utility. It had been worked out theoretically that with no loss of heat energy, about 131 electric horse-power days (24 hours) were required to produce a net (2,000lb.) ton of iron from 65 per cent. pure ore, but in actual practice it had been found in Sweden that 362 electric horse-power days were required for the purpose. Mr. A. J. Rossi had in the Adirondacks produced iron from titanium iron ore at a rate of £3 per ton, but this ore was reckoned at 3s. 1d. per ton, which Mr. Hadfield considered scarcely reasonable. Further, this estimate was based upon the cost of £2 per year for 1 h.p. of electric current delivered, night and day, week in and week out, which was probably much too low. Besides this, there were other considerations. A complete blast furnace producing 350 tons of pig iron per day would cost about £20,000. It had been stated that an electric furnace plant to produce a similar quantity would require a water-power-electric plant with a capacity of a least 60,000 h.p. There were few places where this could be obtained; in addition, the cost of the plant would be excessive. Pig iron had been produced by the blast furnace at as low as £1. 12s. 6d. per ton. While, however, its utility is at present limited—indeed, it has scarcely emerged from the embryo stage—Mr. Hadfield predicted that the next decade would witness great practical advances in electrometallurgy. It may be mentioned that the membership of the institute stood on Dec. 31 at 1,910, an advance of 213 as compared with the preceding 12 months.

**Lightning Research Committee.**—The committee issued its report last week, and the document shows indications of careful compilation. In a preface Sir Oliver Lodge emphasises the importance of taking into account the effect of self-induction, which until the report, many years ago now, of the Lightning Rod Conference had been quite ignored. Through the medium of the Royal Institute of British Architects, the Surveyors' Institution, and the Royal Meteorological Society 5,000 copies of a memorandum containing a series of questions were distributed among observers. The Institution of Electrical Engineers, the War Office, the Home Office, Trinity House, the United States Department of Agriculture, and Mr. John Gavey (engineer-in-chief to the Post Office), also co-operated by supplying information. The report deals with the distinction drawn by Sir Oliver Lodge between the two types of lightning discharge, designated the A and the B flash respectively. The A flash is of the simple type which arises when an electrically-charged cloud approaches the surface of the earth without an intermediate cloud intervening, and under these conditions the ordinary type of lightning conductor acts in two ways—first, by silent discharge, and, secondly, by absorbing the energy of a disruptive charge. In the B type, where another cloud intervenes between the cloud carrying the primary charge and the earth, the two clouds practically form a condenser; and when a discharge from the first into the second takes place the free charge on the earth side of the lower cloud is suddenly relieved, and the disruptive charge from the latter to the earth takes such an erratic course that no series of lightning conductors of the hitherto recognised type suffice to protect the building. The report proceeds to remark that probably the majority of the buildings in this country are not efficiently protected against the effects of a B flash, although in many cases the conductors may be said to have at least partially fulfilled their purpose by carrying off the more violent portion of the discharge. Some of the observations throw an interesting light upon the effects due to the oscillating character of lightning discharges. For instance, a discharge takes place over a lightning rod which may be in contact with or approach closely to the metallic portions of a roof. Powerful electrical oscillations are set up in the latter conductors, and dangerously high electrical pressure may be generated on the distant ends of these conductors. The report states that absolute protection of the whole of a building could only be assured by enclosing the structure in a system of wirework—*i.e.*, a contrivance in the nature of a birdcage This should be well connected at various points to earth, as nearly all buildings have gas and water pipes and other metallic conductors which are likewise earthed. Various other points of interest are referred to, and the report is supplemented by a series of observations on the rules laid down in 1882 by the Lightning Rod Conference and a summary of the latest practice abroad. Mr. Killingworth Hedges, M.I.C.E., who acts as honorary secretary to the committee, has collected a large number of expert reports on recent cases of damage done to buildings from lightning.

**Properties of Sheet Steel.**—The report of the researches carried out during 1904 5 by the holders of the Andrew Carnegie research scholarships has just been issued by the Iron and Steel Institute. The subject of the magnetic and electric properties of various kinds of sheet steel and steel castings is dealt with by Messrs. G. Dillner and A. F. Enström, of Stockholm. The chief object of the investigation was to study the influence of chemical composition and of manufacturing methods on the materials used in electrical engineering work, more especially in dynamo and transformer construction. In summing up the authors deal with the influence exercised by various elements. The fact that an increase of the carbon percentage implies a corresponding increase of the coercive

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force and of the hysteresis energy loss has been very distinctly borne out by the figures obtained for the sheet metal. The increase of the coercive force and the Steinmetz hysteresis coefficient have been found to follow a straight line within the range of a carbon percentage of ·5 per cent. Thus it is obvious that a small amount of carbon is favourable in sheets used in armature cores and transformers. As regards the cast steel, however, it seems to the authors that there ought not to be any inconvenience whatever involved in the increase of the carbon percentage, so far as is shown by the present researches. With the very highest percentage met with in the cast steel employed (carbon = about ·30 per cent.) the authors consider the values of the maximum induction and of the permeability at the induction normal in field poles perfectly satisfactory, whilst the hysteresis properties of the pole material are comparatively unimportant. A high percentage of carbon also produces an increase in the electrical resistance, an effect which must be considered advantageous. An increase of silicon has been found to be accompanied by a quite noticeable increase of the coercive force and of the hysteresis energy loss, whilst the maximum induction does not seem to be influenced to any noteworthy extent. As the hysteresis loss is thus so largely increased by reason of the presence of the silicon—a disadvantage by far outweighing the corresponding gain as regards electric resistance—the conclusions to be drawn are that any addition of that element in making the steel ought, as a rule, to be avoided in the case of sheet material. As to the influence of a similar increment of silicon in cast steel, the results have proved to be anything but unsatisfactory, the electric resistance being quite noticeably increased. It has been stated that an addition of aluminium quite noticeably reduces the hysteresis loss, whilst it increases the electric resistance, and thus reduces at the same time the eddy-current loss. It has been found, too, that an addition of aluminium will reduce the maximum induction and the permeability for ordinary saturation values. The general conclusion is, therefore, that an addition of aluminium improves sheet material which is to be used for constructing dynamos. As regards cast steel the matter is different. With such a high percentage of aluminium as is required in order to increase the electric resistance to an effective degree, the magnetic properties will be too much affected, and the authors point out that the usefulness of aluminium in cast steel is, to say the least, questionable. It is of interest, however, to notice the results obtained from the researches on cast-steel rods containing both silicon and aluminium. In this case low hysteresis losses are found, attributable, probably, to the influence of aluminium, whilst the influence of this element on the permeability and maximum induction seems to be neutralised by the addition of silicon. The addition of silicon and aluminium together seems thus to tend towards a general improvement of the magnetic properties.

**An Electrolytic Switch.**—At the recent meeting of the American Electro-Chemical Society a paper on this subject was presented by Mr. W. S Horry, who first pointed out that the various properties of the aluminium cell are, apart from its assymetric peculiarity, that it presents a high resistance to the passage of an electric current, it possesses capacity, and it leaks. The author suggested a method, described below, whereby these qualities may be utilised for the prevention of the arcs that occur when a current possessing inductance is interrupted. As all continuous-current circuits possess more or less inductance, the voltage rises across the break when a switch carrying such a current is opened. This not only causes an inconvenient flash at the switch, but endangers the insulation of the circuit. If, however, a suitable electrolytic cell be inserted across the break and the circuit then broken, there is no flash at the switch, and the increased voltage will force a current through the cell instead. The insulation of the cell breaks down, but quickly re-establishes itself. After that the mains may be entirely disconnected without any spark. To obtain the best results in this way, an electrolyte for the cell should be chosen that substantially shuts off all current at the working voltage, but allows considerable leakage to occur with any increased pressure—a cell that has a critical voltage a little above the line voltage. For small cells intended for use on circuits of 1 h.p. or less at 110 volts the matter is not of much importance. The plan of the circuits is simply illustrated in Fig. 1. The circuit is represented as a

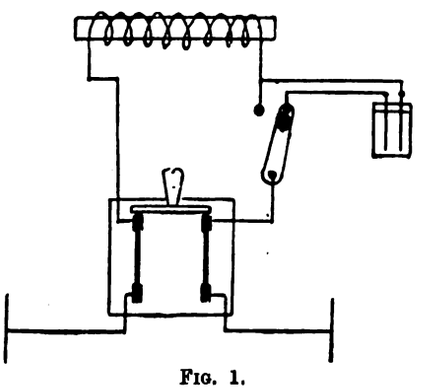

FIG. 1.

line containing an electromagnet, there is a double-pole switch for the line, a rheostat contact, and an aluminium cell. If the switch is closed, no current will flow except that which leaks through the cell, but if the rheostat arm is moved to the left, then the full current will pass. To shut off the current, the rheostat is returned to the position shown and the switch opened. In addition, the cell possesses capacity, and, if it be a large one intended to suppress a powerful arc, there will be a spark at the arm contacts when the terminals of the cells are connected. To close the circuit sparklessly, the rheostat must be moved before the switch is closed. If the arm be moved first, both in opening and closing the circuit, there will be no spark at make, due to capacity, and no arcing at break, due to self-induction. The author exhibited a switch which operates in this way with one movement of the switch handle. There are three knives to it, the middle one having a more extended movement than the other two, so that it operates always in advance of the outer blades.

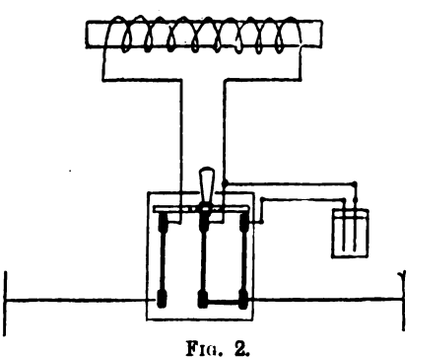

FIG. 2.

Fig. 2 gives a diagram of the connecting circuits. The author described various cells of different sizes, which he has devised for various purposes. For long continued and rapid use a larger cell is necessary than for infrequent use, so that the heat generated by the continued arcing through the cell shall be radiated more rapidly. We are indebted to the *Electrical World* of New York for the above condensation.

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## THE CURTIS STEAM-TURBINE.

The description of this turbine from the pen of Mr. F. Samuelson which appeared in our issue for Feb. 19, 1904, will have made our readers conversant with the essential feature of the Curtis type of steam-turbine. On Friday last we were shown over the Rugby works of the British Thomson-Houston Company, where a large number of these turbines are being manufactured. This visit enabled us to see the many special operations involved in the construction of the parts of these turbines and to gain details as to the latest practice in the design of the same. In the first place, a short *résumé* of the general principles of the turbine will

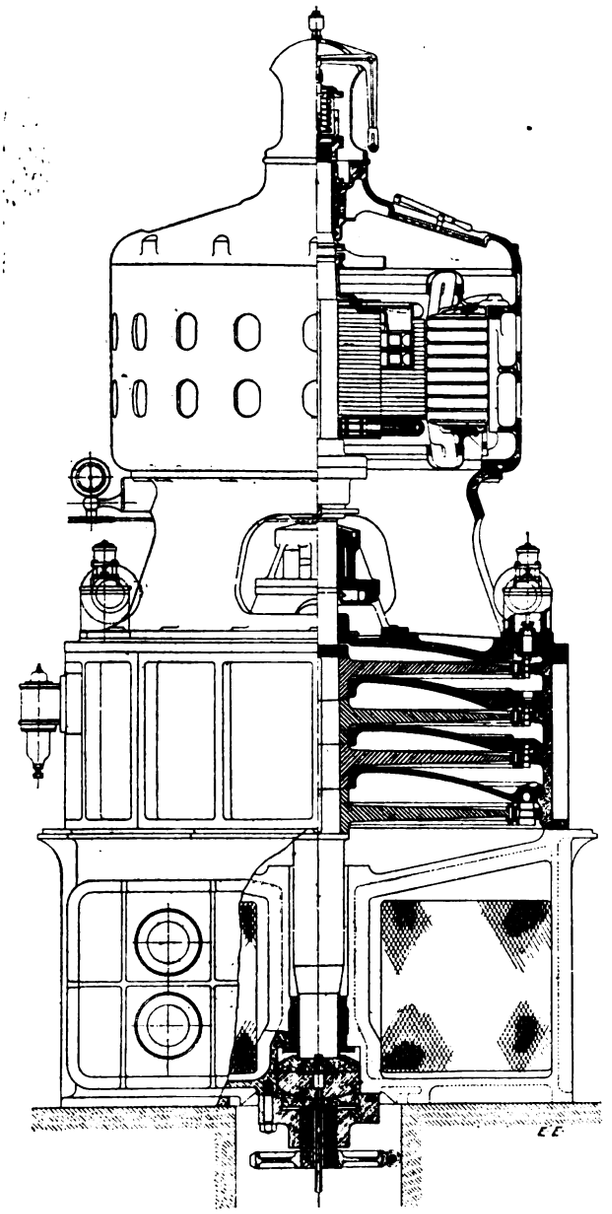

FIG. 1. Section of a Four-Stage Curtis Turbine, with Condenser in Sub-Base.

enable these constructional details to be better appreciated. Thus the Curtis turbine, as shown in section in Fig. 1, is of the "impulse" type, utilising the velocity of steam escaping from a nozzle for its operation, and not the pressure of the steam. Velocity is imparted to the steam through groups of expanding nozzles, so designed as to effectively convert its potential energy into kinetic energy. After leaving the nozzles, the steam passes successively through two or more rings of buckets on the rotating element, interspersed with reversed buckets on the stationary part of the turbine. The function of these stationary buckets or "intermediates" is to redirect the steam received from the rotating buckets so that it will effectively impinge upon the next set of rotating buckets: the steam thus passes through the turbine, rebounding alternately from the stationary to the rotating buckets until it is brought to relative rest. By this means a high steam velocity is efficiently used to impart motion to an element which moves at a comparatively slow speed. The process of expansion through nozzles and subsequent abstraction of velocity by successive impacts with the buckets is generally repeated two or more times, each expansion being designated "a stage." The number of

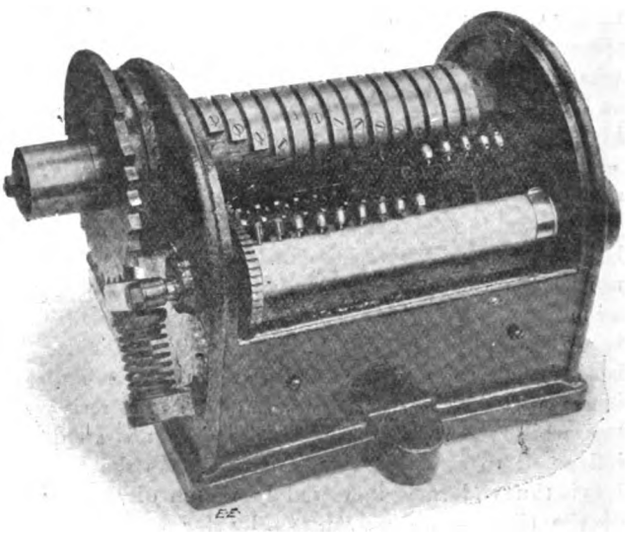

FIG. 2.—Electric Controller for Governor of Curtis Turbine.

stages and the number of rings of buckets in each stage is governed by the degree of expansion, the peripheral velocity of the buckets which is desirable or practicable, and by various conditions of mechanical expediency. Thus the 750-kw. turbine has three stages and the 1,500-kw. machine four stages. Each stage is separated by a diaphragm which is steam-tight, except where nozzles are inserted for the steam to pass into the next stage.

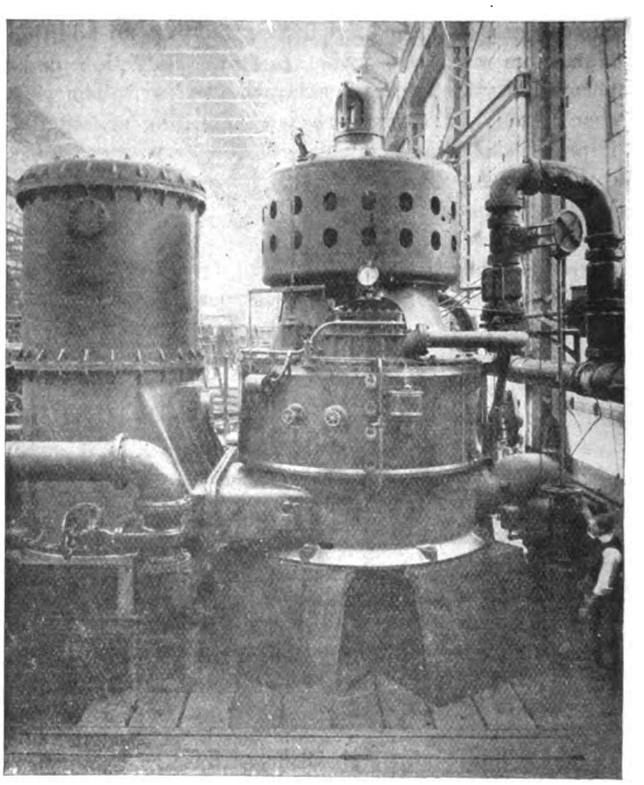

FIG. 3.—View of 1,500 kw. Turbo-Alternator on Test Plate.

One advantage of this system of utilising the velocity of the steam is that the efficiency of the turbine is not so dependent on the mechanical clearance between the fixed and revolving blade as is the case with the pressure type of machine. It also permits of a much more simple system of governing. As the load varies the number of the nozzles which are opened to the steam-chest is varied by the electric governor shown in Fig. 2. The valves over the nozzles

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are electrically controlled by means of this governor, which thus varies the width of the belt of steam impinging on the first series of revolving buckets. In the earlier forms of Curtis turbines the whole of the governing was done on the first stage. In the case of the 1,500-kw. turbine which we saw on trial last Friday the nozzles of the second stage were also governed as the load varied. This was effected by means of a steam relay which automatically closed a certain number of the second-stage nozzles when the load fell below a predetermined value. This relay was actuated from the underside of certain of the first-stage valves, and ensured that when these valves were closed those in the second stage would also be shut. This relay is seen in Fig. 3 at the right-hand side of the four inspection openings. The two hand-wheels which are seen at the left-hand side of the same can be used to close a certain number of the third-stage nozzles if the turbine has to be run for a considerable period at light load. By these means the work taken from the steam can be so divided between four stages of the turbine as may be found most economical. It may be stated here that these large turbines are giving excellent results from a steam-consumption point of view, and are more than fulfilling the guarantees which have been given for them. The great feature, however, of the construction of the Curtis turbine lies in the mechanical strength provided in all the parts, and to this the designers have paid great attention.

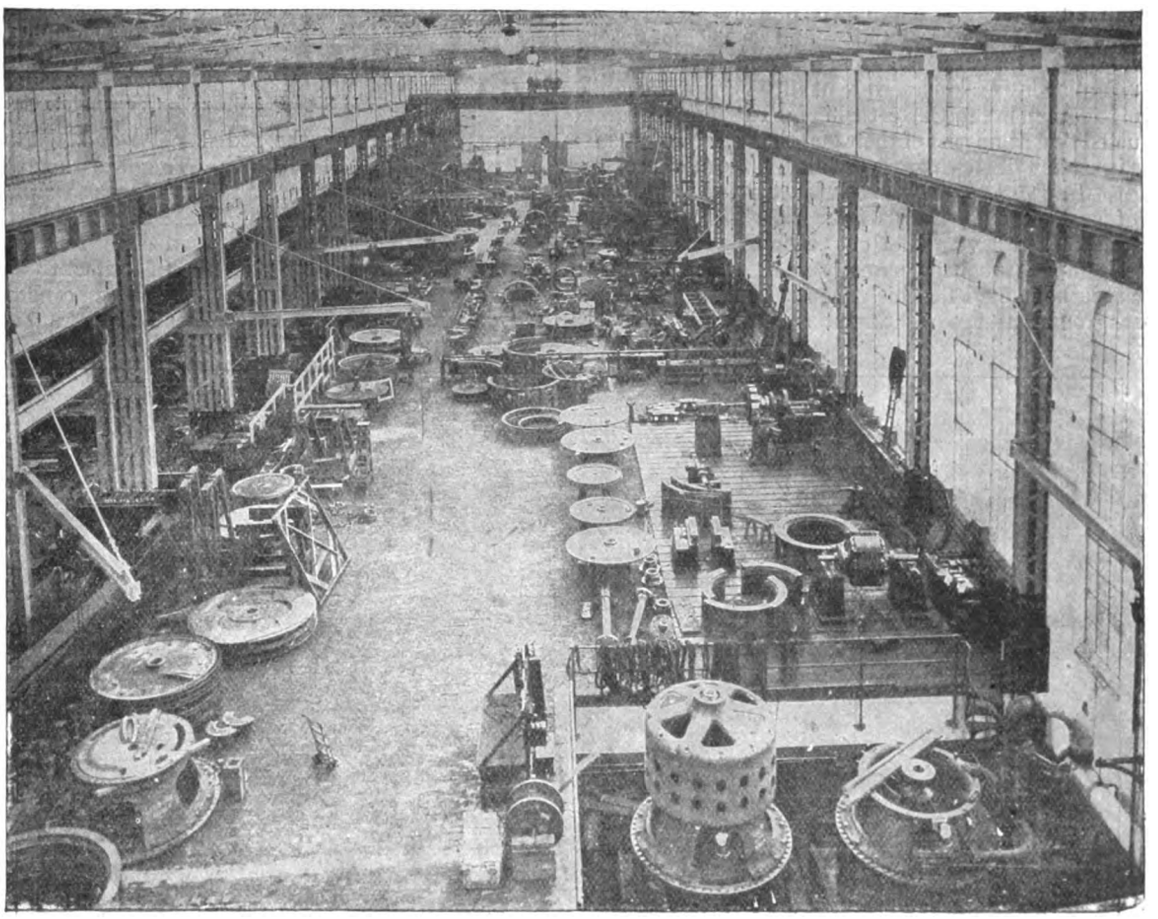

FIG. 4.—One of the Shops of the British Thomson-Houston Company at Rugby in which the Curtis Turbines are manufactured.

Of first consideration in this problem is the revolving part of the turbine, which has to carry the blades for each of the different stages. The firm have adopted a high-grade nickel steel for the turbine shaft, in order to secure not only strength, but rigidity. At the time of our visit we saw one of these shafts being turned in a lathe with a self-hardened steel tool. The stiffness of the turnings, which were coming away from the tool at a high temperature, gave a good idea of the quality of the material from which the shafts are made. The hubs, carried on the spindle, and from which the turbine blade rings are supported, are of cast steel. The details of these can be seen in Fig. 1. Perhaps the most interesting feature in the construction of the turbine is the process by which the turbine blades are machined out of the solid. The rings of rolled steel which are bolted to the turbine hubs are first turned all over and fitted to the same. The outside edge of each ring has a central projection left, which is afterwards used for riveting over a steel strip which unites the ends of each blade. The process of machining out the blades from the solid ring is performed on four machine tools which have been designed specially for the purpose. In the older pair of these machines, a tool the exact width of the steam passage between two adjacent buckets is constrained to move round in a path, one portion of which exactly coincides with the contour of this inter-bucket space. During the other portion of its movements the tool is brought back beyond the edge of the disc so as to clear the same on what may be termed the return stroke. With these machines, which are most ingenious in their construction, only one definite form of bucket can be cut.

In the two newer machines the tool does not move continuously round in one direction, but to and fro over a predetermined path, the contour of which can be varied. With these machines, therefore, the shape of the buckets in each stage can be considerably altered, in order to secure the best economy with a given velocity in the steam escaping from the nozzles. In this machine the tool is slightly withdrawn on the return stroke so as to clear the surface which is being worked. The gear which give the different motions to the tool in order to keep it moving in the desired path and its edge always at right angles to the same are most ingenious. Compressed air is used to give certain of the motions. After the space between two buckets has been machined out there remains but little to be done by hand labour. The edges of the buckets are, however, finished up to a feather edge by filing. A steel band with holes in it is then placed over the projections at the top of the buckets which were turned on the edge of the original ring. These projections are riveted over, and the steel strip then prevents the steam passing through the buckets from spreading radially. The edge of this steel strip is turned and left slightly wider than the blades themselves. Thus, if for any reason the

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clearance should be varied, this edge will run on a corresponding continuous surface at the root of the fixed blades. The blades are thus prevented from engaging one with the other. In fact, the process adopted in adjusting the clearances between the two revolving discs in each stage and the upper and under sides of the fixed blades is to raise the spindle until they are heard to touch, then to lower the spindle until contact again occurs, and then to fix the working position midway between these two extremes. The construction, therefore, is such that no damage is done to the turbine should the revolving parts come in contact with the fixed ones. The blades on the case are usually made of gunmetal, and are cast in sections. The blades are then filed up by hand, but with the castings we saw very little filing was needed.

Another interesting feature in the machine work on these turbines was that of forming the expanding nozzles in the diaphragms between the different stages. The sizes of these nozzles increases naturally in each stage owing to the expansion of steam on its way through the turbine. The general process may be briefly described as that of drilling first an inclined hole through the diaphragm, and then riming out the one end of this round hole into an oval section. In this way the size of the orifice is gradually increased, allowing the steam to expand as is required by the principle adopted in the Curtis turbine. These orifices are so constructed that at no part of their length is there any sudden change in section likely to cause eddying in the steam passing through. In order to secure absolute truth in the revolving parts of each turbine, the surfaces to which the bucket rings are attached have a final cut taken off them after the cast-steel hubs have been actually mounted on the shaft. A special lathe is used for this purpose. It can be seen in the background at the right-hand side of Fig. 4, which shows a view of the main shops in which the turbines are constructed. The other mechanical details are equally worthy of special notice, but several of these are described in our previous article referred to above. With the newer types of turbines it is frequently arranged that they shall stand directly on the condenser casing, as is shown in Fig. 1. This brings the condenser very close to its work, and prevents loss of vacuum due to leaky connecting pipes.

While the turbine attracted most attention, we were also greatly interested in some alternators which were going through the shops, and which are to be driven by these turbines. In these the armatures were fixed and the field-magnet systems revolved. In Fig. 5 we show a view of a six-pole field for a three-phase alternator. The whole of the iron circuits in this field are laminated. The steel

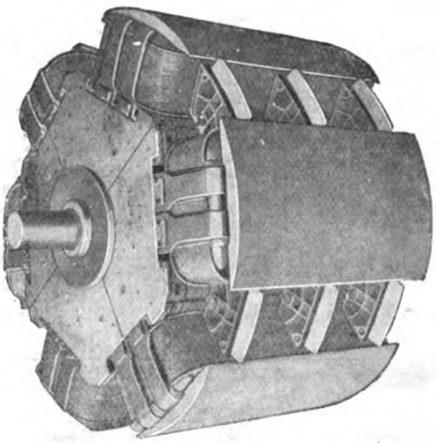

FIG. 5.—Revolving Field Magnet of Alternator for coupling to Curtis Turbine.

laminations forming the radial poles and pole-shoes are built up and riveted together. They are then secured by long wedges into dovetailed recesses in the laminated yoke plates, which are clamped up on the shaft. The field coils are usually of copper strip wound edgewise, with insulation between adjacent turns. In order to resist the centrifugal strains on this, special phosphor-bronze stirrups are placed round the ends of the coils where the same are not supported by the projecting pole-pieces. These phosphor-bronze stirrups, of which there are two at either end of each coil, are also drawn down by wedges passing through the end plates of the yoke. Between adjacent field-magnet coils three or more wedge-shaped castings are secured, in order to keep these coils rigidly clamped up. On the outer edge of each of these clamps an inclined vane is constructed, which has the following object. As

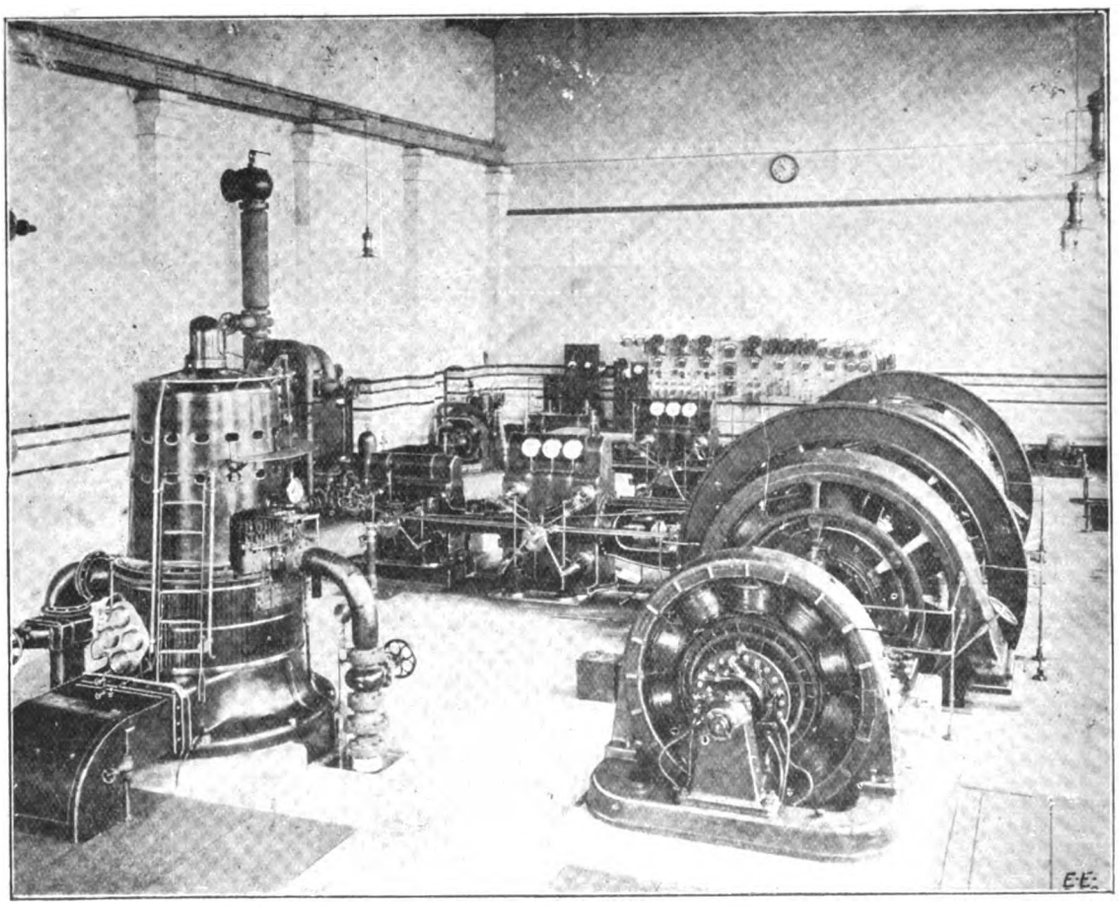

FIG 6.—The Engine Room at the Rugby Power House, showing 750-kw. Curtis Turbine.

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the field-magnet systems revolve, these vanes are so inclined as to force air downwards and out of the bottom of the alternator casing. This secures a downward draught, and prevents steam or heat from the turbine passing up into the alternator. After the field-magnet system has been assembled, it is run for a short time at about 25 per cent. over normal speed, in order that all the parts may take up their final positions before any attempt is made to accurately balance the system. This balancing not only of the field-magnet system, but also of the revolving turbine parts, is naturally carried out by a series of trials run while the balance weights are being added.

The Curtis turbine was first developed by the General Electric Company in America, and the aggregate output of the contracts secured during the first three years was about 600,000 h.p. The British Thomson-Houston Company, while drawing on the experience of the American company, have also taken steps to improve the turbine when manufacturing it at Rugby. They have secured orders aggregating about 32,000 h.p. for turbines, which are either in course of construction or actually installed. Those at work are scattered throughout the United Kingdom in various electric light and power distribution stations. The general impression left by our inspection last week was that the Curtis turbine would, by reason of its construction, have a longer life and stand rougher treatment than a reciprocating engine of the same output.

## NOTES ON THE THEORY AND TESTING OF THE POLYPHASE INDUCTION MOTOR.

BY W. ROGERS.

*(Concluded from page 665.)*

Before an induction motor leaves the "shops," to ensure satisfactory working, it is submitted to an exhaustive series of tests. For the purpose of detecting defects in the magnetic circuit due to faulty design, or mechanical causes, saturation tests are required with the motor running light, and also with the rotor locked, and to obtain an insight into the true performance of a motor it is necessary to know (1) magnetising current at normal voltage; (2) no-load loss; (3) inductive component of the volts—a speed curve will also be required. The magnetising current and no-load loss are obtained by running the motor light at voltages varying from 5 to 125 per cent. of the normal voltage and taking readings of watts, amperes, and volts. If these results are plotted, having the watts and amperes as ordinates and the volts as abscissæ, the resultant curves will represent the running saturation. The inductive component of the volts from which is deduced the inductive leakage, is obtained from data given by the locked saturation curves. These curves are obtained by locking the rotor and applying varying voltages up to 150 per cent. of the normal volts, readings being taken of volts, amperes, kilowatts, and torque. These results when plotted give the required curves. The speed curve is obtained by running the motor on a brake load varying from quarter load to 50 per cent. overload at normal voltage, which is kept constant, readings of volts, amperes, watts, speed, and torque being taken. If the values of amperes and speeds be plotted, using the amperes as abscissæ, the result is a speed curve for different values of load. From the data given by these three tests, it is possible to separate the different losses occurring in the motor, and draw up complete curves showing its performance.

When taking the speed curve of large motors it is not always possible to obtain accurate wattmeter readings of the motor input, the apparent watts (amperes × volts) being only measured. As it is necessary to know the power factor, in cases where it cannot be obtained from the value of true watts ÷ apparent watts, it must be calculated from the total iron loss in the following manner. It is first necessary to find the value of the inductive component of the volts per ampere of current input (taken from the speed curve), and this may be calculated from the information given by the locked saturation curves. If any current C be taken on the ampere curve, and also its corresponding value of V volts, then the apparent kilowatts = C × V ÷ 1,000. Note the real kilowatts taken off the kilowatts curve for the same value of V volts, then the inductive kilowatts

$$= \sqrt{\text{apparent KW.}^2 - \text{real KW.}^2};$$

also inductive volts $= \sqrt{\text{apparent KW.}^2 - \text{real KW.}^2} \div C.$

$\therefore$ Inductive volts per ampere

$$= \sqrt{\text{apparent KW.}^2 - \text{real KW.}^2} \div C^2.$$

Then the total value of inductive volts for any particular value of current input, I, is given by

$$\frac{\sqrt{\text{apparent KW.}^2 - \text{real KW}^2}}{C^2} \times I.$$

The inductive leakage expressed as a percentage

$$= \frac{\dfrac{\sqrt{\text{apparent KW.}^2 - \text{real KW.}^2}}{C^2} \times I}{\text{normal voltage}} \times 100$$

and the value of this quantity in any particular case represents one part of the iron loss. From the running saturation curve read off the current $C^1$ at normal voltage which represents the magnetising current, then this current expressed as a percentage of the value of current input

$$I = \frac{C^1}{I} \times 100.$$

As the total iron loss expressed as a percentage = % inductive leakage + % magnetising current, then the total % inductive loss

$$= \left( \frac{\dfrac{\sqrt{\text{apparent KW.}^2 - \text{real KW}^2}}{C^2} \times I}{\text{normal voltage}} \times 100 \right) + \left( \frac{C^1}{I} \times 100 \right)$$

For the purpose of illustration, suppose the value of this quantity = 38·3 per cent., then the power factor for the same value of current input, I, may be easily obtained. Now the power factor is the ratio of the real kilowatts to the apparent kilowatts, and when there is an inductive loss this ratio is always less than unity. The power factor is found from the right angle relation in a triangle whose three sides are expressed in percentage values, as the power factor is usually expressed as a percentage. In a right-angled triangle the base will represent the power factor, and the vertical side will represent the total percentage inductive loss, which in this case = 38·3 per cent., and this represents the percentage value of the wattless component. In this case we have power factor $= \sqrt{100^2 - 38.3^2} =$ 92·5 per cent.

Having obtained the power factor the other quantities may be easily calculated. The apparent horse power $= \frac{I \times \text{normal voltage}}{746}$; also real horse-power = apparent horse-power × power factor; real watts = real horse-power × 746.

At this point it will be necessary to know the copper loss in the primary winding, but before this can be calculated the primary resistance must be obtained. The formula for calculating the watts lost in a two-phase or three-phase winding $= \frac{C^2 R}{2}$, and the accuracy of this formula may be proved as follows:

Considering, first, a two-phase winding, let C = total current, then $\frac{C}{2}$ = current in each phase.

$$\text{Watts lost in each phase} = \left(\frac{C}{2}\right)^2 \times R = \frac{C^2}{4} \times R.$$

$$\therefore \text{Watts lost in both phases} = 2 \cdot \frac{C^2 R}{4} = \frac{C^2 R}{2}.$$

With a three-phase winding, if C = total current, then $\frac{C}{\sqrt{3}}$ = current in each phase, and

$$\text{Watts lost in each phase} = \left(\frac{C}{\sqrt{3}}\right)^2 \cdot \frac{R}{2} = \frac{C^2}{3} \times \frac{R}{2}.$$

$$\therefore \text{Total loss in the three phases} = 3\left(\frac{C^2}{3} \times \frac{R}{2}\right) = \frac{C^2 R}{2},$$

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In each case R represents the mean value of the primary resistance, which $= \frac{r^1 + r^2 + r^3}{3}$ in a three-phase winding, where $r^1$, $r^2$, and $r^3$ = resistances of each phase.

To allow for the increase in resistance due to heating, it is usual to add on 10 per cent. to the $C^2R$ loss in the primary winding. The other loss to be taken into account is the "no load" loss, which is taken at "normal voltage" from the watts curve of the running saturation.

Total losses are therefore = primary copper loss + 10 per cent. + no-load loss. Then real watts = real horse-power × 746 − total losses.

This quantity "will be further reduced owing to the slip" of the motor. We have motor synchronous speed = alternations ÷ number of poles. Also slip = synchronous speed − motor speed. If the synchronous speed be taken as 100 per cent., then percentage slip

$$= \frac{\text{synchronous speed} - \text{motor speed}}{\text{synchronous speed}} \times 100.$$

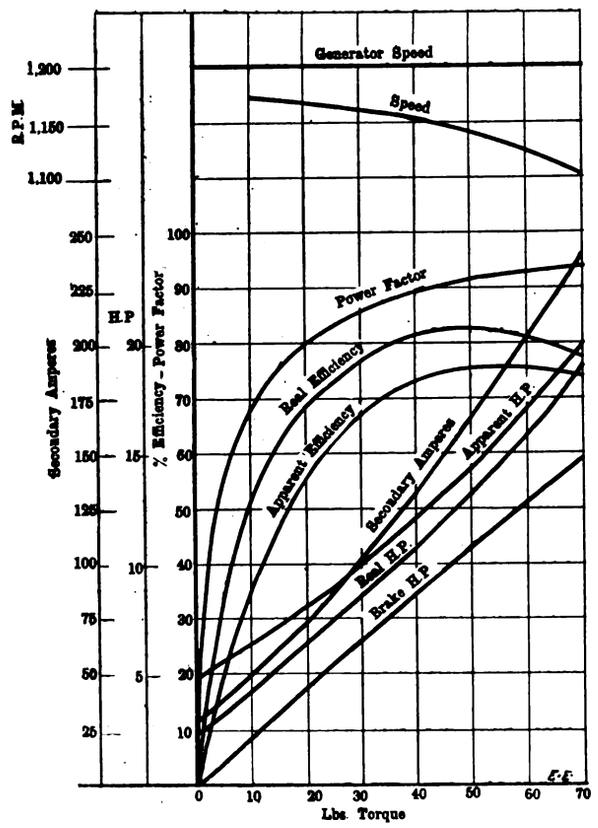


FIG. 5.

Now, $\frac{\text{watts output}}{\text{real watts} - \text{losses}} = \frac{\text{motor speed}}{\text{synchronous speed}}$

$$= \frac{\text{synchronous speed} - \text{slip}}{\text{synchronous speed}}.$$

$$\therefore 100 - \% \text{ slip} = \frac{\text{motor speed}}{\text{synchronous speed}} \times 100.$$

$\therefore$ Watts output = real watts − losses × 100 − % slip.

Brake horse-power = watts output ÷ 746.

Apparent efficiency = brake horse-power ÷ apparent horse-power.

Real efficiency = brake horse-power ÷ real horse-power.

$$\text{Torque} = \frac{\text{brake horse-power}}{\text{speed} \times \cdot 00019} = \frac{\text{brake horse-power} \times 5{,}252}{\text{speed}}$$

Also brake horse-power = speed × torque × ·00019.

Having worked out the quantities mentioned above, if the values of real and apparent efficiency, horse-power, power factor, and speeds be plotted as ordinates, with the corresponding values of torque as abscissæ, the resultant curves will show the actual performance of the motor.

It is possible to find the efficiency direct from the speed-torque curve in the following manner: If the torque is measured at 1ft. radius, note the speed for any particular value of torque. Then

Horse-power developed = torque × speed ÷ 5,252, or

Power in watts = torque × speed ÷ 7·04; also

True power expended = power developed in watts + iron, copper, and friction losses.

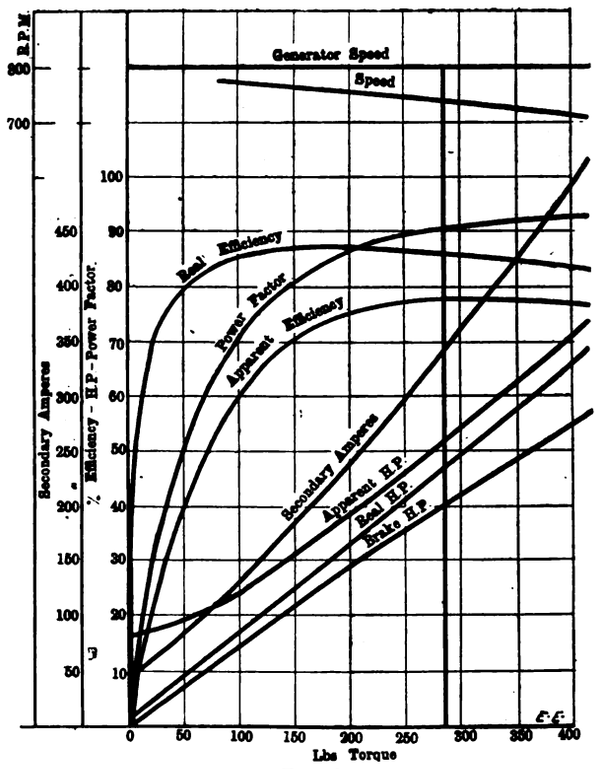


FIG. 6.

The starting torque of an induction motor may be varied, and in practice is generally between one and a half and three times the full-load torque. The value of the

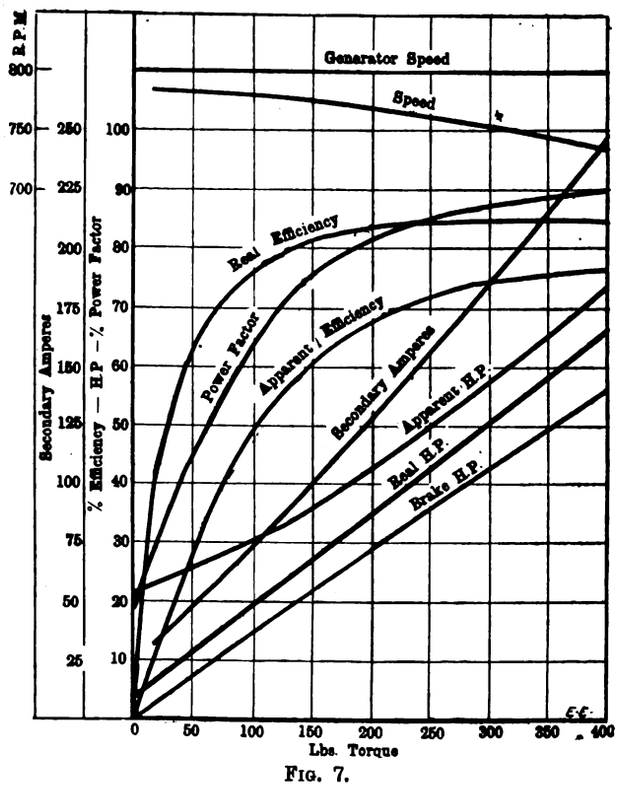


FIG. 7.

starting torque may be found by reading off the locked saturation curve the no-load torque at normal voltage; also read off the power curves the value of torque at the full-load point on the brake horse-power curve. Then no-load torque ÷ full-load torque represents the value of the starting torque as compared with the full-load torque.

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The value of the slip at full load, expressed as a percentage of the synchronous speed, is found by reading off the motor speed curve (on the power curve) the drop in speed below synchronous speed at the full-load point. This drop in speed represents the slip of the motor. Then percentage slip = slip ÷ synchronous speed × 100.

Through the kindness of the British Westinghouse Company, I am able to show three typical performance curves (Figs. 5, 6, and 7) of different sizes of three-phase motors having wound rotors. This type of motor is designed for variable speeds, and is essentially suitable for use when loads have to be carried at reduced speeds, such as with hoist and elevator work. The variable-speed characteristics are obtained by introducing a variable resistance into the "secondary circuit," the slip or drop in speed being directly proportional to the resistance of the rotor circuit. For a given current the torque and power taken from the supply circuit are independent of the speed, and the loss at a reduced speed is proportional to the reduction in speed. When speed variation in an induction motor is obtained by varying the primary voltage, the $C^2$ R loss occurs in the rotor circuit itself. In this case a large reduction in speed will result in a high copper loss. When speed variation is obtained by inserting a variable resistance in the rotor circuit, as in the type of motor under consideration, a large part of the "secondary loss" is dissipated in the external resistance. This type of motor is, therefore, admirably adapted for handling loads at reduced speeds for long periods of time. Its power factor is independent of the speed, and is constant for any given torque. It has the advantage of a heavy starting torque with a minimum current, and runs with small slip when up to speed and with constant torque; the efficiency varies with the speed. In Fig. 8 is shown a photograph representing this type of motor operating a "mine" hoist. The compact appearance of this "hoist" is a good illustration of but one of the many advantages of electrical working in colliery plants.

A characteristic of the induction motor which is regarded as a great disadvantage when compared with the characteristics of the synchronous motor, is the fact that the current taken by it is always a lagging current, but with induction motors of larger size this out-of-phase current is small, and may be considered constant for different values of load. The synchronous motor also takes an out-of-phase current which may be either lagging or leading, depending upon the field excitation of the motor, and as this out-of-phase current is constantly varying it has a very disturbing effect on the supply system. As the lagging current taken by an induction motor is almost constant, the disturbing effects it has on the system are much less. Another great advantage which the induction type has over the synchronous motor is its satisfactory performance in cases of emergency, such as momentary interruption of the supply circuit or temporary overloads. For these reasons, and also for the simplicity and reliability of its operation, the induction motor has taken a leading place in connection with power-transmission plants.

In conclusion, the writer's thanks are due to the British Westinghouse Company for their kindness in supplying him with the curves and photograph illustrating this article.

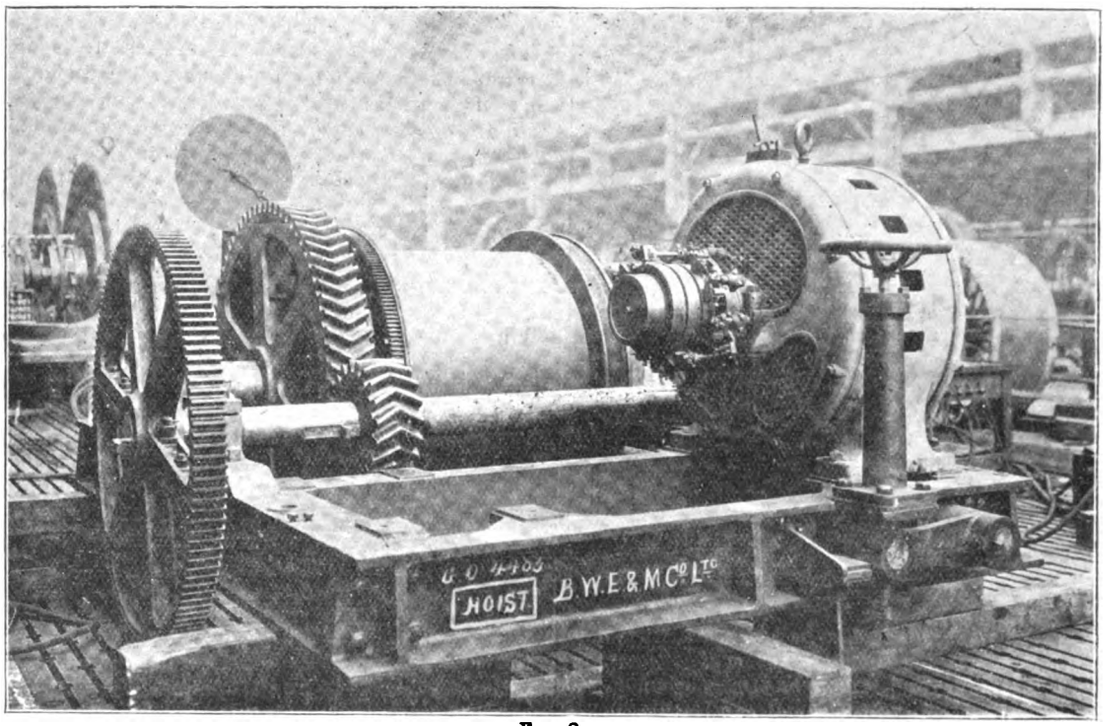


FIG. 8.

## DENNY AND JOHNSON'S TORSION METER.

We are indebted to Messrs. Kelvin and James White, Limited, of Glasgow and London, for some interesting particulars of a new form of torsion indicator recently introduced by them, and by means of which the torsion of a revolving shaft may be easily ascertained, thus enabling the horse-power transmitted to be accurately calculated. Having regard to the increasing use of turbines for marine work, the advent of this instrument is certainly opportune. It is the joint patent, we understand, of Mr. Archibald Denny and Mr. Charles Henry Johnson, the last-mentioned gentleman being an electrical engineer with Messrs. William Denny and Bros.

The accompanying diagram (Fig. 1) shows the general arrangement of the apparatus as applid to turbine-driven shafting. On the shaft the torsion of which it is desired to measure are fixed at a suitable distance apart two light gunmetal wheels, A and B. On each wheel is mounted, as shown, a permanent magnet, the projecting pole of which is made V-shaped in order to produce a dense and definite magnetic field at the point. Underneath the magnets, and set concentrically with the wheels and shaft, are fixed two inductors, A and B, each of which consists of a quadrant-shaped piece of soft iron carried on a gunmetal stand provided with suitable levelling screws. On each piece of iron are mounted a number of separate but similar windings of insulated wire, there being a certain suitable number of windings per unit of circumferential length of the iron. There is in conjunction with the inductors a recording box, in which are mounted two series, A and B, of contact studs, around which are fixed scales. In connection with the series of studs two contact arms, A and B, are arranged, by means of which electrical connection may

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be made at will between any desired stud of a series and its contact arm. There is in series A a stud for every separate winding in the inductor A, and in series B a stud for every separate winding in the inductor B, each stud being connected to its particular winding by means of a separate wire, all of which are contained in the multiple cables, A and B. The remaining ends or returns of the windings on the inductors A and B respectively, are all connected by means of two common wires to the contact arms A and B respectively. Included in each of these two

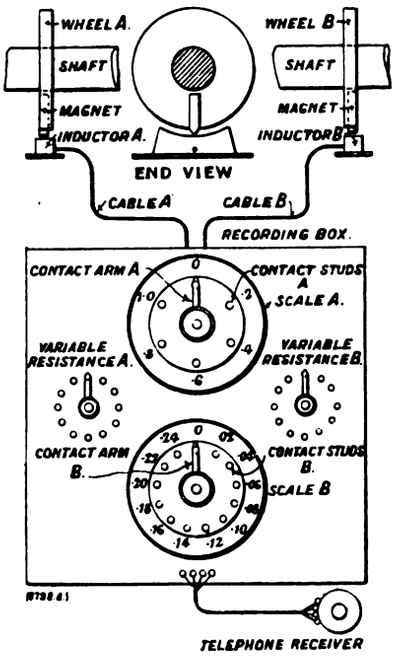


FIG. 1.

circuits is a variable resistance (by means of which the strength of the current flowing in the circuit may be adjusted as desired) and one winding of a differentially-wound telephone receiver. The scale A is divided into five equal parts, there being six separate windings in the inductor A, and thus six studs in the series A; the length of the scale thus represents the circumferential length occupied by all the windings on the inductor, each subdivision representing the distance between neighbouring windings, which is usually 0·2in. The scale B is divided into 13 equal parts, there being 14 separate windings on the inductor B, and thus 14 studs in the series B. The length of the scale, as before, represents the circumferential length occupied by all the windings in the inductor, the distance between neighbouring windings being represented by one division of the scale. The usual distance between neighbouring windings in inductor B is 0·02in. The steel in connection with the inductor at the turbine end of the shaft is set so that the magnet fixed to it is exactly above one or other of the two end windings in the inductor; the correct end winding to set the magnet to being that one from which the magnet will travel towards the other end winding when the shaft rotates. The wheel in connection with the other inductor is also set so that its magnet is exactly above one of the two end windings in the inductor, the correct end winding to set the magnet to in this case being that one from which the magnet will travel in the opposite direction of the other end winding when the shaft rotates. To facilitate the accurate and easy setting of the magnets above their respective windings, lines are cut in the tops of the inductors exactly above the end windings, and the magnets are set to these lines. When the shaft rotates without transmitting power, a current of electricity is induced in the end or zero winding of each inductor, the contact arms being first placed in contact with the end or zero stud in each series. These two separate currents each traverse their respective circuits, passing in each case from the inductor winding, in which they are induced, to the respective zero studs, to which these windings are connected, thence by way of the respective contact arms, resistances, and telephone receiver windings back to the inductors again. The connections to the receiver windings are so arranged that the effects of the two separate currents flowing therein are in opposition, and thus neutralise each other's effect on the receiver when the strengths of the two currents flowing are exactly equal at the same instant. By means of the variable resistances in each of the circuits the currents are made equal in strength, and then so long as the shaft transmits no power, and is thus subject to no torsion, no sound will be heard on listening at the receiver, since the currents induced in the zero windings of the inductors have been equalised and are both induced at exactly the same instant. When transmitting power the shaft is subject to a certain torsion or twist, which causes the zero winding of the inductor next the turbine or engine to be excited in advance of the other by the amount of the torsion of the shaft. A loud ticking sound will then be heard in the receiver, as the currents no longer neutralise each other. Contact arm B is then shifted from stud to stud until the position of greatest silence in the receiver is once more obtained. When this position is found, the reading on the scale B opposite the contact arm represents the circumferential measurement of the angle of torsion of the shaft at the radius of the inductor windings. A current equal in strength at the same instant to that induced in the zero winding of inductor A is now being induced in that winding of inductor B which is in connection with the contact arm B. The scale reading thus represents the displacement of one magnet with regard to the other due to the torsion of the shaft. In the event of the torsion being found to be too great to be measured on scale B alone, contact arm A is shifted from stud to stud until a reading can be obtained on scale B, the torsion reading being equal to the sum of the readings on scales A and B. The reading corresponding to any large displacement of one magnet relatively to the other, is thus easily obtained by the combined use of the scales A and B.

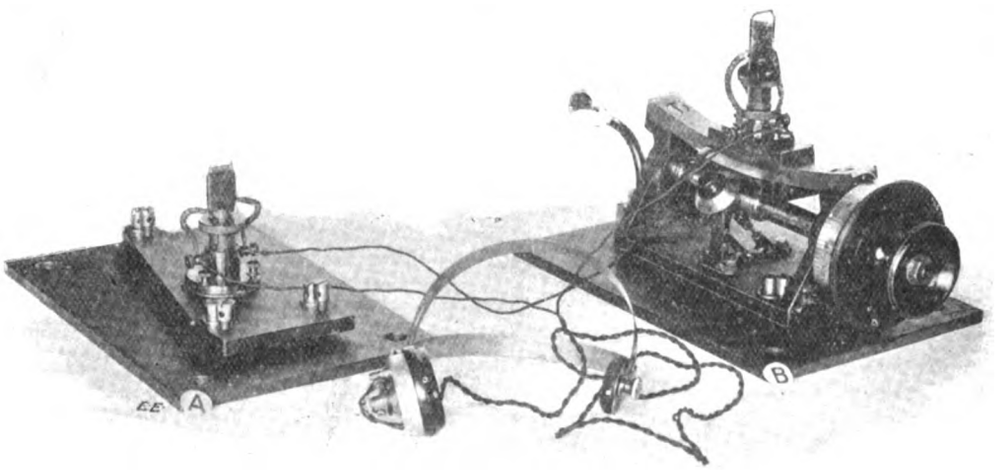


FIG. 2

These instruments were designed and made because, unlike the reciprocating engine, it is impossible to obtain

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the power by means of indicator diagrams in the case of a turbine, and Messrs. William Denny and Bros. foresaw that if success in speed prediction was to be attained in turbines, some means must be devised for ascertaining accurately the power developed and transmitted from the turbine. They have now been tested exhaustively on no less than 11 of the turbine steamers built by that firm, and have proved entirely satisfactory, an average accuracy of 99 per cent. in the readings taken being easily obtained. The recording box is usually placed in a quiet cabin, as while the sound in the telephone is quite definite for fine adjustments, it is desirable to have as little extraneous noise as possible. A recording machine with a strip of paper may be fitted in this cabin, with a pen for recording the revolutions of each engine by means of electric contacts, and a further pen connected from the watch of the observer on the bridge who is taking the time on the mile, while a third pen marks half seconds from a standard clock. By means of these the observer in the cabin is advised when the ship is on the mile and makes his observations of power quite independently of any advice from the engine-room, the revolutions being recorded at the same

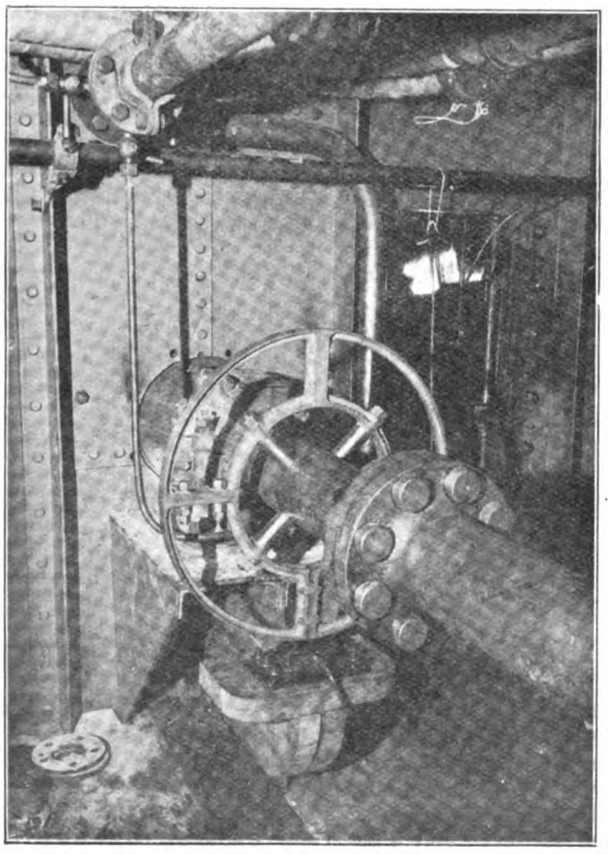

FIG. 3.

time. It is thus practicable to report the result of a run in speed and power within a few minutes of being completed.

Our illustration (Fig. 2) shows the two conductors of a rather different form of torsion meter. In this instrument inductor A consists of a thin soft iron core wound with insulated wire and mounted on a suitable base. Inductor B consists of a similar core and winding on a slider mounted on a quadrant-shaped guide in such a manner that by turning a handwheel the slider carrying the core may be moved backward or forward along the gnide. A telephone receiver is arranged in circuit with the inductors as shown, and each inductor is set beneath a wheel (not shown) carrying a magnet, as in the case of the previously described instrument. To take a reading, the handwheel is moved backward or forward as required until silence is obtained in the receiver. The amount of this adjustment is then noted, and represents the amount of torsion of the shaft. This form of torsion meter is specially suitable for very low rates of revolution, and can be easily arranged to measure the torsion of shafting driven by ordinary reciprocating engines. As the torsion of this class of shafting is variable during a revolution (due to the uneven turning moments of steam-engines), six magnets are employed on each wheel instead of one, and these are spaced equidistant about the circumference of the wheels, and are arranged each in a different parallel plane. The inductors are as shown in Fig. 2, except that there are six separate windings mounted on each inductor base, the six windings on each inductor being arranged in line with the shaft and in the same planes as the magnets carried by the wheels. A switch is arranged by means of which any desired pair of windings on the two inductors may be connected in circuit with the receiver at a time, and, as in the previous case, resistances are provided for adjusting the strength of the induced currents. By these means the torsion at six different points of the circumference can be easily and rapidly measured consecutively, and from these readings the mean torsion during a revolution is obtained for any constant condition of trial lasting for a short period.

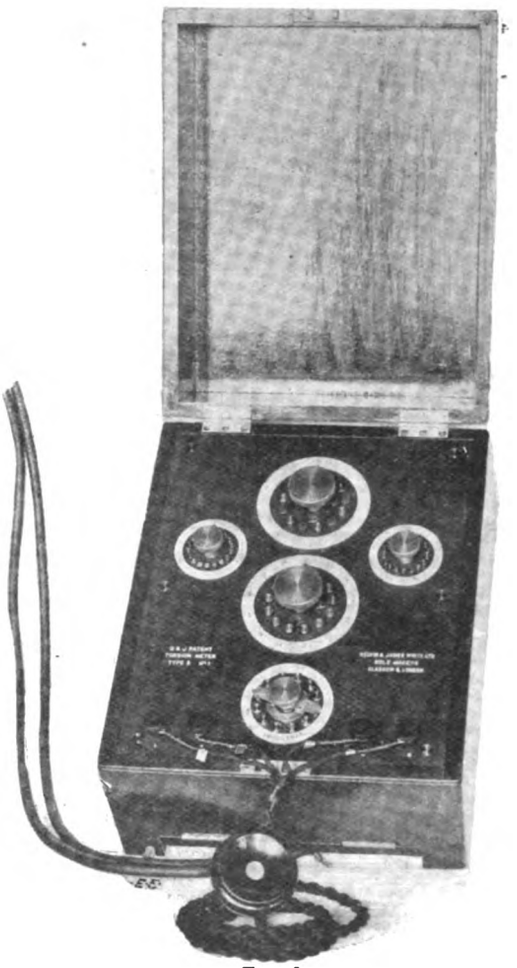

FIG. 4.

An experiment was made with this instrument in the case of a reciprocating engine, whose turning moment was known to be far from regular, and it was found that with six magnets placed equally round the wheel the greatest possible error did not exceed 4 per cent., and by working out a polar diagram of torque and arranging the magnets suitably round the wheel the error involved did not exceed 1 per cent. We need not point out that for laboratory or factory work, in addition to marine work, these instruments should prove extremely valuable.

The further illustrations herewith are from photographs of a set of the first-mentioned type of instruments for turbine work taken on a turbine steamer. Fig. 3 shows the disc fixed at one end of the centre shaft. The disc fixed at the other end of this shaft, and to the remaining shafts, is exactly similar. Fig. 4 shows the recording box. The studs opposite which the letter Z is marked on the scales are for the purpose of testing the accuracy of the zero of the inductors.

From the foregoing description of the "D. and J." patent torsion meters, it will be seen that one of the outstanding features of all the instruments is the total absence of all

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rubbing contacts. The fact that they have no rubbing contacts and are thus subject to no wear and tear, coupled with the fact that they generate their own current and require absolutely no attention when not in use, make them very suitable for fixing permanently on board ship, thus allowing of a daily reading of the power being taken, which would permit of anything causing loss of efficiency to be at once detected. We understand that Messrs. Wm. Denny and Bros. attacked this problem some 10 or 15 years ago in connection with factory shafting, but without practical success. With the advent of turbines, however, they determined that a proper solution must be found. The instruments described in the foregoing are the result, and Messrs. Denny speak highly of the originality and perseverance of Mr. Johnson in carrying this work to a successful conclusion.

## THE KEY ENGINEERING COMPANY'S EXHIBITION.

A week or so ago we had an opportunity of inspecting an interesting exhibition with practical demonstrations organised by the Key Engineering Company in their showrooms at 38, Deansgate, Manchester. The apparatus on view covered a wide range of subjects, including a Thornycroft four-ton steam wagon, and coming down to such small details as primary batteries. We do not now propose to review the whole of the apparatus which was then open to inspection, but merely to refer to one or two points which struck us as being of special interest. Amongst these was the Ross self-lowering trolley arm, which had additional interest at the time from the fatal accident which had occurred a few days before near Wigan. With this trolley arm the feature is that if the trolley comes off the the wire, it does not remain up in a position which will cause it to engage in the overhead construction. When this is the case it comes to be a question of mechanical strength as to whether the overhead wires will pull the trolley off the car, causing mechanical damage to the passengers, or whether it will pull down the overhead wire, causing electric shocks as well as mechanical. With the trolley arm in question this is prevented by a simple mechanism which ensures the arm coming down to a normal level if it comes off the wire. The details by which this is secured will be gathered from the accompanying illustrations, which show the mechanical construction of this trolley arm. Fig. 1 shows the running position. It will be seen that trolley arm, B, which carries the trolley pole, is pivoted on the pin, C, and carries at one end an adjustable stud, *a*. The trolley head, A, which carries the pole is mounted on ball bearings and turns freely round the standard. E is a rocking lever pivoted at *g*, at one end of which is fitted adjustable wedge, G. F shows the cross-head through which the pull of the spring is applied to the trolley pole. D is a movable support for pin, C, which latter is free to move in the slot shown. The instant the trolley pole leaves the wire the stud, *a*, strikes against the rocking lever, E, causing the point *b* to move up and force D out of position at *d*, which causes it to fall, and with it the trolley pole. This condition of affairs is now seen in Fig. 2, which shows the trolley pole locked clear of the wire until reset. To reset the trolley, the rope is pulled down, the trolley arm now moves about point *e*, and support D is lifted again into position. The rocking lever, E, falls back to the normal position, and the trolley pole is free to move on pin, C, and round the standard, as before. Another good feature in the device is that the arm is also locked in a radial direction so that it cannot swing round and cause damage in that way. The device is one which extended trial should bring into general use.

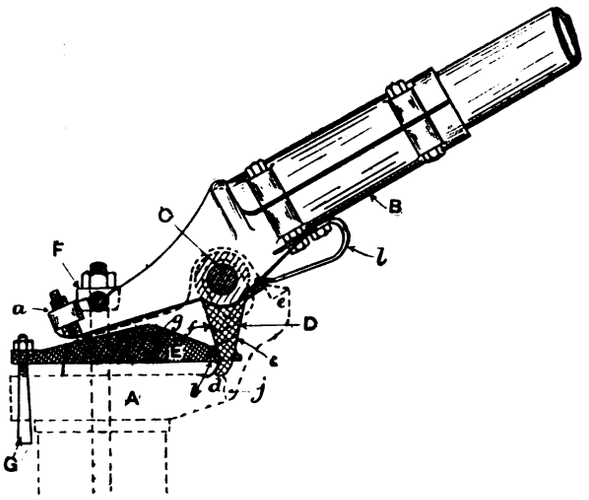


FIG. 1.—The Ross Patent Self-Lowering Trolley Arm in Running position.

Mr. L. Andrews had a good number of his reverse-current circuit breakers on view at this exhibition, and, as usual, he managed to show us one or two new points in the construction of the same. One of these raised the question that, although reverse-current circuit breakers are used in a large number of direct-current stations in the country, it is apparently not generally recognised that the majority of the devices in use are liable to fail to isolate a faulty generator should the fault be equivalent to a direct short-circuit across the brushes. The usual method of testing a reverse-current circuit breaker is to shut the steam off the engine, or to open the field of the generator. Under these conditions almost any reverse-current device will be quite satisfactory on direct-current circuits, as the normal pressure is then maintained across the potential winding on the cut-out, and the current in the series winding is not excessive. Should the brushes of a direct-current generator running in parallel with others be accidentally short-circuited, as is obviously always liable to happen, the conditions are very much more severe, as, in the first place, the potential across the 'bus bars is liable to fall almost to zero, and, in the second place, an enormous reverse current will flow through the series winding, and then will tend to entirely overpower the polarity effect of the combined series and shunt windings, upon which the action of the reverse device is dependent. Attempts have been made in the past to compensate for this defect, of the series current predominating over the potential current, by using a much stronger potential effect than is required to give a satisfactory reverse. This, however, introduces another difficulty, inasmuch as at normal pressure the potential current tends to overcome the series current.

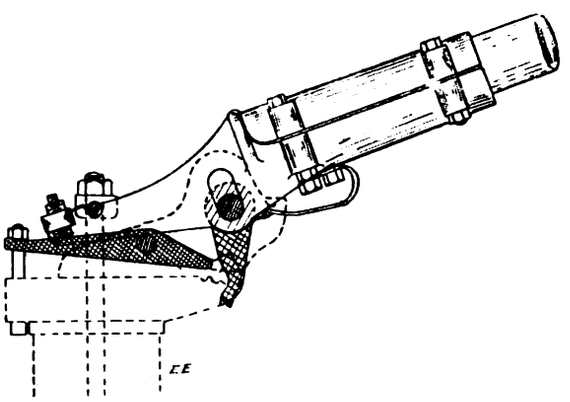


FIG. 2.—The Ross Trolley, Locked.

Several designers have dealt with the difficulty by using permanent magnets instead of magnets energised by a potential winding. Quite a satisfactory relay can undoubtedly be made in this way, but the fact remains that to operate direct-current devices by means of relays involves introducing unnecessary complications and elements of risk. Although the relay may operate satisfactorily, the circuit breaker may not be tripped, in the first place, owing to the contacts of the relay being dirty, and, in the second place, it must be remembered that the current in the tripping coil is often dependent upon the 'bus-bar pressure, and, consequently, if the pressure falls from much below normal, it may be insufficient to trip the circuit breaker. The direct-acting circuit breaker has, therefore, the advantage, in the first place, of greater simplicity, and, in the second place, the heavy current in the series coils assists the current in the potential coil by actively tripping the circuit breaker.

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In the device illustrated in the sectional sketch (Fig. 3) the series and potential windings are so arranged as to entirely prevent the effect of the current in the one winding predominating over the current in the other. In this construction it is possible to work with the core in the shunt winding highly saturated, and, consequently, if the pressure

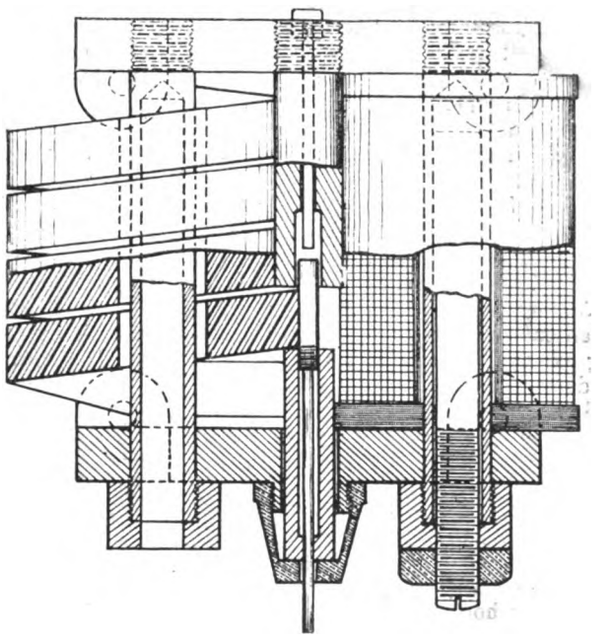

FIG. 3.—Tripping Electromagnets of Andrews' Combined Reverse-Current and Over-load Circuit Breaker.

across the shunt winding drops to something approaching zero, there is still sufficient magnetic force left to cause the device to operate satisfactorily on heavy reverse currents. The characteristic curves A and B (Fig. 4), show the variations in the pull of the tripping core with different generating and motor currents, A with a normal potential and reverse-current device. It will be obvious that if the section of the core in the series winding is appreciably greater than the core in the shunt winding, the latter will become saturated before the former, and consequently some of the flux induced in the series core will leak back through the tripping plunger, thus, with a given excess current, causing this to lift and trip the circuit breaker. It is usually required, however, that a reverse-current circuit breaker shall not be tripped by any amount of forward current, and consequently, to ensure this, the core in the shunt winding should be of heavier section than that in the series in order that the latter may become saturated, and an easy path provided for any flux induced in the series core to return through the shunt core, thus entirely overcoming any tendency to magnetic leakage. To enable the device to be used as a reverse-current breaker only, or as a combined excess current and reverse, the respective cores in the shunt and series windings are made of hollow tubes, and a solid internal core is provided for fitting into either of the hollow cores. Curves A and C (Fig. 4) represent the characteristics of the release with the solid core inserted in the hollow core of the shunt winding. It will be seen that under these conditions there is absolutely no pull on the tripping core with any amount of excess current. Curve B shows the effect of removing the solid core from the shunt winding and inserting it in the series winding. It will be seen that as a reverse-current device the characteristic is not appreciably altered—that is to say, it takes approximately the same reverse current to trip it as with a core in the shunt winding. On the excess-current side, however, the behaviour of the device is entirely altered. The magnetic current leakage, and consequently the pull on the core, increases with the generating current, and will, with a given excess current, trip the circuit breaker. The slope of this curve may be adjusted as desired by varying the position of the core in the series winding.

Another attraction offered by the Key Engineering Company, Limited, to visitors attending their exhibition at Manchester was the opportunity afforded of inspecting the laying of a portion of the 34 miles of fibre conduit now

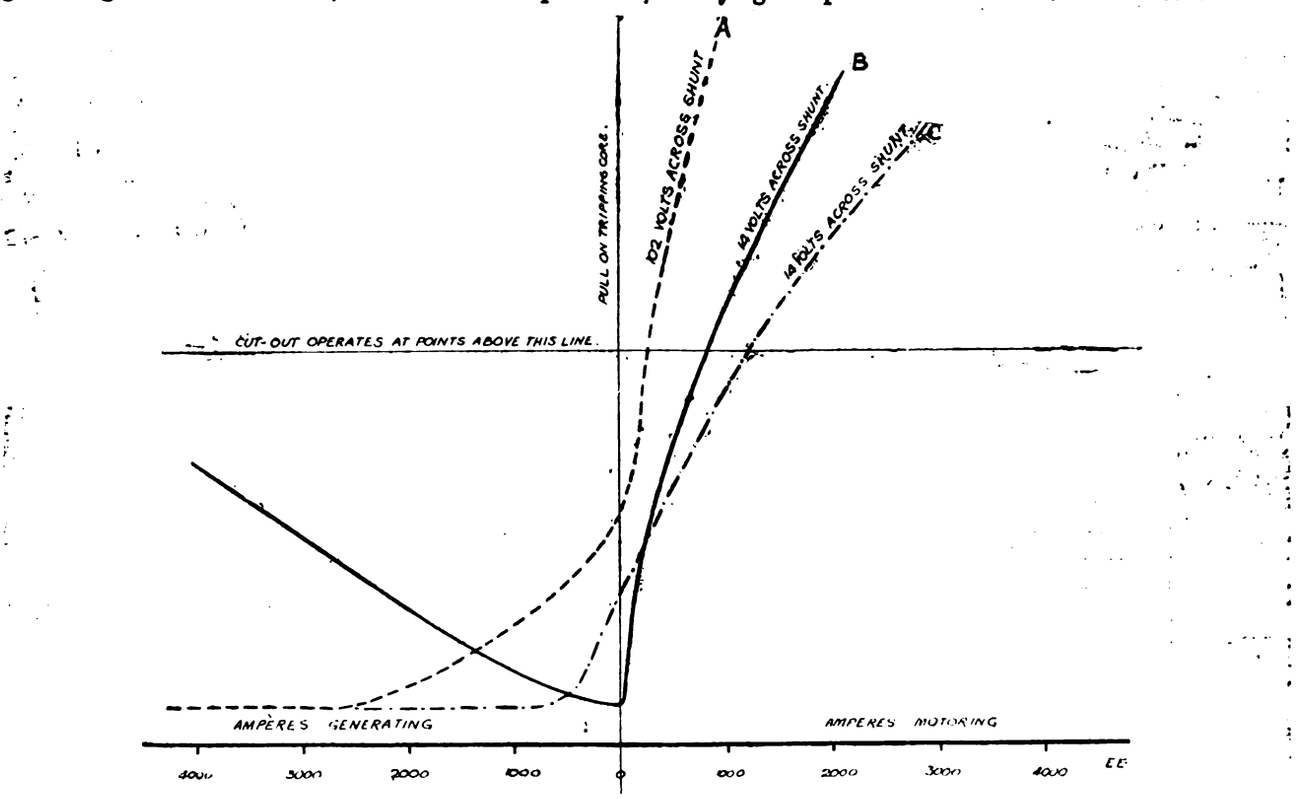


FIG. 4.—Performance Curves of Andrews' Combined Reverse-Current and Over-load Circuit Breaker. The dotted curves are the core set to act as with reverse current only. The full curves show action with core set for combined reverse and over-load tripping.

of 100 volts across the shunt winding, and B with a potential of only 14 volts across this winding. It will be seen that even with a drop of potential of 85 per cent. the reverse current required to operate the cut out is not very much greater than with a normal potential.

An interesting feature of this device is that it may, with a slight alteration, be used as a combined excess-current

being installed by the Manchester Corporation. The accompanying photograph (Fig. 5) was taken during the process of laying a 60-way 3in. duct in Portland-street. The conduits are laid in a trench 3ft. 4in. wide and 9ft. 6in. deep. A bed of coarse concrete 4in. thick was laid at the bottom of the trench, this being topped by a covering of fine sand concrete. The conduits were arranged in 10

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layers of six ways per layer. They were accurately spaced by means of comb-shaped wooden templets, placed at intervals along the trench, the space allowed between each way being 1½in. The space between the ways was filled by the fine sand concrete, and about 1in. of this concrete was used between the respective layers. The conduit consists of tubes about 5ft. long, the ends of

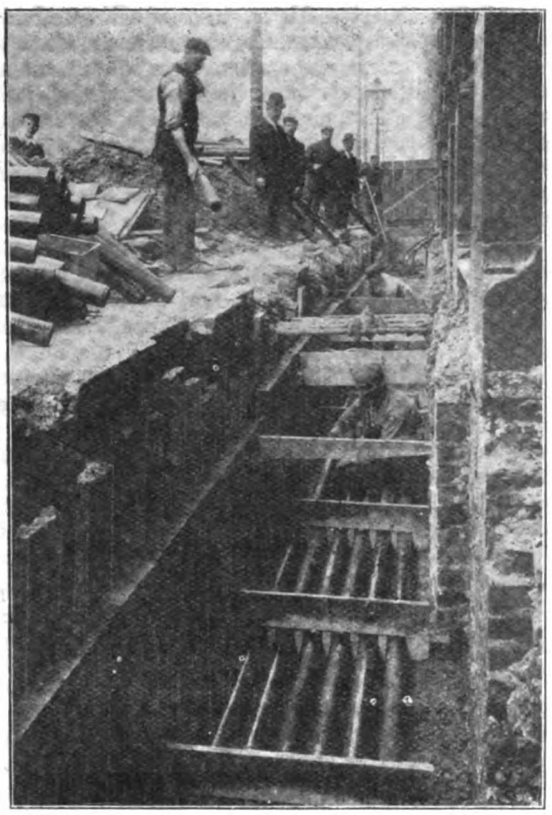

FIG 5.—Laying Fibre Conduits in Portland Street, Manchester.

each tube being tooled to make accurate socket and spigot joints; by this means perfect alignment and an absolutely watertight joint are secured. As a further precaution each joint is bound round with a piece of sticky tape, about 1½in. wide. That no time has been lost in executing this work, and that the public are consequently put to the minimum of inconvenience, is evident from the following figures: at 6.30 a.m. on Saturday, May 6, the work of opening 65 yards of street was commenced, and by 9 a.m. the following Monday morning the whole work was completed, including the filling-in of the trench, and this without any night work. The actual laying of the conduits was commenced at 6.30 on Sunday morning and by 8 30 on Sunday evening the whole of the 65 yards of 60-way duct was completed. In this section 130 tons of concrete were used and 3,900 yards of 3in. duct. This undoubtedly constitutes one of the most perfect examples of conduit work that has yet been carried out in this country, and it is interesting to note that the cost of the work is not greater than if a high-class earthenware conduit had been used.

The firm had also on view a new form of arc lamp from which exceptional results are claimed. It is an improvement on a type of lamp with which they have been experimenting for some time. In it two inclined carbons are used, together with a magnetic arrangement for blowing the arc downwards. The lamp uses pure carbon, and hence gives an intensely white light. With the example we saw at work the current was 11 amperes at 85 volts, and the firm claim to obtain no less than 3 c.p. for every watt expended. The fact that the craters are fully exposed accounts for this good result. The mechanism for controlling the inclined carbons has been perfected, and it is hoped shortly to put this lamp on the market, where it should find a great demand for street-lighting purposes.

Among the other interesting exhibits was a Reavell electrically-driven air process which was at work supplying air to a number of compressed-air tools. The Harris-Anderson system of patent feed purifiers was also exhibited, and experiments were being conducted as required to convince those present of the efficacy of the system. We described this method of feed-water purifying in connection with the new station at West Ham. It has been introduced, amongst other places, at the Glasgow Corporation tramway station, where it has given great satisfaction. The plant there is capable of dealing with 22,000 gallons of water per hour. A recent report from the city analyst concludes, after examination of samples of treated water, as follows: "(1) The analysis shows that there is no oil whatever of any kind present in the water; (2) the analysis shows practically the total absence of any scale-forming or crust-forming matter; (3) the analysis shows that the total alkalinity of the water is equivalent to 2·22 grains of carbonate of soda per gallon, which is exceedingly small, and the presence of which is desirable rather than otherwise; (4) the analysis shows that this water is eminently suitable for boiler feed purposes, and in that respect could hardly be surpassed.

The Delafon Syndicate, Limited, had on exhibition a number of primary batteries, which the Key Engineering Company are agents for in this country. These include forms which are much like those which have become standard articles, but we are informed that the Delafon Company have perfected the construction and used such materials as to get results which are remarkable. For instance, a large demand has arisen for the use of dry cells for the sparking coils on motorcars. The Delafon dry cell is specially adapted for this purpose in consequence of its low internal resistance. The curves which we give herewith are from results taken by an expert at the Manchester School of Technology on this type of battery, which is represented by curve R. The curves M and N are for cells of well-known make, which are looked upon as the best in the market. The reason for testing two of these was that

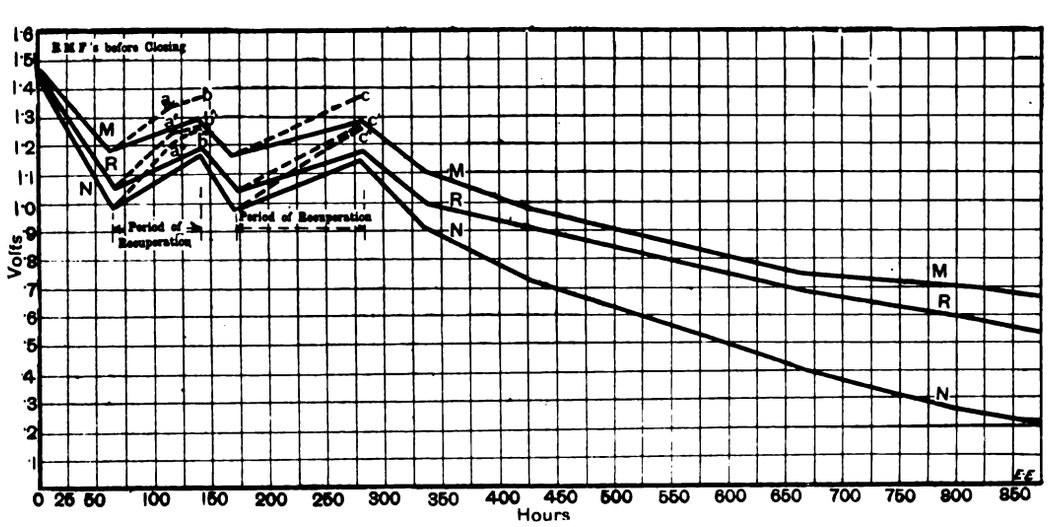


FIG. 6.—Life Test of Delafon Battery (R) against two of another make. The dotted portions of the curves show period of recuperation and E.M.F. on open circuit. The cells were all discharged through resistances of 5 ohms.

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a cell could not be obtained of the same total weight as the one marked R of the Delafon Syndicate. The two batteries M and N were, therefore, selected so that their mean weight was the same as that of R. The actual weights were as follows: M, 9lb. 12oz.; R, 7lb. 1oz; N, 5lb. 4oz. The over-all dimensions were respectively: M, $4\frac{1}{16}$in. by $4\frac{1}{16}$in. by $8\frac{1}{8}$in; R, 7 6in. by 4 92in. by 3·74in.; N, $3\frac{5}{16}$in. by $3\frac{3}{16}$in. by $7\frac{3}{8}$in. The data considered were: (1) the E M.F of each cell on open circuit; (2) the internal resistance; (3) the behaviour of cell when delivering current; (4) the life test when working on a constant circuit; (5) internal condition of elements after the life test. The E M.F.'s of the three cells before the circuits were closed were respectively: M, 1·55; R, 1·53; N, 1·54. On momentary short-circuit the cells gave respectively: M, 13 amperes; R, 19 amperes; N, 10 amperes. Thus the short-circuit current of the Delafon cell is 50 per cent. greater than that of M, and nearly 100 per cent. greater than that of N. This shows that its internal resistance is lower, and that it is able to give a larger current in consequence. The measurement of the internal resistance of the three cells gave respectively: for M, 0·01 ohm; R, 0 05 ohm; N, 0 12 ohm.

The life tests were then commenced, and the curves reproduced herewith obtained. At the end of 65 hours the voltages were found to be: M, 1·12; R, 1 04; N, 0 98. The cells then had a week-end's rest. After another 30 hours' discharge they were again allowed to recuperate until 280 hours had elapsed from the commencement of the test, and they were then continuously discharged (excepting the very small intervals needed to open the circuits to determine the internal resistances), till cell R had reached a potential difference of 0 5 volt. On the above assumptions as to the life limits, the following useful life in hours was obtained for the three cells: M, 1,050; R, 780; N, 420. The useful life in hours per pound weight gives a more accurate comparison, and on this basis M will last 107 hours for each pound, R 112, and N 80. This shows that the Delafon cell lettered R was superior to either of the other two. Some other trials are now proceeding with these cells for motorcar work, and results which were shown lead us to conclude that they will be exceedingly useful in this field. They have the advantage that they do not suddenly cease to give a sparking current, as is the case with accumulators if discharged too far.

## ENGLISH-MADE EDISON LAMPS.

At the time of our visit last week to the British-Thomson Houston Company's Rugby works to see the Curtis turbine, we had also an opportunity of inspecting the modern lamp works in full swing. The making of incandescent lamps has always been associated hitherto with experts in glass-blowing. We were, therefore, surprised to find that in a factory turning out lamps to the extent of 30,000 a week there was only one glass-blower employed. All the rest of the many operations involving glass work were performed by automatic machines fed by girls. These machines were designed for a great variety of purposes, but in general principle they were not unlike. They consisted, as a rule, of a revolving frame with a number of clips in which the lamps in various stages of manufacture could be held. The girl who placed lamps into these clips moved the frame round by one step each time. This brought the lamp successively opposite one or more blow-pipe flames, which automatically performed the operation required. The girl had then only to remove the bulb which had been advanced one stage in manufacture and replace it by another to be operated upon. In this way the bulbs received into the factory passed through a variety of processes. For instance, they first have a small hole made at the upper end. The next step is to fix to the edges of this hole a small glass tube through which the lamp is exhausted. The larger tube at the other end is then prepared to receive the mounted filament, which has already gone through a number of stages of manufacture. The filament is introduced into the lamp, sealed in, and the lamp passes on to the exhausting benches in a very short space of time. These glass-blowing machines are the outcome of years of experimental work, and it would be unfair to the company to describe them in detail. It suffices to say that they allow of comparatively unskilled labour carrying out excellent work in a minimum of time.

The removal of the air from the lamps is done entirely by mechanical pumps. The first part of the exhaustion process is effected by one pump while the lamps are cold. After a certain stage the operation is continued by a second pump, which creates a better vacuum. At the same time current is switched on to the filament, which renders it incandescent. Before the process is commenced, a small quantity of a certain chemical is introduced into the tube through which the lamp is exhausted. This tube is now heated by a blow-pipe, and the substance gives off a gas which combines readily with the remaining traces of air within the lamp. The operator is able to judge by the colour of the light given off by the filament when the vacuum is satisfactory, and she then seals off the tip of lamp. The process of mechanical exhaustion with this final aid in removing the last traces of air is much more rapid than with mercury pumps. We need hardly say that it is also much more healthy for the operators.

As regards the grading of the lamps, the carbon filaments are all flashed to a uniform thickness before they are mounted. Slight variation in the voltage required is then met by varying the length of the filament. The practice adopted by the company is to cut the filaments to practically the right length for a medium voltage, and then to accurately grade the lamps after completion. This is done on the photometer. The voltage applied to the lamp under test is varied until it gives the required candle-power. The girl who feeds the testing lamp-holder socket of the photometer bench reads off this voltage on a scale, the indication of which is automatically given by the operator when adjusting the same to get the correct candle-power. This voltage is marked on the lamp, which is then put with others from the same batch needing equal voltage to give the rated candle-power. Thus, out of one series of lamps, the variation may be from, say, 210 volts up to 230 volts by steps of five volts. The grading ensures that the nominal candle-power will be obtained when the lamp is connected to a circuit of the voltage marked on the glass. Both the standard lamp and the lamp under test are made to revolve while being tried, so as to avoid any error due to the angular positions of the filaments with respect to each other.

The details for testing the lamps for mechanical strength in those parts most likely to be injured were most interesting, and we saw quite a number of lamps being discarded which otherwise would have vexed consumers by their short life. It is in the repairs to these defective lamps that the single glass-blower is employed. The net result of the introduction of so many automatic processes is that a large number of high-class lamps which are well graded as to voltage and candle-power can be turned out in a comparatively small factory four storeys in height.

At present the ground floor is used for other work, but the increase in the demand for lamps will shortly necessitate the moving of this to another building.

## LONDON ELECTRIC POWER BILLS.

Lord Camperdown's Committee to-day threw out the Charing Cross and Strand and City of London Electric Power Bill. They passed the North Metropolitan Bill, and in the Central London case, whilst declining to extend the area of supply, allowed the other parts of the Bill to proceed. They refused to sanction the clauses relating to the linking up of the generating stations and the extension of area in the County of London case, but otherwise allowed the Bill to proceed. With regard to the far-reaching proposals of the Administrative County of London Company, they asked that the opponents and promoters should meet with a view to submitting suggestions for the purpose of obviating any hardships which the passing of the Bill might inflict on other companies.

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THE
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*All communications intended for the Editor should be addressed* C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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## LIGHTNING.

The report of the Lightning Research Committee organised by the Royal Institute of British Architects and the Surveyors' Institute is a most valuable one from several points of view. The preface to the report written by Sir Oliver Lodge, F.R.S., gives a concise and lucid explanation of the two types of discharge which are liable to cause damage to buildings. As Sir Oliver Lodge was the first to insist upon the oscillatory character of certain lightning discharges causing them to be the most destructive, his preface is a good introduction to the records which are given in the report, and which prove his theory most conclusively. These records, which are selected from a large number in the possession of the committee, are published in a form which is to be commended. The routine adopted by the committee is to issue to their expert observer in a given district schedules on which to fill in information as to buildings struck by lightning in the district. On these forms twelve different points are given on which information is desired to enable conclusions to be drawn as to the efficacy or otherwise of the protection afforded by the system of lightning conductors in the buildings struck. The analyses of a number of these selected reports show that, even when a reasonably good earth connection is provided, the discharge frequently leaves the conductor and travels through a high resistance path in order to reach metal work in the building which affords an alternative path to earth. Even the connection of this metal work to the conductor is not always sufficient to prevent damage, and it is necessary to have in large buildings a number of conductors which are interconnected one with the other, and also connected at several points to any large system of metal work in the buildings. An example of this was the St. Pancras Church at Euston, which has a lead roof. The lightning conductor from the tower was connected with one end of this roof. From the damage done by a lightning stroke it was evident that violent electrical oscillations were set up in this lead roof, which ultimately found their way into the hot-water radiator system, and thence into the gas-pipes, which were broken The conclusion was in this case that if an additional lightning conductor had been connected with the other end of the lead roof and the heating system had been connected to earth, no damage would have been done. Other instances from the report clearly emphasise the danger of leaving lead flats or ornamental ironwork unconnected to earth. With the evidence obtained from these reports the committee have been able to suggest amendments to the rules for the erection of lightning conductors which were issued by the Lightning Rod Conference of 1882. The chief points on which modifications should be made may be briefly referred to. The provision of a non-oxidisable point for lightning conductors is no longer insisted upon. Two lightning conductors, one on each side of a factory chimney, are recommended instead of one conductor connected to a ring at the top of the chimney. The use of iron is preferred to that of copper, as its higher resistance, and especially its higher inductance, tend to reduce the surging of current. The use of cinders or coke as a conducting medium round the earth-plate is not advised, owing to possible electrolytic action. Charcoal, or pulverised carbon, is preferred, and may be used in connection with a tubular earth connection consisting of a perforated steel spike driven into moist ground. This earth connection can be kept moist by being connected to the rain-water pipes. Above all, stress is laid on the efficient connection to earth of all metal work within the buildings to be protected. It is interest-

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ing here to consider the problem which has to be solved by the power distribution engineer — *i.e.*, the efficient protection of a large system of metallic conductors, which cannot be directly connected to earth without destroying the object for which they have been erected. A lightning discharge from such a system to earth is the more objectionable, because, as a rule, the currents from the generators would continue to travel along the path of the discharge, which would be rendered more or less conductive. The different types of lightning arresters and systems for the protection of such plants are numerous, and their efficacy is unfortunately dependent to a considerable extent on the character of the lightning discharge. They may frequently do all that is needed for most lightning discharges, and then fail under specially severe circumstances. We believe, however, that all the ingenuity expended on the subject has not succeeded in producing a better system of protection than that of a high-resistance leakage path to earth. With high-voltage installations this is frequently provided by a jet of water passing between the conductors and earth. This device prevents by leakage the accumulation of a high static pressure in the metallic system, and hence tends to prevent the condenser type of lightning discharge, which is the most dangerous. The loss of power in this leakage path may be considerable at extra high voltages, but it is more than counterbalanced by the security afforded against breakdown. It would be well if information as to the working in practice of these various systems of lightning protectors could be regularly collected and analysed by a committee of electrical engineers, proceeding on the same lines as the committee above referred to.

## CORRESPONDENCE.

### ERRATUM.

SIR,—In my answer to No. 776 in last week's issue an obvious oversight led to an error in the value of R, which should read

$$\frac{150 + 175 + 150}{2} + 100 = 338 \text{ approx.}$$

This alters the value of $n$ to 20 approx.—Yours, etc.,

A. F.

## FORTHCOMING EVENTS.

SATURDAY, MAY 20.

**Rugby Engineering Society.**—Visit to the Lots-road power station at Chelsea.

MONDAY, MAY 22.

**Society of Arts.**—At 8 p.m., "The Uses of Electricity in Mines," by Mr. H. W. Ravenshaw. Cantor Lecture (II.).

TUESDAY, MAY 23.

**Society of Arts.**—At 8 p.m., "The Cape-to-Cairo Railway," by Sir C. H. T. Metcalfe.

WEDNESDAY, MAY 24.

**Society of Arts.**—At 8 p.m., "Modern Lightning Conductors," by Mr. Killingworth Hedges.

**Institution of Electrical Engineers (Students' Section).**—At 7.30 p.m., annual general meeting, followed by a paper "On E.M.F. Wave Forms," by Messrs. J. B. Sparks and A. Biederman.

THURSDAY, MAY 25.

**Institution of Electrical Engineers.**—At 8 p.m., "Wireless Telegraphy Measurements," by Messrs. W. Duddell and J. E Taylor.

**Royal Institution.**—At 5 p.m., "Electromagnetic Waves," by Prof. J. A. Fleming. Tyndall Lectures (I.).

FRIDAY, MAY 26.

**Institution of Electrical Engineers.**—At 5 p.m., annual general meeting.

**Physical Society.**—At 3.30 p.m. (National Physical Laboratory, Bushy House) the following demonstrations will be given: (1) "The Specific Heat of Iron at High Temperatures," by Dr. Harker; (2) "The Measurement of Small Inductances," by Mr. Campbell; and (3) "Two New Optical Benches," by Mr. Selby.

## LOCAL SECTIONS: A SUGGESTION.

BY B. C. H. J.

Apart from the parent community in London there are now six local sections of the Institution of Electrical Engineers in the British Isles, and two in our Colonies, having a total of about 2,000 members of all grades. It may be of interest to note that the exact figures of the *British* sections' memberships are as follows: Manchester, 758; Leeds, 225; Glasgow, 214; Birmingham, 214; Newcastle, 200; Dublin, 74. The members of these provincial and Colonial sections nominally enjoy all the benefits of full membership, and so far as hearing papers read and discussed, and partaking in the conversational free feed afterwards, this is a fact, for such papers and discussions are acknowledged to be at least as useful as those provided at the London meetings.

There is one item, however, in which local sections are at a disadvantage, and that is the difficulty of access to technical periodicals and books. The London member who desires to consult the electrical journals from any part of the world can see them at the headquarters in Victoria-street, not to mention the piles of technical periodicals on view at the British Museum and the Patent Office libraries. The very complete collections of technical works at each of these three institutions are also freely open to his inspection. The provincial member, even in a town possessing a local section, is cut off from these advantages, and must have recourse to the local public library, which usually has a meagre selection of technical periodicals and books, more remarkable for being dirty than up-to-date. The members residing in the numerous towns without local sections are even worse off, by the entire lack of papers and discussions, with coffee and "shop" dessert. Further, they have less chance of using the electrical literature in their public libraries, for a simple and sufficiently obvious reason to those who know the class of reading matter provided in public libraries in most towns.

This dragging in of public library facilities is, however, a little beside the mark. The writer wishes to suggest that every local section should have local headquarters of some description, if only a single room, which should be of use primarily as a reference library. Such a library should contain all the electrical and some of the principal engineering periodicals of Great Britain, together with the more important ones of other countries. It should also have a selection of standard electrical books. As regards those other technical works which may be required for reference, but which are too specialistic in character to be obtained at such a local section library, would it be too much to suggest that the ordinary facilities of Mudie's be followed, and that it should be possible for a provincial member to obtain such books from the Institution library by mail, on payment of the necessary postage. Such an arrangement would be of very considerable value to the more studious portion of provincial members.

The writer would further suggest that towns not possessing local sections, but with a certain minimum number of members (of which there are some very big examples, such as Liverpool and Bristol), might be allowed a room and attendant for a certain number of evenings a week, depending on the number of members domiciled there; in which establishment the bill-of-fare would consist of fewer standard books and current electrical literature, while the arrangement of borrowing books from headquarters would hold good as for local sections.

Now, these suggestions may be looked upon with scorn by London members, and one can imagine them saying: "Let the provincial devils wallow in their disadvantages; what are they to ask for privileges similar to those which we ourselves enjoy!" And possibly others may look more charitably upon the matter, and will wonder how much money the Institution would drop down the grid if such an arrangement came into effect. This view, however, would be almost as short-sighted as the scorn of the thoughtless is selfish. Apart from the justice of such an arrangement, the welfare of the Institution would be served by the large increase of membership that would ensue.

At present, beyond the more or less empty honour of the membership initials on a man's business card, and the

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privilege of receiving *Proceedings* dealing with papers read three or four months back (of which full details have generally been published in the electrical periodicals of the long-ago), there is little advantage to a provincial member in his membership. Anyone can participate in the local section meetings, and gather therefrom what crumbs of wisdom are on tap. Consequently there is not the rush there might be to obtain the "degree" of membership, and especially outside of the local section districts. With the advantages suggested, not only would the handicap upon provincial members be lessened, but a large accession of new members would ensue, whose fees would cover the cost of the more expensive arrangement. And in those towns where the membership was hardly up to the strength necessary to allow of a local centre being provided, it may be imagined that the existing members would endeavour to enlist their brethren outside the fold, in order to total the required number of local members.

The arrangement should benefit everybody concerned, and would probably be the means of initiating valuable combinations of technical societies. In Manchester, for instance, there are half a dozen fairly influential engineering organisations, each separately and more or less temporarily housed, who would find it advantageous to become joint possessors of a permanent home, in which to pool their libraries, periodicals, and other possessions for common benefit. This latter scheme has been in the air for some time, but no definite shape has yet been taken. In other towns something similar would doubtless happen, if Manchester, true to axiom, "thinks it to-day."

These suggestions are made in the interests of numbers of members who would welcome the inauguration of such local libraries as a means of reference in time of need, and to enable them to keep in touch with current events. It is hoped that his idea will not be put up as an Aunt Sally to be knocked down, but rather as a target which will be used as a base for sticking valuable points into.

## INSTITUTION OF ELECTRICAL ENGINEERS.

### Students' Visit to Leeds.

(*Concluded from page 668.*)

On Wednesday afternoon the generating station of the

YORKSHIRE POWER COMPANY

at Thornhill was visited. The Curtis turbine has been adopted as the prime mover, one unit of 1,500 kw. being already installed, while another set is expected to be running in a month's time. The boiler-house calls for no special comment, and the switchboard is equipped upon the well-known B.T.H. remote-control system. The lightning arresters are interesting. The line is brought to the first of a series of five small brass cylinders separated from one another by short gaps, the last cylinder being connected to about an 8in. length of 10mm. carbon; two more lengths of carbon follow, and then another series of five brass cylinders as before, the ends of all the arresters for the separate phases and feeders being connected to the common earth-wire. The theory of the arrester is that when a discharge takes place the fumes given off from the brass, besides being in themselves badly conducting, are cooled by the proximity of a comparatively large amount of metal, so that the arc cannot be maintained. Steel chimneys have been adopted built up of 30 rings each 5ft. high, with an iron ladder outside the stack running right to the top.

MESSRS. JOHN FOWLER AND CO.'S WORKS.

were first on the programme on Thursday. This firm build steam-engines for all purposes, making a speciality of heavy traction engines. They have also a completely equipped electrical department. The shops are all electrically-driven, and for this purpose two 300 kw. 200-volt direct-current sets have been installed in the power-house. This company are one of the few in England which has adopted a cast-steel yoke for their multipolar machines. The appearance at first is rather striking, as less than half the section is required compared with the usual cast-iron yoke. Automatic turret lathes have been adopted very largely in these shops. As a continual supply of oil floods the work, a necessary accessory where these machines are used is an oil separator. This consists of a conical pan into which the turnings are shovelled, and which is then revolved at a high speed so that the oil, by centrifugal action, is brought to the widest part of the cone and thrown out into an outside vessel through a slit, so fine that the finest needle will not pass through. Other interesting machines seen in action were a vertical boring mill used for shaping out oval plates by giving a reciprocating motion to the tool, a machine for grinding valve links to any curvature by rocking the table holding the work about an adjustable centre, and a machine for forging boltheads, square or hexagonal, from the round bar.

In the afternoon the works of

MESSRS. GRAHAM, MORTON, AND CO.

were visited. As is well known, this firm make conveying and elevating plants and constructional steelwork of all kinds. In 1903 they erected their present works at Hunslet in the short space of 5½ months, and appear to have been on the hustle ever since. Every labour and time-saving device has been adopted, from a blue-printing equipment which turns out two double-elephant prints, dried and trimmed, in three minutes, to a messenger-boy system in the shops, by which a workman, pressing a button on the nearest standard, calls up a boy who fetches him tools, etc., thus saving the workman the trouble of leaving his work to fetch them himself. With regard to the work of this firm, one type of chain used on their bucket conveyors may be noted. Alternate link pieces consist of a steel drop-forging and a piece of punched steel plate. The forging is made with a projecting flange where the linking pin passes through, and this forms a bearing for the adjoining link of steel plate. In this way all strain is taken off the link-pin, whose function is simply to hold the links together. Another interesting operation is the making of steel colliery trucks in one piece from the sheet. First, the four sides are bent up, leaving, of course, projections at each corner. Next, one pair of opposite sides are corrugated, and, finally, the corner flaps are bent round flush with the other sides, thus giving double strength at the corners.

On Friday morning the party visited the works of

THE FARNLEY IRON COMPANY, LIMITED.

This firm, by taking every care and adopting superior methods of manufacture, turn out a "Best Yorkshire iron" which, although somewhat dearer than the ordinary makes of iron, is preferred by the leading railways and colliery companies for such parts as coupling shackles, which have to withstand sudden shocks. The works stand on the side of a hill, and the ore and coal are delivered from the neighbouring mine at the top, and pass through the various processes on its way down the hill, as it were. Like all the other firms visited, electric driving has been adopted. At first, owing to the heavy nature of the work in most of the machines, the electric drive was not entirely successful, but by substituting belt drives for direct gearing perfect satisfaction is now obtained. The first process is that of "calcining" the ore with coke, which drives off moisture and partially reduces the ore to a lower oxide. After this it is transferred to a blast furnace, the charge also consisting of limestone and coke, of which the following quantities go to produce a ton of iron: 45cwt. of calcined ironstone, 12cwt. of limestone, and 28½cwt. of coke. It is the usual practice to heat the blast from the escaping gases, but at Farnley a cold blast is used, this, it is claimed, tending towards a better quality of iron. The next process after the running of the iron into pigs from the blast furnace is to remove the carbon (about 3 per cent.) in the puddling furnace. Here again the Farnley Company depart from the usual practice, and interpose an intermediate operation—viz, of refining the pig to rid it of small quantities of impurities, chiefly sulphur. In the puddling furnace the refined pig is subjected to a reducing atmosphere, and the carbon goes off as oxide, leaving the pure iron a pasty mass, which is removed and pressed under the steam hammer, when the dross and unburnt fuel squeezes out. The wrought iron is then cut up and piled for heating in a second furnace, after which the piles are hammered into one mass. It is then ready

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for reheating preparatory to being rolled to the section required. After rolling, a circular saw running at the speed of the ordinary wood saw cut the iron in lengths while it is still red hot. The main difference between steel and iron is seen in the character of the fracture when samples are broken in the testing machine. With steel the fracture shows a crystalline structure, while with iron a fibrous structure is observed. This is due to the steel being in the beginning a cast ingot, which afterwards rolled or forged to the desired dimensions, while iron is prepared by hammering and piling, so that it is claimed a much more uniform material is obtained. It is also said that iron is less susceptible than steel to "fatigue" produced by continued alternations of stress.

In the afternoon the party went over to Bradford and visited the works of the

PHŒNIX DYNAMO MANUFACTURING COMPANY.

This firm has a well-equipped factory for the manufacture of continuous and alternating current machinery, especially of small continuous-current enclosed and semi-enclosed motors for workshop driving. It claims that in 1895 it was the first in the North of England to manufacture an enclosed type of motor. Recognising that the

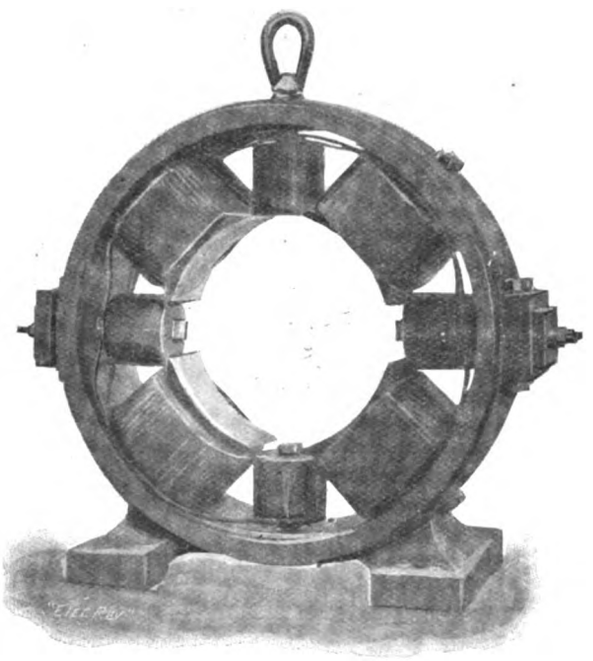

FIG. 1.—Four-Pole Phœnix Dynamo with Intermediate Commutating Poles.

limit of output of a continuous-current machine is controlled simply by the sparking and the heating, they have so perfected their designs in these directions that for the same power a much smaller, and, therefore, cheaper, machine can be built. In the first place, they have designed a special form of commutating pole, with a decreasing breadth in the direction of running when the machine is acting as a dynamo. The party were fortunate in seeing two of these machines of 50 kw. capacity coupled up for Hopkinson's test. With overloads of 50 per cent. they ran without any signs of sparking, and also stood temporary overloads of 100 per cent. To show the effect of the commutating poles, their windings were then short-circuited, and under these circumstances the machine would not stand an overload of 20 per cent. With regard to the heating limit, every arrangement for ventilation both in armature and field coils is provided. In the former, air ducts are provided even in the smallest armatures and the end windings are so designed that there is a space for air circulation between each coil. In field coils a special pattern with air passages right through the windings is used, the coil consisting actually of two concentric coils separately wound. With such a construction it is claimed that the temperature rise is halved for the same amount of energy lost in the coil. For the smaller motors the firm use laminated poles, and by riveting tightly it is found practicable to bolt them direct on to the magnet frame. For larger machines a solid pole is used with laminated pole-shoes. In induction motors only the smallest have squirrel-cage rotors, and in these slots are milled in the brass end plates, and the rotor conductors are sweated in direct. The firm also make a handy form of bench drill for sizes up to ½in. It is driven by a ½-h.p. motor, the motion being conveyed to the drill through a friction gearing, thus giving a ready means of changing speed for the different sizes of drill.

Later in the afternoon the party went over the extensively equipped repair shops of the Bradford Corporation tramways. In the evening the students met together at dinner at the Hotel Metropole, after which a pleasant time was spent in exchanging experiences and reminiscences more or less of an electrical character.

On Saturday morning a very successful and enjoyable week's excursion was brought to a conclusion by visits to the

LEEDS LIGHTING AND TRAMWAY POWER STATIONS.

As these have been dealt with at length in back volumes of the *Electrical Engineer*, it suffices only to mention that the Leeds supply, first started as a single-phase supply at a frequency of 83, is being gradually converted to a 50-frequency two phase system for the benefit of the motor load.

In conclusion, the writer wishes, as a student for the students, to express their appreciation and thanks to the

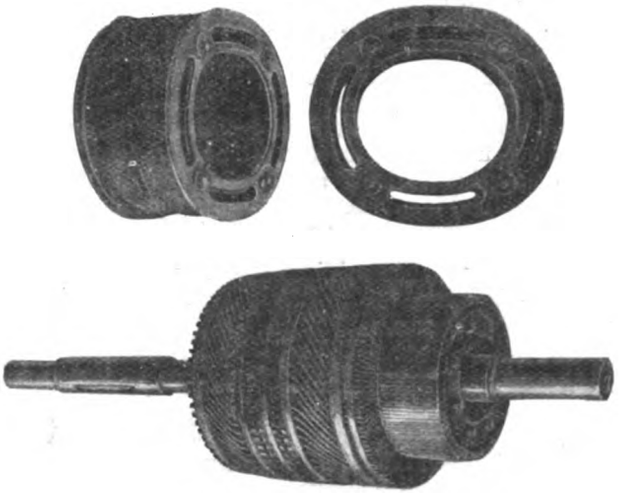

FIG. 2.—Armature and Ventilated Field Coil of Phœnix Dynamo.

proprietors of works for the cordiality with which they were received on every occasion.

## ELECTRICITY AND FIRE INSURANCE.

BY A. H. MAYES.

The unfair and inconsistent attitude adopted by many fire insurance companies with regard to premises wherein electric power for lighting and motive purposes is used, is of such wide importance that a little plain speaking will be entirely justified. In the first place, it appears that the powers that guide the helm of the insurance companies have by some mental process, which it is beyond the power of a practical and impartial person to understand, arrived at the conclusion that a supply of electricity on a premises is a source of considerable fire risk, greater, in fact, than had gas or some other agent been employed. Now, looking at the matter honestly and with a perfectly unbiased mind, one is compelled to say at once that such a contention is absolutely unjustified, opposed to common sense, and totally unsupported by the result of experience.

Even allowing that every fire attributed to electrical causes is rightly classified, it cannot be denied that electricity still stands forth as by far a safer agent than gas. It is, however, quite certain that a little more attention to detail in carrying out installations would still further reduce the possibility of fires from electrical causes, and the writer proposes to say a few words upon this from a practical standpoint. How often one sees the cause of fire vaguely attributed to "the fusing of an electric wire."

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Now, either the fire was not caused in this manner at all, or else the wire in question must have been installed under conditions sufficiently extraordinary to take one's breath away. The smallest conductor ever used, or which is supposed to be used for installation purposes, is No. 18 S W.G., and as the fusing current of No. 18 S.W.G. copper wire is 108 amperes, one is led to ask what sort of branch fuse was in circuit with that unfortunate wire. The alternative conclusion is that there was *no fuse at all*, and, further than that, one is confronted by the appalling question of how such an enormous current could have found its path, even then, through the wire in question. If due to earthing of the wire, the earth must, indeed, have been of an efficient character, and if due to a "short-circuit" the point of contact must have had a strangely low ohmic resistance. Even then we are not out of our troubles, for we have yet to explain how the service company's fuses managed to stand against this great extra demand upon their energies. It will, of course, be evident that the danger point would be reached with a current less than that required to absolutely fuse the wire, but after making all allowances the point requires a large amount of explanation.

Another and more probable source of danger is in installing incandescent lamps in such a manner that the heated bulbs can come into contact with articles of an inflammable character. It is a common practice when installing lamps for lighting a draper's window to attach the lamp to a considerable length of duplex flexible conductor, in order that the light may be hung in any desired position, and thus it is that one frequently sees goods of a highly inflammable character in actual contact with the bulbs. Such a practice as this should be absolutely prohibited, and a rule should be strictly enforced that all lamps used under such conditions be enclosed in a wire net guard or other effective safeguard. The overheating of resistances used in connection with arc lamps is undoubtedly a source of danger, but at the same time one which might be rendered practically nil by proper precautions in the matter of carrying capacity and fixing.

Coming to the question of electricity as used for power work, we are at once confronted by an element of danger in the form of resistances as used for starting and speed-regulating purposes. Here again, however, proper precautions would reduce the fire risk to practically nil, but, unfortunately, great carelessness is often displayed in the method of fixing and protecting these pieces of apparatus. A short time since the writer was inspecting a large motor installation in London, and found gross carelessness displayed in the above matter. A 25-h.p. starting resistance of the wire coil type had been arranged to stand upon the cement floor in the basement, and as the sheet-iron case containing the coils was open at the bottom, a quantity of waste paper and rubbish had gradually worked its way underneath, and actually found its resting place amongst the coils. The above apparatus should certainly have been fixed about a foot from the ground, and have been provided with a perforated iron bottom.

In several other instances it was found that starting resistances were quite unequal to the demands made upon them, having insufficient carrying capacity, and often attaining a red heat in operation. More care was, therefore, essential in selecting a starting resistance suitable for the particular work to be performed. It may be added that the switch and resistance should always be enclosed in an outer case of strong sheet steel, which is an adjunct of a very necessary character on account of the fact that a considerable amount of sparking takes place upon the switch contacts, and particles of molten metal are at times thrown off. Main switches should most certainly be enclosed in cast-iron cases, as they are frequently liable to rough handling, and it often happens that an arc is set up owing to defective action.

Another important adjunct to power installations is the fuse, and unless a proper type be employed they are undoubtedly a source of fire risk. Whether the open or enclosed type of fuse be selected, there are two points of the greatest importance to be observed—that is, that the terminals shall be an ample distance apart, and the device shall be enclosed in a cast-iron case.

If proper attention were paid to the above simple points the fire risk would be still further reduced, and would bring still nearer the day when fire insurance companies will be compelled to admit that electricity is by far the safest agent to employ for both lighting and power.

## TRADE NOTICES AND NOVELTIES.

### Idle-Current Ammeter.

One of the requirements of modern central-station practice is an instrument which will indicate the idle or wattless current

FIG. 1.—Idle-Current Ammeter.

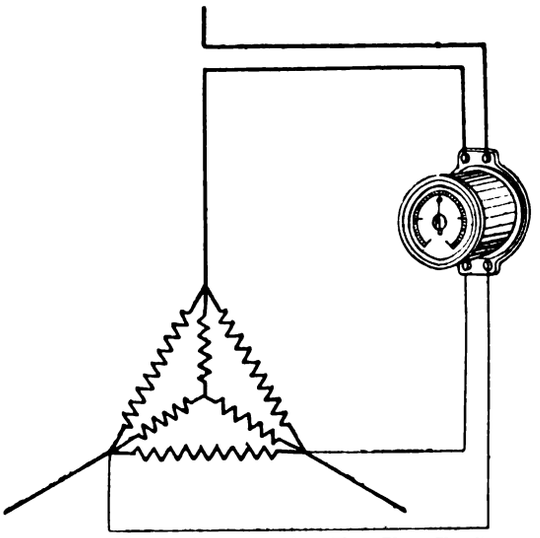

FIG. 2.—Connections for a Three-Phase Circuit.

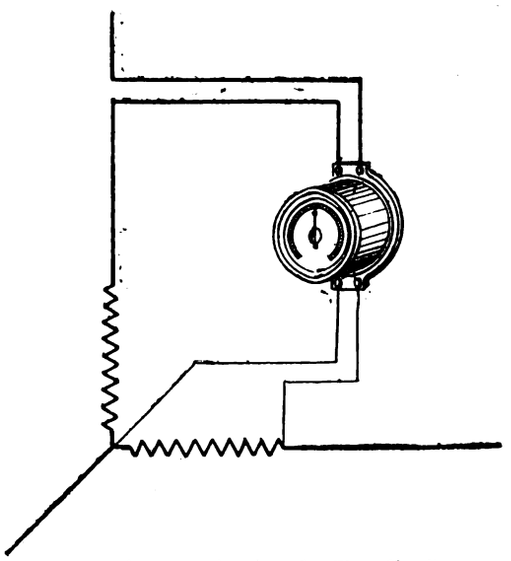

FIG. 3.—Connections for a Two-Phase Circuit.

in any circuit. The knowledge of this quantity enables the most economical regulation to be made, the presence of cross

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currents is at once shown, and the minimum idle current in the circuit obtained. In order to meet this demand the instrument illustrated in Fig. 1 herewith has been put on the market by Messrs. Ferranti Limited, Hollinwood, Lancs. It measures V C sin $a$, where V = virtual volts between phases, C = virtual current in one phase, and $a$ is the angle of lag. At any particular normal voltage, therefore, it can be calibrated in terms of C sin $a$, or, which is the same thing, in terms of the *idle current* in the circuit. By means of this instrument the switchboard attendant is enabled to regulate the excitation of the machines to minimum idle current, which is the condition of most economical working. Power factor indicators have sometimes been used for this purpose. The great disadvantage of these indicators is that as they only measure a ratio, there is no controlling force on the moving part. This latter simply takes up a position where the two magnetic forces acting on it equalise one another. The idle-current ammeter has a strong controlling spring like an ordinary ammeter; its indications are therefore very definite, and can be relied upon. The accompanying diagram (Fig. 2) shows how the instrument should be connected up in a three-phase circuit, while Fig. 3 shows the arrangement for a two-phase circuit.

## Catalogues, etc, Received.

TELEPHONES.—The Berliner Telephone Manufacturing Company, 200, Upper Thames-street, London, E.C., have issued a supplement to the fifth edition of their catalogue, containing reduced prices.

ANTI-FRICTION METAL.—The advantages of Glacier anti-friction metal are dealt with in a pamphlet just issued by the Glacier Anti-Friction Metal Company, Limited, 91, Queen Victoria-street, London, E.C. Results of tests and copies of some valuable testimonials from users are included.

MAXIM LAMPS.—The Sir Hiram Maxim Electrical Company, Limited, Maxim Works, Gillingham-street, Victoria, London, S.W., inform us that they have taken over the entire manufacture of the "Maxim" arc and incandescent lamps. The firm's 1905 catalogue, a copy of which is to hand, illustrates the different patterns of these lamps supplied by them, besides a variety of accessory apparatus.

FEEDER PILLARS.—Sheet No. 119 just issued by Messrs. Ernest F. Moy, Limited, Greenland-place, Camden Town, London, N.W., illustrates a lighting pillar for a three-wire network with 440 volts across the outers. It is fitted with disconnecting links on the three feeders, and 200-ampere 6in. clear break switch fuses on the outers of the four distributors. The middle wire is mounted on a separate panel at the bottom. We note that the firm manufacture feeder pillars to suit any special requirements for traction or lighting systems.

SIEMENS'S PUBLICATIONS.—Two new publications are to hand from Messrs. Siemens Bros. and Co., Limited, York-mansions, York-street, Westminster, S.W. One of these—Leaflet 562—gives dimensions, weights, and gearing ratios of the firm's G. A. motors with geared countershaft. Particulars of the motors are included on Leaflet 560, already noticed in our columns, the outputs varying from 25 b.h.p. to 150 b.h.p.—depending on whether the motors are protected, ventilated-enclosed, or fully enclosed. The other—Specification 7 B—describes their new type 5 B and 5 B A machines—protected, ventilated-enclosed, and fully enclosed. These are small-sized and compactly designed bipolar machines. The outputs in the case of the motors vary from 1 b.h.p. to 3 b.h.p., and for the protected dynamos from 1·7 kw. to 2·6 kw.

## PERSONAL.

The Kingston-on-Thames Town Council have increased the salary of Mr. Edgcome, the electrical engineer, from £350 to £450 per annum.

Mr. W. G. Snell, tramway inspector, has been appointed traffic superintendent of the new Perth tramways system.

Mr. Robert Birkett, electrical engineer to the Burnley Corporation, has been appointed electrical engineer and general manager of the tramways at Southend-on-Sea.

## APPOINTMENTS VACANT.

**Assistant Engineer,** Middlesex County Asylum, Napsbury, St. Albans, Herts. Wages, 35s. weekly and house on the estate. Applications by May 20. See advertisement in last issue.

**General Manager,** Johannesburg, £2,000; Station Engineer, £1,000, with house. Applications to Mordey and Dawbarn, 82, Victoria-street, Westminster.

**Shift Engineer,** Manchester. Wages, £150. Applications by May 22.

**Tramways Manager,** Erith. Salary, £250 per annum. Applications by May 27. See advertisement.

**Chief Assistant Electrical Engineer,** Battersea Borough Council. Commencing salary, £200 per annum. Applications by noon on June 6. See advertisement.

## THE SUPPLY OF CHEAP ELECTRICAL ENERGY FOR INDUSTRIAL PURPOSES.*

BY J. A. JECKELL.

I propose for the sake of convenience to divide this paper into three headings—viz.: (1) a short history of the supply of electrical energy from central supply stations; (2) the advantages of a cheap supply; (3) the possibility of such a supply being given.

In order to rightly understand the present position, it is necessary to see how it arose. You will be aware that about the year 1890 a supply of electricity from central supply stations was beginning to be given. Electricity was used to meet the then pressing demand for a better light. Those of you who were in London about this time probably noticed the very large number of different systems of lighting by gas then in vogue, showing that many attempts were being made to obtain a really first-class light. Electric light, coming to the front at this time, supplied a long-felt want, and was rapidly taken up by a large number of persons who did not mind paying a comparatively high price for it. This is what we may term the *luxury demand*. At this time the supply of electricity was mostly in the hands of companies who, owing to the large price then obtained for electricity, and not because the cost of manufacture was low, were paying good dividends.

About this time the wave of municipal trading swept over the country, and seeing that Parliament considerably favoured (for reasons best known to themselves) the supply of electricity by local authorities, local authorities enticed by the large dividends paid by the companies went in for the business. Some because the supply of other commodities, such as gas and water, having been in the hands of private companies, local authorities thought they had not been well served and could do better if they undertook this new business themselves. Some because they considered that the supply of any commodity which carried with it the right to break up the streets should be in the hands of the highway authority. Others, again, because they owned the gasworks and did not desire competition. Others, again, promoted provisional orders with no intention of putting them in force. This supply of electricity, however, differed in one very essential point from the supply of gas or water, which were up to that time practically the only two forms of municipal trading. If a gasworks or a waterworks did not pay, the simple expedient of raising the price could be resorted to, as both undertakings were virtual monopolies. But electricity works would have to compete with the gasworks whether these were owned by a local authority or by a company. Therefore, in order to make electricity works pay, the methods which are used in commercial undertakings, which have to face competition, required to be adopted, and this was too often lost sight of. These are, as is well known: (1) the expenditure of the smallest amount of capital; (2) the production of the article at the lowest possible figure; (3) the selling of the largest possible amount of that article; (4) the payment of the manager, too, largely depend upon the financial result he obtained.

When local authorities decided to undertake the supply of electric energy, the only course open to them was to consult an expert. Unfortunately, from the view of profit-making, the consulting engineer was not in every way a most desirable person to give advice; being pre-eminently an engineer, he would naturally not look so much to the commercial aspect of the undertaking as he would to the engineering side. It should be remembered that for an engineer commercial knowledge is in some ways a disadvantage. Undoubtedly there is another side to the question, but in successful engineering money may have to be a secondary consideration, and therefore it is not to be expected that consulting engineers should be good commercial men. It is well known that consulting engineers are paid a percentage on the capital outlay, and, therefore, while for not one moment suggesting that a good consulting engineer would on this account recommend increased expenditure, still it must not be forgotten that this percentage does not depend upon the commercial success of the undertaking. Furthermore, the number of consulting engineers who had actually designed, put down, run, and made a commercial success of an electricity supply station was, and is still, limited.

The old Latin proverb *Experientia docet* has a great deal of truth in it, and unless a man is a Heaven-born genius, of which there are few examples in this world, he is not likely to be well acquainted with matters of which he has not had previous experience. However, for local authorities there was no choice in the matter; they had to go to the only men available to advise them with regard to putting down their works. These engineers would be inclined to follow the principle adopted frequently in gas and water works, and erect fine handsome buildings, which are all very well in their way, but do not reduce the cost of manufacture. Further, these engineers took far too limited a view with regard to the supply of electricity in the future. Stations were designed purely for lighting purposes, and too frequently no provision was made for large

* Paper read before the Birmingham Electric Club.

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future extensions. Further, these engineers who designed the stations apparently favoured land practice rather than marine practice. It is, of course, well known that it is more important to have highly economical engines on board ship than on land, because in the former case not only has coal frequently to be purchased at foreign ports at an enormous figure as compared with the prices ruling in England, but for every ton of coal not required a ton of cargo can be carried. Marine practice was, therefore, to use the most efficient steam-engines possible. Compound condensing engines had given place to the triple-expansion condensing engines, and these in many cases had been superseded by quadruple expansion engines. Engineers who designed the electricity works, for the most part, ignored all this experience and installed compound engines non-condensing, either horizontal or vertical. Of course, these were cheap to buy, and as long as electricity was only used to meet the luxury demand for lighting, the load factor of the plant being only some two hours per day, the want of economy of this type of plant was not of so much account.

Gradually, as the small provincial towns went in for the supply of electricity, it was found that the purely luxury demand was not large enough to make the undertakings pay, so it became necessary to see what could be done to remedy this. It is well known that Mr. Wright at Brighton was the first person to thoroughly grasp the trouble and design a remedy. He soon saw that if the plant could be run fully loaded for twice the length of time per day that the energy could be made much cheaper, and that as long as the standing charges were covered a very low price could be charged for the actual energy supplied. To meet this case, he, in conjunction with the late Mr. Reason, brought out the maximum demand system. This served a most useful purpose. It, however, did not do all that was hoped, but perhaps this was partly due to the fact that the price for the first hour was frequently not made high enough, and the price for the subsequent hours was not made low enough. It is not improbable that the high costs of manufacture had something to do with this, because with the station costs standing at, say, 2½d. per unit, engineers hesitated at offering current at 1d. per unit, say, after the first hour at 8d. Partly, too, the system failed because of the inherent dislike of the Britisher to a new thing, and the word "maximum" was strange to people, and they would not take the trouble to understand the system, though probably in principle they were using it in their own works. This system did undoubtedly tend to improve the load factor of the stations, but, due to the too often inefficient plant, improving the load factor did not improve the financial position of the works in that degree which it would have done had the cost of manufacture been reasonably low.

About this time various schemes were brought forward for the purpose of improving the financial position of the various works: (1) Batteries were suggested to deal with the peak. (2) Various-sized plants were installed, in order that as the load increased or diminished the plant could be changed so as to keep the load factor high on the plant in use. This was very necessary, because the plant which had been installed was too often very inefficient except at top load. (3) Some places shut down during the daytime or ran off batteries only. (4) Other places put down separate condensing plant in conjunction with the then existing engines. A paper was read the other day from which it would appear that in the South of England many stations which are non-condensing produce energy at a lower cost than those that are condensing; this is, of course, due to the poorly-designed condensing plant. All these measures, as will be readily understood, did not tend to the production of large quantities of current cheaply, so that it could be sold at a reasonable figure for industrial purposes. The prices charged for electricity for power purposes were ridiculously high; in fact, it seemed as if everything was being done to put difficulties in the way of consumers obtaining a supply of electricity for power purposes. Even engineering societies did not look with a kindly eye on papers which brought out these points. A paper was written for a certain society by a manager who had the audacity to say that the industrial demand had not been obtained because the industrial demand had not been catered for. 6d., 4d., and 3d. per unit for energy were the prices ruling at the time the paper was written, which paper, I need hardly say, was rejected because it was too progressive.

In 1893 it became the duty of the author to design the station at South Shields, the area of which is shown. There was plenty of cheap land to be obtained near to the area where the principal lighting customers would be. This policy—viz., to put down a small non-condensing station just to deal with the lighting customers—had been too often followed, but in this case the committee was wise enough to wait some 15 months to obtain a site on the river where there was water for condensing purposes and an alternative supply of coal. Though this site was far more costly than the previous one would have been, and though we had to run some 1,100 yards before the first customer was reached, the position chosen enabled the station to be designed for lighting, power, and tramway purposes. The *power* has not yet been developed, and the tramways are only just being put in hand. But even though the load on the station has only been a lighting load, this broad policy of choosing a site where water can be obtained for condensing purposes has been fully justified. A departure was also made in the type of plant installed. It should be remembered that this station was designed in 1893. Instead of the small non-condensing steam plants which were generally used at that time, and which had a very short range of economy, larger plants, surface condensing, were installed. These plants were specially designed for economy over a long range of power. The following figures will show you how economical they were:

*Test of Two 200-kw. Plants at South Shields.*

| | A. | | | | |
|---|---|---|---|---|---|
| Kilowatt-hours | 225 | 192 | 150 | 100 | 56 |
| Water per kilowatt-hour | 22·39 | 21·79 | 22·6 | 23·15 | 28·9 |
| Average of five loads | $\frac{118·75}{5}$ = 23·74lb. per kilowatt-hour. | | | | |
| Average of three loads | $\frac{67·54}{3}$ = 22·51lb. per kilowatt-hour. | | | | |

| | B. | | | | |
|---|---|---|---|---|---|
| Kilowatt-hours | 228·5 | 193·6 | 152 | 95·16 | 54·25 |
| Water per kilowatt-hour | 21·88 | 21·75 | 22·11 | 24·7 | 28·26 |
| Average of five loads | $\frac{118·7}{5}$ = 23·74lb. per kilowatt-hour. | | | | |
| Average of three loads | $\frac{66·36}{3}$ = 22·153lb. per kilowatt-hour. | | | | |

By having such a long range of steam economy it was not necessary to instal the small plants for day-load purposes then so often used. If we think for one moment, we will see at once how much more convenient plant of this description is—viz.: (1) it occupies far less room; (2) owing to its economy, the boilers, pipes, pumps, etc., occupy also less room and cost less; (3) there was no necessity, as the load increases or diminishes, for the staff to be rushing about the place because a few amperes come on or go off. Motors are no trouble with plants of this description. There was a certain station having small non-condensing engines where they obtained an order for two 30-h.p. motors, which were used very intermittently, and so much effect had these on the lighting load that the station superintendent had to ask for 10 minutes' notice before they were started, and had to request the consumer not to use them on top load.

The following results will, I think, show the economy of the working of these plants. I have chosen three stations, all on rivers and all buying coal from the same coalfield—viz.: (1) Newcastle-on-Tyne, with turbines; (2) Sunderland, with enclosed high-speed engines; (3) South Shields, with open-type slow-speed marine engines.

*Comparative Works Costs.*

| Name of town. | Comparative output. | Works costs. |
|---|---|---|
| | 1900. | |
| South Shields | 501,839 | 1·08 |
| Newcastle and District | 1,160 649 | 1·39 |
| Sunderland | 640,579 | 1·46 |
| | 1901. | |
| South Shields | 755,826 | 1·22 |
| Newcastle and District | 1,619,671 | 1·22 |
| Sunderland | 1,318,768 | 1·32 |
| | 1902. | |
| South Shields | 985,646 | ·92 |
| Newcastle and District | 2,058 804 | ·94 |
| Sunderland | 2,375,557 | 1·11 |
| | 1903. | |
| South Shields | 1 148,965 | ·76 |
| Newcastle and District | 2,649,841 | ·82 |
| Sunderland | 2 848,285 | 1·05 |
| | 1904. | |
| South Shields | 1,299 289 | ·65 |
| Sunderland | 3,508,139 | ·92 |

The chief thing we have to bear in mind with regard to the supply of electricity for power purposes is that the energy must be sold cheaply. In order to do so we must get down to the rock bottom cost of manufacture. In considering this question, the *capital* cost of the plant is really a secondary consideration, because if the plant is run 12 hours per day the capital is not increased, but, on the other hand, the maintenance is probably increased, the wages are increased a little, the oil is not increased much. The chief item we have to consider is the coal consumption, because after the stand-by charges are paid the coal consumed will be in proportion to the number of hours the plant is run. The author particularly wishes it to be understood that he does not mean that the open-type marine condensing engine is the *only* engine for use in power stations. The moderate-speed enclosed type and the turbine under certain circumstances will probably do equally as well, but local conditions will decide this.

The following hypothetical case will show which is the more important to consider: the steam consumption of the engines or the capital cost. Assuming 1,000-kw. plant running 12 hours per day for 300 days in a year. A set takes 25lb. of steam per unit, B set takes 35lb. of steam per unit. Assuming that best

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Welsh coal costs 30s. per ton, and evaporates 10lb. of water per pound of coal, then

$$\frac{\text{Lb.} \quad \text{Kw.} \quad \text{Hours.} \quad \text{Days.} \quad \text{Price.}}{1 \times 1{,}000 \times 12 \times 300 \times £1.\ 5s.} = £2{,}410.$$
$$2{,}240$$

Therefore B plant costs £2,400 per annum more to run than A, or, capitalised at 6 per cent., £40,000.

This question of cost of manufacture is clearly shown by a list of 64 places, *all* of which have a larger output than that at Coventry, with a larger cost of manufacture. This list shows that some £731,873 per annum might have been saved if the costs had been as low as at Coventry. Many of these places have a very much larger output than Coventry. Several have a much better load factor. Several, too, are better situated with regard to the coal supply. Therefore, it is not unfair to assume that had they all been designed on a broad basis and managed commercially that the average cost would not have exceeded that at Coventry, where we have no very special advantages, and where, in fact, one-third of the plant is quite old-fashioned.

About 1898 triple-expansion engines, condensing or non-condensing, were being put down in the larger stations, but even at a later date than this the advantage of having highly efficient plant was not fully grasped. An instance probably is well known to all of you, where a central-station engineer, in putting down a station for power supply, chose rather to put this station on the top of a hill from which the Jordan was clearly visible a couple of hundred yards away, rather than put it down on the side of the river with the water and an alternative supply of coal available. In view of this fact, I trust you will excuse me so strongly emphasising the necessity for plant of the highest effi iency being installed in stations which intend to deal with a supply for power purposes. At the present time, of course, in larger stations, this is well understood, but we have unfortunately a great number of stations throughout the United Kingdom the plant in which is not as economical as it should be, and it is these stations which have hesitated to go in for a cheap supply of energy. The author hopes before he has finished this paper to convince the gentlemen in charge of these stations that it can be done successfully even in these cases.

The question now comes, *Is* the supply of electricity for power purposes at a very cheap rate advantageous, and, if so, to *whom?*

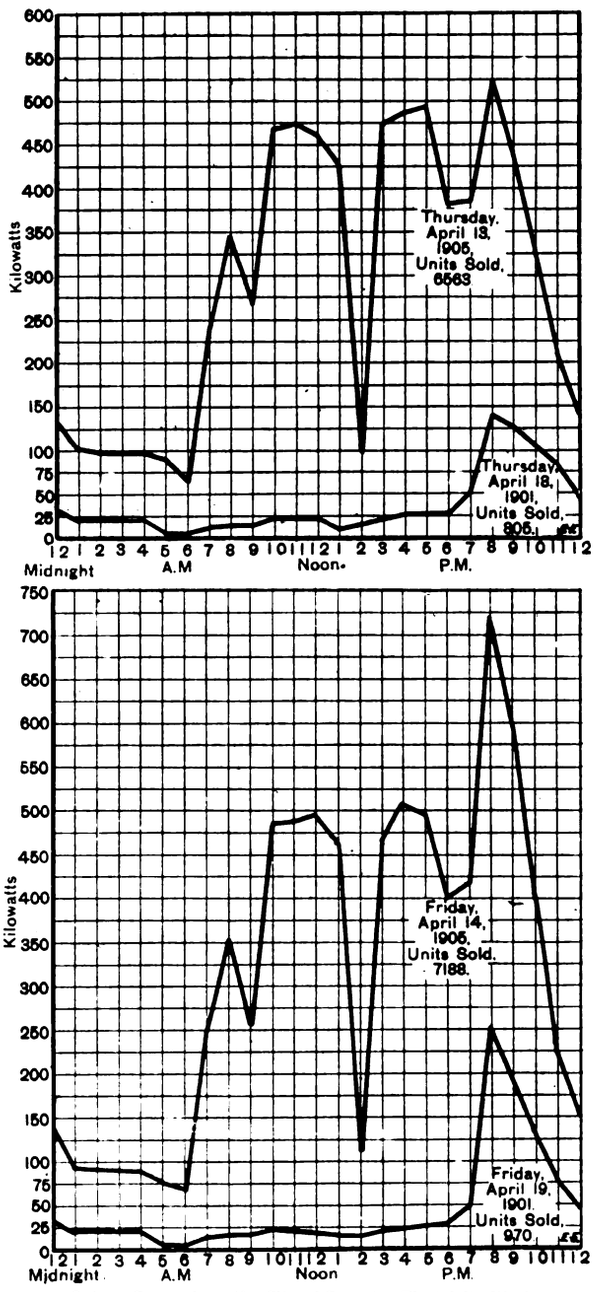
1. *From the Point of View of Patriotism to our Empire.*—It is generally admitted that the British manufacturer has to face very severe competition from goods manufactured abroad. It is, therefore, clearly a duty which we owe to our country to assist the British manufacturer in every way we can. Patriotism to our Empire demands it. Surely we can do this by giving the British manufacturer cheaper methods for producing his goods. That the supply of cheap electrical energy is considered by manufacturers to be an advantage is clearly proved by the thousands of horse-power of electric motors which are being installed by the hard and level headed manufacturers on the Tyne. It is inconceivable that these men would adopt electric driving unless it showed in actual working a considerable advantage, provided, of course, the electricity is supplied at a reasonably cheap rate. It is a curious fact that the first company in England to supply electric energy for power purposes on a large scale was a gas company—not an electric company — viz., the Walker and Wallsend Gas Company. Therefore, from the point of view of patriotism to our Empire, we should advocate and assist in every way we can a cheap supply of electric energy.

2. *From a Point of View of Civic Patriotism.*—We all know that many industries are dying out in the smaller towns. This is undesirable, because the sanitary conditions are likely to be better in the smaller towns and it is a much more healthy and convenient state of things to have a large number of small industrial centres instead of a few large ones. Probably the greatest factor in keeping works in small towns and inducing the industries to start there, is the supply of cheap power, power which can be obtained without the large expenditure necessitated by the use of boilers, steam-engines, chimneys, etc. You will, therefore, see that from a point of view of civic patriotism it is desirable that each inhabitant of a town should do all he can to assist in causing a cheap supply of electrical energy to be given in that town.

3. *From the Health Point of View.*—We all know that one of the greatest problems which is facing us at present is "the housing of the working classes." Nothing holds out as a great possibility for overcoming the difficulty of carrying the worker away from his work in the evening to sleep and live in a healthy atmosphere as electric traction: this will be materially assisted by the supply of cheap electric energy. We all know that municipalities are spending large sums of money on sanitary arrangements. Surely it is a desirable thing that those who have to be at work in a close and too often confined space should have the best atmosphere that can be provided, whether by non-vitiation of the air or by easily-adapted methods of ventilation. It may be of interest to you to know that the author visited a factory within the last fortnight, which factory had been driven previously by gas-engines, but now it is entirely driven by electric motors. The manager told me that it was no uncommon thing to have three or four girls carried out in an afternoon in a fainting condition at the time when the works were being driven by gas-engines, but they had not had a single case of this sort occur during the last 18 months that their works had been driven *exclusively* by electric power.

4. *From the Point of View of the Manufacturer of Electrical Apparatus.*—Surely he would, indeed, welcome the supply of cheap electric energy in the various towns in the United Kingdom, as this would mean increased demand for cables, motors, etc.

We, therefore, see that from the point of view of patriotism to our Empire, from the point of view of civic patriotism to the town we live in, from the point of view of the health of the working classes, from the point of view of the manufacturer of electrical apparatus, that the supply of cheap electrical energy for power purposes is a thing to be most desired of men.




Output Curves from the City of Coventry Electricity Works, showing growth of Day Load.

The only point which I think now requires to be proved is whether this supply of electrical energy cheaply will be a benefit to the supplier, or, as the Act puts it, the undertaker—viz., the owner of the electricity supply works—and this is the question which I propose to deal with next. During the year ending 1902 it became the author's duty to take over the management of the electricity works at Coventry. I would, in passing, wish to say that I should prefer to have given figures other than those at Coventry, but unfortunately they are not at my disposal; but I consider that what the staff has been able to accomplish there can be accomplished anywhere else, providing they work together hand in hand in the way they have done at Coventry, and spell the word "can't" without the "t." The difficulties we have had to contend with have

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TABLE A.—SHOWING RESULTS OF WORKING AT THE COVENTRY CORPORATION ELECTRICITY WORKS.

| Year. | Capital expenditure. | Amount of current sold. Units. | Total revenue. | Station costs. | | Gross profit. | | Average price obtained. |
|---|---|---|---|---|---|---|---|---|
| | | | | Total. | Pence per unit. | Gross profit. | Per cent. of the capital average. | |
| 1896 | £23,556 | 51,114 | £1 246 | £1,287 | 6·04 | - £41 | Nil. | 5 85 |
| 1897 | 31 388 | 79,583 | 1 959 | 1.853 | 5·58 | 106 | ·38 % | 5·90 |
| 1899 | 45 600 | 149 547 | 3,586 | 3 253 | 5·22 | 333 | ·86 % | 5·48 |
| 1900 | 63 565 | 229 607 | 4.069 | 3 282 | 3·43 | 787 | 1·44 % | 4·27 |
| 1901 | 75 913 | 341 810 | 5.897 | 4,358 | 3·05 | 1,539 | 2·15 % | 4·14 |
| 1902 | 78,442 | 404 968 | 6.467 | 4,115 | 2·43 | 2,352 | 3·05 % | 3·83 |
| 1903 | 102,712 | 566 731 | 7 959 | 3,573 | 1·51 | 4,385 | 4 84 % | 3·37 |
| 1904 | 119 470 | 920 192 | 10 695 | 4,449 | 1·16 | 6,246 | 5·62 % | 2·78 |
| 1905 | 134 503 | 1,375,735 | 13,111 | 4,883 | 85 | 8,228 | 6·47 % | 2·28 |

merely induced us to further efforts, and really when one comes to look back upon what has been accomplished, it is surprising to see how small the difficulties really were. Table A will show you the position the works were in and the alteration now. It should be clearly remembered that during the first four years of running the trade in Coventry was good ; in fact, for the first two years it was extremely good, but for the last four years it has been the very reverse. You will notice that for the year ending 1900 the gross profit on the average capital spent was 1·44 per cent., and the average price obtained was 4·27d. per unit. I would prefer to leave out of account the two years ending 1901 and 1902, because the coal was abnormally high during these years, due in a great measure to the way in which the contract was placed.

When the author took over the management it was very evident that a very considerable amount of capital had been spent in proportion to the *earning* capacity of the station. The plant was of an uneconomical type, and there was no inclination, but rather the reverse, on the part of the ratepayers of Coventry to support the electricity undertaking in Coventry. Prices were lowered, being reduced to 1d. for the third hour on the maximum demand system, but this did not have the effect which it was hoped it would have had, due to certain causes, among which was the system of free wiring whereby the more current a man used the more he would pay for the wiring. The long-hour consumer did not seem desirous of taking the light, and we were, therefore, face to face with this position. The author had advised the Corporation, in spite of the very large deficit for 1901, to lower the prices and double the capital. It probably was a very drastic course to take, but from figures which the author would be pleased to place before anyone it was obvious the *only* course to take. The standing charges against the then existing plant were so high that unless the capital was, as it were, watered by well-spent capital, the capital cost per kilowatt of earning capacity made it impossible to make the undertaking pay.

You probably all know that there are a very large number of gas-engines in Coventry. It stands, I believe, the second town in the United Kingdom as having the largest number of gas-engines in proportion to the population. Well, the only course to adopt was to go in for the supply of electric motors, but the difficulties in the way were : (1) that a very low price would have to be charged for the energy because of the competition with the gas-engines, and (2) the firms were too often too badly off to afford any money to buy the motors, so it therefore became necessary to hire them out. This practically meant starting an entirely new business. Consumers had previously been told that the motors would not answer, and it was therefore necessary to disabuse the mind of the would-be consumer on this point, and we had to frequently instal the motors, do the wiring, fix the countershafting, belts, etc.—in other words, we had to do everything we possibly could to obtain customers and keep them. I am bound to say that as a whole the consumers at Coventry were not so disposed to go in for a new thing as people in some parts of England are, but we have, in spite of all this, done fairly well. The majority of the motors have been put on since the end of 1902—that is to say, during the last three years. At the end of 1902 we had something under 100 h.p. of motors connected ; now we have over 1,150 h.p. of motors connected.

As probably you are aware, the old system at Coventry was 87 periods single-phase with a *plant* capacity of 600 kw., earning capacity 350 kw. This plant was retained, and was kept to supply current to the centre of the town, where there are practically no motors. The area outside the centre of the town was changed over to 50 periods two-phase. The plant installed was of the same kind as at South Shields. I am afraid I cannot give you full details of the engineering side of the undertaking now for two reasons : (1) because time will not allow me to do so ; (2) it hardly comes within the scope of the present paper, the object of which is to prove that power can be supplied at a cheap rate for industrial purposes with considerable advantages both to the supplier and to the supplied regardless of the system of supply. However, I may mention that the difficulties in the way of changing over single-phase to two-phase are to a great extent chimerical. It was astonishing to see how little was known in England by the English manufacturer about two-phase working when we decided to change over. We drove ahead and the difficulties disappeared. It was supposed there would be trouble in balancing the sub-stations ; there was none. Difficulties with the old mains were prophesied, but these have yet to be discovered. The first thing that I had to do, and what I would most strongly emphasise you to do first, is to reorganise the books kept, so that month by month, quarter by quarter, we shall know exactly where we stood.

The log sheet shown is the one adopted by the author. You will notice that there are two sides—the right-hand side is for this year's working, and the left-hand side is for the corresponding period of the year before. A wages book, invoice book, and a ledger will allocate everything, which is then transferred to the log book—a method which anyone can understand. This undoubtedly is the first thing to be done to improve the financial position of the station, to keep the books in such a way that at any time the exact position can be seen. The effect upon the station costs has been, as you see, very marked—viz., the station costs for 1900 were 3·43d. per unit, whereas for 1905 they have been brought down to ·85d. per unit. Of course, the true criterion of the financial position of the undertaking is shown by the gross profit made on the average capital spent. This in 1900 was 1·44 per cent., and in 1905 was 6·47 per cent. You will notice that for 1900 the average price obtained was 4·27d. per unit, the average price obtained for 1905 was 2·28d. per unit.

I think no words of mine are necessary to show how great a success has been obtained by adopting what we may call ordinary commercial methods in dealing with a corporation undertaking. Among these I mean the obtaining of orders and the treatment of customers. If we had waited for orders to come to us, we should have had practically none. If orders would come in without being looked after, why is it that hundreds of thousands of pounds are paid every year to people who obtain orders. The capital has been increased from £63,565 in 1900 to £134,503 in 1905, an increase of £70,938. Deducting £787, the gross profit made in 1900 on £63,565. from the gross profit this year, we have made £7,440, being 10·4 per cent. on the *extra* capital spent.

In conclusion, the author wishes to say that he feels sure that what has been done at Coventry can be done elsewhere, providing that the same methods are adopted, and the same loyal support is given to the manager as the author himself has received from the various members of his staff. It is impossible for the manager to be everywhere, and a great many of the economies effected have been the direct result of the care and pains taken by his assistants.

## INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting on the 5th inst. Mr. A. M. Taylor's paper, read before the Birmingham Local Section on Dec. 14 last, was discussed in its amplified form. We gave an abstract of the original paper in our issue for Jan. 15, and the amended paper was dealt with in our issue of the 5th inst.

The subject having been introduced by the author, Mr. C. P. SPARKS expressed dissent upon one or two points. He considered the author had exaggerated the competition between electric and other motors. The electric motor was the motor of the future, in many cases the consumer of power having no option but to employ electric energy. The diversity factor for lighting was poor, but for a power load it was considerably higher than had been assumed by the author, who had also overstated the capital charges. He considered that the author had in general put the cost of generation at too high a figure.

Mr. W. C. P. TAPPER found himself quite at variance with Mr. Taylor regarding the restricted-hour system, which he (Mr. Tapper) had found quite practicable at Stepney. He echoed Mr. Sparks's view that the author's assumptions as to diversity factor were incorrect, instancing the 4·4 (which is increasing) at Hackney, and the Glasgow tramway load of 7·75.

Mr. J. S. HIGHFIELD thought the tone of the paper too pessimistic,

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as, in his opinion, the authorities were selling energy at rates which answered the purpose of the consumer. As to the overlapping of lighting and motor loads during fogs, the author estimated this at 60 per cent. The Metropolitan Company found that it amounted to 80 per cent., which would represent an increase of capital charges. He thought it important to calculate the load factor upon a weekly instead of an annual basis when calculating costs, because the increasing connections caused the load factor to be higher per week than per year, which placed a more favourable complexion upon the accounts than when they were calculated upon an annual basis. A system necessitating the running of separate circuits for motors and lighting to a consumer's premises would be inconvenient. In the case of combined plants fogs would shut down the tramways while increasing the lighting load, so that overlapping would not occur.

Mr. JECKELL did not think the author's figures accorded with practice. Figures were given by the speaker in support of the superiority of electric motors over gas-engines. He instanced a case in which a firm had replaced a 36-h.p. gas-engine by electric motors, and had effected a saving of £11 for a quarter, irrespective of the economy in water cost and floor space.

Mr. VIGNOLES deprecated a reduction upon 1d. per unit for power. Comparing the cost of operating with a gas-engine and an electric motor, he found the results favourable to the former, and, moreover, a motor running nine hours per day would probably have a variable load, thus introducing a diversity factor. The author's suggested prices for restricted-hour supply were much too low. In Grimsby, where they had a sliding scale and a restricted-hour system, a large proportion of their power customers used the latter, though after a time they usually discovered that the sliding scale was more advantageous. The restricted-hour arrangement, however, provided an excellent attraction. He preferred battery sub-stations to isolated accumulators.

Mr. R. A. DAWBARN considered that motors should take a fair ratio of capital charges in proportion to the peak load. For many classes of restricted-hour consumers, 1d. per unit was scarcely low enough. The Huddersfield Corporation had accepted a consumer at ½d. per unit, and it would need a much lower figure than 1d. per unit to tempt cotton-mill proprietors, who for a mill using, say, 1,300 h.p. only stood at a cost of ·231d. per horse-power for their power at present.

In reply, Mr. TAYLOR stated that he thought everyone would agree that in the case of a number of motors all fully and continuously loaded the diversity factor was unity. With any cyclic load factor of motors the diversity factor of the station was the reciprocal of that load factor, assuming all motors to be of the same class, and that the cyclic load factor of the station was equal to the motor load factor multiplied by the diversity factor. He contrasted the poor results obtained at Stepney on the restricted-hour system with the phenomenal success which had attended it at Brighton. Regarding the list of figures which had been given by Mr. Jeckell, he thought it would be found that the brake horse-power hours were over-estimated, which would account for Mr. Jeckell's figures being so low. It appeared to him that lighting and power loads could be treated on the same basis, with equivalent demands, and he thought the restricted-hour system was practicable for many industries.

# LEGAL INTELLIGENCE.

## TELEPHONIC INTERCOMMUNICATION.

In the Chancery Division last week, Mr. Justice Buckley delivered his reserved judgment in the action brought by the Swansea Corporation against the National Telephone Company.

HIS LORDSHIP said he understood this was the first case in which application to the Court had been made to construe or enforce the Telegraph Act of 1899 in reference to intercommunication between competing telephone systems. The question arose under Sub-Section 5 of Section 3, which provided that when the license of an existing company was extended in respect of any exchange area for a period of eight years the company should, at the request of the new licensee of the Postmaster-General, afford all proper facilities for transmission of telephone messages over both systems, provided that the licensee requiring intercommunication should in any such case afford similar facilities. Before September, 1902, the defendants had a system of telephonic communication in the Swansea area, and in September, 1902, the Postmaster-General granted a new license to the plaintiffs, at the same time extending the defendants' license. By November, 1903, the plaintiffs had established their system, and in January, 1904, requested intercommunication, and duly satisfied the Postmaster-General that they had the required number of subscribers. Mr. Gaine had admitted in the box that the defendants desired to raise every objection that could be legitimately put forward to prevent the plaintiffs obtaining the intercommunication they had a right to request and had requested. They had got the benefit of their extended license, but intended to put every obstacle in the way of the new license. Many of the objections were not now relied on, but these remained. The defendants had a central exchange at Swansea and 11 or 12 subsidiary exchanges, and they required that the plaintiffs should provide junction circuits to connect directly the plaintiffs' exchange at Swansea and the defendants' exchange there and with each of nine other subsidiary exchanges, and also junction circuits to connect the Mumbles and Morriston exchanges. The defendants contended that the lines must be duplicated from plaintiffs' exchange to each of the company's subsidiary exchanges. There was no justification for that in the Act. The object of the Act was not to duplicate systems, but that the customers of each company should use the other's trunk line. In the result he declared that under Section 3, Sub-Section 5, of the Telegraph Act, 1899, and the order of the Postmaster-General, and in the facts which had happened, the plaintiffs were entitled to be afforded by the defendants all proper facilities for restricted intercommunication, within the meaning of the order, between persons using the defendants' system and persons using the plaintiffs' system, and he declared that the defendants had refused to give such facilities, and there would be an order that the defendants do give such proper facilities, with liberty to either side to apply to the Court in case any difficulties arose, the defendants to pay the costs of the action.

## WORKMEN'S COMPENSATION ACT.

### Back v. Dick, Kerr, and Co.

An appeal came before the Master of the Rolls, Lord Justice Mathew, and Lord Justice Cozens-Hardy, in which the defendants sought a reversal of the award of compensation made by Judge Lush-Wilson, K.C., sitting at the Exeter County Court. The defendants had entered into a contract to take up the old tramway rails in certain streets in Exeter, and lay down new rails for tramcars to be worked by electric power. The plaintiff was employed in assisting to unload rails from a truck and to stack them there by means of a hand crane, when he was injured by an accident. At the time of the accident the only work under the contract then commenced was that of taking up the old rails in the street on the St. David's Station side of the clock tower, about 700 yards from the place where the accident happened. The question was whether the plaintiff was at the time of the accident employed "on, or in, or about engineering work," engineering work being defined as meaning "any work of construction or alteration or repair of a railroad. . . ." The county court judge, in giving judgment, said: "I have come to the conclusion that it would be impossible to limit the meaning of the words 'engineering work' to the extent contended for on behalf of the employers" (that was, that "engineering work" imported definite locality, and that the engineering work in question must be limited to the portion of the line in course of construction, and could not include storing places or depôts). "Although the word 'work' imports definite locality as meaning the thing on which the labour is bestowed, I think the words 'on, or in, or about engineering work' must include any portion of the selected area upon which the essential operations were conducted. I find that the site upon which the rails were stacked in the yard was on, or in, or about the engineering work," and he accordingly made an award in favour of the applicant.

The COURT allowed the appeal.

The MASTER OF THE ROLLS said that the question of whether the plaintiff was at the time employed on, or in, or about engineering work depended upon the definition of "engineering work" in Section 7, Sub-Section 2, of the Workmen's Compensation Act, 1897, and the decisions of this Court as to the meaning of that term. Previous judgments were to the effect that the term "engineering work" in both limbs of the definition denoted the physical locality where labour of a certain class was being bestowed. It indicated a physical area, and to come within the Act the workman must be employed on, or in, or about that physical area. In the present case the physical area of the engineering work which was actually being carried on at the time was about 700 yards from the scene of the accident. Unless it could be said that the railway yard was part of the physical area of the engineering work, the case did not come within the Act. The learned judge's view was that the railway yard could not be so construed.

Lords Justices MATHEW and COZENS-HARDY concurred.

## FURIOUS DRIVING.

Two motormen in the employ of the Glasgow Corporation tramways department were fined a guinea each last week in the local police court, the charge being furious driving. The circumstances were somewhat exceptional. The cars were proceeding in the same direction, and the accident which resulted in their collision seems to have arisen through each driver trying to reach a junction first. The Magistrate said that although one of the motormen had the right-of-way according to the regulations, these regulations were for guidance, and not for exoneration in the event of an accident.

# COMPANIES' MEETINGS AND REPORTS.

## BRUSH ELECTRICAL ENGINEERING.

The annual meeting of this Company, whose report appeared in our issue of the 5th inst., was held at Salisbury House, London, last week, Lord Vaux of Harrowden presiding.

The CHAIRMAN said that during the past year they had been actively engaged upon very necessary development work in the various departments at their Falcon Works, which were calculated to increase their profits in future years, but which, for the time being, were having just an opposite effect, as the cost had to be met out of revenue. The salient features of the year's business had been the sustained activity in their rolling-stock departments and the growing strength of their mechanical engineering and electrical business. They had executed large rolling-stock orders for various municipal and other tramway undertakings, and they had now completed the delivery to the Metropolitan District Railway of cars and trucks which represented the highest class of electrical railway vehicles yet constructed for service in this country. In view of the electrification of other railways they had made preparations for handling large orders of this description. To meet the growing demand for railway and tramcars and motor omnibuses that would not catch fire, they had laid down plant for the chemical treatment of timber on the most approved principles,

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and the District Railway coaches had all been built of this material. Designs had been completed for a new type of all-steel car, which possessed marked advantages in the saving of weight, and which in other ways tended towards the reduction of traffic expenses. In the manufacture of tramcars they had maintained their position as the leading firm engaged in the industry. The net profit available was practically the same as in the previous year, and the appropriation recommended by the Board was as before. The immediate future of the Company's business appeared more cheerful that when he last addressed the shareholders. They were better organised for both manufacturing and selling, and their goodwill not only throughout the United Kingdom and the Colonies, but in foreign countries, was steadily improving. Taking a general survey of the position, it was felt by the directors that the prospects in the immediate future were such as not to give rise to the anxiety which they had experienced in the past.

The report was eventually adopted.

## CRAIGPARK ELECTRIC CABLE.

The second annual general meeting was held at Glasgow last week, Mr. James T. Tullis presiding. The report, which was adopted, recommended a dividend for the half-year ended March 31 of 6 per cent. per annum on the preference paid-up capital, in addition to an interim dividend already paid to the preference shareholders for the half-year ending Sept. 30, 1904; £300 had been written off preliminary expenses, £1,000 depreciation written off buildings and machinery, and a balance carried forward of £1,018. 9s. 10d.

## CALLENDER'S CABLE AND CONSTRUCTION.

The report for the year ending Dec. 31 shows a balance at the credit of profit and loss for the year's working of £57,065. 15s. 2d., to which has to be added the balance brought forward from 1903, £24,581. 3s., making together £81,646. 18s. 2d. From this must be deducted interest on debenture stock, £11,250; dividend on preference shares, £10,000; appropriation for depreciation of plant and machinery and office furniture, £12,337. 11s. 1d.; and also the balance of cost of the issue of debenture stock, £2,777. 14s. 1d.; leaving an available balance of £45,281. 13s.—which it is proposed to deal with in the following manner: (1) by the payment of a dividend on the ordinary shares at the rate of 10 per cent. per annum (clear of income tax), £17,500; (2) by the payment of a bonus of 2s. 6d. per share, £4,375; (3) by carrying forward to next year's account, £23,406. 13s. In spite of a considerably reduced volume of business, the profits have been over £4,000 in excess of those of last year. Important contracts have already been secured at home and abroad to be carried out this year, and the factory at Erith will be kept busy for some time to come with the orders actually in hand. The Company has carried out a large amount of work in connection with the supply of electric power in South Wales, in the Cleveland district, and in Yorkshire. The directors state that practical experience has shown that the policy adopted two years ago in regard to the companies supplying large areas with electricity under parliamentary powers is a sound one. Further extensive orders are in course of execution for additional mains in these districts, and for new power mains in Lancashire, Derbyshire, Fife, and elsewhere. During the past year a considerable extension of the Company's business has taken place abroad, especially in the East. Cable-laying contracts have been completed or are in progress in Bombay, Calcutta, Kandy, Penang, Kuala, Lumpur, Singapore, and Hong Kong, whilst further orders are now in course of execution for Bangkok and the Kidderpore Docks. Contracts have also been carried out in New Zealand, at Wellington and Dunedin. Considerable orders have been executed in Mexico, and the Company's staff is now cable-laying in the Argentine. In conjunction with other well-known firms in the engineering trade the Company has taken part in the establishment of the British Engineering Company of Egypt, Limited, with the view of securing satisfactory representation in that country when the time comes for the execution of heavy electric contracts there. The Company is now reaping considerable advantage from the expenditure on plant and appliances made at the factory during the past five years. It has thus been possible to produce cables at a profit during the difficult and trying time through which the Company has passed. The machinery, plant, and equipment at Erith and on outside contracts have been maintained in the most efficient condition, the cost thereof being debited to the year's revenue. The directors call attention to the heavy burden upon this Company from the local rates and taxes, the amount payable having been considerably increased during 1904. At Erith alone the sum paid amounts to £3 741 per annum, equal to a dividend of 2¼ per cent. on the ordinary share capital of the Company. The operations of the Anchor Cable Company, Limited, whose shares are held by this Company and its nominees, have been considerably restricted during the past year, owing to the unsatisfactory position of the rubber trade, due to the unprecedented advance in the cost of raw materials, with no corresponding increase in selling prices. The policy of the Anchor Company has therefore been a waiting one, but the plant and machinery at Leigh have in the meantime been put into excellent order, and the trade connection has been considerably increased. It has been shown by events which have occurred during the past year that the control of the Anchor Works has already been of great advantage to the Company's business, and the directors are confident that it will continue to be so. As anticipated at the time of purchase, the clearing up of the contracts undertaken by the old management has been attended with heavy expenditure. A sum has been set aside out of the Company's profits towards meeting the loss thus caused, which will be dealt with when the Anchor Company is finally incorporated with the Company. A further issue of debenture stock amounting to £100,000 was made during the past year, and was readily accepted by the investing public. The directors regret to announce the death of Lieut.-Colonel Elliot, which took place in July, 1904. The vacancy thus caused has been filled by the election of Sir J. Fortescue Flannery, Bart., M.P. Major W. M. Mackenzie is the director retiring by rotation, and he being eligible offers himself for re-election.

## GLOBE TELEGRAPH AND TRUST.

The report for the year ended April 30 states that the net revenue, after deduction of expenses, amounts to £199,123, and makes, with the balance brought forward, a total of £202 180. From this amount there has been distributed a sum of £131,709 in interim dividends, leaving an available balance of £70,471. The directors now recommend a final dividend of 3s. a share on the preference shares and of 4s. 9d. per share on the ordinary shares, making, with previous distributions, total dividends for the year of 6 per cent., less tax, on the preference shares, and of 5⅝ per cent. net on the ordinary shares, leaving a balance of £1,643 to be carried forward.

## SUBMARINE CABLES TRUST.

The report for the year to April 15 states that the revenue for this period amounted to £24,288 and the expenses to £1,161, leaving a balance of £23,127. After providing to meet payment of the coupons, £3,976 had been transferred to the redemption fund, leaving £92 to be carried forward. In accordance with the terms of the trust deed, 34 certificates have been redeemed since the last report by purchase in the open market.

## LIENS REGISTERED.

**British Electric Traction Company, Limited.**—Particulars of a series of debentures, created by resolution of June 16, 1898, securing an amount equal to half the subscribed capital for the time being, have been filed in accordance with Section 14 (4) of the Companies Act, 1900, a debenture of recent date having been produced at time of filing. Property charged: the company's undertaking and property, present and future, including uncalled capital. No trustees for debenture holders. A letter annexed to the return states that these debentures are issued to trustees for holders of debenture stock of like amount, acting under a trust deed, dated June 30, 1898, as modified by a deed of Oct. 6, 1898, and that some debentures of this series have already been registered. The trustees for the debenture stockholders are the Electric and General Investment Company, Limited.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Tonbridge.**—The Urban District Council require tenders for cables. Tenders by May 29.

**Ashton-under-Lyne.**—The Corporation invite tenders for six tramcars. Tenders by May 23.

**Llandudno.**—The Corporation invite tenders for switchboard extensions. Tenders by May 22.

**Darlington.**—The Corporation invite tenders for two storage batteries. Tenders by May 23.

**Islington.**—The Borough Council require tenders for coal-conveyors, etc. Tenders by May 24.

**Cataquexes (Spain).** — The local light and power company require tenders for electrical plant. Tenders by July 1.

**Dartford.**—The Urban District Council invite tenders for the supply and erection of various plant. Tenders by May 24.

**St. Marylebone.**—Tenders are invited for the annual supplies in the electricity department. Tenders by May 28. See advertisement in last issue.

**Madrid.**—The Public Works Department require tenders for carrying out a scheme for an electric tramway for goods transport along Bilbao quays.

**Paris.**—The Colonial Office, 4 bis, Rue Jean-Nicot, require tenders for the supply of lamps and lighting accessories for three years. Tenders by May 23.

**Glasgow.**—The Trustees of the Clyde Navigation invite tenders for electric arc-light installation for the outer basin of Clydebank Dock. Tenders by May 22.

**St. Pancras.**—The Borough Council invite tenders for the supply of arc lamp carbons for 12 months. Tenders by May 23. See advertisement in last issue.

**Partick.**—The Town Council invite tenders for the supply of various plant at their electricity works. Tenders by 12 noon on June 6. See advertisement.

**Edinburgh.**—Tenders are invited for steam and exhaust pipework at McDonald-road electricity supply station. Tenders by 10 a.m. on June 6. See advertisement.

**Liria** – The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

**Edinburgh.**—Tenders are invited for extension of switchboard panel at McDonald-road electricity supply station. Tenders by May 30. See advertisement in last issue.

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**Krakow.**—The Government Railway require tenders for extensions of their electric station, including additional generators, switchboards, motors, etc. Tenders by noon on May 28.

**Kettering.**—The Urban District Council invite tenders for the supply, delivery, and erection of Nernst lamps, posts, etc., for street-lighting within their district. Tenders by May 29.

**Heywood.**—The Town Council invite tenders for the construction of the permanent way and paving and overhead electrical equipment of about four miles of tramways. Tenders by May 22.

**Laventhem (Belgium).**—The Municipality require tenders for erection of central station, laying of mains, etc. Particulars (3s. 4d.) may be obtained from the Secretary of the Mayor of that place.

**The Hague.**—The Post and Telegraphs Department require tenders for the construction of a telegraph line of 10 wires between Bodegraven and Woddinxveen. The estimate is £478. Tenders by May 24.

**Bristol.**—Tenders are invited for single-phase alternating-current transformers and three-phase to direct-current motor-generators. Full particulars from the City Electrical Engineer, Temple Backs, Bristol.

**Buralem.**—The Corporation invite tenders for wiring the town hall, markets, baths, gymnasium, and Wedgwood Institute, and also for the supply of house service fuses and meters. Tenders by May 30. See advertisement in last issue.

**Madrid.**—The Post and Telegraphs Department require tenders for 50 tons 4mm. zinced iron wire and 5 tons 3mm. bronze wire. The maximum price for the iron wire is 580 pesetas and that for the bronze wire 3,400 pesetas per ton. Tenders by June 5.

**Stalybridge.**—The Stalybridge, Hyde, Mossley, and Dukinfield Tramway and Electricity Board require tenders for the supply, delivery, and erection at the Stalybridge sub-station of a 400-kw. motor-generator, together with the necessary switchgear for same.

**Switzerland.**—M. R. Vontobel, of Winterthour, and M. Charles Probst, of Lucerne, have obtained a concession for the construction of a narrow-gauge electric railway from Meiringen to Gletsch. The total cost of the enterprise is estimated at £241,600; £19,600 is to be expended on rolling-stock.

**Bristol.**—The Docks Committee invite tenders for the construction, delivery, erecting in place, fitting, testing, and maintenance for 12 months after completion, of four two-ton movable electric jib cranes, and one three-ton movable electric jib crane to be erected on the adjoining wharf at Canons Marsh. Tenders by June 7.

**Bangour (Scotland).**—The District Lunacy Board invite tenders for the following works: (1) building in boiler economisers, etc.; (2) building in chimney stalk; (3) building in steam and electric cable trenches; (4) steam boilers; (5) engines and dynamos; (6) economisers and piping; (7) overhead travelling cranes; (8) accumulators; (9) switchboard and connections; (10) main cables and branches. Tenders by May 27.

**London, S.E.**—The London County Council invite tenders for the road work and platelaying required for the construction, for electrical traction on the conduit system, of certain authorised tramways in Blackwall-lane, East Greenwich, and from New Cross to Lewisham, and for the reconstruction, for the same system of electrical traction, of a portion of the existing horse tramways in Woolwich-road, and from Lewisham to Catford. Tenders by 10 a.m. on May 23.

## RESULTS OF TENDERS.

**Hammersmith.**—The Borough Council have accepted the tenders of Mr. C. R. Heap and Messrs. Le Carbone for commutator brushes for the electricity works, at £23. 12s. and £9. 3s. 6d. respectively.

**Weymouth.**—The following tenders have been received for wiring, etc., Sunnybank House: Ekless Bros. and Hine, £65; W. Pratt and Co., £65; W. Gee, £59; C. Tett, £52; W. D. Orchard, £49. 15s. 6d. (accepted.)

**Southampton.**—The Town Council have accepted the following tenders: Wm. Griffiths and Co., London, for the work of reconstructing the Portswood-road section of tramways, £1,711. 0s. 7d.; North Eastern Steel Company, Middlesbrough, 250 tons of tramway rails, £5. 10s. a ton; G. R. Turner, Limited, Notts, two 10-ton coal wagons for the electricity department, £128.

**Woolwich.**—Messrs. Browett, Lindley, and Co., Patricroft, near Manchester, report an order from the Government for the supply of a 500 kw. steam generator, including one of their three-crank triple-expansion enclosed forced lubrication steam-engines, coupled to a dynamo by the British Westinghouse Electrical and Manufacturing Company, to be installed at the Royal Arsenal.

**Southampton.**—The Corporation have received the following tenders for (a) supply of about 250 tons of 7in. girder rails and (b) reconstruction of tramways, Portswood-road: North-Eastern Steel Company, Middlesbrough, £5. 10s. per ton (accepted); Bolckow, Vaughan, and Co., Middlesbrough, £5. 12s. 6d.; R. W. Blackwell and Co., London, £5. 15s. 9d.; Lorain Steel Company, London, £5. 16s.; W. Scott, Limited, Leeds, £5. 5s.

**Metropolitan Asylums Board.**—It has been agreed that, subject to the approval of the Local Government Board, the offer of the Tudor Accumulator Company, to renew the electrical storage battery at the Northern Hospital for the sum of £295, and to maintain it for 10 years for a further sum of £28 per annum, be accepted. This price includes cost of installing a new battery of 110 cells, having a capacity of 370 ampere-hours, and for increasing the size of the 10 existing Tudor cells to make them of the same capacity as the proposed new one, at the sum of £340, less an allowance of £45 for old materials—*i.e.*, £295 in all.

**Govan.**—The Electricity Department have accepted the following, among other tenders, for various stores contracts: J. Macqueen and Co., Glasgow, engine and cylinder oil; Ferguson and Timpson, Glasgow, packing and gauge glasses; British Insulated and Helsby Cables, Limited, cables and accessories; C. Sharp, Limited Glasgow, bitumen and compound; Ferranti Limited, Hollinwood, meters up to and including 25 amperes; Chamberlain and Hookham, Birmingham, meters, all sizes over 25 amperes; Keighley Electrical Engineering Company, Keighley, fuse-boxes; D. Richmond and Co., Govan, wrought-iron tubes and fittings; D King and Co., Glasgow, cast-iron pipes; Crompton and Co., London, carbons; J. Kennedy and Sons, Glasgow, coal; British Thomson-Houston Company, Rugby, motors, 1, 2, and 3 h.p.; Lancashire Dynamo and Motor Company, Manchester, motors, all other sizes; Reyrolle and Co., Hebburn-on-Tyne, Monte-Callow, London, and Brook, Hirst and Co., Chester, motor starters; Berry, Skinner, and Co., London, D.P. switches.

**Carshalton.**—The Metropolitan Asylums Board have received the following tenders for installation of electric light, telephones, and fire-alarms, at the Southern Hospital:

| | | | |
|---|---|---|---|
| Buchanan and Curwen, 64, Victoria-street, S.W.* | £8,600 | 0 | 0 |
| Bromley and Batstone, 24-6, Holborn, E.C. | 8,677 | 4 | 3 |
| Belshaw and Co., 53, Victoria-street, S.W. | 8,944 | 0 | 0 |
| Alliance Electrical Company, Limited, 23, Grafton-street, W. | 9,583 | 17 | 0 |
| F. A. Glover and Co., Limited, Vine-street, Clerken-well-road, E.C. | 9,671 | 0 | 0 |
| Wenham and Waters, Limited, Paragon Works, Croydon | 10,790 | 0 | 0 |
| Drake and Gorham, Limited, 65, Victoria-street, S.W. | 10,819 | 0 | 0 |
| Higgins and Griffiths, 4, Albany-street, N.W. | 10,860 | 0 | 0 |
| Bergtheil and Young, Limited, 12, Camomile-street, E.C. | 11,600 | 0 | 0 |

*Recommended for acceptance.

**London County Council.**—The Council have received the following tenders for the execution of the several portions of the work in connection with the construction of the tramways in Archway-road, Highgate:

| | Tramway construction. | Paving works of street widening. |
|---|---|---|
| Dick, Kerr, and Co. | £4 587 15 9 | £1,010 8 5 |
| D. R. Paterson | 4 807 14 2 | 1,036 11 9 |
| J. Mowlem and Co. | 4 920 2 4 | 1,035 8 7 |
| W. Griffiths and Co. | 4,954 13 8 | 1,034 5 10 |
| R. W. Blackwell and Co. | 5,037 15 8 | 1,104 18 6 |
| Muirhead, Greig, and Matthews | 5,074 14 0 | 1,082 1 7 |

Subject to the approval of the Board of Trade and the Islington Metropolitan Borough Council being obtained to the system of electrical traction proposed to be adopted on the tramways, it is proposed to accept the tender of Messrs. Dick, Kerr, and Co., Limited, the firm to be allowed to sublet to the undermentioned firms (or to such other firm or firms as may be approved by the engineer under the contract) the following portions of the work in connection with the tramways in Archway-road—namely: (1) to the Hadfield Steel-foundry Company, Limited, of Sheffield, the manufacture of the special work for the tramways (consisting of points, crossings, etc.); (2) to the Associated Portland Cement Manufacturers, Limited, the supply of cement; and (3) to Messrs. Bayliss, Jones, and Bayliss, Limited, of Wolverhampton, the manufacture of the tie-bars.

# BUSINESS NOTES.

## TRACTION.

**Bonnyrigg.**—The Town Council have approved Sunday running.

**Doncaster.**—A *plébiscite* is to be taken on the question of Sunday running.

**Darlington.**—The first annual tramway report shows revenue £8,544, while the working expenses, including £2,521 for current, total £6,464.

**Karori (N.Z.).**—The Borough Council are contemplating raising a loan of £29,000 for the purpose of providing a Lombard-Guerin system of electric traction between Karori and Wellington.

**Hastings.**—The company's Bill has been placed on the unopposed list, and it is expected that it will be passed without any trouble. Good progress is being made with the work of construction.

**Bradford.**—At a meeting of the Corporation last week the Deputy-Chairman of the Tramway Committee stated, in reply to a question, that it was not proposed to introduce ½d. fares at present.

**West Cumberland Tramways.**—The Bill seeking a further extension of one year from August next from the commencement of the work of construction has been ordered for third reading in the House of Commons.

**Tranent.**—It is reported that the National Construction Electrical Tramway Company cannot see their way at present to undertake an extension of their system from Levenhall to Tranent, but that they will as early as possible inaugurate a system of motor omnibuses.

**Heywood.**—Apparently the agreement for the working of the Heywood trams by the Bury and Rochdale Corporations will now go through without much further delay, as the Tramways Committe have approved the terms outlined by the sub committee, and the Corporation have approved the action of the Tramways Committee.

**Mansfield.**—The Nottingham-road, Chesterfield-road, and Pleasley Hill sections of the Mansfield tramways are rapidly approaching completion, and the engineers anticipate that the cars will be running by June 1. The metals have been laid part of the way through the Market-place, and the men are now at work on the Westgate section.

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**Hythe.**—A proposal for a system of electric trams within the borough has been made by a public company, but no definite action has yet been taken. The question of granting additional licenses for motor passenger cars came before a special meeting of the Town Council last week. After an animated discussion it was decided to grant a portion of the licenses applied for,

**New Engine Company.**—This company have opened works, under the style of Acton Hill Works (opposite tramcar depôt, Uxbridge-road), Acton, W., for the manufacture and repair of motorcars. The works cover 15,000 square feet, and are equipped with the latest tools. We are informed that the company will have on the road a 25-h.p. to 30-h.p. car of a distinctly novel arrangement.

**Railway Motor 'Buses.**—The proposals of the North-Eastern Railway Committee in regard to running motor 'buses are not deemed satisfactory by the Municipal Tramways Conference, which decided to hold a further meeting before the company's Bill comes before the House of Commons committee. The tramways owners stipulated that these motor 'buses shall only be used to act as feeders to the railways.

**Ardrossan (N.B.).**—At a meeting of the local committee of the County Council a letter was read from the promoters of the scheme for constructing a tramway line from Ardrossan to Stevenston to the effect that the scheme had now been formulated, the promoters expressing their intention of applying for a provisional order in November next. The proposed line is to start at a point between Ardrossan and West Kilbride, and to be continued through Ardrossan on to Stevenston.

**Sale-Altrincham.**—Some little difficulty has occurred in regard to the Northenden-road section of this proposed tramway, the Cheshire County Council stipulating for certain street widenings, while the Sale Urban District Council contend that the road is already as wide as the Board of Trade regulations. The matter has been referred to the Board for their views, both parties agreeing to abide by the decision. The lines would be leased to the Manchester Corporation for 42 years.

**Weston Clevedon Light Railways.**—Mr. Justice Swinfen Eady had before him on Saturday a petition for the appointment of a receiver of the Weston, Clevedon, and Portishead Light Railways Company. Counsel stated that an endeavour was being made by the company to carry out an arrangement whereby a reconstruction could be effected. If that arrangement was not come to, the petition would be proceeded with. His lordship directed the petition to stand over till Tuesday week.

**Proposed Ayrshire Tramway.**—At a meeting of Northern District Committee of Ayrshire County Council last week a communication from agents in Edinburgh was laid before the meeting with reference to the inauguration of a tramway system between Ardrossan and Stevenston. The scheme appears to have now taken definite shape, and the promoters propose to apply for a provisional order in November next. A meeting is to be arranged between the District Committee and the promoters with the view of coming to an agreement as to the route.

**Dalkeith.**—A communication has been received by the Town Council from the Edinburgh Suburban Electric Tramways, Limited, stating that the company feel indisposed to proceed with the scheme, so far as the burgh of Dalkeith is concerned, if the running of cars on Sundays is to be prohibited. The financial success of the undertaking, the letter states, would be extremely doubtful if only six days' running were to be allowed. The Council have decided to grant the concession sought as to Sunday cars, while certain minor matters in regard to the agreement have been remitted to committee.

**Cardiff.**—Mr. Arthur Ellis, tramways manager, has reported to the Tramways Committee that the receipts for April, compared with the corresponding month of last year, have increased by £276. Notwithstanding that during the month they had been running nearly eight fewer cars there had been an increase in the number of passengers of 14,506, while the tram miles run had been reduced by 14,949. There was also a decrease in the expenditure, which was £100 less. This had been achieved despite the fact that the loan charges were £336. 2s. 4d. The net increase for the month was £336. 8s. 5½d. Had the loan charges been the same as last year, the net increase would have been £712. The chairman remarked that this was exceedingly satisfactory, and the other members of the committee concurred.

**Glasgow.**—The enquiry into the application under the Private Legislation Procedure (Scotland) Act of the Corporation for, *inter alia*, power to construct a number of tramway extensions has been concluded. Certain sections were abandoned and other disallowed, as mentioned in our issue of last week, but several important routes have been sanctioned, the chief including those from Tollcross to Uddingston, Maryhill terminus to the city boundary, Great Western-road to Gairbraid-street, Nithsdale-road to Dumbreck-road, and one to Baillieston. Power has been given to run omnibuses as feeders to the existing lines, so as to test the advisability of extensions. The carriage of parcels up to 500lb. each was sanctioned, subject to the consent of the Renfrewshire County Council being obtained in respect of the lines in their area.

**Berlin Elevated Railway.**—The general annual meeting of the Elevated and Underground Railway at Berlin was held on the 11th inst., the chairman being ex-Minister of State Hobrecht, who gave details as to the development and expansion of the company. It was stated that the traffic, especially in the section from east to west, had increased in a most satisfactory manner, and traffics generally had been assisted by the demand for dwellings and business offices in the neighbourhood of the stations. The extension of the railway in the city of Charlottenburg was commenced during the past year. If the arrangement with Charlottenburg is ratified by the authorities, the construction of the line will be pushed on as quickly as possible, so that it may be opened in 1907. As to the extension in Berlin, negotiations are going on with the authorities in regard to the construction of the section from Potsdamer Platz to Spittelmarket, and the section from Spittelmarket to Alexander Platz. There is little doubt that these negotiations will end successfully, as all the inhabitants of Berlin are convinced that the "elevated" has become a necessity.

**Lambeth.**—The Borough Council last week considered the question of the electrification of the London and Southern tramway undertaking, which runs from Vauxhall to Norwood. Although the Council has already agreed to support the Bill of the company for the electrification of the system, the Financial Committee now recommend that £225,000 be contributed by Lambeth toward street widenings, in order that the London County Council might purchase and electrify the line. The London County Council declined to purchase unless Lambeth gave one-third of the cost of street widenings. An amendment was submitted that as the Council had already decided to support the company, it was inexpedient that they should give £225,000 in order that the London County Council could purchase and work the trams. Eventually the amendment was rejected, and the recommendation to give £225,000 was then carried by a majority of two.

**Wednesbury.**—A special meeting of the Town Council was convened for the 17th inst. to deal with a report from the General Purposes Committee as to a settlement of the tramway difficulty which has existed for several years. The actual terms on which a settlement has been arrived at between the South Staffordshire (Lessee) Company and the Town Council are shown by the resolutions which the Council will be asked to confirm. These provide that an agreement be entered into with the company for the purchase by the Corporation of the tramway undertaking, including the site of the depôt, workshops, offices, buildings, and the fixed and loose plant, etc.—but excluding the portion of the line running from James Bridge to Moxley—with the electrical equipment, for £23 920, and that application be made to the Local Government Board for consent to a loan of £29 000. A resolution also provides that the seal of the Corporation be fixed to a conveyance for the sale to the tramway (lessee) company of the site of the depôt, workshops, and offices, together with the buildings thereon, and the plant, etc., for £11,500, and that, on the completion of the sale, the proposed loan be proportionately reduced. One result of the settlement is likely to be an early resumption of the tramway service between Wednesbury and Darlaston.

**Lifeguards.**—An inquest was held at Liverpool last week upon Stamford Wilkes, who was killed by an electric tramcar, a question being raised as to the efficiency of the "plough" lifeguard attached to the front of the car. It was stated that the guard passed over the man as he lay on the track after falling from an outside seat on the car, and that he could not be got out till the car had been lifted, an operation which took 11 minutes. Mr. C. R. Bellamy, general manager of the tramways, said that after the accident he examined the lifeguard on the car, and found it was adjusted in the usual way, with a fixed clearance of 2¼in. from the railhead. He found it difficult to reconcile his knowledge of the plough guard with the suggestion that the body had passed beneath it. The Coroner: The fact remains that it did. Mr. Bellamy: This case stands out because of our immunity from accident in Liverpool compared with other places. I am convinced we have the best guard in use in Liverpool, and we have the best record. The Coroner: I know everything has been done to make it as perfect as possible. Last year 123 accidents occurred in which it was efficacious in sweeping the body aside. Mr. Bellamy said he had looked fully into the matter, and was not prepared to make any suggestion for the improvement of the guard. The Coroner remarked that he only mentioned the lifeguard in order that the public mind might be assured that everything was being done to make it as effective as possible. The jury found that death was accidental.

**Live Rail Dangers.**—The Board of Trade have issued Lieut.-Colonel Druitt's report on the fatal accident which befell Fireman Philip Allen near Manors Station, Newcastle, on the North-Eastern Railway, on March 18. He was found lying dead in the six-foot way between the up north and down Tynemouth lines, close to Argyle-street signal-box, having evidently been run over. In an explanatory introduction, Lieut.-Colonel Druitt states that near Argyle-street signal-box there are four passenger lines running approximately east and west. The four passenger lines and the connections between them are fitted for electric traction, but the sidings are not so fitted. The live rails are all protected throughout the length of the sidings by a wooden guard on each side of the rail extending to a height of about 2in. above it, but at the connections this protection can only be given on one side of the live rail, as otherwise it would prevent the shoe of the electric car passing from the live rail of the crossing to that of the passenger line. Lieut.-Colonel Druitt says: "It is impossible to say exactly how this fatal accident occurred, as no one apparently saw Allen from the time he was relieved from duty at 4.30 a.m. until his dead body was found at 5.45 a.m. With regard to men crossing from the south to the north yard while it is dark, the through road, being quite straight and free from any 'live rails,' is safe as far as coming in contact with such rails is concerned, but from a general point of view is not so safe I think as if men walked along the sidings to Manors Station, where there is a recognised crossing from the siding to the platform, and the men might be encouraged to use this crossing at all times."

**Burton.**—The report of the working of the Corporation tramways for a complete year—the previous report embodied only eight months—was issued last week, and is regarded with general satisfaction. The revenue totalled £17,950, the passengers numbered 3,878 269, the traffic receipts per car mile being 9·21d. The increased car mileage run, consequent upon the faster and improved service, is partly accountable for the reduction in the receipts per car mile, and the industrial depression in the town accounts for the small decrease in receipts compared with the correspondingly first eight months' working of the trams. The service has been speeded up since July, the average speed on all routes, including stoppages, now being 6·85

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miles per hour. The gross revenue shows a surplus of income over expenditure of £5,160. 19s. 5d., of which £4 604. 0s. 7d. is absorbed by repayment of debt and interest, leaving a balance of £556. 18s. 10d., which has been carried to repairs and renewal fund. The total receipts amount to 9·49d. per car mile and the total operating charges to 6·76d. per car mile. A parcels delivery system was inaugurated Nov. 1 last; but, contrary to expectation, has met with scanty support so far. This traffic is slightly increasing, but no doubt when the advantages of the system are more understood it will considerably improve. The traffic from passengers' luggage and newspapers shows a satisfactory increase, the total number of parcels of all classes amounting to 39,639 for the year. Three cars were fitted with covers at the end of last year at a total expenditure, including fittings and all alterations to cars, of £84. 13s. each. The extra comfort of these has undoubtedly been appreciated by the public, and the takings on these cars have been increased by about ¾d. per car mile. The cars, overhead and track work, have been generally kept in good repair and maintenance. No serious accidents occurred.

**Belfast.**—At a meeting of the Tramways Committee a deputation of Ligoniel inhabitants was received, a request being put forward by them that the Ligoniel line should be extended to Wolfhill Mill. The deputation maintained that this would not only be a convenience to the people of the district, but it would also be advantageous to the tramway undertaking. The Lord Mayor asked several questions, and after the deputation had retired it was agreed that, as soon as the contract of Messrs. J. G. White and Co. had been completed, this matter should be taken up, and every effort made to meet the wishes of the people of Ligoniel. Another deputation requested that the extension to Greencastle should be completed at once. The town clerk read the clause in the Act of Parliament referring to this matter, and several questions were asked. When the deputation had retired some discussion ensued, and finally it was decided that Mr. Cutler, the city surveyor, should push forward the construction of this extension in every possible way so as to have it completed. The consideration of the by-laws and of the fares was postponed for a week, so as to get information as to the fares charged in other cities. At a subsequent meeting a deputation representing the National Telephone Company was received, a member of which stated that the decision arrived at by the committee, to the effect that all the overhead telephone wires must be removed in streets in which the electric tramcars ran, would be a most serious one for the company, as it would mean that they would have to find underground accommodation for the wires used by 1,000 subscribers. Eventually it was decided that the electrical engineer should consult with the town clerk upon the legal aspect. Mr. Nance presented a report in respect to the tramway on the Queen's road. In the discussion which ensued between the Lord Mayor and the manager, the latter stated that after deducting the working expenses the yearly profit would be about £400. It was considered advisable that the committee should wait some time in order to ascertain the mind of the Harbour Commissioners on this important matter. The Commissioners are apparently prepared to construct this line themselves if the Corporation will pay them a certain sum for working it.

**Edinburgh.**—At a meeting of the Town Council last week for the purpose of considering the electric tramway systems which three companies have submitted to the Council as suitable for the extensions which the Corporation have in view. The three systems under consideration are the Dolter, the Kingsland, and the "G. B." system. The representatives of the companies each in turn explained to the committee the character and distinguishing features of their system, all three being surface-contact systems. Each of the parties claimed that their system might be laid at moderate cost, and each was willing to give details, but the committee refrained from getting figures on that point, as their object in the first place is to determine as far as they are able which is the better system mechanically, and from the point of view of public convenience and safety. Prof Kennedy, the electrical adviser of the Corporation, was present, and questioned the representatives of the companies on points regarding which he thought information was desirable. It was explained that the Dolter system has been working for some years in Paris and on the outskirts of Dresden. The Kingsland system has not yet been in commercial operation except in the case of a short section in Dresden. The owners of the "G. B." system have an experimental line about one-fifth of a mile in length working at Ilford. The committee had already seen the model of the Dolter system, and on the day previous to the meeting they had an opportunity of witnessing a working model of the Kingsland in one of the rooms in the Synod Hall. All three companies have expressed their willingness to lay down their surface-contact system in Gilmore-place and to work it for a year, on condition that if the Corporation are satisfied with the line they should take it over. If they are not satisfied, the company are willing that the line should, in the absence of any other more suitable system, be converted to the overhead system. There is also the alternative offered to the Corporation that if the experimental line should in their opinion, prove a failure, the company selected should remove the system altogether. Prof. Kennedy will report to the committee at an early date. It has been suggested that Morrison-street, where the cable tramway rails have been laid but are not in use, might by arrangement be taken as a street where the Corporation and the public might see the different methods of electric traction in operation.

**London County Council.**—At the meeting of the Council on Tuesday the report of the Highways Committee recommending the immediate acquisition and electrification of the North Metropolitan tramways was adopted by 68 votes against 20. We have already given the substance of this report, which, in conjunction with that of the Finance Committee, goes into the subject with much thoroughness. The latter report agrees with that of the Highways Committee in stating that the electric traction clauses of the lease are inoperative, except through the co-operation of the company, and "it is difficult," they say, "to see what inducement the company would now have to co-operate with the Council. The work of reconstruction, and its attendant losses through interruption and dislocation of traffic would, even with the utmost expedition, probably extend throughout the whole of the remaining term of the lease, and it can hardly be expected that the company would willingly enter upon a work the benefit of which would inure to the Council after the end of the lease, while the losses would fall largely upon the company." They therefore agree that if electrification is to be proceeded with, the Council should have the lines in its possession. The committee remind the Council of the heavy expenditure on capital account during the next few years, and express a wish that the electrification of the northern tramways might have been postponed for a year or two longer, but the reasons against incurring further capital outlay are not so strong when that outlay is upon a remunerative service which it will greatly improve. The approximate figures regarding cost of reconstruction are: reconstruction and authorised extensions, £2 906,120; setting back kerbs, £15 208; extra cost if the whole is on the conduit system, £470.000; street widenings (restricted), £945,275—total, £4 336 603. Further street widenings which are considered to be desirable will cost £794 350. The total expenditure involved in the scheme for purchase and electrification would, therefore, appear to be about £4 773 000, which, however, may be reduced to the extent of £470,000 if half the lines are reconstructed for overhead instead of for conduit traction. To these figures of total cost must be added the estimated cost of the second portion of the Greenwich generating station, which must be commenced at once. This may be taken at about £400,000, making a total outlay in round figures of £5,200,000. The expenditure would take place chiefly in the four years 1906-7 to 1909-10, at the rate of about £1,500,000 per annum. The loss of receipts during reconstruction is estimated to amount to at least £1,000 a mile of single line. Discussing the financial effect of the electrification, the Finance Committee remark that the traffic receipts are estimated at 1s. per car mile, and working expenses, including capital and renewal charges in respect of the power station, at 7d. per car mile, showing an estimated profit of 5d. per car mile. The traffic on the tramways, when reconstructed, is estimated at 21,024 000 miles per annum, on the assumption that 640 cars will run on the average 90 miles a day throughout the year. On these estimates the figures will be: estimated receipts, £1 051,200; estimated working expenses, £613 200; estimated gross profit, £438,000. The reduction of fares either by the introduction of halfpenny fares or the lengthening of existing stages would inevitably reduce the receipts per mile, although it would in all probability at the same time increase the car mileage, and thus add to the working expenses. Regarding the estimated cost of renewal of truck, cars, equipment, etc., and interest and repayment charges on capital outlay, the interest and repayment charges are estimated to be £252 500. If the lines are worked by the conduit system throughout, the sum of £470 000 must be added to the debt, and this is represented by £35 250 by way of interest and repayment, exclusive of street widenings. The estimated financial results of reconstruction are: estimated surplus on working, £438,000; provisions for renewals, £87,600; deduct interest and repayment charges, £287,750—surplus, £62,650. Further charges against the surplus will include annual debt charge on street widenings of £16,400, and increasing the renewals provision to 1½d. per car mile, after the first few years £43,800, making a total of £60,200. The estimated result shown by the above figures cannot, the committee say, be considered as anything but a very narrow margin. Inasmuch, however, as the debt would be repaid on the instalment system, the debt charges would diminish every year by about £5 000, and this sum would be added annually to the surplus. They are most strongly of opinion that provision should be made out of any surplus for the more speedy repayment of so much of the old horse traction debt outstanding as may be said to represent "dead" capital. The report concluded with these words: "There are various factors in the solution of the traffic problem of London, the operation of which it is impossible to foresee, but which must have a bearing upon the financial results of the Council's tramways. We refer to the tube railways now in course of construction, representing a very large expenditure of capital, the probable electrification of suburban railways, and the newly-arrived motor omnibuses. These considerations, having regard to the comparatively small margin of surplus shown by the foregoing estimates, appear to us to point to the necessity of the strictest economy in capital expenditure, and of exercise of caution in dealing with proposals to lower fares or to increase the cost of working the service." After considering this report and that of the Highways Committee, the Council decided, as stated above, in favour of immediate purchase, the terms being: consideration for the unexpired 4½ years of the North Metropolitan Tramways Company, £121,000; and for plant, rolling-stock, etc., £315 000 (approximately). The Highways Committee recommended the purchase of four electrically-driven watering-cars at a cost of £2 500. The construction of a cross-over at the northern end of Upper Clapton-road has been completed. The receipts for the four weeks ending the 6th inst. totalled £55,074, against £42,800 last year.

## LIGHTING AND GENERAL.

**Kirkintilloch.**—The charge for current for electric lighting has been fixed at 5d. per unit.

**Woolwich.**—Sanction has been received to the borrowing of £6,500 for electric light purposes.

**Altrincham.**—The District Council are considering a scheme for an extension of the electric light for purposes of street-lighting in Sale.

**Stonehaven.**—An application from the National Telephone Company asking permission to erect poles on a footpath and also on a road has been refused.

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**Ebbw Vale.**—An enquiry has been held into the application of the District Council for permission to borrow £9 654 for the purpose of installing a system of electric street-lighting.

**Underground Telegraphs.**—The Postmaster General will have £150 000 this year to complete the underground telegraph line from London to Glasgow, and to begin others from London to the east and west.

**Dundee.**—The National Telephone Company are making progress with their underground mains extensions in order to make provision for new subscribers and to include districts not embraced in the original scheme.

**Bexhill.**—The gross profits during the year from the municipal electric light undertaking amounted to £2,668, an increase of some £612 upon those of 1903. Sinking fund and interest, however, reached the total of £2,870.

**Paignton.**—Amended plans, specifications, and estimates from the electric lighting company, together with the agreement, and an application for power to borrow £18,500 for the necessary works, are to be sent to the Local Government Board.

**Hammersmith.**—The premises of 21 additional consumers, representing a maximum of 403 8-c.p. lamps, have been connected to the mains; six consumers have been disconnected. The present number of consumers taking current from the mains is 1,582.

**Glossop.**—An electrical exhibition has been held at the Victoria Hall in aid of the Wood's Hospital. The Mayor performed the opening ceremony. The arrangements were in the hands of the Urban Electric Supply Company's resident engineer, Mr. C. E. Knowles, A.M.I.C.E.

**East Ham.**—A special meeting of the Town Council will be held on the 23rd inst. to consider a resolution consenting to the opposition by the Council to Bills, including the East London and Lower Thames Electric Power, the Administrative County of London and District Electric Power Company, and the Charing Cross and Strand Electricity Supply Corporation, Limited, Bills.

**Stock Exchange.**—The Stock Exchange Committee have ordered the Charing Cross, West End, and City Electricity Supply Company's further issue of £70,000 4 per cent. debenture stock to be quoted in the official list. Application has been made to allow the British Westinghouse Electric Manufacturing Company's further issue of £400,000 4 per cent. mortgage debenture stock to be quoted in the official list.

**Langdon-Davies Motor Co.**—The old company has now been formally wound up, the existing company being a reconstruction of the old company. There have been small alterations in the Board, made when the company was reconstructed, Mr. F. B. O. Hawes, A.M.I.C.E., A.I.E.E., being now chairman and general manager. Messrs. W. Langdon-Davies and A. Soames are now the consulting engineers of the company, and not on the Board.

**Indian Contracts.**—Messrs. Lowdon Bros., electrical engineers, Dundee, are at present executing extensive orders for Calcutta. Yesterday the firm dispatched to India two 80 h.p. engines and dynamos, while within the past fortnight they have contracted to supply several jute mills with lighting plant, the new orders including four engines and dynamos, each of 100 h.p., with the necessary lamps, a 70 h.p. engine and dynamo, and a separate 100-h.p. dynamo, together with 2 300 lamps.—*Dundee Advertiser.*

**Electricity in Mines.**—Messrs. Evershed and Vignoles, Limited, of Acton-lane Works, Chiswick, W., inform us that they have been in communication with the Home Office on the subject of the new rules as far as they concern the continuous indication of insulation resistance. While acknowledging that the tests contemplated by clause 7, section 1, cannot be strictly carried out, the Home Office have stated that instruments made in accordance with Messrs. Evershed and Vignoles's suggestions will meet their requirements.

**Torquay.**—At the last meeting of the Town Council the opinion of Mr. Eve on the position of the authority in connection with the electric station was read. The Dolter Company had asked for a definite decision as to whether the Corporation would be prepared to let the company their electrical undertaking, or whether they would consent to their erecting their own generating station. They suggested a conference. It was decided to ask the Local Government Board to reconsider their recent decision, the Council being unable to withdraw its application for the loan.

**King's Lynn.**—The engineer, in his last report, states that during the month applications had been received for 154 additional lamps of 8 c.p. (or equivalent), making a total of 20,764 lamps and 515 consumers. The following figures are available: units generated, March, 1905, 41,760 (1904, 41,418); total units sold to private consumers (light and power) 20,553 (20 541); units sold at power rates, 8,910 (9 958); cost of fuel, stores, repairs, and wages at station, £126. 17s. 8d. (£120. 12s. 1d.); cost per unit generated, 0·7292d. (0 6988d.); wages of lamplighters and outside staff, £18. 16s. 9d. (£18. 16s. 3d.).

**London Gazette.**—The partnership between Cecil August Esmarch and James Mellanby Morrish, carrying on business as electrical engineers at Albert-road, Middlesbrough, has been dissolved by mutual consent. The first meeting in the estate of Harry John Salter, electrical engineer, 235, High Holborn, London, will be held at Bankruptcy-buildings, Carey-street, London, on May 22 at 12 noon. The British Electric Traction Company, Limited intend to apply to Parliament for additional provision to extend the time for the construction of certain tramroads authorised by the Wellingborough and District Tramways Act, 1900.

**Dry Battery Litigation.**—Some 18 months ago the trade was agitated by legal proceedings with regard to an alleged infringement of dry batteries. This action has now, in consequence of a recent decision in the House of Lords, been revived. The principal firms in the trade, however, contemplate resisting vigorously this renewed attack, and a preliminary meeting took place the other day. Our advertisement columns contain an invitation to join this movement; those interested in the matter should communicate with Mr. Walter Davenport, secretary to the Electrical Manufacturers' Association Incorporated), Ridler-place, Holland-street, Blackfriars, London, S.E.

**Southwark.**—The following motion was brought up at the last meeting of the Borough Council: "Inasmuch as the electric light system of the borough is extravagant, very inefficient, and costly, and has been a heavy burden to the rates, this Council take steps to obtain offers for the same with a view to selling the undertaking as a going concern." The Mayor ruled it out of order. In reply to a number of questions as to the loss or profit on the electric light undertaking, the Mayor said that he might feel it necessary to refuse to accept similar questions, especially at this juncture, when an enquiry was proceeding in the House of Lords on questions affecting electric lighting and where any information given in Southwark might be used generally against municipal undertakings. Anyhow the present questions might be left over for a few weeks.

**Cardiff.**—Mr. Arthur Ellis (borough electrical engineer and manager), in his last report, gives the number of consumers connected to the mains as 1,136, with a total equivalent of 131,022 8-c.p. lamps. The total for the corresponding period of last year was 110 341, there being now an increase of 19 per cent. in the total connections. The total number of units generated at the lighting station at Canton during the month was 115,668, and the total supplied from the Roath power station to the Hayes sub-station was 150,691, the combined alternating and direct current units making a total of 266 359, being an increase of 16 per cent. in the output over that of last year. The estimated revenue was as follows: revenue from street-lighting, £626. 7s.; revenue from private supply, £1,467. 12s. 10d.; making a total of £2,033. 19s. 10d., being an increase over the corresponding period of last month of 8 per cent.

**Electric Power Bills.**—Lord Camperdown's Committee of the House of Lords on the 11th and 12th inst. further considered various Electric Lighting and Supply Bills. After the promoters' case for the City of London Electric Lighting Company (Extension of Powers Bill) was closed, the committee decided to postpone for the present the hearing of the case against the Bill. The same course was pursued in the case of the Charing Cross and Strand Electricity Supply Corporation Bill. Part of the case for the Metropolitan Electric Supply Company, Limited, Various Powers Bill was heard, after which the committee adjourned till Monday, the 15th, when evidence was heard on both sides *re* North Metropolitan Electric Power Supply Company Bill. The committee reserved a decision, and, having heard the opening statement on the Central London Supply Bill, adjourned. On the 17th the case for the promoters of the County of London Electric Supply Company Bill was closed, evidence for the opposition was heard, and, after Mr. Balfour Browne's reply, the committee consulted in private and adjourned.

**Birkenhead.**—Last year's working of the Corporation's electricity undertaking gave the following financial results: 1904 5—capital expenditure at end of year, £118,171 (1903 4 £100 843); revenue from electricity supply, less allowance for bad debts, £12,049 (£10,459); revenue from meter rents and other sources, less depreciation on motors, £848 (£698); total revenue, £12 897 (£11,157); total costs, £4,727 (£4 373); gross profit, £8,169 (£6 784); percentage of gross profit to average capital, 7·46 per cent. (6 99 per cent.); interest on loans, less interest receivable, £3 307 (£2,964); sinking fund, £2,753 (£2,433); percentage of sinking fund to average capital, 2 51 per cent. (2·51 per cent.); financial result after providing for interest and sinking fund, £2,108 (£1 386). The number of lamps, etc., connected at end of year 1904 5 were equivalent to 66 574 8-c.p. lamps, as against 50 353 in 1903 4; the number of units sold were—private supply, 657 045 (566 255); public lighting, 102 376 (94,916)—total, 759 421 (661,171); the units sold per 8 c.p. lamp (connections made during the year averaged) were 12·99 (14·6): the maximum load on feeders was 652 kw. (556); the load factor was 13·29 per cent. (13·29 per cent.); the capacity of dynamos at end of year amounted to 1,375 kw. (1,050); the prices obtained averaged as follows—private supply, 4·08d. (4 05d.); public lighting, 1·70d. (1·86d.)—total supply, 3·76d. (3·79d.).

**Bermondsey.**—On Tuesday evening, at Bermondsey Council, the annual financial statement in connection with the electric light undertaking was presented. The total amount of loans obtained up to March 31, 1905, is £98,030, of which £487. 5s. 2d. has been repaid. The total expenditure on capital account is £105 793. 10s. 9½d., the overdraft in anticipation of losses being £7,651. 0s. 8½d. The revenue account shows the expenditure on the generation of electricity to be £4,032. 11s. 6d.; distribution, £4 497. 6s. 9d.; public lamps, £1 230. 3s.; management expenses and law charges, £1,135. 1s. 9½d.; the total being £7,711. 5s. 4¾d. The income is £12 015. 19s., leaving £4 271. 3s. 1¼d. to be carried to net revenue account, and £33. 10s. 6d. to be set aside for bad debts. Interest on mortgage debts (£2,801. 2s. 2d.), instalments of principal (£362. 19s. 11d.) and payment of to reserve fund (£499 5s. 6d.) absorb £3 663. 7s. 7d. of the £4,271 3s. 1¼d., and £1,000 is added to the reserve fund. The general balance sheet shows the gross liabilities to be £111 265. 16s. 5½d., including overdrafts on capital and revenue accounts of £9,358. 12s. 9½d. The electricity generated from March 31, 1904, to March 31, 1905, was 1,039,503 Board of Trade units, 282 185 units being supplied to public lamps and 649,914 to private consumers by meter. Mr. L. A. Laws, in the employ of the Lincoln Corporation, was appointed mains superintendent. Testimonials were granted to Mr. Wallis, late mains foreman, and to Mr. W. H. Vincent, M.I.E.E., late electrical engineer. Three hundred and sixty-nine equivalent 8-c.p. lamps for private lighting have been applied for during the past month, making 36,368 up to date; or including street-lighting, 39,354. This is 6,710 in excess of the capacity of the present plant. The Council resolved to petition against the Supply of Electricity Bill,

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**Beckenham.**—The Urban District Council have decided to ask the Board of Trade as to the necessity for a provisional order applying the powers of the Beckenham electric lighting order to the Crystal Palace district when taken over. With regard to a suggestion for supplying the Crystal Palace Company with electric current from the Beckenham electric lighting station, it has been resolved, owing to the doubt as to the Council's power of affording a supply under the required circumstances, not to entertain the proposal further.

**Finchley.**—The transfer of the Finchley Electric Light Company's mains and the goodwill of the business was completed on April 14 The electric lighting accounts for the year ended March 31, 1905, show a general expenditure of £2 620, a revenue of £3,922, making a net revenue of £1 300. Interest and sinking fund absorbed £1,072, leaving a balance of £228, which is to be transferred to a reserve fund account. Councillor Todd, in moving the adoption of the accounts, said that, on behalf of the committee and the Council, he ought to congratulate the electrical engineer on the results he had achieved. The recommendation was unanimously approved.

**Batley.**—The electric light has been installed at the Batley and District Hospital at the cost of Mr. Charles Robinson. Messrs. Spivey and Jubb have been the contractors for the installation, and have put in over 90 lamps. The fittings throughout are of steel bronze. All the wards are lighted in the centre, the largest wards having four lights and the smaller ones two. The corridors, staircases, board-rooms, and the rooms used by the staff are also well lighted. At the opening last week an X-ray apparatus was received from an anonymous donor, and the medical staff have subscribed 100 guineas towards an enlargement of the hospital, so that some suitable place can be provided for the installation of the apparatus.

**Hove.**—The Council have confirmed the following proceedings of the Lighting Committee: The thirteenth report and statement of accounts of the electric lighting company for the year ended December, being produced before this committee, the town clerk was directed to ask the company to explain why the accounts had been published before being audited on behalf of the Council as provided for in the deed of transfer. The Council are recommended to authorise the committee to take such steps as they might be advised, as provided for in the deed of transfer of Dec. 8 1892, to obtain an alteration in the prices or charges made by the company, for electric energy within their area of supply. It was stated that Aldrington would be supplied with electric light within three months.

**Darlington.**—At the last meeting of the Electric Lighting and Tramways Committee, Mr. Lunn, manager of the works, submitted his annual report, which showed an increased revenue of £957, or 19 per cent. compared with the previous year, notwithstanding that the price per unit has been reduced by ½d. The report states that there had been a substantial reduction in the cost of production, and there had been generated with the same plant, owing principally to the increased supply for the tramways and otherwise, between 2½ and 3 times as many units as in the previous year. The net profit for last year, in spite of the large interest and sinking fund charges, was nearly £1,500, and it was suggested that the price per unit for lighting be reduced from 4½d. to 4d. For power purposes reductions from 2d. and 1½d. to 1½d. and 1¼d.—that is, 1½d per unit for the first 500 units per quarter and 1¼d. per unit for all over that—were proposed The report was adopted.

**Houghton-le-Spring.**—As a result of a difference between the postal authorities and the Urban District Council, the district has, says the *Yorkshire Post*, been put in a state of isolation as far as telegraphic communication is concerned. Apprehension has been felt by the postal authorities at the proximity to the telegraph wires of the overhead cables erected by the Sunderland District Tramways Company, which has intimated its intention to switch on the current during the present week. They accordingly asked leave of the Council to shift the poles and wires to the other side of the road, but consent was refused, the Council urging that the poles should be erected on private land. To this the postal authorities demurred, stating that the revenue from the local telegraph service would not justify the expense which would be involved. As no agreement has been come to, the telegraph service has been suspended. It is hoped that the matter will be arranged satisfactorily at a conference which has been fixed to take place between the Council and the sectional telegraph engineers.

**St. Marylebone.**—"A Marylebone Consumer" writes to the *Times*, under date May 14, as follows: "The open trough in Montague-place, of which a resident complains, is a trifle compared with the increased voltage which is now being pressed on the consumers. The alteration from 100 to 240 volts will entail a change of every lamp and fitting in the borough. The municipality will change the lamps without cost to the users, but the expense will be enormous, and the whole will have to be paid out of the rates! It is a gift with one hand, while the cost is taken with the other. Moreover, the ratepayers who do not use electricity will have to pay their share of the extravagance. No one seems to wish for the change. Many intend to refuse their consent, which, to their surprise, is asked at the last moment. If they decline to give it, the question is to be decided by an arbitrator of the Board of Trade. What practical decision he can give no one knows. Another important question is also unknown—the influence the increased volt-age will have on assurance policies. Surely the original acquisition of the electric company was muddle enough without this intensification of a bad business. It is to be hoped that those who are now satisfied with their current will refuse to consent to the change."

**Islington.**—The Council on Friday decided to obtain expert's opinion on the extensions of generating plant, estimated at £15,000. At to-night's meeting it will be proposed that two mains extensions be made at a cost of £150 and £80 respectively, and the Lighting Committee will report as follows: "In proceeding to give effect to the resolutions of the Council of April 6 and 14 last authorising us to instal arc lighting in the Newington Green district and in Stroud Green-road, we have carefully considered the type of lamp to be adopted and have tested with satisfactory results the Excello flame lamp, which is manufactured by the Union Electric Company, Limited. We have also had under consideration the desirability of substituting lamps of this make for the ordinary arc lamps erected at certain spots in boundary roads, and are of opinion that it would be advantageous to do so. We recommend that a contract under the seal of the Council be entered into with the Union Electric Company, Limited, for the supply of 42 Excello flame lamps." Referring to the purchase of six mechanical stokers, the committee say that satisfactory tests have been made at the electric lighting station with the mechanical stoker of the chain-grate type manufactured by Messrs. Babcock and Wilcox, and they recommend that three sets of chain-grate mechanical stokers be at once ordered from Messrs. Babcock and Wilcox, subject to their agreeing that the Council shall not be liable for any payment therefor until the sanction to the loan has been received from the London County Council.

**Electrical Mining Machinery.**—Messrs. Ernest Scott and Mountain, Limited, of Newcastle-on-Tyne, and the Close Works, Gateshead, have recently received a contract from the Butterley Coal Company, of Derby, for their Kirkby Colliery in Nottinghamshire, the installation consisting of two horizontal compound-condensing steam-engines, each of 450 h.p., driving on to two slow-speed three-phase generators, each of 310 kw. capacity. This plant will supply current to four endless-rope haulage gears placed underground at distances varying from 20 yards to 650 yards from the shaft bottom, the haulage gears bringing the coal from long distances in bye. The haulage gears are each driven by three-phase motors of Scott and Mountain's latest design, each motor being capable of giving 100 effective horse-power, and the haulage gears are provided with the firm's special type of friction clutch and friction brakes. A complete system of telephones is also being arranged between each haulage room and the main power station at bank. One generating set is of sufficient size to drive the four haulage gears, and the second set is used as a stand-by, and for driving pumping machinery and other machinery at the surface. The Wigan Coal and Iron Company, Limited have also decided to increase their electrical plant at the Manton Colliery, and have placed this work in the hands of Messrs. Scott and Mountain, who recently carried out an installation for pumping and hauling machinery at the Wigan Company's Sovereign pit. The plant at the Manton pit will consist of three compound horizontal steam-engines and crankshaft alternators, each of 550 h.p. In addition to this, there is a continuous-current generator capable of supplying 2 500 lights, which are being installed for lighting at the surface and underground and also the houses of the officials and workmen. The pumping machinery at Manton Colliery consists of five sets of Scott and Mountain's well-known mining pumps, each set being capable of delivering up to 1 000 gallons per minute, and is probably one of the largest in the United Kingdom. We also understand that Messrs. Scott and Mountain have a considerable number of other important contracts in hand, including installations of mining machinery for the Mickley Coal Company, Ashing Coal Company, Harton Coal Company, North Navigation Collieries Company, Swalwell Colliery Company, Shelton Steel and Iron Company, Consett Iron Company, Bell Bros., Limited, Cammell, Laird, and Co., and others, and are extremely busy in their new works at Gateshead, which have now been completed, which gives the firm increased facilities for producing all classes of engineering work and electrical machinery.

**Kingston-on-Thames.**—The borough electrical engineer (Mr. J. E. Edgcome) in his eleventh annual report on the working of the Corporation electricity undertaking for the year ending March 31, 1905, says an extension has been added to the engine-house, consisting of two bays in which the new generating plant has been installed. The three-crank, triple-expansion, high-speed, enclosed engine of 350 h.p. direct coupled to a single-phase alternator of 200 kw. capacity, mentioned in the last report, has been delivered and erected, but not yet taken over from the contractors. A large number of extensions of the distributing mains have been made for the purpose of connecting up consumers. Transformer pillars and section pillars containing disconnecting gear have been erected in various streets. These pillars, which are designed for dividing up the mains throughout the borough into sections, says Mr. Edgcome, are proving a convenient and readily accessible means of controlling the supply throughout the district from various points, and, unlike the underground sub-stations, are not subject to disturbance from water during floods. He also reported a satisfactory increase in the use of electric motors in the borough for driving printing, cutting, and folding machines, hair-brushing machinery, aerated water machinery, organ blowing, boot stitching, dental drills, and ventilating fans, etc. Current for motors and heating apparatus can be supplied through a separate meter at the reduced rate of 3d. per unit, the rental for this extra meter being 6d. per quarter. Small motors for driving sewing machines can be purchased for about £3, the current taken by this type of motor costing about ¼d. per hour. With regard to the question of electric side street lighting still under consideration, experiments were being carried out with a view to obtaining the best results. The working of the Corporation's electricity undertaking for the last 12 months shows a profit of £1,074 owing partly to an increase in the revenue receipts amounting to £430 and partly to the reduction in the cost of generation and distribution amounting to £641, the latter feature being particularly satisfactory. The number of consumers has increased from 630 to 746, an increase of 116. The number of lamps, motors, and other apparatus (in terms of 8 c.p. lamps) applied for and connected has increased from 28,603 to 33,709, an increase of 5,106. This increase in the number of consumers is very satisfactory, and is the largest increase during any 12 months since the works commenced running. The total capital expenditure to March 31, 1905, amounted to £292,205. The amount of capital expended during the year was £5,736, the amount of capital repaid being £2,658, leaving a balance

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of outstanding capital expenditure to March 31, 1905, of £75,860, a total sum of £16,344 having been paid off the capital account. The total works expenditure has been decreased by £447 from £5 046 to £4,599, whilst the total revenue has increased by £430 from £10,002 to £10,432, a net increase of revenue over expenditure of £877, notwithstanding the rebate obtained by the majority of the consumers under the new system of charging. The average cost of fuel per unit sold has been reduced from 1·157d. to ·933d. The engineer states that the adoption of the demand indicator system, with charges of 7d. and 3d. per unit, had in almost every instance considerably decreased the cost of current to private house consumers, and especially to hotels and public-houses. The advantage generally to consumers on the circuit was indicated by the year's working, as a comparison of the total receipts from all classes of consumer showed that owing to the adoption of the demand indicator system with rates of 7d. and 3d., they had benefited by over £600 compared to the amount which they would have paid for the same current under the former flat rate of 6d. per unit. Mr. Edgcome finds that the Corporation's system of deferred payment wiring being now more widely known, an increasing number of consumers are availing themselves of this method of wiring their premises. The work is done on the following plan: The Corporation pay the contractor the cost of the work, such amount being refunded by the householder by means of deferred payments over a period not exceeding five years. A fee of 5 per cent. is charged by the Corporation for preparing the specification and superintending the work, interest at the rate of 5 per cent. per annum being charged each quarter on the outstanding balance. A number of consumers, although not wishing to avail themselves of this opportunity of spreading the payments over a number of years, have had their houses wired under this system in order that the work might be carried out to the specification and under the superintendence of the Corporation, and upon completion of the installation have paid the whole cost of the same, together with the Corporation's fee of 5 per cent. for superintendence, instead of dividing the payments over a period of years. Ten lamps with simple fittings can be installed for from £7 to £8. The gross profits on the works, after paying all charges, exclusive of payment of interest and repayment of capital, has increased from £4,955 to £5,832. There is a surplus after payment of interest amounting to £3,732, and after repayment of capital there still remains, as above stated, a surplus of £1,074, a very satisfactory result, showing that the era of prosperity of the undertaking, which commenced in the previous year, has been more than maintained during the past 12 months. The total capital expenditure sanctioned by the Local Government Board is £99,860, of which £19,654 was borrowed at 2¾ per cent., and the rest at prices varying from 3¼ to 4 per cent. The amount of electricity supplied to private consumers was 414,775 units, which brought in a revenue of £8,747. 13s. 1d., while for the 112,358 units supplied for public lighting the income was £1,586. 16s. 10d., the revenue per unit being 4·749d., which is the lowest price of any given in the table printed with the report, last year's figure (5·211d.) being the highest.

## PROVISIONAL PATENTS, 1905.

MAY 8.

**9649. Improved electric railway signalling system.** Percy Richard Julius Willis, Fife House, Kingston-on-Thames. (John D. Gordon, United States.)

**9655. Improvements in dynamo construction.** Henry Leitner and Richard Norman Lucas, Lynton, Dartnell Park, Byfleet, Surrey.

**9657. Improvements in and relating to electric accumulators.** Paul Alfred Gouin, 60, Queen Victoria-street, London. (Date applied for under Patents Act, 1901, May 9, 1904, being date of application in France.) (Complete specification.)

**9675. Improved electric worm reducing gear and automatic brake connected therewith.** Rowland George Harman, 10, Westmoreland-buildings, Aldersgate-street, London.

**9677. A new or improved connector for electrical conductors.** Edward Wilmer Hill, Norfolk House, Norfolk-street, Strand.

**9685. Improvements in electrical cables.** Henry Edmunds and Philip Dawson, 47, Lincoln's-inn-fields, London.

**9702. Improved field telephone and telegraph apparatus.** Patrick Joseph Kenny, 322, High Holborn, London. (Edward Molyneux, India.) (Complete specification.)

MAY 9.

**9708. Improved process for the electro-deposition of iron.** Sherard Cowper-Coles, Grosvenor Mansions, Victoria-street, Westminster, London.

**9739. Improvements in apparatus for controlling the supply of energy from alternating-current generators to alternating-current motors.** Arthur Pemberton Wood, 34, Castle-street, Liverpool.

**9746. An attachable and detachable light reflecting and diffusing device for electric and other lamps.** Charles Hindle, 30, Liverpool-street, King's Cross, London.

**9783. Improved construction of electric arc lamp.** Hermann Diamant and Andrea Chiesa, 173, Fleet-street, London.

**9794. Improved apparatus for automatically regulating the potential in electric circuits.** Joseph Kloppenstein, 11, Southampton-buildings, Chancery-lane, London.

**9797. Improvement in the method of electrically exploding the charges in the cylinders of explosion engines.** Harry Conduit, 8, Townshend-terrace, Sheen-road, Richmond, Surrey.

MAY 10.

**9815. Improvements in appliances for use in connection with the electric ignition systems for internal-combustion engines.** Charles Thomas Brock Sangster, 24, Temple-row, Birmingham.

**9837. Improvements in apparatus for compounding synchronous alternating-current machines.** Bruce Peebles and Co., Limited, and Jens Lassen La Cour, 34, Castle-street, Liverpool. (Complete specification.)

**9838. Improvements in multiple-unit controlling apparatus for electrically-propelled trains and the like.** Bruce Peebles and Co., Limited, and Jens Lassen La Cour, 34, Castle-street, Liverpool.

**9839. Improved means for the regulation of speed of compensated single-phase motors.** Bruce Peebles and Co., Limited, and Jens Lassen La Cour, 34, Castle-street, Liverpool. (Complete specification.)

**9865. Improvements in electric cables or conductors.** Allan Berlin, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, May 10, 1904, being date of application in Sweden.) (Complete specification.)

**9884. Improvements in main distributors for telephone exchanges.** Franklin Wise Howorth, 46, Lincoln's-inn-fields, London. (The Deutsche Telephonwerke R. Stock und Co. G. m. b. H., Germany.) (Complete specification.)

**9887. Improvements in and relating to the electrical driving of printing presses, calender rolls, and the like.** The British Thomson-Houston Company, Limited, and George Matthews Brown, 83, Cannon-street, London.

**9890. Magneto-electric igniter for explosion motors.** Leberecht Kootz, 40, Chancery-lane, London.

MAY 11.

**9892. Improvements of apparatus for regulating electric repulsion motors and similar purposes.** Edwin Freund, 39, Victoria-street, London.

**9901. A primary battery.** Sydney Robert Richardson, 45, Godwin-road, Cliftonville, Margate.

**9908. Improvements in connectors for electrical conductors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**9940. Improvements in the regulation of electric circuits subject to rapidly-fluctuating loads.** William Armistead and Max James Eccles Tilney, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

**9949. An improved telegraph key or "tapper."** Joseph Lancelot Addison, 70, Chancery-lane, London.

**9966. Improvements relating to electric group time fuses.** Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (The Firm Fabrik Elektrischer Zünder G. m. b. H., Germany.) (Complete specification.)

**9973. Improvements in electric controlling apparatus.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

MAY 12.

**9974. Improvements relating to oil, gas, vapour, steam, compressed-air, and hydraulic motors for steamships, electricity works, and road vehicles, and general work.** George Sellers and William Smith, care of the Caledonian Engineering and Shipbuilding Company, Preston.

**9991. Improvements in electric switches.** The Electric Ignition Company, Limited, and Frederick Harold Hall, 24, Temple-row, Birmingham. (Complete specification.)

**9993. A safety guard for the live rail of electric traction railways.** Alexander Swanson, Oathkin-avenue, Rutherglen, near Glasgow.

**10009. Improvements in magneto ignition devices for internal-combustion engines and the like.** Edward Russell Clarke, 35, Leinster-gardens, Hyde Park, London.

**10016. Improvements in electric meters.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**10017. Improvements relating to the control of electric motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**10047. Improvements in electric cables.** Willoughby Statham Smith and William Puddicombe Granville, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**10051. Improvements in brush-holders.** George Croydon Marks, 18, Southampton-buildings, Chancery-lane, London. (Abbot Augustus Low, United States.) (Complete specification.)

MAY 13.

**10067. Improvements in and relating to the treating of patients by static, galvanic, or like electrical currents.** Gerald Joseph Macaura, Sunbridge-chambers, Bradford, Yorks. (Complete specification.)

**10100. Improvements relating to overhead current collectors for electric railways and tramways.** Paul Platte, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, May 14, 1904, being date of application in Germany.) (Complete specification.)

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**10085. Improvements in the ventilating arrangements of dynamo-electric generators and motors.** Siemens Bros. and Co., Limited, Queen Anne's-chambers, Broadway, Westminster, London. (Messrs. Siemens Schuckertwerke G. m. b. H., Germany.) (Complete specification.)

**10097. Improvements in receivers for electric waves.** Johann Christian Schäfer, 3, Upper Vernon-street, London. (Date applied for under Patents Act, 1901, May 18, 1904, being date of application in Germany.) (Complete specification.)

**10111. Improvements in and relating to electric conductors.** Stanislaus Berger, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, May 14, 1904, being date of application in Germany.) (Complete specification.)

**10112. Improved insulating base for electric switches, plugs, pushes, and the like.** The General Contracts Company, Limited, and Joseph Gordon Salamon, 149, Strand, London.

**10118. Improvements in improved system of electric train-lighting.** Henry Leitner and Richard Norman Lucas, 4, South-street, Finsbury, London.

**10119. Improvements in electric insulating materials.** William Kennedy-Laurie Dickson, 64, Strand, London.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published June 1.*

1904.

**8227. Alternating-current motors.** Zani.

**10457. Alternating-current electric motors.** British Thomson-Houston Company, Limited. (General Electric Company.)

**10656. Enclosed fuses for electrical installations.** Fellenberg.

**10711. Motor vehicle for agricultural purposes, applicable also for extinguishing fires, watering gardens, generating electric light, and other purposes.** Fröle.

**10722. Reverse-current electric circuit breakers.** Andrews.

**10794. Electrolytic apparatus.** Blackmore and Byrnes.

**11288. Electric accumulator electrodes or plates.** Ricks.

**11917. Process for obtaining producer-gas and electrical energy from peat.** Warburton.

**12333. High-tension electric switches.** British Thomson-Houston Company, Limited. (Allgemeine Elektricitäts-Ges.)

**12607. Combined electric lampholder and candle-nozzle.** Tiffin.

**13264. Continuous current electric motors and generators.** Torda.

**13643. Signals in telephonic exchange.** Oppenheimer. (Act.-Ges. Mix und Genest.)

**13947. Construction of electric tumbler switch.** Smith.

**15118. Dynamo-electric machines.** British Thomson-Houston Company, Limited. (General Electric Company.)

**15267. Electric light fittings.** Irving.

**15300. Electric transformers.** British Thomson-Houston Company, Limited. (General Electric Company.)

**15465. Hoisting and similar apparatus.** British Thomson-Houston Company, Limited. (General Electric Company.)

**15466. Air-brake systems and valves therefor.** British Thomson-Houston Company, Limited. (General Electric Company.)

**15634. Systems of electrical distribution and apparatus therefor.** Ferguson. (Date applied for under International Convention, July 13, 1903.)

**25641. Space telegraphy.** Stone. (Date applied for under International Convention, Nov. 25, 1903.)

**28968. Series commutator motors for single-phase alternating current.** Maschinenfabrik Oerlikon. (Date applied for under International Convention, Feb. 29, 1904.)

1905.

**3280. Devices for exerting an electromagnetic influence upon the arcs of electric arc lamps.** Carbone.

**3442. Gloves for electric insulation purposes.** Weilbier.

**3511. Devices for preventing the overcharging of electric cables.** Land und Seekabelwerke Akt.-Ges. (Date applied for under International Convention, March 31, 1904.)

**6286. Attaching electric insulators to tubular or like arms or brackets.** Siemens Bros. and Co., Limited, and Perry.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ½-¼ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 7/16-17/32 |
| British Insulated and Helsby Cables, Ord., 1-100,000 .... | 5 | – | 5¼-6 |
| —— 6 per cent. Cum. Pref., 1-100,000 ..... | 5 | – | 5¼-6 |
| —— 4½ per cent. Mortgage Debentures ..... | 100 | – | 102-105 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. ..... | 100 | – | 100-102 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 ..... | 5 | – | 2 13/16-3 1/16 |
| —— 4 per cent. Mortgage Debenture Stock ..... | 100 | – | 89-91 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,751 .. | 2 | – | ½-¾ |
| —— Non. Cum., 6 per cent. Pref. ..... | 2 | – | 1⅛-1⅛ xd |
| —— 4½ per cent. 1st Debenture Stock ..... | 100 | – | 92-95 |
| —— 4½ per cent. 2nd Debenture Stock ..... | 100 | – | 79-82 |
| Callender's Cable, Debentures ..... | 100 | – | 107-109 |
| —— Ordinary ..... | 5 | – | 10¼-11¼ |
| —— 5 per cent. Pref. ..... | 5 | – | 5⅛-5⅜ |
| Crompton and Co. ..... | 5 | – | 2-2¼ |
| —— 5 per cent. Debentures ..... | 100 | – | 95 100 p.c. |
| Edison and Swan United, "A" Shares, 1-99,261 ..... | 5 | – | 1¼-1⅜ |
| —— "A" Shares, 01-017,139 ..... | 5 | – | 2-2¼ |
| —— 5 per cent. Debentures ..... | 100 | – | 85-90 |
| —— 4 per cent. Deb. Stock, Red. ..... | 100 | – | 82-87 |
| Electric Construction, Limited, Nos. 1 to 112,100 ..... | 2 | – | ¼-1¼ |
| —— 7 per cent. Cumulative Pref. ..... | 2 | – | 2¼-2½ |
| —— 4 per cent. Perp. 1st Mort. Deb. ..... | 100 | – | 96-99 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-96 |
| General Electric Company (1900), 5 per cent. Cum. Pref. .. | 10 | – | 9¼-10 |
| —— 4 per cent. 1st Mort. Deb. Stock ..... | 100 | – | 97-101 |
| W. T. Henley's Telegraph Works, Ordinary ..... | 5 | – | 11¼-12¼ |
| —— 4½ per cent. Preference ..... | 5 | – | 5¼-5⅜ |
| —— 4½ per cent. Debentures ..... | 100 | – | 109-111 |
| India Rubber, Gutta Percha, and Telegraph Works ..... | 10 | – | 16-17 |
| —— 4 per cent. Debentures ..... | 100 | – | 100-103 |
| Parker, Thos., Limited, Ordinary ..... | 10 | – | 10-10¼ |
| Telegraph Construction and Maintenance ..... | 12 | – | 34-36 |
| —— 5 per cent. Bonds ..... | 100 | – | 103-105 |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary ..... | 10 | – | 11⅜-12¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 ..... | 10 | – | 10-10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 ... | 10 | – | 11-12 |
| —— 4½ per cent. Debenture Stock. Red. ..... | 100 | – | 106-108 |
| Bromley (Kent) Electric Light and Power Co. ..... | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. 1st Debenture Stock, Red. ..... | 100 | – | 102-105 |
| Brompton and Kensington, Ordinary ..... | 5 | – | 9¼-10¼ |
| —— 7 per cent. Preference ..... | 5 | – | 9¼-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 .. | 5 | – | 8⅛-8⅜ xd |
| —— Nos. 60,001-80,000 ..... | 5 | – | 7⅜-8⅛ xd |
| Cambridge Electric Supply Company, Ltd., £10 Ord. .... | 8 | – | 12¼-13¼ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 105-108 |
| Charing Cross and Strand, 70,001-80,000 ..... | 5 | – | 7⅛-8¼ |
| —— 4½ per cent. Cum. Pref. ..... | 5 | – | 5⅛-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 4⅞-5⅛ |
| —— 40,001-80,000 ..... | 5 | – | 4⅛-5⅛ |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.).. | 100 | – | 105 107 |
| Chelsea Electricity Supply ..... | 5 | – | 6½-7 |
| —— 4½ per cent. Debentures ..... | 100 | – | 109-111 |
| City of London, Ordinary ..... | 10 | – | 11-12 |
| —— 6 per cent. Cumulative Pref. ..... | 10 | – | 13⅜-14¼ |
| —— 5 per cent. Debenture Stock ..... | 100 | – | 124-128 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) .. | 100 | – | 104-106 |
| County of London Electric Supply, Ordinary ..... | 10 | – | 8⅜-8½ |
| —— 6 per cent. Cum. Pref. ..... | 10 | – | 12-12¼ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 102-104 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. ..... | 100 | .. | 112-115 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 .. | 5 | – | 5⅜-5½ |
| —— 6 per cent. Cum. Pref. ..... | 5 | – | 5-5½ |
| —— 4½ per cent. First Mort. Deb. ..... | 100 | – | 107-109 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 2¼-2⅜ |
| —— 5 per cent. Debenture Stock, Red. ..... | 100 | – | 86-91 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 ..... | 5 | – | 5¼-5⅜ |
| —— 4½ per cent. First Deb. Stock, Red. ..... | 100 | – | 101-104 |
| Havana Electricity, Limited, 1-15,000 ..... | 10 | – | 9¼-10¼ |
| Hove Electric Lighting, Limited, Ord., 1-13,000 ..... | 5 | – | 7¼-8 |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 100-103 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 ..... | 1 | – | ¾-⅞ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | | 12-13 |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red ..... | 100 | – | 101-103 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅜-10¼ |
| London Electric, Ordinary ..... | 5 | – | 2¼-2⅜ |
| —— 5 per cent. Pref. ..... | 5 | – | 5¼-5⅜ |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red... | 100 | – | 99-101 |
| Metropolitan Ordinary ..... | 10 | – | 18-19 |
| —— 4½ per cent. First Mortgage Debenture Stock .... | 100 | – | 109-114 |
| —— 4½ per cent. Cum. Pref. ..... | 5 | – | 5¼-5⅜ |
| —— 3½ per cent. Mortgage Debenture, Red. ..... | 100 | – | 97-99 |
| Midland Electric Power Dis., Ld., 4½ p c. 1st Mort. Deb.. | 100 | – | 99-101 p.c. |
| Newcastle-upon-Tyne Electric Supply, Ordinary ..... | 5 | – | 98-101 |
| —— Preference ..... | 4 | – | 100-102 |
| Notting Hill Electric Lighting ..... | 10 | – | 14¼-15¼ |
| —— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.) .. | 100 | | 100-102 |
| Oxford Electric, Ordinary, 1-95 and 10,214,510 ..... | 5 | – | 6¼-6⅜ |
| —— 4 per cent. Debenture Stock ..... | 100 | – | 98-100 |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures ..... | 100 | – | 101-104 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 .. | 5 | – | 2⅜-3⅛ |
| —— 4 per cent. Debenture Stock ..... | 100 | – | 79-83 |
| South London, Ordinary ..... | | – | 3¾-4¼ |
| South Metropolitan Electric Light and Power Co., Ord... | 1 | .. | 13/16-15/16 |
| —— 7 per cent. Cum. Pref. ..... | 1 | .. | 1 11/32-1 13/32 |
| —— 4½ per cent. 1st Mort. Deb. ..... | 100 | .. | 105-108 |
| —— Ditto, June, 1904 ..... | | – | |
| St. James's and Pall Mall, Ordinary, 101-80,080 ..... | 5 | – | 14-15 |
| —— 7 per cent. Pref. ..... | 5 | – | 8¼-8⅜ |
| —— 3½ per cent. Deb. ..... | 100 | – | 98-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 ..... | 5 | – | 4¼-5¼ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5-5¼ |
| Westminster, Ordinary ..... | 5 | – | 12-13 |
| —— 5 per cent. Cum. Pref., 110,101-138,261 ..... | 5 | – | 5-5¼ |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 ..... | 5 | – | 5¼-5⅝ |
| —— Ord. ..... | 5 | .. | 8¼-8½ |
| —— Permanent 5 per cent. Debenture Stock, 1888 .. | 100 | – | 141-144 |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 105-107 |
| Barcelona Tramways, Limited, Ord., 1-20,000 ..... | 10 | .. | 11¼-11⅜ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 ..... | 10 | .. | 9⅜-10¼ |
| —— 5 per cent. Deb., Red., 1-600 ..... | 100 | .. | 99-102 |
| —— 4½ per cent. Red. Deb. Stock ..... | 100 | .. | 96-100 |
| Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606.. | 1 | .. | ¾-⅞ |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 ..... | 1 | .. | 15/16-1 1/16 |
| Belfast Street Tramways, Ord., 1-26,600 ..... | 10 | .. | 10¼-11¼ |
| Blackpool and Fleetwood Tramroad ..... | 10 | – | 13⅜-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 ..... | 5 | – | ¾-1¼ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 ..... | 5 | – | 3¾-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 91-96 |
| British Columbia Electric Railway Co., Ord. Def. ..... | 100 | – | 103-106 |
| —— Ord Pref. ..... | 100 | – | 100-103 |
| —— Non. Cum. 5 per cent. Pref. ..... | 10 | – | 10¼-10⅜ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each | 40 | – | 103-105 p c |
| —— 4½ per cent. Vancouver Power Deb. ..... | 100 | – | 99-102 |
| British Electric Traction Ord. 1-500,000 & 60,001-90,000 | 10 | – | 9-9¼ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 ..... | 10 | – | 10¾-11¼ |
| —— 5 per cent. Perpetual Debenture Stock ..... | 100 | – | 121-123 |
| —— 4½ per cent. 2nd Deb. Stock ..... | 100 | – | 96-98 |

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| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| | £ | | £ |
| Buenos Ayres and Belgrano Tram. | 5 | – | 3⅛-3⅜ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | | 5 9/16-5 13/16 |
| —— "B" 6 per cent. Cm. Pf., 1-27,600 | 5 | – | 5½-5⅝ |
| —— 5 per cent. Deb. Stock, Red. | 100 | – | 107-109 |
| —— Prov. Certs., all paid | 100 | – | 103-106 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | – | 97-99 |
| Calcutta Tramways, Limited, 1-102,268 | 5 | .. | 8⅛-8⅜ |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | .. | 107-109 |
| Cape Electric Tramways Nos. 1-480,000 | 1 | – | 1½-1½ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | – | 4⅞-5⅛ |
| —— 4 per cent. 1st Mortgage Deb., 1-5,000 (1917) | 100 | – | 99-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | | 101-103 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | | 9½-10 |
| —— 5 per cent. Cum. Pref. | 10 | – | 11-12 |
| —— 4 per cent. Debentures | 100 | – | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | – | 13½-14½ |
| —— 5 per cent. Pref., Nos. within 1-60,000 | 10 | – | 15½-16½ |
| —— 5½ per cent. Mort. Debs., 1-5,000, Red. | 100 | – | 94-97 |
| Imperial Tramways Ordinary | all | – | 18-19 |
| —— 5 per cent. Cum. Pref. | all | – | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 | | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 50,001-60,000 | 5 | | 2⅞-3⅛ |
| —— 4 per cent. Debenture Stock | 100 | – | 85-90 |
| Kilmarnock and District Lighting and Traction, Pref. | 5 | – | 8-8½ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | – | 9⅜-10⅛ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | – | 99-102 |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 | .. | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016 | 1 | .. | 9/32-11/32 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | .. | 1-1 1/16 |
| —— 4½ per cent. Deb. Stock, Red. | 100 | .. | 105-107 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000 | $1,000 | .. | 106-110 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 | .. | 101-104 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 | .. | 103-105 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000 | 5 | – | ⅛-1½ |
| Oldham, Ashton, and Hyde Tramway, Ordinary | 10 | | 12 |
| —— 5 per cent Cum. Pref. | 10 | – | 9½-9⅞ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk. | 100 | – | 105 108 |
| Potteries Electric Traction, Ordinary 20,001-40,00 | 10 | – | 9 9⅛ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | – | 9⅛ 9⅜ |
| —— 4½ per cent. Debenture Stock | 100 | – | 101-104 xd |
| South Lancashire Electric Traction and Power Company —— £250,000 Ordinary | 1 | | 1 |
| —— £101,132 6 per cent. Preference | 1 | | |
| —— £597,170 4½ per cent. Debenture Stock | 100 p.c. | – | 100 p.c. |

## Electric Railways.—

| | | | |
|---|---|---|---|
| Central London, Ordinary | 100 | – | 91-93 |
| —— 4 per cent. Pref. | 100 | – | 101-103 |
| —— ,, ,, deferred | 100 | – | 80-83 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | – | 110-112 |
| City and South London, Consolidated Ordinary | 100 | – | 39-41 |
| —— 4 per cent. Debenture Stock | 100 | – | 107-109 |
| —— 5 per cent. Pref. Stock '91 | 100 | – | 120-123 |
| —— ,, ,, ,, '96 | 100 | – | 118-121 |
| —— ,, ,, ,, '01 | 100 | – | 115-118 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | – | 10-10⅛ |
| —— Ordinary, 1-50,000 | 10 | – | 3⅞-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | – | – | 99-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | – | – | 101-102 |
| Waterloo and City, Ordinary | 100 | – | 91-93 |

## Telephones.—

| | | | |
|---|---|---|---|
| National Telephone, Preferred | 100 | – | 108½-109½ |
| —— Deferred Stock | 100 | – | 101-103 |
| —— 6 per cent. Cum. First Pref. | 10 | – | 12⅛-13⅛ |
| —— 5 per cent. Cum. Second Pref. | 10 | – | 11⅛-12⅛ |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | – | 5⅜ 5⅝ |
| —— 5½ per cent. Deb. Stock, Red. | 100 | – | 100-102 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 104-106 |
| —— 4 per cent. Prov. Cert. | – | .. | 103½-105½ |
| Oriental Telephone and Electric Company | 1 | .. | 1½-1⅝ xd |
| —— 6 per cent. Cum. Pref. | 1 | .. | 1½-1⅝ xd |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905. | 1904. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | April 29 | 1,178 | 1,187 | – 9 | + 5,349h | 19¼ | 19¼ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·14 |
| Ayr Corporation | May 13 | 235 | 213 | + 22 | + 859 | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 336,049 | 1·03 | 10·11 | 1,770 | 5·0 |
| Barking Corporation | — | — | — | — | — | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 14 | 991 | 1,035 | – 44 | — | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,349,701 | 1·158 | 9·98 | 2,383b | 6·1 |
| Birmingham Corporation | ,, 13 | 356 | 257 | + 99 | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | — | — | — | — | — | 6¼ | 6¼ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 3 | 803 | 866 | – 63 | + 135 | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10·94 | — | 4·59 |
| Blackpool Corporation | ,, 11 | 574 | 5 2 | + 72 | + 323 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 13 | 327 | 293 | + 23 | + 76 | 16½ | 16½ | Dec. 31 | 32,021 | 2,253,984 | 600,757 | 3·34 | 12·75 | 2,001 | 7·05 |
| Bolton Corporation | ,, 14 | 1,902 | 1,788 | + 114 | + 500 | 38 | 38 | March 31 | 94,161 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·89 |
| Bournemouth Corporation | April 26 | 1,577 | 1,018 | + 559 | — | 10·15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | May 6 | 4,024 | 5,565 | –1,542 | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 14 | 937 | 856 | + 71 | + 434h | 9 | 7½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 12 | 4,992 | 4,783 | + 201 | — | 51½ | 51½ | Dec. 31g | 253,150 | 44,391,439 | 6,035,528 | — | — | — | — |
| Burnley Corporation | ,, 13 | 1,118 | 973 | + 145 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 14 | 310 | 322 | – 12 | — | 8½ | — | March 31j | 11,574 | 2,556,134 | 282,378 | 1·08 | 9·84 | 1,570 | 7·57 |
| Cardiff Corporation | ,, 6 | 1,805 | 1,820 | – 15 | + 23 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 13 | 181 | 175 | + 6 | + 311 | — | — | Dec. 31g | 9,987 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 13 | 6,759 | 6,703 | + 51 | + 1,834h | 6 | 6 | ,, 31 | 362,471 | 44,953,988 | 1,292,674a | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 14 | 2,555 | 2,832 | – 277 | – 2,976h | 6⅛ | 6⅛ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Colchester Corporation | ,, 10 | 184 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 11 | 505 | 452 | + 53 | — | — | — | ,, 31g | 25,657 | 6,353,323 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | ,, 12 | 240 | 210 | + 30 | + 65 | 7·23 | 7·23 | March 31a | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 13 | 198 | 195 | + 3 | — | 4½ | 4½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0·94 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | ,, 12 | 117 | 120 | – 3 | — h | 7 | 6½ | Dec. 31g | 6,234 | 388,905 | 107,164 | 3·88 | 14·09 | 932 | 7·39 |
| Dublin U. T., electric cars | ,, 12 | 4,033 | 3,950 | + 83 | } — | 47 | 46 | ,, 31g | 134,648 | — | 3,429,356 | — | — | — | — h |
| Dublin S. District, Electric | ,, 12 | 967 | 841 | + 126 | | | | | | | | | | | |
| Dundee City Tramways | ,, 10 | 823 | 790 | + 33 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 13 | 365 | 695 | + 173 | + 192 | 10·77 | 10·75 | March 31 | 34,312 | 12,950,269 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 13 | 15,321 | 14,112 | +1,209 | +38,941h | 145 | 123 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Gloucester Corporation | ,, 10 | 310 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 3 | 3,392 | 2,749 | + 643 | — | 33 | 30½ | March 31 | 68,283 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,069 | 8·77 |
| Huddersfield Corporation | ,, 13 | 1,252 | 1,189 | + 63 | — | 35 | 35 | ,, 31 | 65,545 | 11,899,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | ,, 13 | 2,037 | 1,992 | + 44 | + 89 | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | April 29 | 546 | 446 | + 100 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | May 10 | 125 | 125 | — | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 10 | 218 | 211 | + 7 | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 13 | 5,753 | 5,240 | + 483 | + 1,840 | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | April 2 | 1,961 | — | — | — | 7¼ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | May 6 | 10,474 | 10,067 | + 407 | + 7,573 | 103 | 103 | Dec. 31g | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | ,, 14 | 1,251 | 1,656 | – 145 | – 126h | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — e |
| London County Council | ,, 6 | 13,249 | 10,728 | +2,521 | +11,360 | 46¼ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | ,, 11 | 125 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 13 | 12 380 | 11,355 | +1,025 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 13 | 123 | 103 | + 20 | — | 2½ | — | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newcastle-on-Tyne Corptn. | ,, 13 | 3,495 | 3,534 | – 39 | — | 45 | 38½ | ,, 25 | 185,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111b | — |
| Newport (Mon.) Corporation | — | — | — | — | — | 15 | — | — | — | — | — | — | — | — | — |
| Oldham Corporation | ,, 14 | 1 558 | 1 106 | + 452 | + 3,018 | 34½ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 13 | 1,834 | 1,715 | + 179 | — | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·16 | 12·39 | — | — |
| Reading Corporation | ,, 11 | 622 | 568 | + 54 | — | — | — | — | — | — | — | — | — | — | — |
| Rochdale Corporation | April 29 | 682 | 120 | + 452 | + 1,811 | 4½ | 4½ | 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | May 11 | 426 | 403 | + 23 | — | — | — | ,, 31 | 23,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·68 |
| Salford Corporation | ,, 15 | 4,167 | 3,947 | + 220 | + 907 | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 13 | 95 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 14 | 4,856 | 4,573 | + 283 | + 622 | 34¼ | — | ,, 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 10 | 917 | 903 | + 14 | + 264 | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 10 | 318 | 253 | + 65 | + 174 | 6¼ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 12 | 590 | 445 | + 45 | — | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 14 | 1,177 | 1,185 | – 8 | – 53 | 19 51 | 18·48 | ,, 31 | 62,505 | 14,848,958 | 1,433,463 | 1·01 | 10·46 | — | 6·02 |
| Swindon Corporation | ,, 3 | 176 | — | — | — | 3½ | — | — | — | — | — | — | — | — | — |
| Wallasey U D C | ,, 6 | 736 | 669 | + 67 | + 204 | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·50 |
| Warrington Corporation | ,, 11 | 311 | 281 | + 30 | + 113 | 7¼ | — | — | — | — | — | — | — | — | — |
| West Ham Corporation | ,, 11 | 1,658 | 970 | + 688 | + 3,721 | 8·62, | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 10 | 743 | 542 | + 207 | — | 7½ | — | ,, 31g | 20,878 | 4,263,066 | 417,335 | — | 12·006 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile. b Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures. Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**Tramways and Light Railways Association.**—The *Official Circular* for May contains the discussion on Mr. Parish's paper on "Friction as Affected by Lubrication," and an abstract of the measure to continue and amend the Light Railways Act, 1896.

**Opening Streets.**—A conference of representatives of the City Corporation, the Westminster City Council, and metropolitan borough councils was held at Westminster on Tuesday, when a resolution was passed urging the Government to introduce a Bill to give the highway authorities greater power to prevent the constant opening of public streets by the Postmaster-General and electric light and other companies.

**Faraday Society.**—The issue dated May of the society's *Transactions* contains Mr. J. G. A. Rhodin's paper on "Mass Analyses of Muntz's Metal by Electrolysis, and some Notes on the Electrolytic Properties of this Alloy"; Mr. R. B. Denison's paper on the "Equilibrium between Sodium and Magnesium Sulphates"; Mr. F. W. Harbord's paper on "Recent Developments in Electric Smelting in Connection with Iron and Steel"; Mr. A. H. Hiorns's paper on "Alloys of Copper and Bismuth"; and the first part of Messrs. R. S. Hutton's and W. H. Patterson's paper on "Electrically-Heated Carbon Tube Furnaces."

**New Publications.**—Messrs. Crosby Lockwood and Son will be shortly publishing a work on "Modern Lightning Conductors," which is likely to contain much of interest to all who wish to study the question of protecting buildings against damage by lightning. The author, Mr. Killingworth Hedges, C.E., was the honorary secretary of the Lightning Research Committee, whose report has just been issued, and in the new volume, besides illustrating many of the examples of lightning strokes furnished by the committee's observers, he describes the best methods for carrying out the suggestions contained in their report.

**The Liege Exhibition.**—The Liége International Exhibition has been opened under the auspices of King Leopold. The British section, under the direction of Mr. Imré Kiralfy, who accepted the honorary commissariat a few weeks ago, presents an animated picture of British industry and art, and as new applications from representative British firms are coming in, the few empty spaces in the section are being rapidly filled. Besides the United Kingdom, Canada, with a palatial building, forms a great centre of attraction. The King of Belgium has intimated to the British Commissioner his intention to make a special visit to the British section early next month.

**Milan Exhibition.**—It is reported that the Italian delegates who have been sent to England by the executive committee of the Milan International Exhibition are now in London. They have been presented to Lord Lansdowne by the Italian Chargé d'Affaires. The exhibition, which is the first international exhibition ever organised in Italy, will be held to celebrate the inauguration of the new Simplon Pass, and will be opened in Milan next April. It is under the patronage of the King of Italy, and will receive financial support from the Government. Italy, France, Austria-Hungary, Germany, Switzerland, Russia, Portugal, Spain, Belgium, the United States, and Japan are expected to participate officially.

**Birmingham Section.**—The report of the committee for the session 1904-5 states that seven general meetings were held, and the parent Institution has decided to include most of the papers in the *Journal*. The Institution has also decided to award a premium of £10 to Messrs. D. K. Morris and J. K. Catterson-Smith for their paper on "Some Uses of the Oscillograph," read during the previous session. The membership, all grades, has increased from 258 to 293. The chairman for the session 1905-6 is Mr. R. Threlfall, F.R.S., and the vice-chairman Mr. R. A. Chattock. Members are invited to submit papers in time to enable the committee to draw up a complete programme before the first meeting in November. It is not necessary that all papers should be sufficiently original for inclusion in the *Journal* so long as they are calculated to promote useful discussions.

**London County Council Combined Tickets.**—At Tuesday's meeting of the Council the Highways Committee recommended that circular tickets should be issued at the price of 5d., entitling the holder to travel by steamboat from Westminster Pier to Greenwich Pier, with the option of returning by tram to any of the London termini. The single tram fare from Greenwich to any of the termini is 3d., but it is proposed that the inclusive fare of 5d. shall be divided equally between the two departments for each passenger returning by tram, as the arrangement is likely to lead to increased tram traffic. It is proposed that, in the first place, the system shall be for one year, in order to see how the experiment works. The Council have deferred their decision. The suggested arrangement seems likely to prove a convenience to the public and a useful source of revenue to the tramway department.

**Optical Convention.**—This convention, regarding which we have given some particulars in previous issues, opens at the Northampton Institute on Tuesday next, and will continue until the end of the week. The president is Dr. R. T. Glazebrook, and sectional meetings will be presided over by the Earl of Rosse, Lord Blythswood, and Sir W. Adney. Such scientists as Lords Kelvin and Rayleigh, Profs. S. P. Thompson, Poynting, and Schuster, and Sir Howard Grubb are also lending their support to the movement. In his inaugural address the president will describe the objects and scope of the convention, and give a short account of the history of optical theory, with special reference to its application in practice. This will be followed during the convention by a number of instructive lectures and demonstrations. A comprehensive catalogue has been compiled giving descriptions of the instruments included in the various classes and other information.

**Rotating Diaphragm.**—At the recent meeting of the American Electro-Chemical Society, Prof. W. D. Bancroft presented a paper on "A Rotating Diaphragm," of which an abstract appears in the *Electrical World* of New York. The author stated that if in an acidulated copper sulphate solution a cylindrical graphite rod is interposed between two copper electrodes, copper will be deposited on one side and oxygen developed on the other side of the graphite rod, if the impressed voltage is high enough. After this has been done the graphite cylinder may be revolved through 180deg., so that the precipitated copper side will now face the cathode. The copper will then dissolve and the graphite cylinder will behave like a reversible intermediate electrode. Instead of reversing the graphite diaphragm repeatedly through 180deg., it is possible to revolve it rapidly. In this case it will also behave like an ideally reversible electrode. Experiments show that no visible amount of copper precipitates on such a rotating electrode, although a considerable proportion of the total current flows through the electrode.

**Municipal Enterprise.**—The Ipswich Corporation electric supply department has issued a businesslike collection of literature emphasising the advantages of electricity for power and lighting. In connection with the former it is pointed out that industrial users of power are

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almost invariably the gainers by taking a supply from a large central station, on account of such stations being designed to yield the maximum efficiency and being under the control of a highly-trained staff. Regarding lighting, the pamphlets point out its great hygienic advantages in the home, and particularly in the nursery, while the attractiveness of an electrically-lighted shop window is duly enforced upon the minds of such consumers. Carefully worked out particulars are given as to the relative cost of current for various types of lamp, with information as to the special features of the different kinds. There are also hints on wiring houses for electric lighting, and some remarks upon electric ventilation. The various pamphlets are composed in lucid language, and their judicious dissemination should see a material increase in the department's load-factor.

**The Light Railways Act.**—A Bill to continue and amend the Light Railways Act, 1896, has been presented to the House of Commons by Mr. Gerald Balfour, supported by Mr. Bonar Law. The measure further provides that if any order under the principal Act is not confirmed by the Board of Trade on the ground that the proposals of the promoters ought to be submitted to Parliament in pursuance of Sub-Section 3 of Section 9 of the principal Act, the Board may submit the proposal to Parliament by bringing in a Bill for the confirmation of the order. This sub-section provides that if, on account of the magnitude of a proposal or other special reason, the Board consider that it ought to be submitted to Parliament, they shall not confirm such order. On bringing in such Bills for the confirmation of orders, the Board shall make a special report to Parliament. If, while a Bill confirming any such order is pending before Parliament, a petition is presented against the order, the matter may be referred to a select committee, or to a joint committee, the petitioner being allowed to appear and oppose as in the case of private Bills. The length of lines authorised as light railways up to the present date is 1,567 miles, and 429 miles have been constructed and opened for traffic.

**Egypt.**—Messrs. W. P. Thompson and Co., patent agents, Liverpool, notify that by Khedivial decree, and with the consent of the 14 Governments who, by the treaty of 1876, guarantee the independence and ex-territoriality of the International Courts of Justice in Egypt (commonly called the "Mixed Tribunals), the English language becomes as from 18th inst. official in such courts. This is one of the results of Lord Cromer's 20 years of unobtrusive but strenuous administration. Hitherto, French and Arabic have been the only official languages, and hence have been used exclusively in the courts, on the railways, and in Government departments generally. In the great prosperity of Egypt, and its expansion and development under British rule as a mining and manufacturing country, the protection of patents and trade marks there has taken a prominent part; but even in this department, though a very large portion of the trade is in British ships, the patents and trade marks have till now been registered only in the French language. Messrs. Thompson and Co. remark that, notwithstanding this, the business of protecting inventions has assumed large proportions, and their Cairo and Khartoum agents report themselves as overwhelmed with work. Their agents add: "Far too little of this is from England, though it would be well if British manufacturers would more generally register their marks here, the Act in itself forming a good advertisement for their products and being calculated to lead to enquiries for their goods." Until comparatively recently Egypt was a happy hunting ground for forgers of trade marks, and even now there is a large business one in imitating English marks, as no action can be brought for infringement until a mark is registered in the country, the same state of affairs prevailing in the Soudan.

**Lighting New York.**—A Bill has been passed by the New York State Senate creating a commission of three members with authority to regulate the price of gas and electric light and power, and providing for the supervision of such undertakings. The commissioners will have power to investigate the quality of gas supplied and the operations of persons or municipalities in supplying gas and electricity for light, heat, and power, and may order such improvements as will best promote public interests, preserve the public health, and protect those using gas and electricity. The commission may prescribe methods of keeping accounts and books by gas and electric corporations, and will have supervision of the power companies at Niagara Falls and other places. It may require each company to file an annual report showing in detail all its financial operations for the year, and it is vested with power to examine the books of any company. The commission is authorised to supervise the inspection of gas and electric meters by any State or municipal officer, and may adopt rules to govern such tests. It may also itself appoint an inspector of electric meters. This is not the extent of the power of the commission, as any gas or electricity company incorporated hereafter must obtain the consent of the commission before it can conduct its undertaking or issue any stock, and no existing company shall increase its capital without the consent of the commission. These restrictions should be sufficient to satisfy the most democratic, and their effect will doubtless depend largely upon the spirit in which they are exercised. Under the Tammany oligarchy there would be fruitful scope for corruption, but since the City Fathers of New York are reported to have been materially purged of that element the regulations may result in improved public services.

**Statutory Rights as to Laying of Cables.**—A point of some interest was involved in an application made last week to Mr. Justice Warrington. The applicants were the Wandsworth Borough Council, who sought to restrain the London United Tramways Company from opening roads under the Council's jurisdiction for the purpose of laying cables from the Lots-road generating station of the Underground Electric Railways Company of London for the transmission of power to work the tramway company's projected lines in Surbiton, Kingston, and Wimbledon. The company's Act states that "the company may execute all such works . . . as may be necessary or convenient for the working of the tramways by mechanical power . . . or for providing access to or forming connections with any generating station," etc. The Council contended that this only entitled the company to open the streets for the purpose of obtaining a supply of power from generating stations belonging to the respondents themselves. Mr. Cripps, K.C, on behalf of the Council, characterised as "absurd" the company's claim to connect with "any generating station," remarking that under such circumstances they might have it conveyed from John o' Groats. Mr. Balfour Browne, K.C., pointed out the obvious answer to this latter argument, and stated that there was not only no obligation upon a company to provide its own generating station, but that it was quite a common thing for the local authority to insist upon supplying the power themselves. His Lordship held that there was nothing in the Act to restrict the words "for providing access to or forming connections with any generating station" to a generating station belonging to the company, or that in making the connections the company were confined to the streets in which the trams were to run. This is surely the common-sense interpretation of the Act; indeed, it is a little difficult

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to see how anybody could place a different construction upon it.

**Acceleration Tests.**—The results of a series of tests conducted by the New York Central and Hudson River Railroad and the General Electric Company on a "Pacific" type of steam locomotive and an electric locomotive having practically the same weight on the drivers are described in the *Electrical World* of New York. These tests show a marked superiority in favour of the electrically-driven locomotive. The run was made on April 29. Each locomotive was required to haul a six-car train, the total train weight being 487 5 tons for the steam locomotive and 427 tons for the electric locomotive. The line E.M.F. during acceleration was 680 volts for the series and the series parallel positions and 515 for the parallel position of the controller. These conditions of voltage were as nearly as possible what will obtain in actual practice within the electric zone in the neighbourhood of New York. The tabulated results are as follows:

| | Steam. | Electric. | Difference in favour of electric. |
|---|---|---|---|
| Length over all | 67ft. 7⅜in. | 36ft. 11¼in. | 30ft. 8⅛in. |
| Total weight (including tender for steam locomotive) | 342,000lb. | 200,500lb. | 141,500lb. |
| Concentrated weight on each driving axle | 47,000lb. | 35,500lb. | 11,500lb. |
| Revenue bearing load back of locomotive | 256 tons | 307·25 tons | 51·25 tons |
| Acceleration miles per hour per second averaging up to 50 miles per hour | ·246 | ·394 | ·148 |
| Time required to reach speed of 50 miles per hour | 203 seconds | 127 seconds | 76 seconds |

The electric locomotive from the first turn of the wheels accelerated faster than the steam locomotive, and at a distance of 1,500ft. from the starting point the electric locomotive led by a train length. At all speeds the smooth running qualities of the electric locomotive were very noticeable.

**Theory of the Electrolytic Rectifier.**—In the May issue of the *Physical Review* (New York) there appears an article upon the theory of the electrolytic rectifier from the pen of Mr. S. R. Cook, who has investigated the subject in some detail. The author's conclusions are that whenever oxygen is the primary or secondary product of the anion, the aluminium anode is covered with a film of hydroxide which has a very high resistance, so high, indeed, that it acts as a dielectric to the charge on the ions. This non-conducting film between the metallic aluminium and the electrolyte produces a condenser effect with the negative charge on the anions of the electrolyte. The conditions then that always exist, when a direct current is applied to an electrolytic rectifier with a well-formed aluminium anode, are: (1) When any potential less than the critical potential is applied to the electrodes there is induced an equal and opposite charge in the electrolyte next to the respective electrodes. (This is on the assumption that the film acts as a perfect dielectric.) (2) When the current is broken there exists bound charges in the electrolyte and on the electrodes. These bound charges on the electrodes, which may be assumed to be equal to the bound charges in the electrolyte, are what produce the counter E M F. The curve of decay shows the rate at which these charged ions pass through the film and give up their charge to the metallic plate. (3) When the current is reversed the hydrogen ions pass through the film more readily than the oxygen or other negative ions, forming a gas between the metallic aluminium and the film, thus breaking away the film and exposing the metal to the charged ions. (4) When an alternating current is applied, the film acts as a semi-permeable membrane. The hydrogen atoms having less mass and greater velocity than the oxygen or other negative ions, pass through much more freely than the more slowly-moving anions. (5) The critical potential value for an electrolytic rectifier depends upon the electrolyte used and the temperature of the cell. When the critical potential has been passed, the film crystallises and in crystallising exposes the metallic aluminium. The crystallisation continues so long as the potential is kept above the critical value.

**Institution of Mining Engineers.**—The fifteenth annual report of this institution affords interesting reading. The institution includes in its membership six different societies—viz., the Midland Counties Institution of Engineers; the Midland Institute of Mining, Civil, and Mechanical Engineers; the Mining Institute of Scotland; the North of England Institute of Mining and Mechanical Engineers; the North Staffordshire Institute of Mining and Mechanical Engineers; and the South Staffordshire and East Worcestershire Institute of Mining Engineers. The membership for the last 15 years shows a steady increase, the total for 1904 being 2,781. The Manchester Geological and Mining Society applied to join the society during the year, and their request has been cordially agreed to. The report gives a list of the numerous papers which have been read before the different societies during the past year. Those dealing with applications of electricity have, in certain instances, already been abstracted in our columns, but the following list will be of interest, as it will serve as a reference to the source of much useful information. These papers are: "Notes on Glapwell Colliery," by Mr. M. Deacon; "An Electrical Heading Machine," by Mr. Percy C. Greaves; "The Three-Phase Electric Haulage Plant at Shirebrook Colliery, Mansfield," by Mr. William Hay; "A Comparison of Three-Phase and Continuous Currents for Mining Purposes," by Mr. Roslyn Holiday; "Comments on the Proposed 'Rules for the Installation and Use of Electricity in Mines,'" by Mr. William Maurice; "Notes on Electric Power applied to Winding in Main Shafts," by Mr. W. C. Mountain; "Comparison of Electric and Compressed-Air Locomotives in American Mines," by Mr. Beverley S. Randolph; "Description of the Duddingston Shale Mines and the Niddrie Castle Crude Oil Works," by Mr. J. Balfour Sneddon; "Alternating Currents and their Possible Application to Mining Operations: Part II.—How Alternating Currents may be Used in Mining," by Mr. S. F. Walker; "The Report of the Departmental Committee on the Use of Electricity in Mines," by Mr. S. F. Walker; "Electric Coal-cutting," by Mr. W. Walker.

**Electricity in German Mines.**—The paper read by Mr. E. O. Forster Brown before the Mining Institute of Scotland early this year has just been printed in the *Transactions* of the Institution of Mining Engineers. The author gives some interesting figures as to special cases in which electrical energy has been applied to winding engines, hauling gear, pumping, etc., in various mines in Germany. Amongst the pumping plants were noticed one installed in the Victor Colliery at Rauxel, in Westphalia. The feature of the equipment is the high lift obtained with centrifugal pumps. The steam-engines and three-phase alternator installed are used for supplying the pump motors only. The three-phase alternator runs at 112 revolutions, and generates current at 5,000 volts, which is transmitted to the motor-driven pumps at the pit bottom some 1,640ft. from the surface. The centrifugal pump is of the Sülzer type in two parts, each part is in four steps and is driven by a separate motor; the first pump sucks the water from a depth of 13ft. (4m.), and delivers it to the second part at half the velocity required for the total lift; and the second part supplies the remaining velocity required. The

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motors, of 600 h.p. each, are keyed on the same shaft as their respective pumps, and run at 1,035 revolutions a minute. The total vertical lift exceeds 1,640ft. (500m.), and the total quantity of water pumped is 1,540 gallons per minute. As the generating plant only drives the pump, the motors of the latter do not require to be switched on underground, but start working with the steam-engine at the surface. From the results of tests made of this pumping plant running under normal conditions, it appears that the efficiency of the pump is 75 per cent., and of the dynamo, cable, motors, and pump 60 per cent. The author describes also some winding gear in one or two mines, of which we have already given particulars in our columns. It is interesting to note his general statement that the new plants are, with rare exceptions, worked on the three-phase system because the machinery for the same is cheaper to construct than for direct-current working. It also admits of higher voltages being economically used, which keeps down the cost of the cables. The three-phase system, however, is disadvantageous for those machines where speed regulation of the motor is required, though even for such purposes a good deal of three-phase current is used.

**Power Distribution.**—An article in the May number of *Electrics* discusses the subject of the supply of power in bulk to collieries and the like. To meet the contention of some owners that they can generate energy more cheaply than a power company can supply it, the writer specifies the conditions that have to be met. The colliery may require an average through the day, say for 10 hours, of 1,000 h.p.; a maximum now and then during the day of 1,500 h.p.; an average throughout the night, say for 10 hours, of 250 h.p.; a maximum now and then during the night of 500 h.p. Nothing at all (unless for ventilating) for, say, four hours in each day, between shifts, etc. This gives an average over the 24 hours of, roughly, 600 h.p. But in order to get this a plant must be installed that can supply the maximum possible demand—*i.e.*, 1,500 h.p.—or 2½ times as much as is ordinarily required. Such a plant, however, would not be sufficient in case of a breakdown, or during repairs. If to supply 1,500 h.p. of maximum demand two engines and generators are required of, say, 750 h.p. each, then, to make things safe, a third 750-h.p. set must be provided in case of a breakdown, or during repairs to one of the other sets. The colliery that wishes to be independent will therefore have to buy 2,250 h.p. of generating plant, engines, boilers, switchboard, accessory plant, buildings, and foundations in order to cope with an average demand of 600 h.p. In other words, it will have to pay nearly four times over for its plant. No colliery company, unless it is a very large concern with many pits near together that can be served from one central point, can hope to have a load factor sufficiently high to make its costs low enough to compete with the selling price of a power company. If the colliery is a "whole hogger" in electrics, the load factors of its various appliances may be as follows:

| | | | |
|---|---|---|---|
| Ventilating ..... | say 250 h.p., | 100 % | load factor |
| Winding ..... | „ 1,000 „ | 20 % | „ |
| Pumping ..... | „ 200 „ | 50 % | „ |
| Haulage..... | „ 1,000 „ | 25 % | „ |
| Surface and other machines | „ 300 „ | 12½ % | „ |
| | | | average |
| Total ..... | 2,750 h.p., | 36 % | load factor. |

Exception may be taken to the above load factor of 20 per cent. for winding, but on close examination it will be found to be, if anything, over the mark. If coal is raised continuously for nine hours out of each 24, it is safe to say that full power—whether steam or electricity is immaterial—is applied to the winding drum for less than two hours. For about another three hours a varying amount of power is used, but during the remainder of the nine hours braking is taking place, or the cages are at rest. The writer gives this as one of the examples most favourable to independent plant. He then gives reasons why the colliery proprietor can operate more advantageously by taking supply in bulk. Although the power company pays more for its coal, it can claim economy not only in the size of its units of plant, the centralisation and consequent reduction in its establishment charges, and its small transmission losses, but it has the valuable asset of a highly diversified power factor. The company is thereby enabled to deal with a very large connected load by means of a comparatively small running plant.

**The Telephone Transfer.**—Prior to the spirited scenes which brought the deliberations of our legislators to a summary conclusion on Monday night, the members of the House of Commons found time to consider the motion for the appointment of a select committee to consider the agreement with the National Telephone Company. In reply to sundry criticisms, Lord Stanley stated that the committee would have all the powers of an ordinary select committee, and could make the fullest enquiry, and report to the House, but it would not have power to alter the terms of the agreement. It might, however, make recommendations, and he would have to consider whether, in view of any such recommendations, he could go on with the agreement. If the House did not accept the agreement as a whole, it would fall to the ground. He promised that the House should have an opportunity of giving a definite decision before Aug. 31. After further criticism, Lord Stanley agreed to the insertion of words under which the committee, if it made any recommendations as to modifications in the agreement, might report whether it should be affirmed with such modifications. The motion was then carried, and the committee constituted as follows: Lord Bingham, Mr. Benn, Sir Horatio Davies, Mr. Keir Hardie, Mr. Helme, Sir William Holland, Mr. Lambton, Mr. Morrison, Mr. Joseph Nolan, Sir Charles Renshaw, Colonel Royds, and Mr. Stuart-Wortley. The provision empowering the select committee to make recommendations for varying the terms of the agreement is calculated to diminish any chance of the negotiations proving abortive after all. At a conference at the Westminster Palace Hotel on Monday of county boroughs of England and Wales and of Scotch cities and boroughs (Alderman J. W. Southern, of Manchester, in the chair) a resolution to the following effect was submitted: "That, inasmuch as the agreement between the Postmaster-General and the National Telephone Company, dated Feb. 2, 1905, fails to provide for a cheap and efficient telephone service for the whole country, this conference of county boroughs of England and Wales and of the principal cities and burghs of Scotland, whilst expressing no opinion as to the principle of State control of the telephone system, desires to record its strong disapproval of the terms of the agreement, and viewing as it does the proposal with much apprehension, desires to place its objections in detail before the Select Committee." An amendment was proposed in favour of supporting the agreement, but asking the Postmaster-General to reconsider the whole system of telephone rates, with a view to reducing them and making them more commensurate with the degree of user of the various subscribers, and also asking that adequate provision be made for the benefit of local authorities in regard to wayleaves and contributions in lieu of local rates. This was negatived. Another amendment was proposed approving of the agreement, but urging that all necessary provision should be made for safeguarding the interests of municipalities, whether owning their own telephone system or not. This was also negatived, and

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the original motion was carried. Alderman Southern and Bailie James Alexander (Glasgow) were appointed to take all necessary steps for bringing the resolution before the Select Committee.

**Pneumatic Dispatch Scheme.**—A number of important witnesses have given evidence on this subject before the Committee of the House of Commons presided over by Sir Henry Aubrey Fletcher. The inventor of the system underwent an extensive cross-examination, as also did Mr. A. E. Stuart, one of the syndicate's engineers, both witnesses giving testimony substantially on the lines of the general scheme that has been made public. Mr. Stuart did not believe that any block would arise from the dispatch of evening newspapers at certain hours of the afternoon in addition to the ordinary traffic. The reason why the pneumatic tunnel for the dispatch of mails from the General Post Office to Euston Station was given up was because the mails were sent along in train loads, so that when they reached Euston the unloading took so long that all the advantage of the tube was lost. The cardinal principle of conveyance by pneumatic tube was frequency of dispatch. Parcels would be dispatched at the rate of 600 per hour. Sir John Wolfe Barry considered that no undue degree of inconvenience would arise from the opening of the streets, the cut-and-cover method being employed, and that the scheme would be of great utility. Colonel Crompton stated that he had made a study of the pneumatic system, and had thoroughly investigated its working in New York, Philadelphia, and Boston with a view to its applicability to London traffic. The Post Office authorities in the United States had informed him that interruptions to the tube traffic were so rare as to be negligible. With a sufficient network of tubes leading out of the congested newspaper district the company would be capable of dealing with a far larger amount of traffic than the newspapers would furnish. The promoters had placed observers at various points in the streets who took note of the amount of parcel traffic of the same kind as the tubes would carry. The calculations based on their observations were that the establishment of the scheme would take 19 6 per cent. of the cart traffic off the streets. Dealing with the objections to breaking up the streets, Colonel Crompton said the idea was to have the pneumatic tubes laid below gas and electric mains, and once they were laid it was unlikely they would have to be touched for years. Sir Alexander Binnie, formerly chief engineer to the London County Council, believed the scheme would be a great benefit to the public, and would do a great deal towards relieving the congestion of street traffic. In his opinion the system had gone beyond the point of experiment. As an engineer he saw nothing to militate against its successful working. It is understood that the attitude of the Postmaster-General will be influenced by that of the London County Council and the City Corporation. There will probably be no occasion for the committee to defer their decision until the report of the London Traffic Commission has been issued, Sir David Barbour, chairman of the Commission, having intimated that the scheme is not likely to be affected by the report.

**Telephony in Canada.**—We have received copies of reports, aggregating 14 in number, prepared by the Select Committee appointed by the Canadian Government to enquire into the subject of telephonic control. These reports bring matters down to April 19. The committee, which is sitting at Ottawa, is composed of Sir William Mulock, Mr. Boyce, Mr. Burrows, Mr. Demers (St. John's and Iberville), Mr. Grant, Mr. Johnston (Cape Breton, South), Mr. Maclean (York), Mr. Monk, Mr. Roche (Marquette), Mr. Smith (Nanaimo), and Mr. Zimmerman. Investigations have been made into the systems in vogue in various parts of the world, and also into the effect of competition between the Bell and the independent companies in the States. It appears that there are a number of rural systems in operation in Canada at a cost far below the tariff of the Bell Company, whose terms for connection with their trunk lines are of a most onerous character. To further promote monopoly the Bell Company have entered into agreements with nearly every railway company for excluding the users of the local telephone systems from obtaining connection with the systems owned by such companies. In certain parts of Ontario and Quebec, for which the Bell Company on being approached by would-be customers had demanded prohibitive terms, local co-operative associations have supplied a service at a fraction of the charge required by the Bell Company. The systems have been installed by these local companies at a cost of from £7 to £10 per instrument, and the expense of operation and maintenance is stated to have been so small as to be hardly worth considering; in fact, the message fees from non-subscribers are more than sufficient to meet these charges. The opinion prevails in certain quarters that with Government ownership of the trunk lines and municipal or private control of the local systems the telephone industry of the Dominion would receive a great impetus, and might well be consolidated into an admirable system. Amongst the witnesses who have been heard before the committee was Councillor J. Willock, the chairman of the Glasgow Electricity Committee. He was able to give the committee intimate details as to the methods by which the large undertakings of the Glasgow Corporation are organised, financed, and controlled. He spoke well of the Glasgow telephone undertaking, and stood a severe cross-examination on the same. Amongst the points on which he was questioned was that of local management *versus* Government control. Mr. Willock favoured the Government working of trunk lines, but considered that corporations were better adapted for conducting local exchanges. His reason for this was that when the Government expropriate the company and the corporation he thought they would pay too much for the plant acquired, and hence would not be able to give telephone connections at the same rates as now obtain under the Glasgow Corporation system. He explained that in Glasgow the tramways, the gas, the electricity, and the telephone departments are so worked that no considerable profits are made. If there is a surplus, this goes in reduction of the cost of the individual service by which the surplus has been earned. Owing to this, the tramway fares has been reduced by over 50 per cent. since the Corporation took them over. At the same time, any profit from one department is not used to reduce the rate of charges in another. He considered that the telephones in Glasgow were paying their way, and that competition had resulted in a very large increase in the actual number of telephones used. Both the Corporation and the National Telephone Company gained by the competition, and while there were interchanges of subscribers between the two concerns the net result was an increase in the total number. Telephones were now much more used in Glasgow for private houses than they were before the competition commenced. The third annual report of the Corporation telephone department was gone into in detail before the committee, but as we have already given the essential figures from this we do not propose to reproduce them as given by Mr. Willock before the Canadian Committee. This interchange of ideas between large home corporations and the Colonies has every advantage, and we are glad to observe that the Canadian Committee were impressed by Glasgow's success in municipal work.

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## MESSRS. ERNEST SCOTT AND MOUNTAIN'S NEW WORKS AT GATESHEAD.

Messrs. Ernest Scott and Mountain commenced electrical manufacturing in 1888, when Mr. W. C. Mountain joined the firm. In those days machinery for electric lighting was the chief output from the electrical department of the firm, which had previously acquired a good reputation for manufacturing pumps and auxiliary machinery for warships. Mr. Mountain, however, recognised that at an early date there was a considerable future in connection with the adaptation of electricity for pumping, hauling, and coal-cutting in mines and collieries, and in the year 1890 the firm carried out their first mining contract, this being an electrical pumping installation for the Cowpen Coal Company, for their North Seaton Colliery, near Blyth. The plant consisted of a steam-engine, with generator, three-throw pump, and motor, the pump being placed at a distance of nearly two miles in-bye, and delivering 300 gallons of water per minute. Other orders quickly followed, and the next important contract was for a set of main shaft pumps for the Lothlan Coal Company, near Edinburgh, which was suggested by Mr. John Morison, now of Cramlington, who was at that time general manager to the Lothian Coal Company. To begin with, two sets of pumps were installed, delivering a total of 230 gallons per minute against a head of 790ft., with generating machinery at bank, and shortly after a third set was supplied. This company have now so far extended their electrical machinery that in all they have about 16 sets of pumps working at their various collieries. Applications of electricity to underground haulage on an extensive scale followed, and one of the largest installations which the firm carried out in those days was that for the Broughton and Plas Power Coal Company, Wrexham. The first plant consisted of a horizontal steam-engine and rope-driven dynamo, with an endless rope haulage gear placed 1,200 yards from the bottom of the shaft. This gear was fitted with three rope wheels, and worked by a 150-h.p. electric motor, the total length of the three roads operated being 4,600 yards. The generating machinery was placed in a house at bank, and provision was made for the addition of further sets. The firm were also among the first to apply electricity to coal-cutting, their earliest machine, of the disc type, being supplied to Mr. G. A. Mitchell, of Glasgow, for one of his collieries, about 12 years ago. This earlier work in the application of electricity to mining work was carried out with direct-current machinery, but the firm were amongst the first to introduce three-phase plant into English and Welsh collieries. Their first installation with this class of machinery was for the Tredegar Coal and Iron Company, at their Pochin, Ty Tryst, and Bedwellty Collieries in South Wales. This is now one of the largest and most successful installations in the United Kingdom. At the Pochin Colliery the plant consists of two engines, each of 360 h.p., each driving a 250 kw. three-phase alternator, the underground equipment including two main and tail haulage gears of 55 h.p., and two endless rope haulage gears of 75 h.p. each, together with main shaft and in-bye pumps, and smaller pumps, etc.

The old works of the firm were situated at Newcastle, in the Close. The space there available between the river front and the street was limited, and for this reason the firm had to curtail their field of operations. Thus in the earlier days they manufactured some marine engines, but this branch had to be given up to make room for the electrical department and the manufacture of high-speed engines. Even then, when we paid our last visit to the old works some 18 months ago, we were struck by the congested state of the shops and by the large variety of plant which was going through. The new works, which were officially opened on Saturday last, are situated in Gateshead, on the site of engineering works which were formerly used by Messrs. Black, Hawthorne, and Co. Part of the old shops have been utilised, but the bulk of the covered-in portion of the site is taken up by new buildings erected specially for the firm. The result is a thoroughly equipped, up-to-date factory, which should enable the firm to execute a larger volume of orders much more promptly than they could possibly have done in the old works.

Out of the total area of seven acres, as shown in Fig. 1, two acres are roofed in. There is a direct siding to the North-Eastern Railway, so that material can be handled without transhipment and at a minimum of cost. There are four separate buildings on the site. The largest has four bays, one of which is no less than 558ft. long and 43ft. wide. The north-west bay forms the light machine

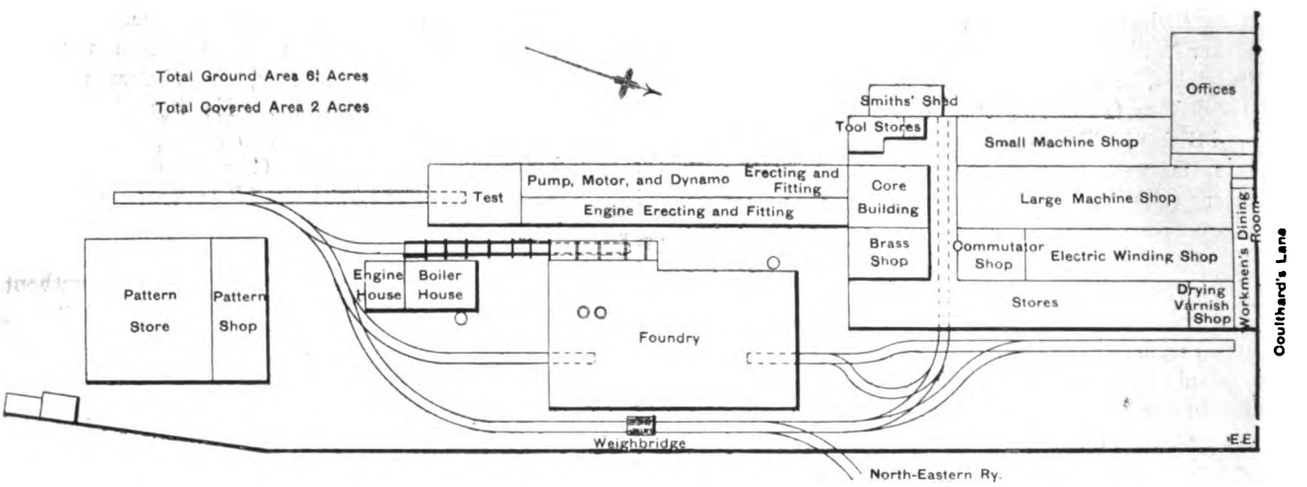


FIG. 1.—Plan of Messrs. Ernest Scott and Mountain's New Works at Gateshead-on-Tyne.

shop, and is 234ft. long by 34ft. wide. It includes all the light machinery, such as small lathes, slotting and milling machines, etc, while at the end of the shop is the tool store and tool fettling department. The smiths' shop is situated on the west side of this bay, in a building specially constructed for the purpose. The large bay comprises the heavy machine tool shop, the core-building department, and the general erecting shop and light fitting department, the far end being devoted to the testing of all classes of machinery. The machine tools in this bay include a planing machine which will take work 20ft. long, 6ft. 6in. high, and 8ft. wide; a 27in. centre lathe; a 20in. vertical lathe; and three boring mills each capable of boring up to 10ft. diameter. The erecting shop (Fig. 2) is provided with ample accommodation in the way of benches, with vices, etc., wall drilling machines, and a great variety of portable tools used in the erection of the specialities of the firm. The shop is served by 15-ton overhead electric travelling cranes. The testing department includes a very complete equipment for the testing of high-speed engines, dynamos, electric motors, three-throw and centrifugal pumps, etc. The third bay in the main building forms the electric and brass shop, in which the whole of the armatures, field magnets, commutators, and other electrical details are constructed. The shop is 264ft. long and 34ft. wide, and the adjoining shop of the same size is utilised for general stores. The foundry is a separate building, 175ft. long, 112ft. wide, with a floor space of 18,000 square feet, and here are two cupolas of a combined capacity of 11 tons per hour. The brassfoundry

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is under the same roof, and the light moulding is carried out in a small bay at the east side of the foundry. Almost adjoining the foundry is the boiler-house and electric generating station, where a large portion of the electric current for driving the works is produced. The pattern shop and stores consist of three bays in one building, 100ft. by 120ft., and the department is fitted up with modern wood-working tools. Ample space is left on the site for future extensions, and these can take place at any time without interfering with the continuous working of the present shops. The whole of the shafting in the various departments is operated by electric motors so placed as to not

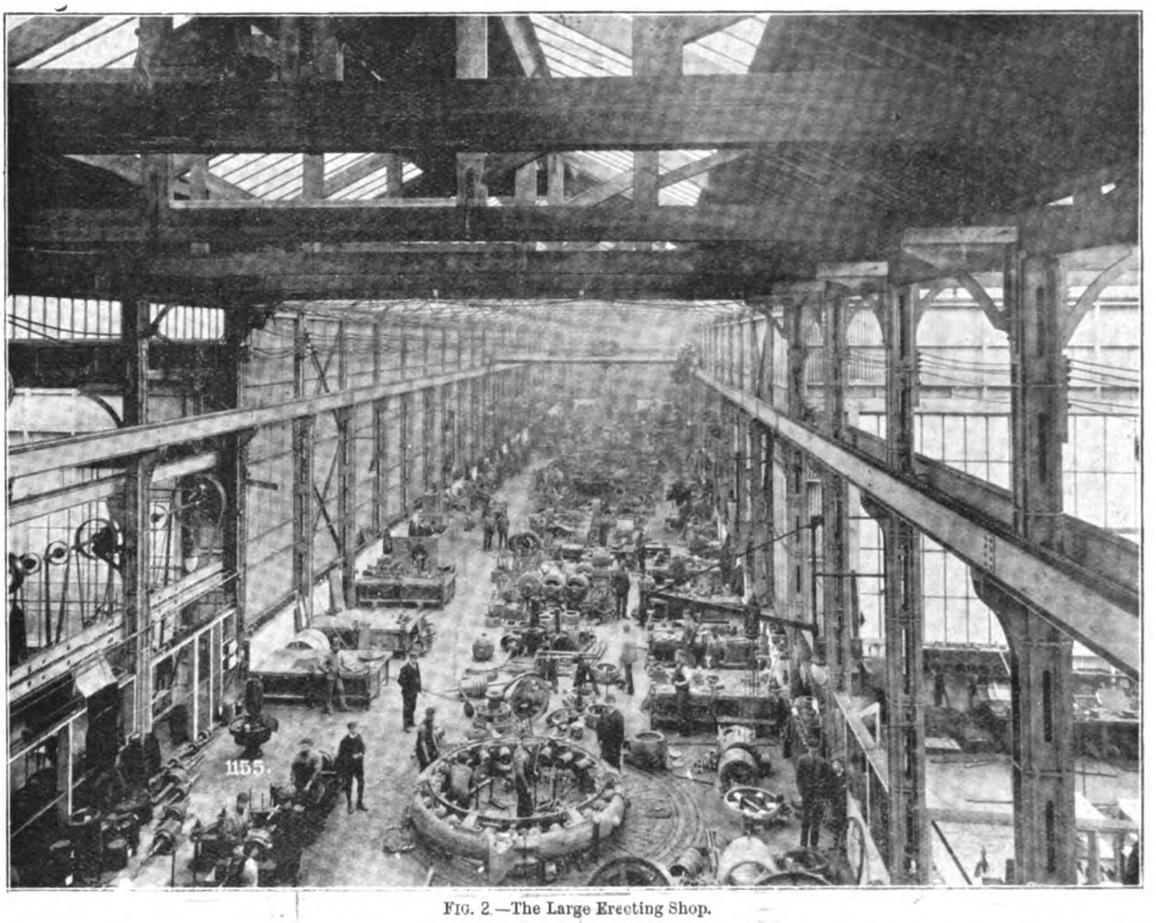


FIG. 2.—The Large Erecting Shop.

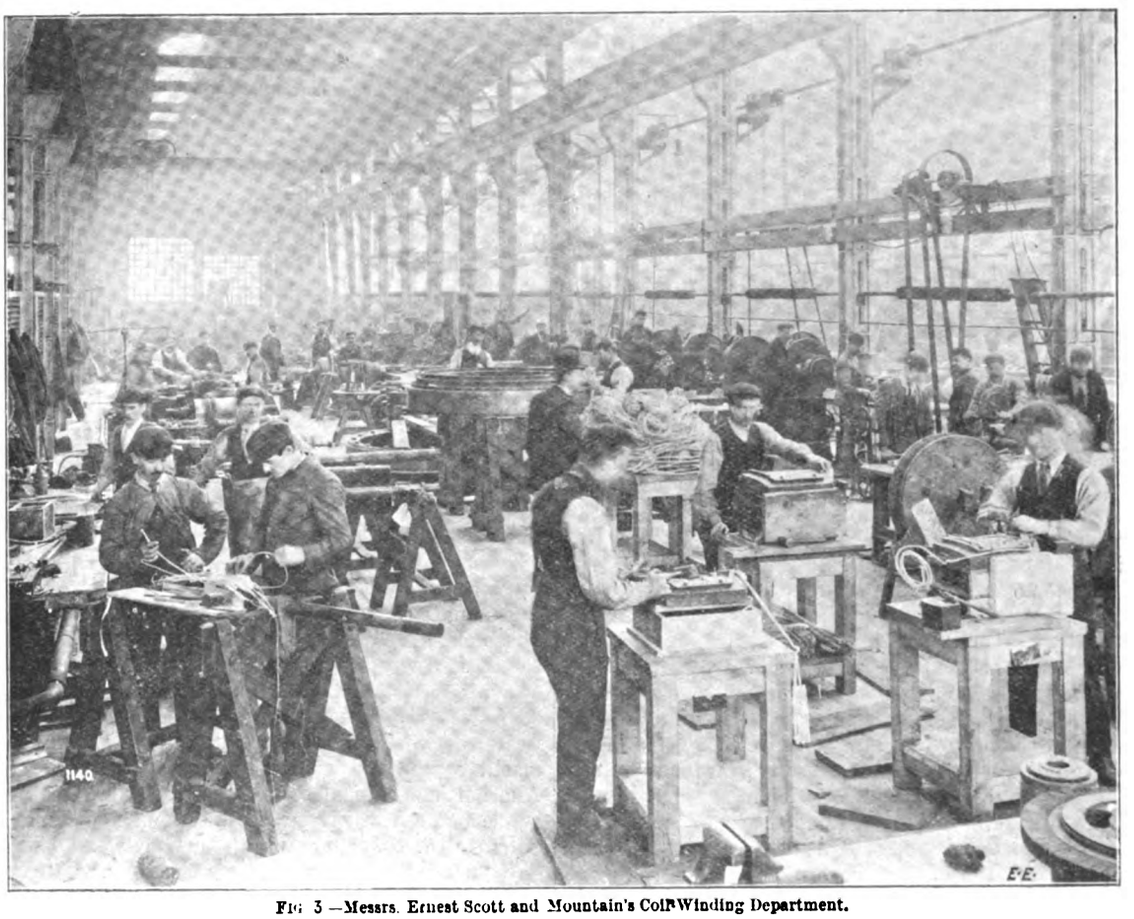


FIG. 3.—Messrs. Ernest Scott and Mountain's Coil-Winding Department.

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interfere with the general working of the machinery, and the shops are heated by live steam. The offices are large and well arranged, and, in addition to a dining-room for the staff, there is a dining-room for the workmen, where accommodation is provided for about 200 to sit down, and special cooking facilities are afforded. Every department is in communication with the office and the other parts of the works by means of a private telephone system.

In Figs. 3 and 4 we give views taken in the armature-winding department, the first of which shows the preparation of the coil on formers, and Fig. 4 the building up of these former-wound coils on to the armature cores. The feature which specially struck us in our inspection on Saturday last was the large variety of plant which the firm had under erection in their shops. In spite of the variety it was evident that mines and collieries would find a use for practically all the material in question. A large number of pumping plants, for instance, were under construction, including two sets of three-throw horizontal pumps with rams 18in. diameter by 22in. stroke for the Consett Iron Company, each pump being capable of delivering 1,500 gallons per minute against a working head of 400ft. when

Amongst the large electrical machinery going through the shops we were particularly struck with two machines of 300 kw. which are being manufactured for the Mickley Coal Company, near Newcastle. These machines are large for their output, due to the fact that they are to be driven by engines running at 100 revolutions per minute. The field-magnet system, although of large diameter, is made of cast steel in two parts only. The field-magnet poles are circular in section and are provided with pole-shoes, which present a flat surface to the armature. This gives a varying air-gap, which has considerable influence on the commutation of the machine.

Amongst the engines of the high-speed type which were on view was one with three cranks for compound working. It had one high-pressure cylinder 13in. in diameter and two low-pressure cylinders, each 16in. diameter. In each case the stroke was 9in. This engine is one of three in course of manufacture for Messrs. J. Ross and Co, Philipstoun Oilworks, Linlithgow, N.B. They will each develop 350 effective horse-power. The engines are completely enclosed, and a system of forced lubrication is applied to all the working parts. Duplicate oil-pumps are

FIG. 4.—The Armature-Winding Shop.

running at a speed of 26 revolutions per minute. These large pumps will be driven by electric motors from the generating plant, which Messrs. Ernest Scott and Mountain are also supplying. The motors are connected to the countershaft of the pump by means of ropes, and there is a further reduction by spur gear to give the speed of 26 revolutions on the main pump shaft. Amongst the electric winding gears almost completed was one for Swalwell Colliery, fitted with double drums, one drum being 5ft. diameter and the other 7ft. 6in. diameter, for winding from two levels. This gear is capable of dealing with 100 tons per hour from a depth up to 300ft., and will be driven by a three-phase electric motor of 150 h.p. complete, with special regulating gear for reversing and varying the speed. A number of haulage gears were also on view, including one of the endless rope type for the Azov Coal Company, Russia. This had a rope wheel 5ft. diameter, and was driven by a 40-h.p. motor. This gear is complete with friction brake and friction clutch, and is driven through a train of machine-cut gearing, the whole being mounted on a steel girder bed-plate made in sections for taking to pieces and getting in-bye.

used for the purpose, which are driven from an eccentric on the engine shaft. The oiling of the crank-pins is not carried out through holes in the crankshaft, but the oil is led through the cross-head guides to each cross-head pin and then down to the crank-pin by means of a pipe. This method of carrying the oil to the crank-pin leaves the crankshaft its full strength.

Amongst the mining material on view there was a three-phase electric coalcutter of the disc type. The feature of the design was that to save headroom the induction motor was arranged with a vertical spindle. The motion was then transmitted through a series of spur and bevel gearings to the disc in which the cutting tools were carried. The machine we saw could undercut to a depth of 4ft. 6in. Another machine also on view, but driven by a direct-current motor, was arranged to do much the same undercut. A list of the other pumping plants, air-compressors, haulage gear, and other mining accessories which we saw would be tediously long. It suffices to say that every type of plant for use in collieries and mines was represented.

The opening ceremony on Saturday last was performed by Lord Armstrong in the presence of a large gathering of

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representative visitors. In the course of his speech Lord Armstrong thanked Mr. Scott and the directors of the firm for the invitation to the opening of the works, which he felt would do a great deal to increase on the Tyne the industry connected with electricity. He considered that the firm had shown themselves among the leaders and pioneers in this country in the utilising of electricity for

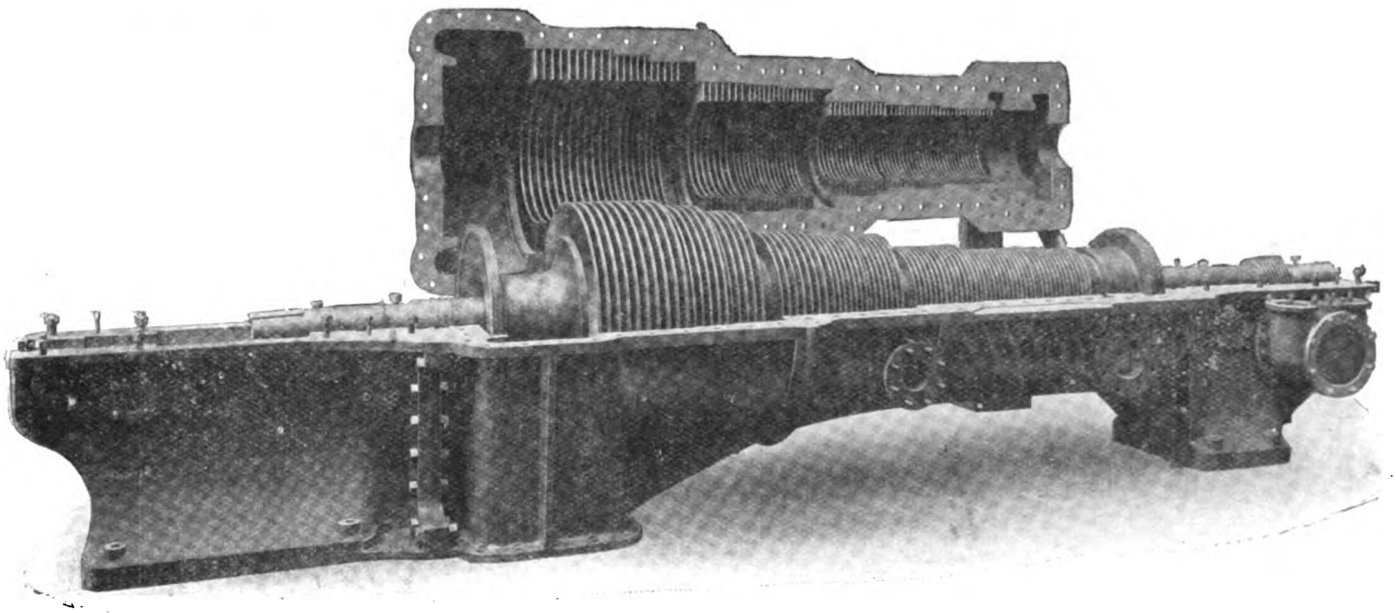

FIG. 1.—View of a Willans-Parsons Steam Turbine with hinged top opened, and showing Shrouded Blades and the Low-Pressure Balancing Ring.

the purpose of working in collieries. They often read in the papers of how the foreigners were going forward, and especially of how the Germans were trying to oust Englishmen in every part of the world, but as long as they had energy and enterprise shown in this country such as they had in the past, and the good work turned out which was being turned out at the present time, he had no fear that the Germans or anybody else would take away the reputation which had been won, or oust England from the commercial field.

## THE WILLANS-PARSONS STEAM-TURBINE.

It is now more than two years ago since Messrs. Willans and Robinson, Limited, decided to take up the manufacture of steam-turbines, and after a careful survey of the work being done in the direction of building turbines of different types, not only in this country but on the Continent and in America, they decided that the parallel-flow turbine, on the system proposed and developed by the Hon. C. A. Parsons, had stood the test of time and was in a more advanced position for manufacture on a large scale than any other. Negotiations were entered into with the Hon. C. A. Parsons and Co., and a license to manufacture under their patents was taken. Consequently the Willans-Parsons turbine is identical in principle and in its main features with the Parsons standard type, and it is only in details of design and manufacture that there are any differences. As, however, these alterations have been introduced with a view to lending greater flexibility to the turbine when in use, and facilitating manufacture on the interchangeable system, a few remarks on the subject may be of interest.

Special attention has been given to the arrangement of the necessary details, such as governor gear, oil-pump, steam and water piping, etc., as it has been found that ability to inspect the working portion of a turbine without dismantling any attendant gear is a convenience appreciated by those who have to take charge of the running and maintenance of machinery. To enable this to be attained, all the gearing and fittings named above are mounted on the bottom half of the bearing pedestals, and the top cover of the turbine, as well as the bearing caps of the three main bearings, are left free for instant removal.

To further facilitate opening the turbine, the top half of the casing has been arranged with two hinges, thus avoiding the use of guide studs and placing the turbine cover in a suitable position for examination. In the case

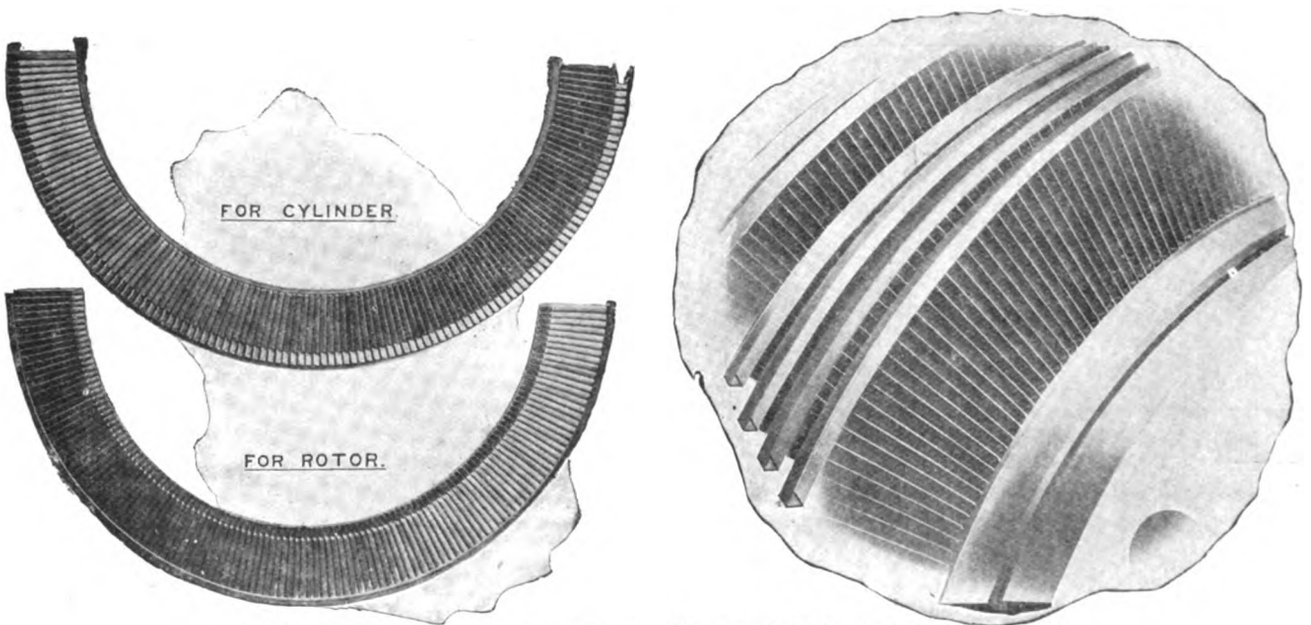


FIG. 2.—Details of the Special System of Securing and Shrouding the Blades of a Willans-Parsons Turbine.

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of the 1,000-kw. Willans-Parsons turbine, it is possible for two men to remove the main bearing caps and to open up the turbine for inspection in less than an hour. A view of a turbine opened up in this manner will be found in Fig. 1.

By a rearrangement of the balancing passages, it has been found possible to somewhat shorten the length of the ordinary parallel-flow turbine and, further, due to Fullager's patent system of balancing, it has been found possible to dispense with the large balance piston at the high-pressure end of the turbine, and to substitute in its place one of considerably smaller dimensions at the low-pressure end. It has been found in practice that this method of arranging the balancing pistons has the advantage of enabling castings of a more symmetrical form to be adopted, and in this way many of the troubles brought about by unequal expansion of the different parts are avoided.

An improved method of attaching the blades to the rotor and casing has been adopted in the Willans-Parsons turbine—extraordinary stiffness and rigidity is given to the blade rings when they have been fitted into their respective body or shaft grooves. In the ordinary turbine of this type, each blade is fixed separately into the rotor and casing by means of its own caulking piece. In the Willans-Parsons steam-turbine, as will be seen from Fig. 2, the blades for one complete ring are built up on two half-rings, which rings have had the necessary grooves for receiving the blades cut in them by means of automatic machinery. These complete half-rings of blades are then caulked into the shaft or the casing. Attention might be drawn to the fact that the cutting and assembling of the blading by means of specially designed automatic machinery, ensures that the whole of the blade angles and openings on which the efficiency depends are mathematically correct.

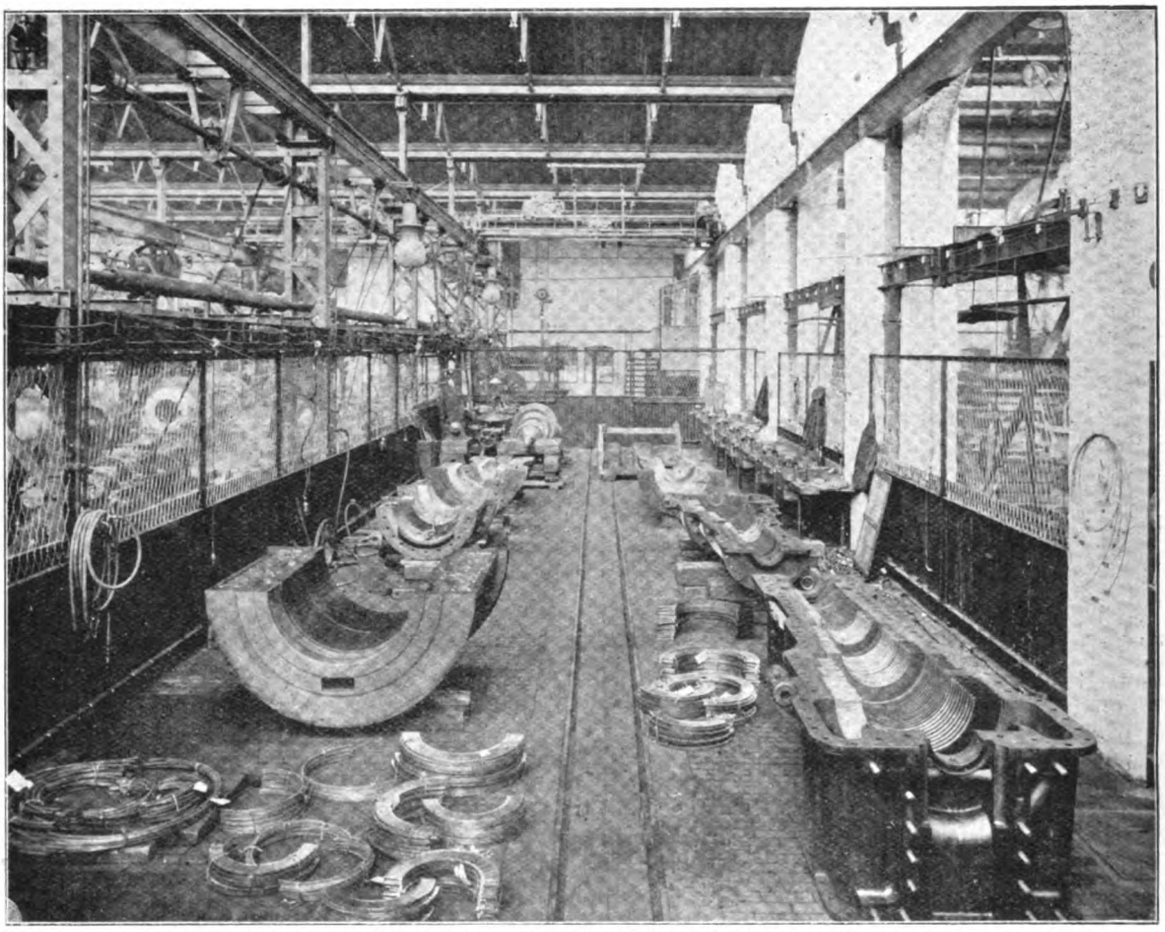

FIG. 3.—View of Erecting Shop at Rugby, showing Parts of Turbines ready for erection.

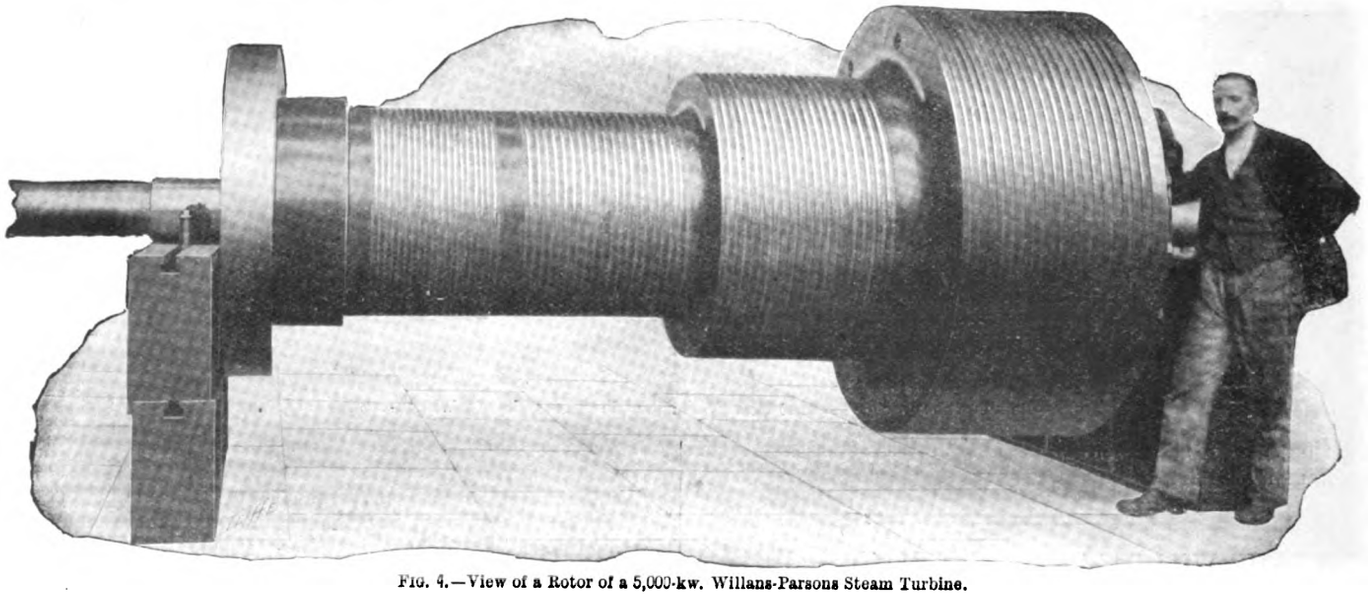

FIG. 4.—View of a Rotor of a 5,000-kw. Willans-Parsons Steam Turbine.

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Fig. 2 shows two of these half-rings complete for assembling on the shaft and in the casing.

Another feature of the Willans-Parsons turbine consists in the special channel shrouding encircling the blades, which Messrs. Willans and Robinson have the right to use under the patent of Mr. H. F. Fullager. This shrouding is fixed on the half-ring of blades before assembly on the shaft, or in the casing, and has several points of merit. It adds materially to the mechanical strength of the blades themselves and removes any danger of the blades stripping, should the rotor come into contact with the casing, or the blading on the casing come into contact with the revolving shaft. Further, the action of the channel shrouding when under working conditions minimises the loss due to leakage over the revolving or fixed rows of blades, and by this means a considerable gain in the steam economy is effected. A view of the shrouding round the blades is shown on the right-hand side of Fig. 2.

Special attention has been paid to the question of governor gear with a view of making it as simple and as reliable as possible. By dispensing with some of the intermediate gears hitherto used on governors controlling steam-turbines, it has been found possible to eliminate many of the undesirable features, and to obtain results in the direction of close governing which it is believed surpass anything hitherto obtainable. All the turbines are fitted with by-pass valves which automatically open when the maximum economical output of the turbine is exceeded, and by means of these by-pass valves any required overload can be obtained up to the full capacity of the generator, the steam economy of the turbine being, of course, reduced.

At the present time Messrs. Willans and Robinson have 24,250 kw. of this type of turbine at work or nearing completion, the smallest at the present time being of 750 kw. normal capacity and the largest of 5,000 kw. normal capacity. Among others might be mentioned the following: two 3,000-kw. and one 1,500-kw. for the Glasgow Corporation; two 1,000-kw. for the Bristol Corporation; one 3,000-kw. for the Metropolitan Electric Supply Company, London; two 1,000-kw. for Messrs. Bruce Peebles and Co., Limited; and one 1,000-kw. for the English McKenna Steel Process Company, Birkenhead. The figures as to the steam consumption of these turbines are not yet available for publication, but we understand that some most successful trials have been made. The reputation for accurate workmanship in the production of engine parts which Messrs. Willans and Robinson have secured will be an additional recommendation of their turbines, which will supersede reciprocating engines where large units are needed. The mechanical details above described tend to give strength, durability, and economy to the turbine.

## A STUDY OF SHORT-DISTANCE TELEPHONY.

BY VALENTINE RYAN.

It would only appear natural to suppose that the universal use of electric bells would have paved the way for the general adoption of short-distance telephones; yet the demand for these telephones to-day is not what it might be—it is far behind what it promised to be some six years ago. What at one time promised to be a very popular application of electricity has made comparatively little headway. Is there any need, then, to be surprised at wiring contractors only regarding telephone work as "a side line"—something to be taken advantage of when it comes in their way—a somewhat convenient source of work to tide them over their slack seasons? Besides, all contractors appear convinced that it would never pay to make a speciality of it. Manufacturers apparently think the way to alter this state of things is to make periodical reductions in the price of their telephones and accessories. This has been done on such a scale that one does not know whether to marvel most at the profits that must have been formerly realised, or how it is that the telephones can be made and sold to the trade at the present prices and yield a fair profit. Purchasers should not receive such reductions in too favourable a way; they should rather remember that the first cost of a telephone installation is too often by no means the last.

A move in a better direction—one that would assuredly prove conducive to more desirable results—would be for the manufacturers to consider that their responsibility did not cease entirely when the telephones were delivered in good order to their purchasers. By this is meant that the makers might exhibit more interest in what was proposed to be done with the telephones in the first instance; then how these expectations were realised—this being done with a view to rendering the installing of telephones more desirable work in the estimation of contractors; also to enable them to make their telephones and accessories more adapted to the systems on which they are intended to work, by this means forming, as it were, a community of interest between the contractors and themselves. In the following article the installations shall be of primary interest; then how far the telephones and their accessories facilitate the working of the same will be pointed out.

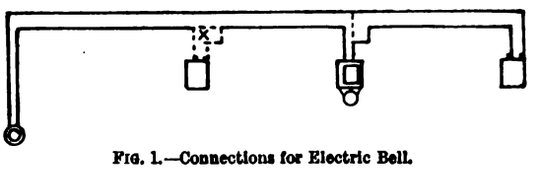

FIG. 1.—Connections for Electric Bell.

No hard-and-fast rules can be laid down for installing telephones—every installation must be considered on its own merits. An outline of the routine working of each installation should be arrived at by the contractor, and in doing so he must keep in view the routine working of the establishment, then propose such an equipment as will be convenient for the same, and submit sample telephones for approval. Considerable experience is required to arrive at the arrangement that affords the necessary communication, and still not instal one that provides means of communication such as is seldom used. The latter are not uncommon; capital is sunk in them that affords no return. Some contractors exhibit much ingenuity in this direction, others try original arrangements, and then wonder why they will not work. One has to remind them that they must modify the recognised systems to suit the particular requirements of the installation they happen to be dealing with, and only depart from the standard practice when there are substantial reasons for doing so. Telephone manufacturers deem they are generous when they issue time-honoured diagrams of connections. The original idea in drawing these was, apparently, to produce something that appeared symmetrical, and so at first sight simple; now it seems to be recognised as a tradition that these diagrams are to be rigidly copied, the only changes permitted being those that will help to identify a particular pattern of instrument. Wiremen, as a rule, do not attach much importance to them; they prefer to do things in what they call "a common-sense manner."

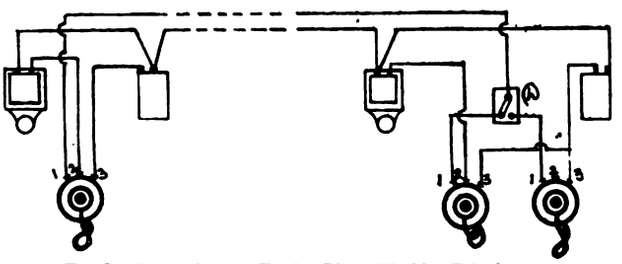

FIG. 2.—Connections for Testing Direct-Working Telephones.

The effect of the lack of interest on the part of the manufacturers, and of the contractors meeting with difficulties to which they are not disposed to devote much time, is evident in many telephone installations. The following examples, chosen for their simplicity, illustrate this, as they deal with electric bells, which form an integral part of all telephone equipments. The wiring for an electric bell is a simple piece of work. When the battery may not be placed close to the bell, as is often the case, it is the general practice to place it in some out-of-the-way corner, and lead the wires from the bell to it, as shown in Fig. 1. This mistake is frequently met with in more complicated systems of wiring, and has resulted in the waste of much time and wire. Obviously, the only correct

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method of doing this is to choose any convenient place along the course of the wire and insert the battery there as is shown at X (Fig. 2). In the particulars given for installing their instruments, manufacturers never include such suggestions as might tend to economise wire, but they can afford due prominence to a price list of the same.

Ordinary electric bells are not adapted to being made in large sizes, though there is a good demand for such bells, especially for outdoor use; however, they lend themselves readily to being installed in larger numbers, which, in many respects, makes up for deficiency. Now, can a few electric bells be arranged to work in series? One would look in vain for any information on this matter in manufacturers' catalogues. Connecting the terminals in the ordinary way the action would be intermittent; two bells will work satisfactorily in series, if one armature is cut out, and the coils connected permanently in the circuit, and the armature of the second bell will break the circuit, which will suffice for both bells.

When telephones are being installed, difficulties are sometimes encountered before they are made to work satisfactorily. Wiremen seem endowed with wonderful confidence in the correctness of their work, and attribute the faults to the telephones, which they proceed to take to pieces. The same happens when a fault occurs at any subsequent period, and it can be safely asserted that only 2 or 3 per cent. of such faults occur in the telephones. In the wiring and the batteries the faults should be looked for. With the receivers placed on the hooks, any telephone installation may be considered as an ordinary electric bell one; so, when a fault arises, he should first proceed to get the bell system in order, paying no attention to the telephones

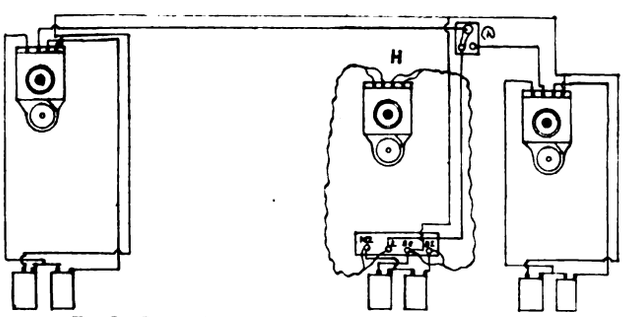


FIG. 3. Connections for Testing Induction-Coil Telephones.

proper until this is done; the transmitter, receiver, and induction coil and their connections are quite independent of the bell. Wiremen and their employers fail to realise this; some contractors test their telephones before they instal them, and thus put an end to such troubles. The more reliable way of doing this is to arrange for them to speak over a moderate distance. The following is a convenient method of doing so: First instal a pair of telephones with a view to their being of some use; then at either end arrange for connecting up a second telephone, without disturbing the connections of the first beyond altering the position of a two-point switch. This switch, D (Figs. 2 and 3), enables one to speak with either telephone, so that the person at the far end cannot tell whether he is speaking to the telephone being tested or the other one. This has a decided advantage, for it enables one to obtain the exact relative merits of the two transmitters, so that the person testing can form a correct estimate of the loudness of the transmitter at his end. When a faulty instrument is met with, the facility this method affords of restoring communication saves much time.

The connections for testing a direct working telephone are shown in Fig. 2. The battery at either station is used to ring the bell at the other; when speaking, both batteries are in the circuit, so the batteries then *must* be connected in series. Even telephone manufacturers overlook this point when they recommend a pair of cells at each end for distances of from 50 to 300 yards; this means four cells in circuit with the transmitters, which is too much. A low-resistance bell, or a more sensitive adjustment of an ordinary one, would be better advice, as the cells and transmitters are liable, in the course of time, to such variations, that it is not advisable to push matters to extremes. For the trifling extra cost induction-coil instruments prove a better investment when the distance exceeds 55 yards. Manufacturers will doubtless regard this as a very restricted limit, yet in a good majority of installations the length does not exceed that of half a coil of wire. In all other respects there is no limit to the usefulness of these unimposing instruments. Latterly they have been gaining favour with the general public, who up to the present have not fully appreciated their value; many are disposed to regard them simply as "cheaper editions" of the older types of telephones with which they happen to be familiar. This does not do them justice, for they are free from the encumbrances of the latter, and more adapted to being an additional comfort to those who use them. With the introduction of efficient direct working systems, short-distance telephony enters a new stage of its existence. On completing the circuit of a direct working telephone a grating noise is often heard. This is due to an abnormal charge gradually accumulating on the poles of the cells. By giving the batteries some other more constant work to do, or using ones that are already erected for some other purpose, this noise may be avoided.

In Fig. 3 are shown the connections for testing an induction-coil telephone, H, in a similar manner. A separate battery is permanently connected up to the terminals, as also are the "line and return" leads. A pair of receiver cords, with tags at each end, may be conveniently used for making temporary connections to the instrument

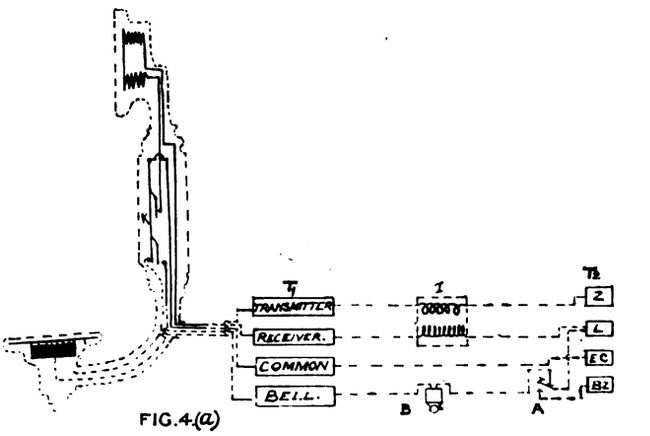


FIG. 4 (*a*)

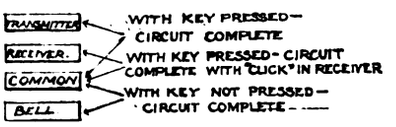


FIG. 4 (*b*)

T1, micro-telephone terminals; T2, telephone terminals; I, induction coil; A, ringing push button; K, speaking switch key; B, telephone bell.

that is being tested, care being taken to make the cords of unequal length, so that the tags will not complete the battery circuit when not in use. To the micro-telephones an undue amount of faults are attributed; these also prove a source of trouble to contractors when they have to place a new one on an instrument. It is not advisable to take them to pieces for any reason; they should rather be returned to the makers. The internal wiring of one for use with an induction coil instrument is shown in Fig 4 (*a*). Inside the telephone there are terminals to which the ends of the flexible cords are attached, as shown; to the right of these is shown a simple outline of the connections inside the instrument to the terminals of the same. It will be noticed that the ringing push-button breaks the local bell circuit when pressed, thus saving battery power; if it did not do so, this bell, and the one at the station signalled to, would be in parallel. The upper end of the "speaking" key is the "common" return connection. When the identity of the ends of the flexible cords is unknown, the end of the "common" connection may be found by the aid of a battery and galvanometer; when this is found the others can be readily identified. In Fig. 4 (*b*) a "key" to the test is given. When micro-telephones have a horizontal transmitter, as shown above, it tends to improve the speaking if they are held in a slightly horizontal position, not quite so vertically as people are disposed to do.

For 10 lines, and perhaps 15 lines, the intercommunication system can be strongly recommended; but it certainly

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does not permit of being extended indefinitely, as is commonly done. The clumsiness and disadvantages of it increase too quickly; besides, it will be found that there is seldom any real reason for using it on the larger size installations. A better plan is to divide such installations into two separate systems—an intercommunication one for the principals and heads of the departments, the other communicating with a central station only for the use of the employés generally; then, if the principals overhear any business conversation, it is not a matter of much consequence. There is no liability of the employés doing so, as they have no access to the system; the latter are prone to use the telephone for their own convenience or pleasure rather than for their employers' advantage. Again, if the matter is examined more closely, it will be usually found that for routine work the employés generally only require to be in communication with a general office, or some such source of administration. What usually happens is that an outline of the requirements of the proposed installation is given to the contractor; with this the latter sets to work, exerting at times quite an amusing amount of ingenuity. If he can discover names enough for them, that alone is a sufficient excuse for proposing extra stations. The result affords mutual satisfaction, until the purchaser has been deceived so many times by not being able to distinguish which of the neighbouring bells is ringing. Mistakes thus arising, he is provoked to reversing the syllables of the expression he has been using.

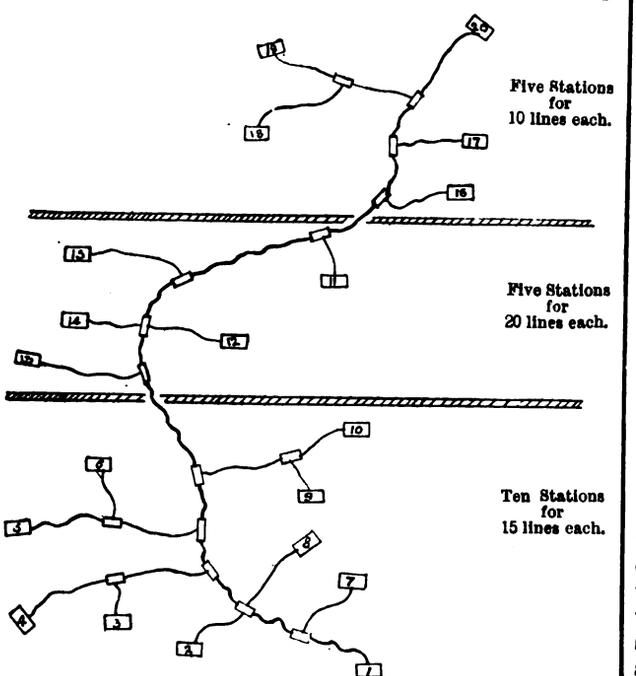


FIG. 5.—Twenty Stations arranged on modified form of the Intercommunication System.

The following original method of wiring is recommended simply as a protest against what can only be adequately termed the *abuse* of the intercommunication system. When the number of stations on the proposed installation counted up amount to, say, 20, the contractor would right away suggest a 20-way intercommunication system. If a little more thought was devoted to examining the routine work of the establishment, it would not be unusual to find that the system could be conveniently divided into, say, three separate systems interlaced (Fig. 5), those stations situated in the administrative part of the establishment being provided with 20-way instruments, those in the second section having, say, 15-way instruments, and those in the third 10-way instruments. Then each station could intercommunicate with all those situated in the same section, and also with those situated in the central section; in other words, the stations in the central section would be able to intercommunicate with all, while those in the other sections would be able to intercommunicate amongst themselves, and be interlaced with those in the central section.

When wiring such telephone installations, the course for the main cable should be decided beforehand, choosing, as far as possible, a diagonal course (as shown in Fig. 5) between the intermediate stations; a considerable length of cable would thus be saved over running them in what generally amounts to a loop round the stations. In a great number of commercial establishments—for example, large factories—such a telephone system could be arranged to be of as practical use as an ordinary 20-way intercommunication one, the central portion in such cases being the general offices, with which all stations require to communicate; the separate departments have, it must be admitted, little intercourse with each other. By adopting this system the cost of the installation would be considerably reduced by lessening the cost of the multiple-cable, and, to a smaller extent, the cost of the telephones. The saving effected over the ordinary method is a function of the degree to which it is found expedient to adopt the system described.

*(To be continued.)*

## ARMATURE REACTION.*

BY EDWARD EUGÉNE BROWN, MEMBER.

In my address to you at the beginning of the session, I promised later on in the session to read a portion which I had left out owing to the length of my paper. When I came to write this paper, I found the subject was hardly to be treated within the limits of the brief time at my disposal this evening. However, I hope, without claiming any originality, to make it sufficiently interesting to the members of the local section.

It was known at an early date in the study of electrical machinery that sparking at the brushes of continuous-current machines was caused by the self-induction of the coil short-circuited by the brush, the brush being placed at the point where the reversal of the current takes place, which is necessary to convert the alternating current into a continuous one, this reversal consisting in the dying out of the current in one direction and the rising of the current to its full value in the other direction. The self-induction of the coil retards the action, and if the circuit of the coil is broken before the action is complete, then a spark at the brush will occur. It was known that, to prevent this sparking, a lead or forward movement if a dynamo, or a backward movement if a motor, must be given to the brush from the neutral or symmetrical line between the pole-pieces. Further, that this movement must bring the coil into a magnetic field, which neutralises the self-induction of the coil, and so prevents sparking.

The subject had been most deeply investigated by the mathematical physicists, and equations with numerous constants to be determined by experiment were offered to the designer, but none of these were in a useful form, and, moreover, they did not agree, giving such various values as to be useless; and even now, although the subject has been skilfully handled, and is in a form that is extremely useful to designers, it cannot yet be said to be complete. The *a priori* calculation of the self-induction of a coil of such a shape as an armature coil is very difficult, depending as it does on the permeability of the medium surrounding the coil, the varying shape of the coil, the mutual induction in neighbouring coils, its position in the slot, and the shape of the slot; but it has been demonstrated that the self-induction does not alter its value to any great extent whether the armature is moving or still—this has simplified very much the calculation. We wish to determine then what is the number of lines linked with the turns per ampere? Various values, deduced from experiments, have been given—those by Mr. Hobart as four lines per ampere per centimetre length of the embedded part of the coils, and ·8 lines for the free ends of the coil. From these values can be worked out the inductance and the E.M.F. of the coil, or the reactance voltage, as it is termed, from the formula

$$2\pi n L C = \text{reactance E.M.F. in volts,}$$

where L = inductance in henrys;
C = current in the coil;
$n$ = frequency of commutation;
$2\pi n L$ = reactance in ohms.

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, May 15.

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This formula supposes that the current in the coil falls as a sine curve, and this is doubtful—any variation may alter the value very much. This formula has been simplified by Mr. Mavor to

$$\text{Reactance voltage} = \frac{E\,C\,f\,m}{d\,F},$$

where E = total E.M.F. generated in armature in volts;
C = total armature current in amperes;
$f$ = induction field in C.G.S. lines per centimetre per length of slot due to one turn;
$m$ = armature turns per commutator section;
$d$ = diameter of core measured;
F = average flux taken over the whole of the surface of the armature in C.G.S. lines per square centimetre.

Or again, $\text{Reactance voltage} = 2\,\pi\,n\,(e + \cdot 1\,f)\,\frac{E \times C}{F}$,

where $e$ = embedded length of conductor;
$f$ = free length of conductor;
F = armature C.G.S. lines.

It is not actually decided what is a satisfactory value for the reactance voltage, except that it should be as low as possible and probably not higher than six volts as a maximum. If below three volts, and the machine has other good constants, the brushes may be placed in the neutral zone, and will run sparklessly—without movement from no load to even an overload.

There is the limit of reduction to all the factors which make up a low reactance voltage when we arrive at one turn per section, and have made the armature as short as possible, so that if the speed is high we cannot keep the reactance voltage low enough so as to be neutralised by the carbon brushes; or if the speed is too high to prevent the use of carbon brushes, owing to the difficulty at such a high speed in securing a good contact with the rigid surface of the carbon, then we must rely upon moving the brushes, so that the coil is in a fringe of the field, to get a reversing E.M.F. to oppose the self-induction voltage of the coil. At no load this fringe of the field would cause sparking, as there is no reactance voltage to oppose it, so that fixed position of the brushes cannot thus be obtained. Moreover, it is found that as the load increases so must the brush be moved forward. This is caused by the field necessary for commutation moving away in the direction of rotation as the load on the armature increases. So that, unless the reactance voltage can be kept very low, we must take means to keep down the armature reaction which causes the distortion of the field.

The contact resistance of the brush is an important factor in commutation. With metallic brushes, such as copper gauze or even brass gauze, this resistance can be but little relied on to keep down the short-circuited current or to allow it gradually to reduce before reversing. For this purpose carbon brushes are mostly used. These can be made of various specific resistances, or varied in resistance in their thickness, so that across the thickness they have a very high resistance, but longitudinally they have a low resistance. The density at the surface cannot be anything like as high as that of metallic brushes—not more than 50 amperes per square inch as a maximum, 30 amperes being mostly used, but lower is preferable. If run too high, they get red hot at the tips and disintegrate. Mr. Hawkins gives a formula which includes the brush contact, R:

$$\frac{R\,T}{L} > 02 \text{ as a minimum,}$$

where T = total time of short-circuit in seconds;
L = self-induction in henrys.

The numerical part often reaches 2 with carbon brushes, but should not be less than 1; but, of course, the number has to be decided by the conditions in any individual case, depending upon the current and voltage, the volts between the commutator segments being an important factor in commutation.

With the high speeds used for turbo-generators it is impossible to keep down the reactance voltage, and this is the reason why I have brought the subject before you as interesting at this time. Whilst the speeds are kept low, as in dynamos coupled to ordinary reciprocating engines, there has been little necessity for considering means for reducing armature reaction, carbon brushes fulfilling every requirement.

The conductors on an armature act like a separate magnet opposing the field magnet, but it is preferable to regard the whole magnetic circuit of the field magnet and armature as one, the conductors on the armature being so disposed that they form a belt, which tends to distort the magnetism in the gap where the armature revolves. If the brushes are given a lead, then the conductors between the double angle of lead—that is, on each side of the neutral line—act as demagnetising turns opposing the field. In the old two-pole smooth-core dynamos we used to take the value of these back turns as one-sixth of the ampere-turns on the armature, but, of course, as it depends on the amount of lead, it should be determined for each winding, and can only be approximately calculated, but near enough for practical purposes.

Some writers treat the subject by calculating the lead as if just under the forward pole-piece, but a dynamo with so great a lead could hardly be satisfactory; the lead should never be greater than half the distance between the neutral point and the tip of the pole-piece, but the shape of the pole-piece has great influence on the lead. In slotted cores the reaction is generally greater than in smooth cores, but the saturation of the teeth will prevent excessive reaction. These back or demagnetising turns can be compensated for by increased field winding, either from the shunt or series coil. The conductors at right angles to the belt of back turns form the distorting or cross magnetising turns. These are the turns which drive away the field from the leading pole-tips, and so necessitate the continual movement of the brushes, the leading tip is weakened and the trailing tip strengthened, the induction being driven across the pole from one side to the other.

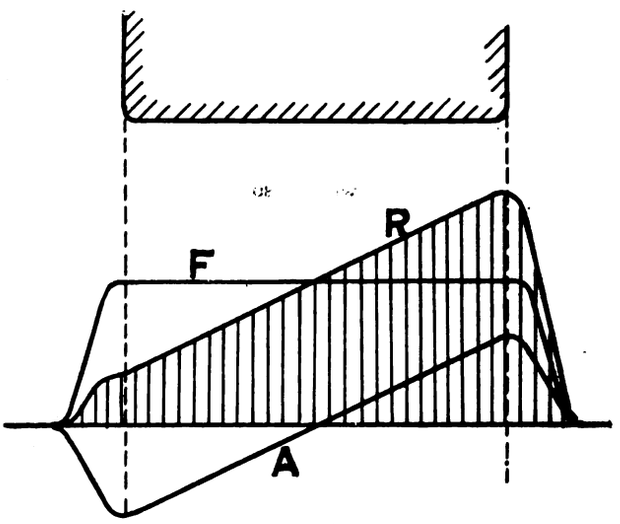


FIG. 1.

The diagram (Fig. 1) shows the resultant curve from the induction on the field and the cross induction of the armature ampere-turns. Assuming that the induction is equal on every part of the pole-piece, the field due to the magnets is shown by the Curve F, that due to the cross magnetising turns on the armature by A, and the combined Curve R by the shaded part; it will be seen how very much diminished the induction is in the leading pole-tip, and may be so much weakened as to render commutation impossible. Fig. 2 shows the result of too large a load on the armature, increasing the cross magnetisation till the field for commutation is in the wrong direction. A slot parallel to the path of the lines in the middle of the pole-piece, putting reluctance in the path of the distortion, would alter the curve materially, and might cure a sparking machine by furnishing a positive field at the point necessary. This is shown in Fig. 3, and is the same machine as shown in Fig. 2, but with the magnet slotted through.

Various ways of shaping the pole-shoes have been used—by diminishing the pole area so as to concentrate the induction, or boring the armature space elliptical so as to

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have a greater bore at the tips than at the middle, tending to throw the lines further out towards the neutral zone, thus providing a field for commutation without excessive lead. In connection with slotting the pole, a good design is to form the magnet of a multipolar into separate horseshoes, which would be like slotting the poles right through. These separate magnets could be quite short and the coils close to armature, preventing leakage. But the most successful alteration to the magnets is to provide auxiliary poles, forming a field exactly at the place required by the coil that is being commutated. These extra poles should be in the circuit of the armature, so as to provide a field increasing with the armature current to counteract the reactance voltage of the coil, permitting the current in the coil to reverse properly. It is necessary to scheme these additional poles so that the leakage is minimised, as they would tend to largely increase the leakage of the main magnets.

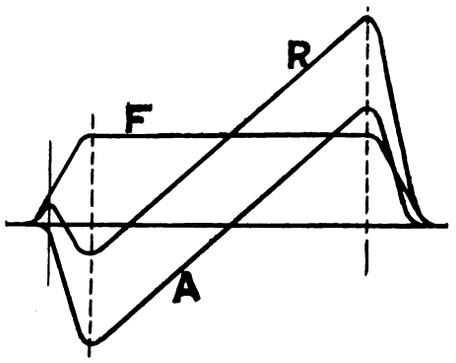


FIG. 2.

An ingenious method has been used by Mr. Sayers of introducing some extra turns on the armature, which are not in the armature circuit as a whole, but are between the commutator segments and the armature coil. As these additional turns are wound somewhat forward from the short-circuited coil, and in the neighbourhood of the pole-tips, they get the necessary field to neutralise the reactance voltage of the coil. It is difficult to see how this can work satisfactorily, as at small loads it provides the field where it is not wanted, which would cause sparking; in fact, the additional coil alone has not solved the problem, and extended pole-pieces have been used in conjunction with the device.

To wind coils round the armature in as close proximity as possible so as to neutralise the cross magnetisation has been often proposed. There are considerable structural difficulties. An early attempt was in a machine made by

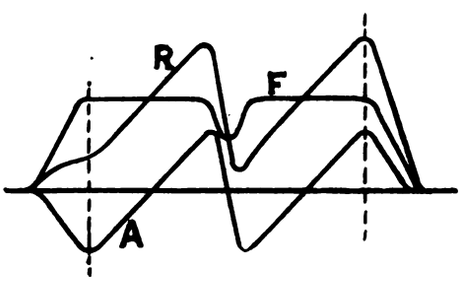


FIG. 3

Eickemeyer. Coils in series with the armature wound on that part of the pole which is weakened by the armature turns, thus preventing the loss of field necessary for commutation, have been proposed in various forms. In America the Thomson-Houston Company, in 1887, used inclined, or horse-collar, coils round the pole-pieces as near the armature as possible. Coils wound in slots in the pole-pieces have been suggested and used in various ways, but were difficult to arrange, and generally failed because the number of turns necessary could not be got in without diminishing the section of the pole-piece, or causing great leakage; also there was difficulty in ventilating these coils to keep down the temperature. In some plating dynamos of large current, where only a few turns are necessary, they are more successful. So nearly all these devices were abandoned, as good machines with sparkless running and fixed lead could be designed on ordinary lines if due regard were made to getting a strong field with a sufficient number of sections in the commutator.

Max Déri, of Vienna, in working out a combined alternating and direct current machine, thought of the plan of designing a direct-current machine with compensating winding in the pole-pieces, by using a field magnet in the form of a stator of a revolving-field motor, but the armature just as the ordinary direct-current winding. The exciting shunt coils would be wound to form the necessary number of poles, but the compensating winding in series with the armature would be wound in every slot, and would form a winding whose centre would give a pole somewhat backward from that of the shunt winding, thus neutralising the shifting of the field. In an exhaustive paper on the subject Dr. Friedrich Eichberg, of Vienna, gives a complete analysis of the system, and compares the relation

$$\frac{\text{magnet ampere-turns}}{\text{armature ampere-turns}},$$

where he states that in modern machines the proportion is of the value of about 1 to 5, but with special attention to design can the value 1 to 3 be obtained. Dr. Eichberg's analysis of the reactions is very interesting, and worth quoting. He sums up thus:

"(*a*) The flux through the short-circuited coil is

$$F_s = \frac{4\pi}{10} \cdot \frac{N J}{\Sigma m};$$

$\Sigma m$ = total magnetic resistance of the spreading field;
N = number of turns in short-circuited coil;
J = current in short-circuited coil.

In general, neither $\Sigma m$ nor N is a constant quantity, and J depends on the number of turns in the short-circuited winding. For the simplest case of commutation is N and $\Sigma m$ constant, and J assumes, by going through all values from 0 upwards, a positive to an equally large negative value. From this simple case we form the base for the following. The E.M.F. of self-induction or reactance voltage is

$$e_s = \frac{2 F_s \cdot N}{t} \cdot 10^{-8},$$

where = the time of short-circuit. If $b$ = the brush thickness on the circumference of the commutator, and $v$ the peripheral speed of same, $t = \frac{b}{v}$, and therefore

$$e_s = \frac{2 F_s \cdot N \cdot v}{b} \cdot 10^{-8} = 2 \frac{4\pi}{10} \cdot \frac{N^2 \cdot J \cdot v}{\Sigma m \cdot b} \cdot 10^{-8} \quad (A)$$

This E.M.F. is only under the above conditions a constant quantity.

(*b*) We take for the over-compensation an ideal case, that the armature and compensation winding have the same axis which is vertical to the axis of the exciting field. The application to other cases is not difficult.

If $N_c$ and $N_a$ be the total number of conductors in the compensation winding and armature windings respectively, related to the full armature current, $J \cdot 2a$, where $2a$ is the number of armature circuits, the compensation windings obtained from the commutating field is consequently

$$\frac{J \cdot 2a \cdot (N_c - N_a)}{2p},$$

and all windings $N_c - N_a$ operate fully so far as the commutating results in the ideal neutral zone.

$$\frac{N_c - N_a}{2p} = N_0$$

are then the over-compensation turns per pole to the full armature current. $2a \cdot N_0 = n_0$ is the number of over-compensation turns per pole related to the current J. The cross-section of the commutating field is $b \cdot l$, where $b$ again represents the brush thickness related to the armature circumference and $l$ the length of the armature.

If $B_c$ represents the flux of the commutating field, then we have the equation

$$b \cdot l \cdot B_c = \frac{4\pi}{10} \cdot \frac{n_0 \times J}{\Sigma M} \quad . \quad . \quad . \quad (B_1)$$

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$\Sigma M_c$ is the magnetic resistance of the commutating field at the armature circumference of the brush breadth, $b$, and armature length, $l$. The E.M.F. induced through the movement of the short-circuited coil is

$$e_1 = B_c \cdot l \cdot v \cdot N \cdot 10^{-8} \quad . \quad . \quad . \quad (B_2)$$

If we now introduce $(B_1)$ and $(B_2)$ we get

$$e_i = \frac{4\pi}{10} \cdot \frac{n_0 \cdot J}{\Sigma M_c} \cdot \frac{1}{b \cdot l} \cdot l \cdot v \cdot N \cdot 10^{-8}$$

or,

$$e_i = \frac{4\pi}{10} \cdot \frac{n_0 \cdot J \cdot v \cdot N \cdot 10^{-8}}{b\,(\Sigma M_c)} \quad . \quad . \quad . \quad (B)$$

This is also an E.M.F. of constant quantity, and is, therefore, capable of annulling the reactance voltage. If we take the equation A = B we get

$$2 \cdot \frac{4\pi}{10} \cdot \frac{N^2 \cdot J \cdot v \cdot 10^{-8}}{(\Sigma m) \cdot b} = \frac{4\pi}{10} \cdot \frac{n_0 \cdot J \cdot v \cdot N \cdot 10^{-8}}{b\,(\Sigma M_c)}.$$

Shortening this we get

$$\frac{2N}{n_0} = \frac{\Sigma m}{\Sigma M_c}, \text{ or } \frac{n_0}{N} = \frac{2 \cdot (\Sigma M_c)}{\Sigma m} \quad . \quad . \quad . \quad (C)$$

which means that the number of compensation turns per pole is in proportion to the number of ampere-turns in the short-circuited coil, as twice the magnetic resistance of the commutation field is in proportion to the magnetic resistance of the field which produces the reactance voltage. It is equally important as interesting that this relation is completely independent of the magnitude of the current to be commutated and the peripheral velocity of the armature. For the case of a commutation field equally strong in all places (therefore homogeneous), which does not exist in practice, but can be thought of in theory, we could divide both sides of equation (C) by $\frac{d\pi}{2p \cdot b}$, and get

$$\frac{\frac{n_0}{N \cdot d\pi}}{2p \cdot b} = \frac{\frac{2 \cdot (\Sigma M_c)}{d\pi} b \cdot 2p}{\Sigma m}.$$

The denominator on the left side then means that the number of armature turns related to the current J per pole, we will call $n_a = \frac{N \cdot d\pi}{b}$.

The expression $\frac{\Sigma M_c}{d\pi} b \cdot 2p$ represents the magnitude of the magnetic resistance of the main field (which is above mentioned as being homogeneous). We will call $\Sigma M$. Then is

$$\frac{n_0}{n_a} = 2 \cdot \frac{\Sigma M}{\Sigma m}.$$

That is, for this case the proportion of the over-compensation turns per pole to the armature turns per pole equals the proportion of twice the magnetic resistance of the main (total) field to the magnetic resistance of the field produced by the reactance voltage.

If we put $n_0 = n_c - n_a$, then

$$\frac{n_c - n_a}{n_a} = \frac{2 \cdot (\Sigma M)}{(\Sigma m)}; \text{ or } \frac{n_c}{n_a} = \frac{2 \cdot (\Sigma M) + (\Sigma m)}{\Sigma m}.$$

Since

$$\frac{n_c}{n_a} = \frac{N_c}{N_a},$$

so we get

$$\frac{N_c}{N_a} = \frac{2 \Sigma M + \Sigma m}{\Sigma m} \quad . \quad . \quad . \quad . \quad . \quad (D)$$

This proportion $\frac{N_c}{N_a}$ is at the same time the proportion of the copper in the compensation turns to the copper in the armature turns, which, therefore, substantially depends on the magnetic disposition of the machine."

Prof. Ryan, to whom we owe much for the investigation into armature reaction, proposed to wind these compensation coils in slots in the pole-pieces, using an ordinary radial-pole field magnet, so that every element of the armature winding could find a corresponding opposing element in the pole-piece, thus completely neutralising the armature effect on the field. Ryan also added a pole on the point of commutation to provide a reversing field, and thus enabled a very large overload to be got out of the machine with a fixed point of commutation. This method is probably the most successful in the use of windings in slots on the pole-pieces.

Various modifications of the slotted pole windings have been proposed and used with more or less success. Dynamos for very high speeds have been made by Messrs. Brown, Boveri, and Co., of Baden, who have sent me photographs of their machines. They are wound on the Déri plan. The best results have been obtained with the shunt separately excited—they run at 3,000 to 3,500 revolutions per minute with fixed brushes. The shunt coils

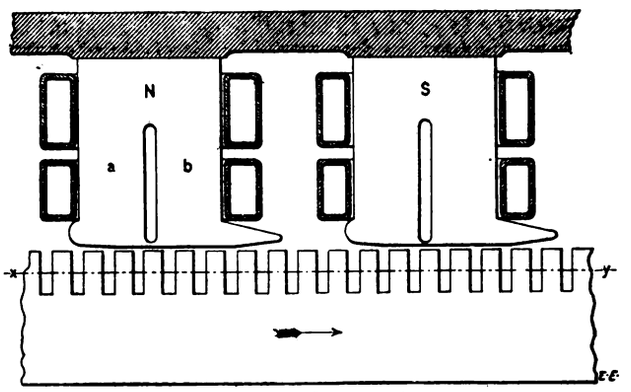


FIG. 4.—Development of 50-kw. Lundell Generator.

are not spread in the slots, but wound across several slots to form a two or four pole field as desired; one tooth between the shunt windings serves as a reversing pole. All makers of turbo-generators of the direct-current type use similar methods—the Austrian Union Company, Oerlikon Company, Parsons and Co., amongst others. Sautter, Harlé, and Co., of Paris, use an ordinary four-pole field with reversing poles of considerable size between the usual poles. Although these additional poles must cause considerable leakage, yet it is a question whether this is not the cheapest form of field, and it certainly can be made effective; motors are being made by this method, and stand considerable overloading and reversal of direction of rotation without sparking.

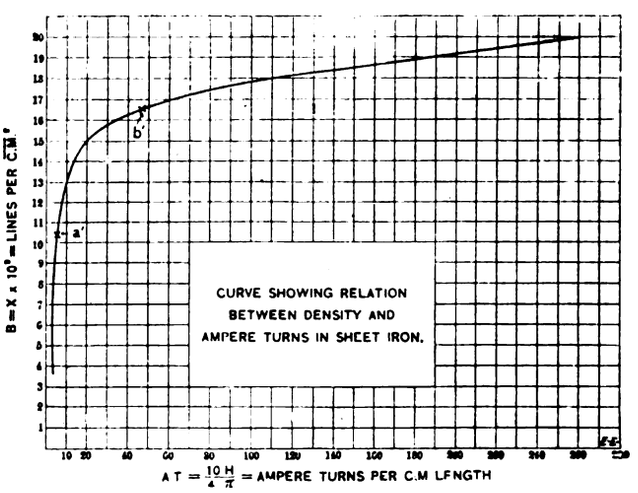


FIG. 4A.—Sheet-Iron Magnetisation Curve.

This is especially useful for motors with intermittent loads, and where reversal of the direction of rotation is required, such as for lifts, cranes, cogging mills, etc. For ordinary motors, with longer constant loads, heating will come in before the large load, so that ordinary methods suffice, and very high speeds are not necessary in motors, except in some rare case for centrifugal fans and pumps, which can be treated as special.

A very successful means of securing a fixed lead of the brushes is found in the machine designed by Mr. Lundell (Fig. 4). The pole is slotted radially into two equal parts, but the forward part has the pole-piece extended, so that this half, having an air-gap of lower reluctance than the other half,

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has at no load the greater number of lines of induction passing through it. By this means it is at a high saturation point, but as the load is put on the armature the excitation is increased either by series winding or by increasing the shunt current. This increased excitation then affects the

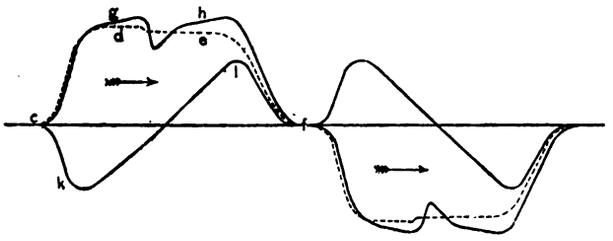
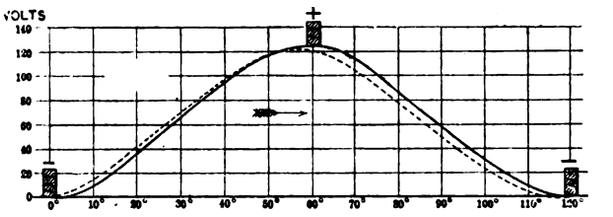



FIG. 5.—Calculated Pole-Face Induction.

back part of the pole-piece, because being less saturated than the forward part, in spite of its greater air-gap reluctance, its permeability makes its total reluctance less Thus the zone of the commutating space is kept constant, and no change in lead is necessary for change of load.




IG. 6.—Distribution of Potential around Commutator.

The diagram (Fig. 4A) shows a magnetisation curve. The back part of the magnet core is worked on the part of the curve marked $a^1$ and the front part at $b^1$, the knee of the curve being avoided. Fig. 5 shows the resultant curves due to armature and field at no load, and Fig. 6 the curves of potential at the brushes, where the movement of the

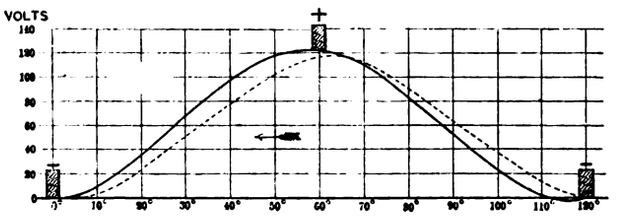



FIG. 6A.—Distribution of Potential around Commutator, Generator running in wrong direction.

necessary commutating field is so small as to give constant lead. In this form of magnet the values of the induction used are in lines per square inch: pole-face, 55,000 to 59,000; pole-core, 85,000 to 90,000; yoke, 80,000 to 85,000; armature core, 85,000 to 90,000; armature teeth, 130,000 to 140,000. There is no loss of efficiency in this

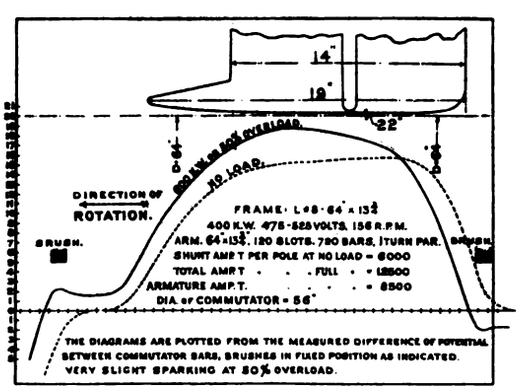



FIG. 7.

method, but an actual gain, as the polar arc can be made as much as 78 per cent. of the polar pitch, thus keeping down the gap reluctance.

Satisfactory machines have been made of dimensions much smaller than the ordinary sizes for the output and speed, such as 125 kw., 450 revolutions, with the armature 26½in. diameter, 9½in. long, which would be about 39in. by 8in. in ordinary practice; 400 kw. at 400 revolutions, armature 44in. diameter, 11½in. long; 420 kw. at 320 revolutions, 52in. diameter, 11½in. long; 400 kw. at 156 revolutions, 64in. diameter, 13¾in. long. A diagram of the latter dynamo is shown in Fig. 7. The curve on dotted lines gives an accurate idea of the flux distribution through the armature teeth and the armature conductors at no load. The conformation or shape of this curve is wholly dependent on the flux from the poles, as there are no disturbing currents in the armature conductors. The curve in full lines represents the resultant flux through the teeth, and the armature conductors at 50 per cent. overload = 600 kw. This flux is dependent upon the flux from the poles and upon the disturbing influence of the currents in the armature conductors. The latter are causing a cross magnetising and a demagnetising effect on the flux from the poles as well as a disturbance (extra flux) in the teeth at or near the points of commutation, as clearly shown by the peculiarity of the curve at these points. The development of the pole-face on a straight line shows the air-gap to be ·22in. in the centre of the pole. The curves are plotted from the measured differences of potential between commutator bars. The small distortion at 50 per cent. overload considering the large armature reaction, which amounts to 12,750 ampere-turns per pole, shows the value of the principle, which is very satisfactory for dynamos, or motors which run in one direction only, at ordinary speeds. Whether the principle could be used for dynamos at the speeds used for steam-turbines has not yet been tried, but by careful design the difficulties might be overcome.

## FORTHCOMING EVENTS.

FRIDAY, MAY 26.

**Institution of Electrical Engineers.**—At 5 p.m., annual general meeting.

**Physical Society.**—At 3.30 p.m. (National Physical Laboratory, Bushy House) the following demonstrations will be given: (1) "The Specific Heat of Iron at High Temperatures," by Dr. Harker; (2) "The Measurement of Small Inductances," by Mr. Campbell; and (3) "Two New Optical Benches," by Mr. Selby.

**Royal Institution.**—At 9 p.m., "The Development of Spectro-Chemistry," by Prof. J. W. Brühl.

SATURDAY, MAY 27.

**City and Mechanical Engineers' Society.**—At 2 p.m., visit to Messrs. D. Napier and Son's motor works, Acton Vale.

**Electrical Engineers (R.E.V.).**—Exhibition of corps work at headquarters.

TUESDAY, MAY 30.

**Optical Convention.**—At 8 p.m., opening ceremony (Northampton Institute).

THURSDAY, JUNE 1.

**Royal Institution.**—At 5 p.m., "Electromagnetic Waves," by Prof. J. A. Fleming (Tyndall Lecture II.).

**Chemical Society.**—At 8 p.m., general meeting.

**Incorporated Municipal Electrical Association.**—June 27-30, annual convention.

## NEW COMPANIES REGISTERED.

**S. M. H. Tramway Syndicate, Limited.**—Capital, £1,000. Object: to apply for powers to construct light railways or tramways in Durham, to equip, maintain, and work the same by means of electrical or other power, etc. Registered office: 13, St. Helens-place, E.C.

**Kerry Electric Supply Company, Limited.**—Capital, £2,000; and without articles of association, for the purpose of acquiring and taking over as a going concern the business of generating and supplying electric light and electric energy now carried on by the Killarney Electric Lighting Company, Limited, at Killarney, county Kerry. Registered office: Killarney, co. Kerry.

### Lien Registered.

**Auto-Electric Rifle and Target Company, Limited.**—Lien registered May 11 for £100 7 per cent. debentures, part of £5,000; amount previously issued, £2 800; no trustees; charged on the undertaking and all the property, present and future.

### Lien Discharged.

**National Electric Construction Company, Limited.**—Discharge registered May 12 of mortgage dated Aug. 4, 1904, for £20,000.

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### TO CORRESPONDENTS.

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## THE LONDON POWER BILLS.

The Select Committee of the House of Lords under the chairmanship of the Earl of Camperdown completed their consideration of the London Power Bills on Tuesday last, and reported certain of these Bills to Parliament. Amongst the eight or nine applicants for powers for the supply of electricity in bulk appearing before the committee the most successful has been the Administrative County of London and District Electric Power Company. In our issue for March 24 this year we published a map of the very large area over which this company wish to supply. The committee have passed its application for rights over the whole of the eastern portion of this area, which was termed the industrial area. A small exception is made in the case of Stoke Newington, which has been given to the North Metropolitan Power Company. It has also secured the right to supply in bulk to authorised distributors in all that portion in the west of London which lies to the south of the River Thames. Approximately it may be said that the County of London and District Electric Power Company has secured about seven-eighths of the area applied for. The Metropolitan Electric Supply Company have been granted by the committee that portion of the western non-industrial area which lies to the north of the river. The committee have in passing these Bills forward to Parliament inserted clauses which more or less protect existing undertakers. The chief provisions drafted to secure this object are to be found in Clauses 48 and 48A, which are reproduced elsewhere in this issue. The companies which have already the power to supply electric energy within the area affected have not agreed to these clauses, and distinctly stated through their counsel that they could only be efficiently protected by the striking out of their areas from the Bill. Under Clause 48A the onus is left with the Board of Trade to determine when competition between existing undertakers and the power company shall be allowed, and the terms and conditions which shall be adopted for the protection of the present distributors. The sections of this clause are worthy of careful perusal. Thus it is clear from the first section that the cost to the consumer of electrical energy for power purposes is to be the ruling factor which is to influence the Board of Trade in allowing the new company to come into any area. It was ably argued by Mr. J. D. Fitzgerald that one method of protecting existing undertakers would be to insist that if the power company were to supply the manufacturer direct at certain schedule prices they must also give, if required, a supply in bulk to the authorised distributor at such a price that he would be able to compete at these rates. Under Clause 3 the power company can be prevented from cutting rates in any one district in order to get the consent of the Board of Trade to supply, and then increasing the rates when they have ousted the present undertakers. It is true that under this clause the Board of Trade is empowered to give their consent to an increase in charges, but as they would have the whole facts before them they could prevent preferential rates being given to any district. Under Clause 4 the new company would have to give a supply wherever demanded, and hence would be prevented from picking and choosing which consumers they would supply and which consumers it would not pay them to reach. Under Clause 5 the company can be compelled to lay mains in certain streets within a reasonable time. In another clause elsewhere in the Bill it is further provided that "if the company do not within the prescribed period comply with such requirements, the Board of Trade may order that the powers of the company to distribute energy within such area shall cease." The general effect of the two clauses in question, if the

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Bill eventually survives the strenuous opposition which it will meet in the House of Commons, will be to grant very great discretionary powers to the Board of Trade In fact, before the power company commence operations on a large scale, they would need to convince the Board of Trade on the very matters which the committee have been hearing evidence for the last two months. The ultimate good which a cheap supply of electric power would confer on Greater London cannot be too strongly insisted on, and this will be duly recognised by the Board of Trade. When it comes, however, to competition with undertakers who are handicapped by the fact that they have had to bear heavy pioneering costs, it is exceedingly difficult to reconcile conflicting interests. It seems to us, however, that provided the power supply company are forced to give existing undertakers a bulk supply at such rates that they can afford to throw out of service their existing plant and still pay out of profits the capital charges on the same, then consent should be given. There is no doubt that the success of power distribution on the Tyne under the engineering skill of Mr. C. H. Merz has led to the committee's decision, and this gentleman is to be congratulated on having convinced the Select Committee of the feasibility of his scheme for London. Whichever way the decision of Parliament may go, the result of the fight is bound to be a cheaper supply of electrical energy throughout the London areas. If the Bills pass, the fears of competition will force the present undertakers to reduce prices, and should the opposition succeed in throwing out the Bills this year, they must also reduce rates to remove the temptation for the promoters to try again next session.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### LIGHTNING.

SIR,—Your suggestion that a committee should be formed to collect and consider particulars of the working of lightning arresters is a good one, but why make it a committee of electrical engineers? Why not follow closely the Lightning Research Committee, and select principally members who are not known as experts on the subject? The result might then be as productive of surprising results as the report just issued, especially if the particulars to be considered were also mostly by non-experts. This report is valuable, inasmuch as it provides a ready excuse for any lightning conductor system that may fail, for blame can be put entirely on lightning and not on the man who made a mistake in the application of the system. Moreover, it will be impossible to prove whether the system was applied in accordance with the committee's recommendations or not, since this report is so contradictory that it may be read in any way one likes. So far as it is good it is not new, and so far as it is new it is not good. It is not probable that experts will regard it as the acme of wisdom on the subject.

It is impossible in the necessarily limited space available for a letter to do more than point out two or three of its peculiarities. The fact that Sir Oliver Lodge's preface is at variance with the report that follows is, perhaps, scarcely a matter for surprise, but I may point out that while it is insisted upon that the only means of securing protection is to adopt the complete birdcage system, it is suggested that where heavy expense is not justified two or more conductors might be erected in the ordinary manner, connected by a horizontal conductor, and the metal work of roof and rainfall pipes connected and "earthed." For a tower, spire, or chimney shaft two conductors are recommended. Now, neither of these form a cage system. Are we to suppose that the committee are recommending what they believe will not be effective?

The cage system is not new. It may be said to date back to Faraday, and is undoubtedly the most perfect system of protection, because, when, it is adopted, there is no necessity for the careful consideration that an expert finds it necessary to bestow on a case. All that is required is to apply the system in its entirety, and no heed need be taken of alternative paths or complications of metals in the building. It is essentially the novices' method of protection, but I presume that no one would urge seriously that the bastard cage system that the committee may be presumed to recommend would be equally effective. Was it not tried by Melsens, and failed?

The true birdcage system would be prohibitive in cost in most cases where it was possible of application, and no electric light leads or telephone wires could be taken into the buildings, since they could not be connected; while in many cases, such as buildings not entirely detached, it would be impossible of application.

As regards joints, the committee may be presumed to confirming and even accentuating the necessity for connections that will show no resistances, yet they appear to consider the resistance of joints so unimportant that they do not advise their being tested when the "earths" are tested.

That the report is not more satisfactory is not to be wondered at considering the very meagre, and in some cases absolutely incorrect, particulars of the cases that were sent by reporters. The committee (or one of its members) appears to have been trying ever since its inception to disturb public confidence in the efficacy of conductors, either to justify its existence or for another purpose that is probably obvious. Much has been made in (possibly inspired) newspaper paragraphs of the fact that the committee received reports of 125 cases of damage by lightning in the three years, out of which 40 were to buildings that were supposed to have been efficiently protected. That my statement is warranted is, I think, shown by the fact that the committee states it deems it unnecessary to go into details of the "unprotected" cases, but appends a selection from the list of "protected" ones, and then gives details of 34, out of which 26 only are justifiably placed in this list. What the 16 cases not specified were we are, I suppose, not permitted to know, but we may presume they are on a par with the detailed account, sent to the committee by one of its members, of damage by lightning to the Houses of Parliament that did not occur!

It would be absurd for me to hazard a guess as to the number of cloud-to-earth lightning discharges that occur in this country every year. Suffice it to say that the number is enormous, and since very lofty structures are admittedly somewhat more exposed to be struck than low ones, and the majority of very lofty ones are provided with lightning conductors, it is reasonable to suppose that if the committee's wholesale condemnation was justified, an alarming number of lightning conductor failures would be reported annually. Now, what are the actual figures?

I can state from a close investigation into the subject, extending over the past 17 years, that from 300 to 400 buildings are damaged by lightning in this country every year, out of which less than a dozen a year had conductors, and these had mostly been in existence for periods ranging from 20 to 60 years, had been fitted by plumbers, ironmongers, builders, and others whose trades did not imply that they were experts, and would have been condemned as inefficient before the accidents by anyone with the faintest pretence to knowledge of the subject. Is a lightning conductor to be regarded as the only contrivance on earth that must be efficient for half a century without attention or repair, and irrespective of whether it was properly applied in the first instance or not.

And what about the cases in which conductors have been struck and have not failed? It may not be generally known that there are usually signs by which one can tell whether a conductor has been struck or not, and that it is quite a common thing to come across those signs I have in my possession three examples, and might have made a large collection but that I did not until comparatively recently think they were of interest. It is not easy, also, to get them because the owners generally like to keep them as curiosities, or say that, as they have answered so well, they will not have them disturbed.

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When the Lightning Rod Conference—which meant well, and only failed through being too brief—commenced its labours, it enquired into the method employed by experts, adopted what was good and rejected what appeared bad. It also made a point of acquiring all the information on the subject that was available. Had the recent committee adopted the same plan, I venture to think it would not have stated that a tube such as it appears to recommend gives as much effective area as the earth-plate recommended by the conference. But does the committee recommend this? And is the tube to be driven a distance of 30ft. below water-level? If so, why add the trickle from the rain-pipe?

Tubular earths were recommended by Spang in America nearly 40 years ago, and I believe they were extensively used there, and yet we hear that lightning conductors have got into disrepute among our Transatlantic cousins owing to the number of failures that have occurred there. They were also used in this country some 20 to 30 years ago, but proved unsatisfactory.—Yours, etc., ALFRED HANDS.

## INDUCTION MOTORS.

SIR,—With regard to the excellent articles by Mr. Rogers on the induction motor, there are one or two points which he leaves somewhat obscure. For instance, the use of the letters R and C on p. 663; is R reactance or resistance, and is C resistance or reactance? This part of his paper is not quite clear to the direct-current man. To fix ideas would Mr. Rogers show some method of simply calculating the following?

A choking coil on a 500-volt circuit takes six amperes but only 2,000 watts; another choking coil on the same circuit takes four amperes 1,600 watts. What current do they take (1) when in series, (2) when in parallel? How do the formulæ given apply?

Lastly, how is the magnetising current got at no load? Suppose the current at no load three amperes on a 200-volt machine, and cos $\phi = \cdot 5$. Can we assume the component at right angles to be the magnetising current and neglect leakage?

I put forward these points as they are generally very obscurely put in text-books, not to say contradictory.—Yours, etc., STUDENT.

## THE LACK OF ADAPTATION IN BRITISH TRADE METHODS.

BY SIMPLEX.

Technology and commercial organisation are so intimately blended in the upbuilding of an engineering firm, that we think no apology is needed for the introduction of such a subject as the present into the pages of a journal devoted to the interests of British electrical engineering. The immediate cause of this note was a conversation which we have had with a gentleman who, though not an Englishman, has for years identified himself with British manufacture, and who by extensive travel in former years has obtained the necessary qualifications to give an opinion of the methods of British engineering trading from an entirely detached point of view. Though we are aware that friendly advice from a stranger within our gates is not always unbiassed by ulterior motives, we are convinced that the remarks which we here record are worthy of serious consideration.

This gentleman, before visiting England, had some experience with British commerce in the Far East, receiving at various times consignments of goods—some of them fragile instruments—packed in such a way that they were either badly broken in transit or damaged by water and rough usage on arrival at ports not always adapted, either in cranage appliances, wharf storage, or the highest class of labour, for the accommodation of delicate goods unless most carefully packed. His experience was that when a British firm was remonstrated with as to the unsuitable manner in which the goods were packed, having regard to the prevailing conditions, a letter of disclaimer for all damage done was received in return, the firm probably stating that the "goods were dispatched in good condition from our works, being carefully packed in a manner which we have found to be sufficient for all reasonable usage." Very possibly: but in some parts of the world "reasonable usage" is too expensive a luxury to be attainable. Such treatment was contrasted with methods of packing adopted by German and American firms: an instance concerning the former country being quoted where the interior of the case was heavily lined, first with sheet zinc, and then with a specially prepared felt impregnated with bitumen, to preserve the goods from water, while a package was received from America consisting of one case within the other, the inner being supported on all sides from the outer by spiral springs, reducing to a minimum the danger of shock to the contained apparatus. These examples illustrate the difference in care in adapting their methods to special conditions displayed by British and foreign firms.

Another point raised was that British manufacturers were inflexible as to the quality of goods supplied to a foreign market. The German custom is to send out a series of qualities of any manufacture which they wish to introduce to a reliable agent, asking him to feel the pulse of the market as to which quality best suits the conditions. Upon his report being received, the manufacturer lays himself out to make that quality. It is clearly understood, both by the maker and buyer, that the goods may not be the best obtainable, but so long as they suit the market they will be supplied in sufficient quantity to meet the demand. In every probability the introduction of a cheap line will lead to the demand for a better quality, enabling the firm to increase its business. The British manufacturer will have nothing of this sort. He makes one grade of goods, and if they do not suit the market he deplores the bad taste of the buyer.

The British manufacturer is slow to understand that at various corners of the world there are other languages besides English. When an Englishmen sends a tender to a French, German, or Russian firm, he sends it in English. When a Frenchman quotes a Russian for any goods, he takes care that language and prices are Russian. As a case in point, our critic instanced the fact recently made public in our newspapers that the German Consul-General in Shanghai has recently written home saying that, as a result of the present war, North China will shortly be much more widely open to trade than in the past, Canton, Hankow, and Tchungking possibly developing into rivalry with Shanghai and Hong-Kong. And this German official, with an intelligent anticipation of events, offers the German Consulate building, the support of commercial experts attached to the Consulate, and competent instructors, in order that German commercial men may learn to speak the language of that Celestial Empire. This forward policy of dealing directly with the Chinese was contrasted by our friend with the condition of things in Hong-Kong. Our informant stated that this British colony, though now the second port in the world, is almost entirely dependant for its prosperity on its shipping interests. The bulk of the profit in trading goes to the Chinese middleman who can talk pidgin English, because the Englishman is apparently unable to speak enough Chinese to get into contact with the actual native buyer or seller.

To take a case nearer home, the undoubted influence exercised by the German Government on that of the Ottoman Empire on behalf of Messrs Krupp in the recent purchase of guns, shows how well recognised is the relation between engineering and national prosperity in Germany. What likelihood is there of official Britain taking so strong a manufacturing step? It is holding the wrong end of the stick to say that if the British Government would similarly support the manufacturer our industries would grow. The Government would like to see something to support; industry and intelligent enterprise must first be shown, and direct pressure brought to bear. The direct advantage to be gained must be demonstrated by the manufacturers before the Government would commit itself to such grave proceedings. Our somnolent firms must be prepared to dance before the Government will consider the question of piping.

So much for our foreign trade methods. Since his residence in England our critic has studied the organisa-

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tion of our firms and educational agencies, and is surprised at the want of correlation between the training system in school and shop. In his words: "You English are essentially a brilliant race of engineers, but you are too stubborn. Your established methods have met former conditions successfully, and you do not see that old landmarks are giving way to new ones." For example, the new engineer must be equally efficiently trained in science, commerce, and industry. But, according to our friend, the educated Englishman hates to dirty his hands. For an ordinary railway journey the clerk buys a second-class season ticket to differentiate himself from the artisan who is travelling with a workman's ticket. Yet the clerk with his nice clothes is, owing to the law of supply and demand, probably getting 25s. a week; the navvy is perhaps earning 7d. an hour for 56 hours a week, time and a quarter for every extra two hours per day, time and a half after that, and double time on Sunday and Bank holidays! As a contrast to that, the German workman will spend some years in a technical school with the single purpose of becoming an intelligent artisan, the result being that a German mechanic is perhaps the best man of any operative in the world to be sent away to erect plant without special technical supervision. Again, an English firm when touting for orders usually sends out a traveller whose commercial instinct far outstrips his engineering knowledge. German firms organise departments of "commercial engineers," whose functions are both to drive bargains and talk intelligent shop

Our foreign critic concluded with the statement: "British trade will flourish. There is no fear that the stamina of the Englishman will desert him when face to face with difficulty. But my association with an English firm causes me to regret very sincerely that so much of the Englishman's difficulty is of his own making."

Is it true, then, that we are "impossible"?

## REPORTING ACCIDENTS IN CONNECTION WITH ELECTRIC LIGHTING.

BY A BARRISTER.

Section 38 of the Electric Lighting (Clauses) Act, 1899, enacts that the undertakers shall send to the Board of Trade notice of any accident by explosion or fire, and also of any other accident of such kind as to have caused, or be likely to have caused, loss of life or personal injury which has occurred in any part of the undertakers' works or their circuits, or in connection with those works or circuits, and also notice of any loss of life or personal injury occasioned by any such accident. The notice must be sent by the earliest practicable post after the accident occurs, or, as the case be, after the loss of life or personal injury becomes known to the undertakers. If the undertakers fail to comply with these provisions, they are liable for each default to a penalty not exceeding £20. The Board of Trade may also, if they deem it necessary, appoint any electric inspector or other fit person to enquire and report as to the cause of any accident affecting the safety of the public which may have been occasioned by or in connection with the undertakers' works, whether notice of the accident has or has not been received from the undertakers, or as to the manner and extent in and to which the provisions of the special order and the principal Act and of the Board of Trade regulations, so far as those provisions affect the safety of the public, have been complied with by the undertakers; and any person appointed under this section, not being an electric inspector, shall, for the purposes of his appointment, have all the powers of an electric inspector under the special order.

There is also another Act which requires notice of any accident to be sent to the Board of Trade in the case of certain employments, and that is the Notice of Accidents Act, 1894. Section 1 of this Act provides that where there occurs in any employment to which this section applies any accident which causes to any person employed therein either loss of life or such bodily injury as to prevent him on any one of the three working days next after the occurrence of the accident from being employed for five hours on his ordinary work, his employer shall, as soon as possible, and in case of an accident not resulting in death, not later than six days after the occurrence of the accident, send to the Board of Trade notice in writing of the accident, specifying the time and place of the occurrence, its probable cause, the name and residence of any person killed or injured, the work on which any such person was employed at the time of the accident, and in the case of an injury the nature of the injury. If any person wilfully makes default in complying with the requirements of this section, he is liable on summary conviction to a fine not exceeding 40s. For the purposes of this section the expression "working day" shall mean a day on which the person injured would, but for the injury, be employed in his ordinary work. The employments to which this section applies are "construction, use, working, or repair of any railway, tramroad, tramway, gasworks, canal, bridge, tunnel, harbour, dock, port, pier, quay, or other work authorised by any local or personal Act of Parliament; construction or repair by means of a scaffolding of any building which exceeds 30ft. in height, or use or working of any such building in which more than 20 persons, not being domestic servants, are employed for wages; use or working of any traction engine or other engine or machine worked by steam in the open air." And by Section 2 of the Act of 1894, if the Board of Trade are of opinion that any other employment in which 20 persons or more, not being domestic servants, are employed by the same employer is specially dangerous to life or limb, the Board may, by order, direct that Section 1 of this Act shall apply to that employment.

Rule 15 of the Board of Trade regulations made under the Electric Lighting Acts, 1882 and 1888, provides that "where any accident by explosion or fire, or any other accident of such kind as to have caused or to be likely to have caused loss of life or personal injury has occurred at any part of any electric line or work, the undertakers shall give immediate notice thereof to the Board of Trade." And Rule 47 provides that "if the undertakers make default in complying with any of the preceding regulations, they shall on conviction be liable to a penalty not exceeding £10 for every such default, and to a daily penalty not exceeding £10. The recovery of a penalty under these regulations shall not affect the liability of the undertakers to make compensation in respect of any damage or injury which may be caused by reason of the default."

Works for generating or transforming electricity come within the Factory and Workshop Act, 1901. Section 149 of that Act, in conjunction with the sixth schedule, Sub-Section 20, classes amongst "non-textile factories," "'electrical stations'; that is to say, any premises or that part of any premises in which electrical energy is generated or transformed for the purpose of supply by way of trade or for the lighting of any street, public place or public building, or of any hotel, or of any railway, mine, or other industrial undertaking." Electric accumulator works have been certified by the Secretary of State to be dangerous or injurious to health. The following special regulations have been issued for such works:

*Duties of Occupiers.*—They shall provide bath and lavatory accommodation with a plentiful supply of hot and cold water, soap, nail-brushes, and towels. They shall provide respirators and overall suits for all persons employed in the operation of mixing. They shall provide gloves and aprons for all persons employed in the occupation of rubbing. They shall see that the gloves are constantly inspected and renewed when defective.

*Duties of Persons Employed.*—In cases where the co-operation of the workers is required for carrying out the foregoing rules, and where such co-operation is not given, the workers shall be held liable in accordance with the Factory and Workshop Act, 1891, Section 9. A good respirator is a cambric bag, with or without a thin flexible wire made to fit over the nose.

It appears from the report of the chief inspector of factories and workshops for the year 1901, that the Dangerous Trades Committee have submitted certain recommendations as regards electrical works, which will be

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found at pp. 28-30 of their report. The following is an extract from the report (p 28):

"*Electrical Stations.*—These important works continue, and will continue, to increase in number and size, especially now that it is made clear by the new Act that any place in which electrical energy is generated or transformed (except private houses) is a factory, and as such under the regulations of Factory Acts. The way to supervision has been paved by calling attention of occupiers and managers to the recommendations of the Dangerous Trades Committee on electrical works, and I annex a report by Mr. Fearon showing how far the recommendations are already generally observed, the difficulties as to others, and making additional recommendations. It is only necessary to add to his report that it is of little use having a card of instructions as to artificial respiration hung up in the works unless the engineers and employés sometimes practice the rules given, so as to know what to do when occasion requires without reference to the card."

One effect of putting electrical stations as above defined within the Factory and Workshop Act, 1901, is to require notice of accidents causing death or bodily injury within the meaning of Section 19 to be given to the inspector for the district. The above provisions are independent of the notice to the Board of Trade of accidents and enquiries into the same provided for by Section 38 of the schedule to the Electric Lighting (Clauses) Act, 1899, previously referred to. The latter section covers a wider field than the former.

Section 19 of the Factory and Workshop Act, 1901, provides (1) that where there occurs in a factory or workshop any accident which either (*a*) causes loss of life to a person employed in the factory or workshops, or (*b*) causes to a person employed in the factory or workshop such bodily injury as to prevent him on any one of the three working days next after the occurrence of the accident from being employed for five hours on his ordinary work, written notice shall forthwith be sent to the inspector for the district; (2) if the accident causes loss of life, or is produced either by machinery moved by steam, water, or other mechanical power . . . notice shall forthwith be sent to the certifying surgeon for the district. The notice shall state the residence of the person killed or injured, and the place to which he has been removed. The penalty for not giving the proper notices is a fine not exceeding £5.

Sub-Section 1 (*b*) is similar to part of Section 1 (1) of the Notice of Accidents Act, 1894, referred to earlier. That Act, however, does not apply to factories or workshops, but only applies to certain employments specified in the Act. It would seem from the Factory Act that every "bodily injury" caused by an "accident" which prevents a person from being employed during the statutory period must be reported, no matter how the injury arose.

## LONDON ELECTRIC POWER BILLS.

As announced briefly in our issue of last week, the Committee of the House of Lords struck out a number of Power Bills on Thursday, 18th inst. The two principal survivors are the Administrative County of London and District Company and the Metropolitan Electric Supply Company. It was decided that the latter company should take those portions of the non-industrial areas to the west of London over which they sought powers, and that these should be omitted from the Administrative County of London area

These two Bills were reconsidered by the committee on Monday last, after the parties interested had had an opportunity to formulate reasonable suggestions to obviate the hardship that, in the opinion of the committee, must arise from the entry of a new power company into an area in which the undertaking of a company was subject to purchase by the local authority.

Mr. BALFOUR BROWNE, K.C, who appeared for the various companies, said the consideration his clients had given to the subject induced them to believe that there was no way to obviate the hardship but by leaving out of the Administrative Bill those districts in which existing companies were under statutory powers of purchase.

Mr. RAM, K.C., on behalf of the Metropolitan Electric Supply Company, said they had decided to omit Kensington from their area, as this was the only district in which a company had power to supply, but they reserved the right to carry mains through the area.

Mr. FITZGERALD, K.C. (for the Administrative County of London Company), said that with regard to outside districts to the west of London, like Teddington, Twickenham, and Isleworth, his company was not opposed by the existing supply companies. He submitted two clauses to the committee which, he contended, would meet the hardships complained of, and which were, after discussion, accepted by the committee. The first was Clause 48 of the Bill, which was amended to read as follows:

"48. The powers of the company for the supply of energy shall be subject to the following provisions:

"1. Energy shall be supplied under this Act only (*a*) for supply to authorised undertakers, and (*b*) for providing power to any person.

"2. The energy supplied to authorised undertakers may be used by them for lighting or other purposes, and the energy supplied to any person for power may be used by such person for lighting any premises on any part of which the power is utilised, but save as aforesaid the company shall not supply energy for lighting purposes. Provided that where energy is supplied to any person for power within the area of supply of any authorised distributors the energy used by such person for such lighting purposes shall not in any year, except with the consent in writing of the authorised distributors, exceed 20 per cent. of the total amount of energy supplied to such person, and save as aforesaid the company shall not supply energy for lighting purposes.

"3. Energy shall not be supplied under this Act by the company (except to authorised undertakers or to the proprietors or trustees of any railway, tramway, or waterworks, or of any dock, canal, or navigation lawfully entitled to use energy, or to any Government department) in any area being at the passing of this Act the area of supply of any authorised distributors except with the consent of those distributors, but that consent shall not be unreasonably withheld. If any question arises whether that consent is unreasonably withheld, that question shall be determined by the Board of Trade. The consent shall be deemed to be unreasonably withheld if the authorised distributors are not willing and in a position to give the requisite supply upon reasonable terms and within a reasonable time, and in considering what are reasonable terms and what is a reasonable time the Board of Trade shall have regard to all the circumstances of the case, including, amongst other things, the terms upon which and the time within which the company are willing and in a position to give the supply, and the fact (if such be the case) that the undertaking of the authorised distributor is liable to be purchased under the principal Acts.

"4. If at any time after the passing of this Act any local authority, company, or person become authorised distributors in any area within the area of supply under this Act, the company shall be subject to any provisions which may be made by the Act or provisioual order under which the distributors become authorised, as to the taking over of any supply then given by the company for use exclusively within the area of supply of the distributors or otherwise, as to the powers of the company to supply within that area, and such provisions may be made in any such provisional order under the principal Acts."

The new clause, numbered 48A, reads: "The following provisions shall apply and have effect in relation to the supply of energy by the company under the provisions of this Act within the area of any authorised distributor where the consent of such distributor has been withheld:

"1. Where the consent of any such distributor in such area has been withheld, the company, in making application to the Board of Trade to determine whether such consent has been unreasonably withheld, shall deposit with the Board of Trade a statement of prices proposed to be charged by the company in respect of such supply through-

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out such area not exceeding the price stated in the second schedule to this Act.

"2. In dispensing with any consent under the section of this Act whereof the marginal note is 'conditions affecting supply,' the Board of Trade may, if they think fit, impose upon the company such terms and conditions as the Board may think necessary for the protection of such distributor and for affording a supply of energy under this Act throughout such area, and such terms and conditions may at any time be enforced by such distributor in any court of competent jurisdiction.

"3. The company shall not, after commencing to supply energy within such area, increase the prices in such statement without the consent of the Board of Trade, which consent the Board of Trade are hereby empowered to give.

"4. Where the Board of Trade have dispensed with the consent of such distributor under the section of this Act whereof the marginal note is 'conditions affecting supply,' the company shall, in respect of the supply of energy for providing power to any person within such area, be subject to the same obligations to afford a supply of energy as the authorised distributors therein.

"5. The Board of Trade may, if they think fit, in any case where they have so dispensed with the consent of an authorised distributor, require the company to lay within a period prescribed by the Board suitable and sufficient distributing mains in such streets within the area of such distributor as they think reasonable for affording a supply of energy to persons for power within such area."

Mr. FITZGERALD explained that the total result of all these amendments was that the Board of Trade would have the widest possible power to deal with the circumstances of each particular case. It was quite true that it left the matter in the hands of the Board of Trade, but the greatest difficulty was experienced in trying to frame a clause which would meet the varying conditions of each case which might arise. By leaving it in this way it would enable the Board of Trade to say if the company were going to supply at ¾d., "You must supply in bulk to the authorised distributors at ½d. so that they will be in a position to give a competitive supply."

After further discussion, the CHAIRMAN said that so far as the hardship to the existing companies was concerned, the committee had decided that when they came to deal with the clauses they would insert a clause such as Mr. Fitzgerald had proposed, which in principle, at any rate, would set out what he indicated. The committee had decided that the two Bills could now proceed; but with regard to area, they would give the Administrative County of London Company an area which was understood as the industrial area, and also the area asked for on the south side of the Thames, and also St. Pancras, which was not in the Metropolitan Electric Supply Company's Bill. A portion of Stoke Newington which had been given to the North Metropolitan Company would be taken out of the Administrative Bill. To the Metropolitan Electric Supply Company they would give the area they asked for north of the river.

On Tuesday the clauses of these Bills were further discussed. To the Administrative County of London Bill a new sub-clause was added, which reads: "If the company do not within the prescribed period comply with such requirements, the Board of Trade may order that the powers of the company to distribute energy within such area [except to authorised undertakers or to the proprietors or trustees of any railway, tramway, or waterworks, or of any dock, canal, and navigation entitled to use energy, or to any Government department] shall cease."

On Clause 57 the Chairman pointed out that the standard price which had relation to the sliding scale was fixed in the Bill at 1d., while the standard dividend was 8 per cent. It had been insisted over and over again during the hearing that the promoters could supply at ¾d. or even less, so that it was evident if their anticipations were realised the promoters would have a comfortable dividend of about 11 per cent. to begin with. The promoters agreed to reduce the standard price for the sliding scale to ¾d.

Mr. NIELD, on behalf of other power companies, objected to Clause 65, which allows the Administrative Company to enter into agreements with railway and other companies for the electrical working of their undertakings both inside and outside the area of supply, but the committee accepted the clause.

Opposition was offered to the clause for exempting the generating stations from the London Building Act and the by-laws of the West Ham Corporation. After hearing evidence and argument, the committee passed the clause with the following addition: "this section shall not be deemed to exempt the generating station and works of the company from the operation of the Factory and Workshops Act, 1901."

Mr. FREEMAN, K C, for the Metropolitan Water Board, brought up a clause for the protection of the pipes of the Board against possible damage, and evidence in support of the clause was given by Mr. C. H. Wordingham.

The proposal was ultimately accepted by the committee, a clause being inserted to make the company liable for any damage caused by electrolysis as the result of laying the company's mains.

Other clauses were amended.

The clauses of the Metropolitan Electric Supply Bill were considered and amended, and the two Bills were reported to the House.

## CATALOGUES, ETC, RECEVIED.

METERS.—The International Electric Company, 55, Redcross-street, Barbican, London, E C., have just issued a new illustrated price list of their electricity meters. It includes full particulars of the company's direct-current watt-hour meters (type A. G.), alternate-current watt-hour meters (type A. W.), for single-phase circuits, and prices for ampere-hour meters showing kilowatt-hours at a given voltage.

"ROYAL" DRY CELLS.—From Messrs. Gent and Co., Limited, Faraday Works, Leicester, we have a price list of their "Royal" dry cells. It is claimed that these cells have an extraordinary capacity in ampere-hours when the discharge rate is low, and a correspondingly long life. One special feature in regard to them is the improved carbon terminal, which ensures secure clamping of the line wire without the use of tools.

CABLES.—Messrs. Callender's Cable and Construction Company, Limited, Hamilton House, Victoria-embankment, London, E.C., have issued a catalogue which combines some very excellent features. In the fore part we find the usual tables of dimensions, weights, and resistances of copper conductors in British and metrical units, and British standard sizes of stranded conductors, radial thicknesses for paper dielectric, lead and armour for underground cables, and a table of comparative diameters and weights of high-conductivity copper wire for different wire gauges, etc. Then follow specifications and prices of cables, the different types being illustrated by means of coloured sectional diagrams. Over 40 of these diagrams and specifications are given. Next in order comes some general information of a useful character for reference, and then a series of feeder curves. The latter are intended to give a ready means of arriving at a suitable area of copper conductor for most ordinary cases of supply feeders. In these curves the "line of extreme safe limit of current density" is clearly indicated as a safeguard against running the conductors at a higher current density than is found judicious by experience. Messrs. Callender's private code and a list of useful telegraphic addresses are included at the end.

## PERSONAL.

Mr. David Moonie, superintendent of Aberdeen Corporation tramways, is about to retire on an allowance from the Town Council, and it is proposed that the entire system of electric cars should be put under the control of Mr. J. A. Bell, the city electrical engineer, and that Mr. J. D. Caird, the acting superintendent, be appointed traffic manager.

The salary of the telephone manager at Brighton, Mr. D. J. Barnes, has been increased as from April 1 from £250 to £300 per annum, on the understanding that he is responsible for and is to carry out all works in connection with the extension from time to time of the Corporation telephones undertaking, in addition to the other duties set out in his agreement with the Corporation of March 12, 1903.

Mr. J. R. Williams, A.M.I.E.E., has been appointed to the combined position of chief mechanical engineer and power-station superintendent of the Sheffield Corporation tramways.

The Brighton Town Council have decided to increase the salary of Mr. John Christie, engineer and manager of the Corporation electricity works, from £500 to £750 a year, and thence by annual increments of £50 to £1,000 per annum.

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## BOARD OF TRADE REGULATIONS.

We referred last week to the receipt of the revised regulations which the Board of Trade are empowered to issue under the Electric Lighting Acts of 1882 and 1888. The revisions which have been made are in the right direction, and will tend towards the more economical distribution of electrical energy. The regulations have been revised after consultation with those interested in the subject. There are four sets of regulations now to be issued for securing a proper and efficient supply of energy in order to meet the different cases where the authorities are: (1) a local authority in the provinces; (2) a company in the provinces or in the city of London; (3) a company in London, except as to the City; (4) a local authority in London.

The regulations which are given below are those for a local authority in the provinces. They are practically the same as those for the other three cases, except as regards details which are not of a technical nature. For instance, under the regulation for provision of constant supply a company in the provinces has to obtain the consent of the local authority before an intermittent supply can be given. In London the consent of the London County Council, as well as that of the local authority, has to be obtained by a supply company. In both cases, however, the Board of Trade consent is dispensed with. In the case of a local authority in London, the London County Council has to be consulted. Again, in the third clause of Section B and in the fourth clause of the same section, dealing respectively with the declared pressure at consumers' terminals and the declared frequency and system of supply, much the same alterations are made. In the event, however, of the consent of the local authority or of the London County Council to the proposed changes being withheld, the matter can be referred to the Board of Trade. It is interesting to compare the alterations which have been made in these new regulations as compared with those which were issued previously. Amongst these is the omission of a limit in amount of energy which may be transmitted through a given high-pressure cable. Extra high-pressure current can now be delivered to a factory, or mine, subject to the regulations which have been issued by the Home Office. The variation allowed in frequency is now fixed at 2½ per cent. up or down, and the variation in voltage remains at 4 per cent. up or down. Other points in connection with the fusing of networks have been made which will, we think, give general satisfaction. The full draft of the regulations reads as follows:

*Definitions.*

In the following regulations

The expression "the order" means the ————

The expression "the undertakers" means the undertakers for the purposes of the order.

The expression "consumer's wires" means any electric lines on a consumer's premises which are connected with the service lines of the undertakers at the consumer's terminals.

The expression "sub-station" means any premises in which energy is transformed or converted for the purpose of supply to consumers, and which are large enough to admit the entrance of a person after the transforming or converting apparatus is in position, provided that for the purpose of these regulations any place within any such premises which is used solely for some purpose other than such transformation or conversion shall not be deemed to form part of a sub-station.

The expression "overhead line" means any electric line which is placed above ground and in the open air.

The expression "pressure" means the difference of electrical potential between any two conductors through which a supply of energy is given, or between any part of either conductor and the earth; and, subject to the variations allowed by No. B 3 of these regulations: (*a*) where the conditions of the supply are such that the pressure at any pair of consumer's terminals does not exceed 250 volts, the supply shall be deemed a low-pressure supply; (*b*) where the conditions of the supply are such that the pressure exceeds 250 volts, but does not exceed 650 volts, the supply shall be deemed a medium-pressure supply; (*c*) where the conditions of the supply are such that the pressure exceeds 650 volts, but does not exceed 3,000 volts, the supply shall be deemed a high-pressure supply; and (*d*) where the conditions of the supply are such that the pressure exceeds 3,000 volts, the supply shall be deemed an extra high-pressure supply.

The expression "factory" has the same meaning as in the Factory and Workshop Act, 1901.

The expression "mine" means a mine to which the Coal Mines Regulation Act, 1887, or the Metalliferous Mines Regulation Act, 1872, applies.

Where these regulations require any metallic body to be "efficiently connected with earth," it shall be connected with the general mass of earth in such manner as will ensure at all times an immediate and safe discharge of electrical energy.

Other expressions to which meanings are assigned in the order or in the Electric Lighting Acts, 1882 and 1888, have the same respective meanings in these regulations.

A.—Regulations for Securing the Safety of the Public.

*General.*

1. *Pressure of Supply to Consumers.*—The pressure of a supply delivered to any consumer shall not exceed the limit of low pressure except for special purposes, for which a medium-pressure supply may be given on the consumer undertaking to comply with the following conditions:

(*a*) Where the supply is for power purposes—(1) The frame of every electric motor shall be efficiently connected with earth. (2) The consumer's wires forming the connections to motors, or otherwise in connection with the supply, shall be, as far as practicable, completely enclosed in strong metal casing efficiently connected with earth, or they shall be fixed in such a manner that there shall be no danger of any shock. (3) The supply to every motor shall be controlled by means of an efficient cut-off switch, placed in such a position as to be easily handled by the person in charge of the motor, and connected so that by its means all pressure can be cut off from the motor itself, and from any regulating switch, resistance, or other device in connection therewith. (4) Switches, efficient fuses, or other automatic circuit breakers shall be provided so as to protect the circuits from excess of current, and all switches and cut-outs shall be so enclosed and protected that there shall be no danger of any shock being obtained in the ordinary handling thereof, or of any fire being caused by their normal or abnormal action. (5) A notice shall be fixed in a conspicuous position at every motor and switchboard in connection with the supply forbidding unauthorised persons to touch the motors or apparatus.

(*b*) Where the supply is for arc lamps in series—(1) The consumer's wires forming the connections to the arc lamps, or otherwise in connection with the supply, shall be, as far as practicable, completely enclosed in strong metal casing efficiently connected with earth, or they shall be fixed in such a manner that there shall be no danger of any shock. (2) The supply to every arc lamp shall be controlled by means of an efficient cut-off switch, placed in such a position as to be easily handled by the person in charge of the arc lighting, and connected so that by its means all pressure can be cut off from the arc lamp itself, and from any regulating switch, resistance, or other device in connection therewith. Provided that where the arc lamps are connected in series across the outer conductors of a three-wire system, it shall be sufficient if one such switch be provided for each series of arc lamps. (3) Switches, efficient fuses, or other automatic cut-outs shall be provided so as to protect the circuits from excess of current, and all switches and cut-outs shall be so enclosed and protected that there shall be no danger of any shock being obtained in the ordinary handling thereof, or of any fire being caused by their normal or abnormal action.

(*c*) Where the supply is for incandescent lamps in series—(1) The consumer's wires forming the connections to the incandescent lamps, or otherwise in connection with the supply, shall be completely enclosed in strong metal casing, and this casing, together with the switches and lampholders, if metallic, shall be efficiently connected with earth. (2) Switches, efficient fuses, or other automatic cut-outs shall be provided so as to protect the circuits from excess of current, and all switches and cut-outs shall be so enclosed and protected that there shall be no danger of any shock being obtained in the ordinary handling thereof, or of any fire being caused by their normal or abnormal action.

When the supply is for any special purpose other than those above mentioned, or where the pressure of the supply exceeds the limits of medium pressure, it shall be subject to such other regulations as the Board of Trade may from time to time prescribe.

2. *Introduction of Three-Wire System into Consumer's Premises.*—When the pressure between the outer conductors of a three-wire system exceeds 250 volts and the three wires of the system or two pairs of wires are brought into a consumer's premises, the supply shall be given to two pairs of terminals arranged in such a manner that there shall be no danger of any shock, and the wiring from those terminals shall be kept distinct.

3. *Extra High-Pressure Supply to Consumer's Premises.*—An extra high-pressure supply shall not be given to any consumer's premises other than a factory, a mine, or electric traction

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works; and no such supply shall be given except with the consent of the Board of Trade and subject to such regulations as the Board may prescribe.

4. *Minimum Size of Conductors.*—The sectional area of the conductor in any electric line laid or erected in any street after the date of these regulations shall not be less than that of a strand of seven wires, each of which is of No. 20 standard wire gauge, and the sectional area of every wire in a strand forming any such conductor shall not be less than that gauge. This regulation shall not apply in the case of an electric line placed in a lamp-post.

5. *Insulation Test of Low-Pressure and Medium-Pressure Mains.*—Every low-pressure and medium-pressure main shall be tested for insulation after having been placed in position and before it is used for the purposes of supply, the testing pressure being the maximum pressure to which it is intended to be subjected in use, and in any case at least 200 volts, and the undertakers shall duly record the results of the tests of each main, or section of a main.

6. *Maintenance of Insulation.*—The insulation of every complete circuit used for the supply of energy, including all machinery, apparatus, and devices forming part of, or in connection with, that circuit, shall be so maintained that the leakage current shall not under any conditions exceed one-thousandth part of the maximum supply current; and suitable means shall be provided for the indication and localisation of leakage. Every leakage shall be remedied without delay. Every such circuit shall be tested for insulation at least once in every week, and the undertakers shall duly record the results of the testings. Provided that where the Board of Trade have approved of any part of any electric circuit being connected with earth, the provisions of this regulation shall not apply to that circuit so long as the connection with earth exists.

7. *Testing of Insulation of all Parts of High-Pressure Circuit.* A high-pressure circuit shall not be brought into use unless the insulation of every part thereof has withstood the continuous application, during half an hour, in the case of every electric line of a pressure twice the maximum pressure to which it is intended to be subjected in use, and, in the case of every machine, device, or apparatus, of a pressure 50 per cent. greater than the said maximum pressure. The undertakers shall duly record the results of each test.

8. *Circuit Breaker for High-Pressure Mains, etc.*—Every high-pressure main, conductor, or other apparatus shall be protected by a suitable fuse or automatic circuit breaker. Provided that it shall not be incumbent upon the undertakers to provide such a fuse or circuit breaker for the outer conductor of a concentric main which is, with the approval of the Board of Trade, efficiently connected with earth.

9. *Transformers.*—In every case where a high-pressure supply is transformed for the purpose of supply to one or more consumers, some suitable automatic and quick-acting means shall be provided to protect the consumer's wires from any accidental contact with or leakage from the high-pressure system, either within or without the transforming apparatus.

10. *Connection of Transformers with Earth.*—The metallic portion of every transformer, with the exception of the conductors thereof, shall be efficiently connected with earth.

11. *Protection from Lightning.*—Where any portion of any electric line or any support for an electric line is exposed in such a position as to be liable to cause injury from lightning, it shall be efficiently protected against such liability.

12. *Report of Accidents to Board of Trade.*—Where any accident by explosion or fire, or any other accident of such kind as to have caused or to be likely to have caused loss of life or personal injury, has occurred at any part of any electric line or work, the undertakers shall give immediate notice thereof to the Board of Trade.

*Overhead Lines.*

13. *Overhead Lines.*—Overhead lines shall not after the date of these regulations be erected or maintained except in accordance with plans approved by the Board of Trade and subject to such regulations as the Board may prescribe. Provided that this regulation shall not apply to any electric lines which have been erected at the date of these regulations so long as those lines are maintained in accordance with any regulations of the Board of Trade which are in force and applicable thereto at that date and with any requirements of the Board made thereunder.

*Electric Lines other than Overhead Lines.*

14. *Construction of Receptacles for Electric Lines.*—All conduits, pipes, casings, and street boxes used as receptacles for electric lines shall be constructed of durable material, and where laid under carriageways shall be of ample strength to prevent damage from heavy traffic, and reasonable means shall be taken by the undertakers to prevent accumulation of gas in such receptacles.

15. *Crossing Pipes, etc.*—Where any electric line crosses, or is in proximity to, any metallic substance, special precautions shall be taken by the undertakers against the possibility of any electrical charging of the metallic substance from the line or from any metal conduit, pipe, or casing enclosing the line.

16. *Electric Continuity of Metal Conduits, Pipes, and Casings of High-Pressure Line.*—All metal conduits, pipes, or casings containing any high-pressure electric line shall be efficiently connected with earth, and shall be so jointed and connected across all street boxes and other openings as to make good electrical connection throughout their whole length.

17. *Precautions to be taken when Bare Conductors are used.*—Where the conductors of electric lines placed in any conduit are not continuously covered with insulating material they shall be secured in position, and no unfixed uninsulated material of a conducting nature shall be contained in the conduit. No such conductor shall be at a pressure exceeding 300 volts from earth. Adequate precautions shall also be taken to ensure that no accumulation of water shall take place in any part of the conduit, and to prevent any dangerous access of moisture to the conductors or the insulators. The insulators of any such electric line shall be so disposed that they can be readily inspected, but this requirement shall not apply to any such insulators which before the date of these regulations were not required by any regulation then in force to be so capable of ready inspection.

18. *High-Pressure Lines laid above Ground or in Subways.*—Every portion of any high-pressure electric line placed above the surface of the ground, or in any subway not in the sole occupation of the undertakers, shall be completely enclosed either in a tube of highly insulating material embedded in brickwork, masonry, or cement concrete, or in strong metal casing efficiently connected with earth.

19. *Protection for the Surface of the Ground and Electric Lines.*—Where any high-pressure electric line is laid beneath the surface of the ground, efficient means shall be taken to render it impossible that the surface of the ground or any neighbouring electric line or conductor shall become charged by leakage from the high-pressure electric line.

20. *Completion and Control of High-Pressure Lines.*—A high-pressure electric line shall not be used for the supply of energy before it has been completely laid, properly jointed, examined, and tested, or until it is in the sole charge of the undertakers, and every such line shall during its use be in the sole charge of the undertakers.

*Sub-Stations and Street Boxes.*

21. *Sub-Stations.*—Sub-stations shall be established in suitable places and shall be in the sole occupation and charge of the undertakers. Sub-stations shall be erected above ground wherever possible, but where necessarily underground they shall be constructed in accordance with plans approved by the Board of Trade.

22. *Street Boxes.*—In addition to the provisions contained in Regulation 14 as to the construction of receptacles for electric lines, the following conditions shall be observed with respect to street boxes: (*a*) The covers of all street boxes shall be so secured that they cannot be opened except by means of a special appliance. (*b*) The covers of all street boxes containing high-pressure apparatus other than cables shall be connected to strips of metal laid immediately underneath the street, and efficient means shall be taken to render it impossible that the covers or other exposed parts of these boxes, or any adjacent material forming the surface of the street, shall become electrically charged, whether by reason of leakage, defect, or otherwise. (*c*) Where street boxes are used as transformer chambers, reasonable means shall be taken to prevent as far as possible any influx of water, either from the adjacent soil or by means of pipes; and in the case of any such street box exceeding one cubic yard in capacity, ample provision shall be made, by ventilation or otherwise, for the immediate escape of any gas which may by accident have obtained access to the box, and for the prevention of danger from sparking. (*d*) All street boxes shall be regularly inspected for the presence of gas, and if any influx or accumulation is discovered, the undertakers shall give immediate notice to the authority or company whose gas-mains are laid in the neighbourhood of the street box. (*e*) Where mains at different pressures pass through the same street box they shall be readily distinguishable from one another.

23. *Maximum Power in Case of Underground Sub-Station, etc.*—The maximum power supplied to any underground sub-station or street box shall not, without the consent of the Board of Trade, exceed 30 kw. in the case of a sub-station or street box containing a single transformer, or 75 kw. in the case of a sub-station or street box containing two or more transformers.

*Consumer's Premises.*

24. *Responsibility of Undertakers for their Lines, etc., on Consumer's Premises.*—The undertakers shall be responsible for all electric lines, fittings, and apparatus belonging to them, or under their control, which may be upon a consumer's premises being maintained in a safe condition and in all respects fit for supplying energy.

25. *Fire Risks.*—In delivering the energy to a consumer's terminals the undertakers shall exercise all due precautions so as to avoid risk of causing fire on the premises.

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26. *Main Fuses or Circuit Breakers.*—A suitable safety fuse or other automatic circuit breaker shall be inserted in each service line within a consumer's premises as close as possible to the point of entry, and contained within a suitable locked or sealed receptacle of fireproof construction, except in cases where the service line is protected by fuses in a street box; but no fuse or automatic circuit breaker shall be inserted in the intermediate conductor of a three-wire system where the pressure between the adjacent conductors exceeds 125 volts.

27. *Treatment of Service Lines and Apparatus on Consumer's Premises.*—All service lines and apparatus placed on a consumer's premises shall be highly insulated and thoroughly protected against injury to the insulation or access of moisture, and any metal forming part of the electric circuit shall not unless efficiently connected with earth be exposed so that it can be touched. All electric lines shall be so fixed and protected as to prevent the possibility of electrical discharge to any adjacent metallic substance.

28. *Transformers and High-Pressure Apparatus to be Enclosed in Metal, etc.*—Where the general supply of energy is a high-pressure supply, and transforming apparatus is installed on a consumer's premises, the whole of the high-pressure service lines, conductors, and apparatus, including the transforming apparatus itself, so far as they are on the consumer's premises, shall be completely enclosed in solid walls, or in strong metal casing efficiently connected with earth and securely fastened throughout.

29. *Connection to Consumer's Premises not to be made where Leakage would result.*—The undertakers shall not connect a consumer's wires with their mains unless they are reasonably satisfied that the connection would not cause a leakage from those wires or fittings exceeding one ten-thousandth part of the maximum supply current to the premises; and where the undertakers decline to make such connection they shall serve upon the consumer a notice stating their reasons for so declining.

30. *Discontinuance of Supply on Discovery of Leakage on Consumer's Premises.*—If the undertakers are reasonably satisfied, after making all proper examination by testing or otherwise, that a leakage exists at some part of a consumer's wires or fittings of such extent as to be a source of danger, any officer of the undertakers, duly authorised by them in writing, or, if the undertakers so require, an electric inspector, may, for the purpose of discovering whether the leakage exists at any part of a circuit within or upon any consumer's premises, by notice require the consumer at some reasonable time after the service of the notice to permit him to inspect and test the wires and fittings belonging to the consumer and forming part of the circuit. In any case where the undertakers require the services of an electric inspector under this regulation they shall pay him the prescribed fee. If on any such testing the officer or the electric inspector discovers a leakage from the consumer's wires exceeding one ten-thousandth part of the maximum supply current to the premises, or if the consumer does not give all due facilities for inspection and testing, the undertaker shall forthwith discontinue the supply of energy to the premises in question, giving immediate notice of the discontinuance to the consumer, and shall not recommence the supply until they are reasonably satisfied that the leakage has been removed. This regulation shall not affect any power contained in the order or otherwise enabling the undertakers to discontinue the supply.

31. *Appeal to Electric Inspector.*—If any consumer is dissatisfied with the action of the undertakers in refusing to give, or in discontinuing, or in not recommencing the supply of energy to his premises, the wires and fittings of that consumer shall, on his application, and on payment of the prescribed fee, be tested for the existence of leakage by an electric inspector. This regulation shall be endorsed on every notice given under the provisions of either of the two last preceding regulations.

*Arc Lighting.*

32. *Height from Ground.*—Arc lamps used in any street for public lighting shall be so fixed as not to be in any part at a less height than 10ft. from the ground.

33. *Arc Lamps to be Guarded.*—All arc lamps shall be so guarded as to prevent pieces of ignited carbon or broken glass falling from them, and shall not be used in situations where there is any danger of the presence of explosive dust or gas.

*Connection of Circuits with Earth.*

34. *Connection with Earth of a Three-Wire System.*—Where the pressure of a supply between the adjacent conductors of a three-wire system of mains exceeds 125 volts, the intermediate conductor shall be connected with earth, subject to the concurrence of the Postmaster-General, and in accordance with the following conditions: (*a*) the connection with earth of the intermediate conductor shall be made at one point only on each distinct circuit—namely, at the generating station, sub-station, or transformer—and the insulation of the circuit shall be efficiently maintained at all other parts; (*b*) the current from the intermediate conductor to earth shall be continuously recorded, and if it at any time exceed one-thousandth part of the maximum supply current, steps shall be immediately taken to improve the insulation of the system.

*Penalties.*

35. *Penalties for Default.*—If the undertakers make default in complying with any of the preceding regulations, they shall, on conviction, be liable to a penalty not exceeding £10 for every such default, and to a daily penalty not exceeding £10. The recovery of a penalty under these regulations shall not affect the liability of the undertakers to make compensation in respect of any damage or injury which may be caused by reason of the default.

B.—Regulations for Ensuring a Proper and Sufficient Supply of Electrical Energy.

1. *Undertakers to Provide Constant Supply.*—From the time when the undertakers commence to supply energy through any distributing main, they shall maintain a supply sufficient for the use of all the consumers for the time being entitled to be supplied from that main; and that supply shall, except so far as the Board of Trade may otherwise from time to time permit, be constantly maintained, and in the case of continuous currents, without change of polarity. Provided that, for the purposes of testing, or for any other purposes connected with the efficient working of the undertaking, the authority by whom the electric inspector is appointed may give permission to the undertakers to discontinue the supply at such intervals of time and for such periods as that authority may think expedient. When the supply is so discontinued, or the polarity is changed, notice to all persons likely to be affected shall be given of such discontinuance or change, and of the probable duration thereof.

2. *Measures for Restricting Area Liable to Stoppage.*—The system of distributing mains shall be separated into sections corresponding approximately to the different feeders, and these sections shall be interconnected only through suitable circuit breakers or fuses arranged so as to be readily inspected.

3. *Fixing of Declared Pressure at Consumer's Terminals.*—Before commencing to give a supply of energy to any consumer, the undertakers shall declare to that consumer the constant pressure at which they propose to supply energy at his terminals. The pressure so declared shall be constantly maintained, subject to a variation not exceeding 4 per cent. under any conditions of supply which the consumer is entitled to receive, or such other variation as the Board of Trade may from time to time allow, and shall not be altered or departed from to an extent greater than that variation except by consent of the Board of Trade, and upon such terms and conditions as the Board of Trade may impose, and after public notice has been given during a period of one month, in such manner as the Board of Trade may require, of the intention of the undertakers to apply for consent to alter the same. Provided that any regulation in force at the date of these regulations whereby the consent of any consumer (or in default thereof the consent of the Board of Trade) was then required to a change in the declared constant pressure to that consumer's premises shall, notwithstanding anything in these regulations, continue of full force and effect in the case of any consumer whose consent was then so required, and shall apply in that case as if it had been expressly set out in these regulations.

4. *Fixing of System and Declared Frequency.*—Before commencing to give a supply of energy to any consumer, the undertakers shall declare to that consumer the system which they propose to adopt, whether alternating or continuous current, and in the case of alternating current the frequency—that is to say, the number of complete periods per second at which they propose to supply. The system and frequency so declared shall be maintained subject, as respects frequency, to a variation not exceeding 2½ per cent. from the declared frequency, and shall not be altered or departed from except by consent of the Board of Trade, and upon such terms and conditions as the Board of Trade may impose, and after public notice has been given during a period of one month, in such manner as the Board of Trade may require, of the intention of the undertakers to apply for consent to alter the same.

5. *Penalty for Default.*—If the undertakers make default in complying with any of these regulations as to supply, they shall, subject to the provisions of the order, be liable on conviction to a penalty not exceeding £5 for every such default, and to a daily penalty not exceeding £5.

These regulations are made subject to the power of the Board of Trade to make such further or other regulations as they may think expedient; and nothing in these regulations shall be construed to authorise the undertakers to lay any electric line or work their undertaking otherwise than in accordance with the order and the principal Act, or to supply energy otherwise than by a system for the time being approved of by the Board of Trade under the order.

These regulations are, so far as they relate to factories and mines, in addition to and not in substitution for any regulations made by a Secretary of State under any Act relating to factories or mines.

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## INSTITUTION OF ELECTRICAL ENGINEERS.

The following is an abstract of the discussion upon Mr. H. L. Webb's paper entitled "Telephone Traffic," which was illustrated by the mutoscope:

Mr. J. GAVEY referred to the economy in the time of the exchange assistant effected by automatic signalling as compared with the magneto principle. He calculated that the operator could render double the amount of service under the former system. There was also a saving on floor space. In addition, there was an economy in a large exchange system like that of London, where 20 to 25 per cent. of the lines were devoted to junction purposes, as the junction connection in a magneto system occupied 79·55 seconds against 38·97 seconds for the relay system.

Mr. W. W. COOK pointed out that it might be inferred from the paper that the introduction of supervisory signals was the result of the introduction of signal lamps, but this was incorrect, as supervisory signals could have been attained without signal lamps. At the same time he readily admitted the utility of lamp signals, which enabled the operator to have a continuous knowledge of what was going on, but this knowledge was not the whole secret of the effectiveness of the modern supervisory signal. The operator needed to know what was happening on each side of the cord circuit, and this was attained by the common battery system. He defended the reliability of the ring-off indicator, but admitted that it had three weaknesses—it had to be worked by the subscriber, who was called upon to perform an action that had no necessary connection with what he was attempting to do; it did not give continuous supervision; and it did not provide the operator with independent knowledge of what was going on. A system of supervisory signals was good or bad according to the degree in which it obviated listening in. He quoted some figures from New York showing that with the magneto system the operator had to come into circuit on an average 5½ times, the time occupied for a local call being 14 seconds, and for a junction call 16 seconds. The introduction of the common battery system disposed of this and maintained the integrity of the connection. The only possible uncertainty with the present system of supervisory signals was whether the calling signal being alight meant that the subscriber had not replied, and whether he had replied and gone away, though in practice the operator had no difficulty in distinguishing. In order to make a test another lamp might be added, which could only come into circuit after the subscriber had answered.

Mr. J. E. KINGSBURY calculated that there must be some 5,000,000 telephonic messages sent in the United Kingdom daily. He emphasised the economy that might be effected in regard to the switchboard by stating that everything in the switchboard, except the line, depended upon the traffic, the only fixed item being the material connected to one line, which had to be there whether the traffic was large or small. Regarding the evolution of the switchboard, he agreed with the author that the proximity of the answering jack and lamp signal was a great advantage, but it was not a modern discovery.

Mr. S. J. GODDARD would have liked more information about traffic. There were four important points to be considered in the study of this—the number of calls made by the individual subscriber, which it was essential to know in order to distribute the work equally between the operators; the variation of traffic during the busy hours of the day; the state of the junction traffic; and the methods of dealing with the calls by the operators and the subscribers. This called for constant observation of the operator's method.

Mr. D. H. KENNEDY related the results of tests he had made with a stop-watch in order to complete the operation denoted as A in the author's diagrams—observing the lamp, plugging in, and replying to the subscriber. He had found it possible to perform this in one second. The Post Office system used a pilot lamp for each 60 subscribers. In the course of his experiments he found it necessary to put the pilot lamps out of service, which retarded the operation by nine seconds. The speaker described other tests, showing that a junction call involved four individuals in 16 mental operations, and the quickest time in which these could be performed was 7½ seconds. The panels were of triple design, and he noticed that those on the right hand could be dealt with more quickly than those on the left or in the centre. The author had divided the history of telephonic development into two periods, which he (the speaker) thought involved more than was shown in the paper. During the first period of 16 years English engineers took a fair share in telephonic development, but during the latter period of eight years most of the improvements had been due to America, although English engineers had held their own in cable design. For more than 20 years the Post Office had possessed a system which had many of the attributes of the common battery system. He considered that the progress in America was due to competition.

Mr. F. GILL said the author's figures regarding New York showed a high standard of efficiency. He recognised that American engineers were a very capable class, but he would claim one point for this country—that positive disconnecting signals were used here in 1892, some time before the lamp signal. Turning to the financial side, which had been omitted from the paper, he strongly advocated a flat rate, as in New York. The trouble with engaged lines had been materially reduced in that city by relay apparatus and the double-supervision system. The London lines were more heavily loaded than those of New York by some 25 per cent., which meant that the plant had to carry an extra load.

Briefly replying, Mr. WEBB expressed gratification that no one had seriously quarrelled with his paper. He had no desire to parade the efficiency of New York, but simply gave it as a suitable illustration. The paper, he was glad to say, had achieved its main object, which was to provide an opportunity for discussing telephonic development.

A vote of thanks was unanimously accorded the author.

# LEGAL INTELLIGENCE.

## WATER SUPPLY.

In the Chancery Division last week Mr. Justice Farwell had before him the case of the Birmingham Corporation *v.* the Birmingham Canal Navigation Company, which concerned the right of the Corporation to take water from the canal for the purposes of their generating station at Summer-lane for the purposes of electric lighting. The plaintiffs asked for a declaration that they are entitled to take water from the Birmingham and Fazeley Canal for condensing and other purposes in connection with their steam-engines, or for such other relief as the nature of the case required. The defendants contended that a generating station did not come within the statute controlling such matters, and therefore the plaintiffs had no right to take the water from the canal.

After hearing the arguments of counsel on both sides, his Lordship said he wished to consider his decision, and accordingly reserved judgment.

## OPENING STREETS.

The opinion of Mr. Justice Warrington was asked last week as to the meaning of certain words in the Acts of Parliament empowering the London and United Tramways, Limited, to construct electric tramways in Surbiton, Kingston, and Wimbledon.

The company propose to lay down a line of cables to pass through the boroughs of Wandsworth, Fulham, and Chelsea to connect the tramways at Wimbledon with the generating station in Lots-road, Chelsea (owned by another body), some five miles distant. The words in their Acts which they say enable them to do this are: "The company may execute all such works . . . as may be necessary or convenient for the working of the tramways by mechanical power . . . or for providing access to or forming connections with any generating station," etc.

Mr. CRIPPS, K.C., moved on behalf of the local authority that the company might be restrained from breaking up roads within the borough of Wandsworth, contending that they had no power whatever under their Acts to do this.

Mr. BALFOUR BROWNE, K.C., contended that there was no obligation on the part of the company to provide their own generating station, and in fact it was quite a common thing for local authorities to insist upon supplying the power themselves. His learned friend characterised as absurd the company's claim to connect with "any generating station," saying that if they were right they might go as far as John o' Groats for their electrical energy. There was, however, a very practical answer to that argument. It would not pay to go any great distance.

Mr. JUSTICE WARRINGTON held that there was nothing in the Act to confine the words "for providing access to or forming connections with any generating station" to a generating station belonging to the company, or that in making the connections the company were confined to the streets in which the trams were to run. The learned judge added, however, that, assuming his construction of the section to be right, he had heard no argument or evidence on the point as to whether the proposed cable was necessary or convenient.

The motion was accordingly dismissed, the costs to be the costs of the action.

## STREET ELECTRIC BOXES.

Before Mr. Justice Grantham and a special jury the action of Hayward *v.* Mayor and Corporation of Ealing came on for hearing. Plaintiff, an Ealing fruiterer, claimed damages for injuries alleged to have been sustained through a street electric box. He asserted that he was standing outside his shop in May last year with one foot upon the box when he received an electric shock which caused his leg to give way. It was found that the knee-cap had been fractured, and medical evidence was called for plaintiff to prove that the sudden contraction of the muscles caused by an electric shock would produce the injury to the knee. Defendants denied that the box was defective, and alleged that the injury was caused by plaintiff slipping, the box cover being wet at the time.

GEORGE MUNDY, electrician, called on behalf of the plaintiff, described experiments which he had made in connection with the box. He said that with the full voltage of 102 applied there was a tense sensation, and his feet appeared glued to the spot. When the current was switched off his legs collapsed, but he did not fall in the manner described by the plaintiff.

HIS LORDSHIP, in summing up, remarked that if the plaintiff did receive a shock, it must have been caused by the cover. There was, however, a great deal of expert evidence to show that he was mistaken. So far as he knew, there was no instance of a human being having such a shock as was now alleged.

The jury disagreed, and were discharged.

HIS LORDSHIP said the case was full of difficulties, and if he had been on the jury he should have expected a disagreement.

## ALLEGED SMOKE NUISANCE.

At Jarrow last week the County of Durham Electric Power Distribution Company was summoned at the instance of the Corporation, under the Public Health Act, through black smoke being emitted from the chimney of their power station.

At the outset of the proceedings, Mr. BURTON, who represented the company, suggested that the case should be adjourned. He denied that there was any nuisance created, but such smoke as was emitted from the chimney would soon be stopped altogether. The company

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had entered into an arrangement by which electricity required for the town would be made at the other side of the river, and the power station would in future be used only as a transmission station. When that was carried out there would be no more smoke created there.

Evidence having been given as to the emission of the smoke, Mr. JOSEPH STANHOPE WATSON, technical manager to the defendants, said the company was laying cables from Wallsend to Jarrow, and when the work was completed the steam plant at the station would be shut down. It was expected that the work would be finished by the end of June.

The magistrates considered in private, and on returning to court the CHAIRMAN said the justices considered the offence proved, and they made an order for the nuisance to be abated within two months and to pay the costs. If the order was not complied with in the time stated a substantial daily penalty would be fixed.

# COMPANIES' MEETINGS AND REPORTS.

## WESTERN TELEGRAPH.

The ordinary general meeting of this Company was held last week at River Plate House, Sir John Wolfe Barry presiding.

The CHAIRMAN said that the commerce of South America had steadily increased, and the vast resources of the country were being satisfactorily developed. The Company had participated in this progress, the message receipts having amounted to £227,324 as compared with £202,062 in the corresponding period of last year. The revenue amounted to £218,264 and the working expenses to £105,547. After providing for debenture stock and debenture interest and sinking fund, and £4,821 for income tax, there remained a balance of £123,831, which, with £4,439 brought forward, made a total of £128,270. First and second interim dividends amounting to £62,379 had been paid, and after transferring £60,000 to the general reserve fund and £2,600 to the maintenance ships' reserve fund there remained £3,891 to carry forward.

The report was unanimously adopted.

## CAPE ELECTRIC TRAMWAYS.

In accordance with a requisition, an extraordinary general meeting of the Cape Electric Tramways, Limited, was held last week at Salisbury House for the purpose of submitting a resolution instructing the directors not to purchase the tramways of the Cape Town Consolidated Tramways and Land Company, Limited, either under the option to purchase or otherwise, and not to renew the lease thereof; also to elect a director or directors to fill any vacancy on the Board.

Mr. L. BREITMEYER, who presided, stated that the Board had convened the meeting under compulsion, but it was quite superfluous, because the requisitionists asked for something which they had already obtained. As far back at the last annual meeting the directors stated that they would not deal with this Camps Bay property, nor even with its lease, without reference to the shareholders, and these assurances were repeated in more definite and precise form at the special meeting held on April 19 last. With these pledges by the directors the majority of the shareholders were quite satisfied, accepting them in the same *bona fide* manner as they were made. With the voting power held by the directors it would be an easy matter for them to vote against the resolution of the requisitionists or to substitute any amendment; but the demand of the requisitionists was identical with the policy of the Board, as often expressed previously, and for that reason they accepted the resolution, which he begged formally to move.

Mr. PARRISH, in seconding the resolution, said that in the notice calling the meeting the secretary stated that his directors had on three separate occasions definitely stated that they did not intend to purchase the tramways of the Cape Town Consolidated Tramways and Land Company, Limited, or to renew the lease thereof. If this were the case, he had never heard of it, and, in fact, he did not think it was so. The chairman at the last general meeting, held in November last, made some general statements on the subject which in no way could bind the Board. The only way the Board could declare itself clear on the matter was to pass a resolution and enter it on the minutes, which he had never heard had been done. But even if this were done, it could be altered at any time a quorum was present to do so. The speaker proceeded to give a general review of the position of affairs in recent years.

After some discussion, the resolution was carried unanimously, and Mr. Rommel was elected to the vacancy in the directorate.

## ELECTRIC LIGHTING AND TRACTION COMPANY OF AUSTRALIA.

The fifth annual meeting of this Company was held at Winchester House on Monday, Mr. J. B. Braithwaite presiding.

In moving the adoption of the report, the CHAIRMAN said that when they came to analyse the profits of the separate stations it was very significant and encouraging to find that Melbourne headed the list, as some of their difficulties in the past had been due to the relatively slow growth of their business there. The total lamp connections stood at 130,232, as compared with 89,644 lights at the close of the preceding financial year. With regard to the South Australian undertakings, he stated that, in view of possible developments, it had been thought advisable to separate them from the rest of the business. They had, therefore, formed the Adelaide Electric Supply Company, Limited, which had made an issue of £50,000 in 6 per cent. cumulative preference shares. The result of the change was that this Company for their expenditure of £115,000 on the Adelaide and Port Adelaide undertakings, had received £127,500 in the ordinary shares of the new company and also £35,000 in cash. This sum would be employed in the development of their Melbourne and Geelong businesses. After providing for debenture interest, banker's interest, standing charges, etc., there was a debit balance on the year's working of £4,666, which raised the total debit balance to £12,088. The returns for the first six months of the current year, which were the summer months, were almost exactly double those for the corresponding period of the previous year. However, the winter months were those which controlled the situation, and he hardly thought that they could count on the winter revenue showing so great an improvement.

The accounts were adopted.

## BRISBANE ELECTRIC TRAMWAYS INVESTMENT.

The fourth annual general meeting of the Brisbane Electric Tramways Investment Company, Limited, was held at Winchester House, under the presidency of Sir Malcolm D. McEacharn.

The CHAIRMAN stated that the Brisbane Tramways Company, in which this Company is interested, had placed to the credit of renewals fund £3,000, paid in dividends £44,000, and carried forward £2,908. Taking the dividends received from that source, adding thereto the amount brought forward from last year, etc., and deducting the London and Brisbane charges, there was a net balance available of £44,239. The debenture stock interest had absorbed £18,188. The directors proposed to set aside to reserve fund £5,000, bringing the same up to £14,216, to start an accidents insurance fund with the sum of £500, and after payment of the full 5 per cent. on the preference shares there would remain the sum of £2,719 to carry forward to next account. Notwithstanding the opening of the Toowong extension in July last year, and an increased car mileage run in that year of some 85,000 miles, the traffic receipts showed an increase of only £543 as compared with the year 1903. The receipts on the Toowong line from the date of opening—July 23, 1904—to Dec. 31, 1904, amounted to £3,627, thus showing a falling off on the other lines of £3,084 in 1904 as compared with 1903. On the other hand, it was satisfactory to note that, notwithstanding the increased mileage, the expenditure had been kept down in every possible direction, and was less than in 1903, the net result for both years being practically the same. Queensland had been undergoing a period of severe industrial depression, but there were indications of returning prosperity.

The report was adopted unanimously.

## ORIENTAL TELEPHONE AND ELECTRIC.

The Oriental Telephone and Electric Company, Limited, have convened a meeting for the 31st inst., when a resolution will be proposed empowering the directors to create debenture stock to the extent of £200,000, and to issue it from time to time as they may deem expedient.

The Board states that the raising of further capital has now become necessary to provide for the reconstruction and extension of the Company's installations to comply with the requirements of the Governments of India, the Straits Settlements, and Hong-Kong, and for the development of the growing business of the Company and its associated companies. The directors consider that such further capital will be used with much advantage to the Company's business. They have carefully considered and taken advice with regard to the cheapest and most desirable mode of raising it, and are of opinion that the creation of debenture stock is the course most favourable to the interests of the shareholders.

## WEST AFRICAN TELEGRAPH.

The report for 1904, to be presented to the meeting on May 31, states that revenue for the period under review amounted to £60,914, from which is deducted £14,994 for ordinary expenses and £9,840 for expenditure relating to maintenance of cables, leaving a balance of £36,080, to which is added £2,663 brought from the preceding year, making a total available balance of £38,743. The sum of £1,667 has been provided for income tax, £25,000 has been transferred to the general reserve fund, and an interim dividend of 2 per cent., absorbing £4,662, was paid on Dec. 1 last. The directors recommend a final dividend of 2½ per cent., making 4½ per cent. for the year, the balance of £1,676 being carried forward. The liability of the Company to maintain certain cables on the West Coast of Africa, in accordance with the arrangement entered into with the French Government, dated Feb. 10, 1902, expired in September, 1904.

## WEST INDIA AND PANAMA TELEGRAPH.

The report for the half-year ended Dec. 31, 1904, states that the amount to credit of revenue is £27,135, against £32,399 for the corresponding half of 1903. Expenses have been £21,422, against £25,245, leaving a balance of £5,714, to which is added £1,838, interest on investments and £1,583 brought from last account, making a total of £9,135. It is proposed to pay a dividend of 5s. per share on account of arrears to Dec. 31, 1904, on the first preference shares, and to carry forward £494. This will leave the following dividends in arrear: on the first preference shares, £3,456, and on the second preference shares £12,605. Expenses of repairing cables during the half-year were £10,424, against which the sum of £4,050 has been received for the charter of the Company's repairing steamer "Henry Holmes." These expenses are, however, exclusive of a further expenditure of £3,446, which has been charged to reserve, in respect of 40 knots of new cable used in the repair and partial

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renewal of the two cables between Jamaica and Porto Rico. Instead of the expected improvement in the Company's traffic receipts, there has been a decrease during the half-year of £1,862, as compared with the corresponding period, and those for the current half-year also show a decline. In December a contract was entered into with the Telegraph Construction and Maintenance Company for the manufacture of 215 knots of cable for stock, which have since been delivered in the West Indies. Owing to continued ill-health, Mr. Andrews has resigned his seat at the Board. Mr. Le Rougetel having terminated his connection with the International Ocean Telegraph Company resigned his position as their nominee on the Board of this Company. The International Company nominated Mr. Tom Waldemar Goulding as a director in his place, and he has been elected to a seat at the Board.

## APPOINTMENTS VACANT.

**General Manager,** Johannesburg, £2,000; Station Engineer, £1,000, with house. Applications to Mordey and Dawbarn, 82, Victoria-street, Westminster.

**Tramways Manager,** Erith. Salary, £250 per annum. Applications by May 27. See advertisement in last issue.

**Chief Assistant Electrical Engineer,** Battersea Borough Council. Commencing salary, £200 per annum. Applications by noon on June 6. See advertisement in last issue.

**Assistant Borough Electrical Engineer,** Poplar. Salary, £200 per annum, rising by annual increments of £10 to a maximum of £300 per annum. Applications by June 14. See advertisement.

**Articled Improver,** Maidenhead Electricity Works. Applications efore June 9. See advertisement.

**Junior Engineer,** Dundee Electricity Department. Applications to H. Richardson, A.M.I.E.E., general manager and engineer. See advertisement.

**Jointer,** experience with electric light cables, East Sussex County Asylum, Hellingly. See advertisement.

**Director,** with £5-10,000, large electrical supply company on the Riviera. See advertisement.

**Partnerships (two).** See advertisements.

**Assistant Engineer,** Newcastle City Asylum, Gosforth. Wages, 36s. weekly and house on the estate. Applications by June 3. See advertisement.

**Switchboard Attendants (three),** North of England. Wages to commence 35s. per week of 56 hours. See advertisement.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Tonbridge.**—The Urban District Council require tenders for cables. Tenders by May 29.

**St. Marylebone.**—Tenders are invited for the annual supplies in the electricity department. Tenders by May 28.

**Copenhagen.**—Tenders are invited for supply of armoured cable. Apply to Belysningsvaesenet, Vestre boulevard 22.

**Cataquoxes (Spain).** — The local light and power company require tenders for electrical plant. Tenders by July 1.

**Edinburgh.**—Tenders are invited for extension of switchboard panel at McDonald-road electricity supply station. Tenders by May 30.

**Madrid.**—The Public Works Department require tenders for carrying out a scheme for an electric tramway for goods transport along Bilbao quays.

**Madrid.**—The Post and Telegraphs Department require tenders for construction and working of a telephone line at Matron (Balearcs). Tenders by June 5.

**Bracebridge (near Lincoln).**—Tenders are invited for the installation of fire alarms, telephones, bells, and tell-tale clocks at the Bracebridge Asylum. Tenders by June 7.

**Partick.**—The Town Council invite tenders for the supply of various plant at their electricity works. Tenders by 12 noon on June 6. See advertisement in last issue.

**Edinburgh.**—Tenders are invited for steam and exhaust pipework at McDonald-road electricity supply station. Tenders by 10 a.m. on June 6. See advertisement in last issue.

**Lirla.**—The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

**Krakow.**—The Government Railway require tenders for extensions of their electric station, including additional generators, switchboards, motors, etc. Tenders by noon on May 28.

**Kettering.**—The Urban District Council invite tenders for the supply, delivery, and erection of Nernst lamps, posts, etc., for street-lighting within their district. Tenders by May 29.

**Talgarth (Wales).**—Tenders are invited for (1) wiring of the new farm buildings, including the supply and fixing of motors and (2) fire-alarm installation at the Brecon and Radnor Asylum. Tenders by June 7.

**Burslem.**—The Corporation invite tenders for wiring the town hall, markets, baths, gymnasium, and Wedgwood Institute, and also for the supply of house service fuses and meters. Tenders by May 30. See advertisement in last issue.

**Leventhem (Belgium).**—The Municipality require tenders for erection of central station, laying of mains, etc. Particulars (3s. 4d.) may be obtained from the Secretary of the Mayor of that place.

**Bristol.**—Tenders are invited for single-phase alternating current transformers and three-phase to direct-current motor-generators. Full particulars from the City Electrical Engineer, Temple Backs, Bristol.

**Edinburgh.**—Tenders are invited for the supply of lead sheathed, paper-insulated copper cables for electricity supply conductors for the year ending May 15, 1906. Tenders by June 5. See advertisement.

**Madrid.**—The Post and Telegraphs Department require tenders for 50 tons 4mm. zinced iron wire and 5 tons 3mm. bronze wire. The maximum price for the iron wire is 580 pesetas and that for the bronze wire 3,400 pesetas per ton. Tenders by June 5.

**Stalybridge.**—The Stalybridge, Hyde, Mossley, and Dukinfield Tramway and Electricity Board require tenders for the supply, delivery, and erection at the Stalybridge sub-station of a 400-kw. motor-generator, together with the necessary switchgear for same.

**Ossett (Yorks).**—The Town Council invite tenders for the following plant: (Section No. 1) quick-speed engines for direct coupling to dynamos; (2) dynamos, boosters, and balancers; (3) storage battery; (4) switchboard; (5) travelling crane; (6) cables. Tenders by June 14.

**Switzerland.**—M. R. Vontobel, of Winterthour, and M. Charles Probst, of Lucerne, have obtained a concession for the construction of a narrow-gauge electric railway from Meiringen to Gletsch. The total cost of the enterprise is estimated at £241,600; £19,600 is to be expended on rolling-stock.

**Brussels.**—Tenders are required for the maintenance of the electric lighting of the buildings belonging to the Roads and Bridges Department for the three years ending Dec. 31, 1907. Specification No. 40 may be obtained for 4d. at Brussels, Rue des Augustins, No. 15. Tenders by May 29 by a registered letter.

**Bristol.**—The Docks Committee invite tenders for the construction, delivery, erecting in place, fitting, testing, and maintenance for 12 months after completion, of four two-ton movable electric jib cranes, and one three-ton movable electric jib crane to be erected on the adjoining wharf at Canons Marsh. Tenders by June 7.

**Bangour (Scotland).**—The District Lunacy Board invite tenders for the following works: (1) building in boiler economisers, etc.; (2) building in chimney stalk; (3) building in steam and electric cable trenches; (4) steam boilers; (5) engines and dynamos; (6) economisers and piping; (7) overhead travelling cranes; (8) accumulators; (9) switchboard and connections; (10) main cables and branches. Tenders by May 27.

**Hammersmith.**—The Council are about to supply all electricity to the stands at the Olympia Electrical Exhibition, and invite propositions from bona fide British manufacturers for the hire of the necessary materials for the distribution inside the hall. The materials required will consist of (A) meters; (B) lead-covered and armoured cables; (C) distribution pillars; (D) fuse and switch boxes for exhibitors' stands; (E) continuous-current plant (motor-generators, rotary converters, or steam driven). Tenders by June 2. See advertisement.

## RESULTS OF TENDERS.

**Electric Fans.**—Messrs. W. H. Allen, Son, and Co., Bedford, have obtained the contract for a large number of fans driven by electric motors which are to be installed in the engine-rooms and lower parts of the battleships and cruisers which are now being built.

**Hull.**—The Trustees of the William-street Primitive Methodist Chapel have received the following tenders for lighting premises by electricity:

| | | | |
|---|---|---|---|
| King and Co., Hull | £151 | 7 | 6 |
| E. M. Parsons, Hull | 124 | 0 | 0 |
| A. Shaw, Hull (accepted) | 145 | 10 | 6 |
| T. Stather and Co., Hull | 134 | 0 | 0 |
| Harrison and Co., Hull | 158 | 12 | 6 |
| A. Smith, Bridlington | 94 | 0 | 0 |
| J. H. Nicholson, Hull | 108 | 0 | 0 |
| Wright and Fillingham, Hull | 75 | 15 | 8 |
| A. Innes, Leeds | 114 | 18 | 6 |
| H. Hyde, Hull | 118 | 5 | 0 |
| R. J. Nicholson and Co., Manchester | 130 | 4 | 7 |
| C. Wokes and Co., Hull | 123 | 17 | 0 |
| H. H. Butterfield, Leeds | 251 | 14 | 0 |

**Devonport.**—The following tenders have been received for the supply of one surface condenser with electrically-driven pumps for the Electricity Department:

| | |
|---|---|
| Summers and Scott, Limited | £1,090 |
| Mirrlees, Watson, and Co. (accepted) | 1,105 |
| Cole, Marchent, and Morley | 1,158 |
| I. Storey and Son | 1,215 |
| Masson and Scott and Co., Limited | 1,250 |
| Brush Electrical Engineering Company | 1,261 |
| J. Wright and Co. | 1,271 |
| Willans and Robinson | 1,304 |
| Richardsons and Westgarth | 1,320 |
| Worthington Pump Company | 1,354 |
| Bertrams, Limited | 1,356 |
| Balcke and Co. | 1,394 |
| W. H. Allen and Son | 1,387 |
| Carrick and Wardle | 1,485 |
| Browett-Lindley | 1,500 |
| Bellis and Morcom | 1,535 |
| Mather and Platt | 1,620 |
| Haste Pump and Co. | 1,750 |
| Wheeler Condensing Engineering Company | 2,091 |
| Hayward-Tyler and Co. | 2,142 |

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**Bury.**—The Guardians have accepted the tender of F. W. Smith and Co., Salford, for wiring, at £330; and that of Messrs. Ashworth and Parker, Bury, for the electric plant, at £1,090.

**London County Council.**—The following tenders have been received (1) for the supply of 750 000 stoneware ducts required for the electric cables in connection with the reconstruction for electrical traction of portions of the Council's existing tramways, and for the construction of various authorised tramways:

| | | | |
|---|---|---|---|
| G. Skey and Co., Limited, London | £9,481 | 5 | 0 |
| Stanley Bros., Limited, Nuneaton | 10,250 | 0 | 0 |
| Stourbridge Glazed Brick and Fireclay Company, Limited, Dudley (250,000 ducts only) | 3,791 | 13 | 4 |
| J. Knowles and Co., London | 11,437 | 10 | 0 |
| H. R. Mansfield, Burton-on-Trent | 11 437 | 10 | 0 |
| H. Tugby and Co., Limited, Ashby-de-la-Zouch | 11,437 | 10 | 0 |
| T. Wragge and Son, Limited, Swadlincote, Derbyshire | 11,437 | 10 | 0 |
| Sutton and Co., Ashby-de-la-Zouch | 12 875 | 0 | 0 |
| Ingham's Firebrick Company, Dewsbury | 12,987 | 10 | 0 |
| J. F. Cummings and Co., London | 13 193 | 15 | 0 |
| Naylor Bros., Huddersfield | 16 250 | 0 | 0 |
| J. J. Lee, Crumpsall, Manchester | 18,500 | 0 | 0 |

It is recommended that the respective tenders (*a*) of G. Skey and Co., Limited, for the supply in connection with the reconstruction of portions of the London County Council tramways and the construction of various authorised tramways of 500,000 stoneware ducts for the sum of £6,287. 10s., and (*b*) of Stanley Bros., Limited, for the supply of 250,000 ducts for the sum of £3,450, be accepted.

(2) For the supply, delivery, and erection of the three 10 ton overhead travelling hand cranes required for use at the Streatham, Battersea, and Wandsworth sub-stations:

| | | | |
|---|---|---|---|
| Herbert, Morris, and Bastert, Limited, Loughborough (not to specification) | £477 | 8 | 0 |
| Jessop and Appleby Bros. (Leicester and London), Limited, Leicester (not to specification) | 620 | 0 | 0 |
| J. Gibb and Co., Limited, London | 664 | 0 | 0 |
| Carrick and Ritchie, Edinburgh* | 678 | 0 | 0 |
| J. Carrick and Sons, Limited, Edinburgh | 680 | 0 | 0 |
| Ditto (alternative) | 761 | 0 | 0 |
| J. Smith (Keighley), Limited, Keighley | 699 | 0 | 0 |
| Holt and Willett, Cradley Heath | 725 | 0 | 0 |
| Rodgers and Kaye, Bradford | 740 | 0 | 0 |
| J. Hitchen and Son, Limited, Halifax | 760 | 0 | 0 |
| Ditto (alternative) | 775 | 0 | 0 |
| C. and A. Musker (1901), Limited, Liverpool | 810 | 0 | 0 |
| Tangyes Limited, Birmingham | 871 | 0 | 0 |
| Ransomes and Rapier, Limited, London | 909 | 0 | 0 |
| J. Spencer and Co., Hollinwood, Lancashire | 915 | 0 | 0 |
| Pickerings, Limited, Stockton-on-Tees | 927 | 10 | 0 |
| J. M. Henderson and Co., Aberdeen | 980 | 0 | 0 |
| J. Booth and Bros., Limited, Leeds | 990 | 0 | 0 |
| T. Larmuth and Co., Salford | 1,025 | 0 | 0 |
| Leeds Engineering and Hydraulic Company, Limited, Leeds | 1,085 | 0 | 0 |
| T. Smith and Son, Leeds | 1,128 | 0 | 0 |
| Flavell and Churchill, London | 1,150 | 0 | 0 |
| Steel Rope Pulley Block Company, Limited, Sheffield | 1,192 | 0 | 0 |
| Rawlinsons Limited, Leeds | 1,225 | 0 | 0 |
| Parsons (Brierley Hill) Limited, Brierley Hill, Staffs | 1,275 | 0 | 0 |
| Cowans, Sheldon, and Co., Limited, Carlisle | 1,290 | 0 | 0 |
| Dougill's Engineering, Limited, Leeds | 1 770 | 0 | 0 |
| Butter Bros. and Co., Glasgow | 2,335 | 0 | 0 |

* Recommended for acceptance.

(3) For the supply, delivery, erection, and maintenance of the accumulators required for use at the Greenwich electricity generating station:

Supply, delivery, and erection.

| | | | |
|---|---|---|---|
| Tudor Accumulator Company, Limited, London | £1 875 | 12 | 0 |
| British Accumulator Company, Limited, London | 1 947 | 10 | 0 |
| Electrical Power Storage Company, Limited, London | 2 105 | 18 | 0 |
| D.P. Battery Company, Limited, London | 2,173 | 0 | 8 |
| Chloride Electrical Storage Company, Limited, Manchester | 2 177 | 0 | 0 |
| Accumulator Industries, Limited, Woking | 2,371 | 2 | 4 |
| A.B.P. Accumulator Company, Limited, Stockton-on-Tees | 2 755 | 11 | 0 |
| Hart Accumulator Company, Limited, London | 3,447 | 6 | 0 |

Maintenance.

| | | | |
|---|---|---|---|
| Tudor Accumulator Company, Limited | 1,120 | 0 | 0 |
| British Accumulator Company, Limited | 1,200 | 0 | 0 |
| Electrical Power Storage Company, Limited | 900 | 0 | 0 |
| D.P. Battery Company, Limited | 1,300 | 0 | 0 |
| Chloride Electrical Storage Company, Limited | 1,170 | 0 | 0 |
| Accumulator Industries, Limited | 1 045 | 0 | 0 |
| A.B.P. Accumulator Company, Limited | 2,000 | 0 | 0 |
| Hart Accumulator Company, Limited | 2,858 | 10 | 0 |

It is recommended that the tender of the Tudor Accumulator Company, Limited, amounting to £1,875. 12s. for the supply, delivery, and erection, and £1,120 for the maintenance during a period of 10 years, of the battery of accumulators required for use at the Greenwich electricity generating station, be accepted.

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**Outing.**—The second annual picnic of the St. Annes-on-the-Sea electricity department took place on May 16. The chairman of the Council (Mr. G. W. Spring) and the chief engineer (Mr. J. H. Clothier) accompanied the party to Ingleton, where a most enjoyable day was spent. Mr. J. C. Fairchild, assistant engineer, made excellent provision for the comfort and enjoyment of those present.

# BUSINESS NOTES.

## TRACTION.

**Erith.**—The tramways are expected to be completed by July 1.

**Kirkcaldy-Leven.**—This line is expected to be in operation by next spring.

**Guildford.**—The Board of Trade have confirmed the order for a tramway between Guildford Station and Stoughton.

**Leith.**—The drivers and conductors employed in connection with Leith tramways have been officially inspected by members of the Corporation.

**Great Northern, Piccadilly, and Brompton Railway.**—In the House of Commons on Wednesday the Great Northern, Piccadilly, and Brompton Railway (No. 1) Bill was read a third time.

**Reading.**—The Corporation have approved the annual report of the tramways manager (Mr. Binns), and have adopted his recommendation that the surplus of £3,542 be used for the creation of a reserve fund.

**Leicester.**—The Belgrave-road and Stoneygate routes have just attained their anniversary as electrified lines. During the year there have been carried on the whole system, all of which is now electrified, 20,915,085 passengers.

**Dalkeith.**—Terms of agreement between the Edinburgh Suburban Electric Tramways, Limited, and the Town Council have been settled. There will be a 15-minute service, and the through fare from the Edinburgh city boundary to Dalkeith will not exceed 4d., and the charge between Dalkeith and Eskbank will not be more than 1d.

**Cardiff.**—As one of the Corporation cars was proceeding along Working-street last week the overhead wire snapped. No accidents occurred, though the conductor had a rather narrow escape. He was standing at the rear end of the upper deck, when the wire struck him on the shoulder and then fell into the roadway, but he escaped without injury of any kind.

**Live Rails.**—It is reported that the electrified section of the Lancashire and Yorkshire Railway between Liverpool and Southport is being metalled with a very hard, marble-like stone which offers great resistance to the passage of electricity. This non-conducting ballast, which, it is stated, will withstand a current of 3,000 volts without penetration, is spread in a thin layer underneath and between the sleepers. It has already been adopted on the North-Eastern Railway Company's electrified lines.

**Tramcars and Railways.**—In consequence of the increasing competition of the Bradford Corporation tramways, the Midland Railway Company has asked for an abatement in the assessment of its lines within the city. The committee has offered a reduction of £3,000, which will mean a loss to the Corporation revenue of £1 250. The takings of the Bradford city tramways for 12 months ended March 25 show an increase over the preceding year of £31,363, only part of which is attributed to the Bradford Exhibition.

**Aberavon.**—A Bill to confirm a provisional order authorising the Aberavon District Tramways Syndicate, Limited, to construct tramways in the borough of Aberavon came before the Examiners of the House of Lords for proof of compliance with the Standing Orders. There was no opposition at this stage, and the necessary formal proofs having been given, the Examiner certified that the Standing Orders had been duly complied with. The Bill will accordingly, in the usual course, be reported for second reading.

**New Paper.**—We have received No. 1 of the *Tramway and Vehicle Worker* (price 1d.), a weekly paper devoted to tramway, motor, and vehicle work. It is to be the official organ of the Amalgamated Association of Tramway and Vehicle Workers' Union. There will be a leader in each issue upon passing tramway and vehicle topics, descriptions of different firms' equipments, instructive paragraphs, and other features. The first number is excellently composed, and in providing motormen with a medium of instruction and information it should have a distinct sphere.

**Paris Tube Railway.**—The new Paris railway company, known as the "Tube Boulevard," which will run from the Porte Saint Ouen to Versailles, has just increased its capital in consequence of the promulgation of the law granting the concession. The length of the line will be about eight miles. The municipal rates payable to the city of Paris will be 1c. (about one-tenth of a penny) per second-class ticket for the first 30 million tickets sold, 2c. per ticket beyond that number, and 25c. on every first-class ticket. The concession is for 35 years. The cost of construction is estimated at about £3 000,000.

**Greenock.**—The negotiations between the Corporation and the company regarding the supply of energy have now been completed, and an agreement for the next five years has been signed by Lord Emlyn, chairman of the company, and Provost Denholm. The agreement is for five years, during which time the company will take from the Corporation all the energy needed for the tramways. The company guarantees a minimum annual consumption of 500 000 units, and the rates are as follows: first 500,000 units per annum 1·5d. per unit; next 200,000 units per annum, 1·25d. per unit; next 200 000 units per annum, 1·00d. per unit; all units consumed per annum in excess of 900,000 units, 0·85d. per unit.

**Dundee.**—The tramway manager has submitted to the Tramway Committee a statement of the charges he proposes for the carriage of parcels. His scheme is as follows: collections to be at intervals from business houses as might be arranged; conductors to accept parcels at any of the fixed stopping places *en route*, for delivery in any part of the city; appointment of agents in convenient parts of the city; issue of weekly tickets for the carriage of dinner and other baskets. The scale is: up to 7lb., 1d.; up to 14lb., 2lb.; up to 28lb., 3d. Dinner baskets, one parcel per day, 3d. per week, and special terms for traders with 50 parcels or over per week. The proposals were agreed to,

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Attention was drawn to the damage done to the permanent way of the tramways in Ferry-road between Craigie-terrace and Springhill by traction engine traffic. The burgh engineer was instructed to go over the road and submit a report.

**Wednesbury.**—At the meeting of the Town Council the Mayor moved that the Council approve an agreement with the South Staffordshire Tramway Company for the purchase of the tramway undertaking in the borough, including the depôt, offices, and machinery at King's Hill, but excluding any portion of the line between James Bridge and Darlaston, for £23,920. He explained that of this £11,500 represented the price of the depôt which was to be resold, and the balance would be repayable in 30 years, the tramway company reimbursing both principal and interest. A promise had been given that the reconstruction and electrical equipment of the Darlaston line should be undertaken forthwith, and when this had been carried out measures could be taken for the reopening of the Dudley section. The motion was agreed to, as was a further resolution authorising the sale of the depôt to the tramway lessee company.

**Batley.**—The electrification of the old Bradford-road tramway is now to be undertaken. Everything is in readiness in regard to the arrangements between the company and the local authorities. The Tramways Committee have decided to accept the tender of Messrs. Dick, Kerr, and Co. for the laying of the rails and the erection of the overhead wires, the Corporation undertaking the paving of the track. The project comprises the equipment of a double line from the junction with the other electric routes in Dewsbury Market-place to Birstall, and thence a single line to the junction at Birkenshaw. It is proposed to undertake the Dewsbury-to-Batley section first, and to keep the old engines and cars plying from Hick-lane to Birstall until that is finished. It is hoped that the Dewsbury-Batley section will be ready for opening by the end of July. The rest of the track will occupy another month or six weeks, and the early autumn should see the completion of the system. The Board of Trade only extended the present running powers by steam for six months, that period expiring on Aug. 21.

**Belfast.**—At the meeting of the Tramways Committee on Monday a deputation attended in support of an extension of the Stransmillis-road line. As the Corporation possess no powers for this at present, it was decided to defer the matter. Mr. M'Cowen, electrical engineer, submitted the following report on the question of overhead telephone wires: "I strongly recommend the removal of all overhead telephone wires on the tramway routes within the city, where possible. The existence of other wires above the trolley wires is always a possible source of danger, and even though protected by guard wires, the adoption of the latter is not desirable, as they are often the cause of accidents and trouble. With reference to isolated cases of telephone wires crossing the trolley wires in outlying districts, I have already reported on this matter on March 27 last. The insulated cables which the Telephone Company proposed to erect in such cases would be about ¾in. in diameter." The report was adopted by the committee, who considered that they should not take any risk in regard to this important matter. Reports on the progress of the different works were presented. The general manager reported that the whole of the car equipments and car trucks could be had at any time, while of the car bodies 22 were already dispatched from the works, 16 were in the paint shops, 52 were in progress in the car-building shop, and the remaining 80 would all be started before the middle of June. The Brush Company expected to have the 170 cars in Belfast, and completely finished and fitted on their trucks, on or before Aug. 1. The work at the Knock and Falls depôts was finished; at the Sandy-row, Antrim-road, and Mountpottinger depôts the work was well in hand; and he hoped to commence work at the Shore-road depôt by the end of May. The city surveyor reported that up to the present good progress had been made with the generating station, and that no delay had been occasioned to other contractors. In regard to permanent way, he reported that the amount of new work to be done reduced to single track was 60 miles, and the lines to be bonded and repaired 16 miles. The work has now been going on for nearly four months, and the equivalent of 20 miles of new work single track has been completed, and two miles single track bonded and repaired. The rate of progress during the last month or six weeks has been considerably greater than during the first two months of construction. Feeder cables have been laid on the Antrim road, Ligoniel and Crumlin roads, Springfield-road, Falls-road, Shore-road, and Shankill-road to a total length of 6 miles 570 yards. The total length of route feeder cables to be laid is 33 miles. In order to carry out the training of the drivers, it was decided to purchase a quantity of generating plant at a cost not to exceed £900, most of this plant being afterwards available when the electric tramcars are running. Mr. M'Cowen explained that he had written to 17 firms on this subject, and that he had now a great deal of information which would assist them in the future. Mr. Nance stated that the teaching of the 236 men would cost close on £2,000, but, in his opinion, this was the only way in which the work could be satisfactorily done. Terms have been agreed with the British Electric Traction Company for supplying current for the Cavehill and Whitewell lines.

**London County Council.**—At Tuesday's meeting of the Council the Highways Committee submitted a recommendation that an expenditure of £5,513 be authorised for constructing the tramways in Archway-road, Highgate, between the Archway Tavern and the county boundary at Highgate Archway. It was also recommended that an agreement be entered into between the Council and the County Council of Middlesex and the Metropolitan Electric Tramways, Limited, embodying the following terms: that the Council shall construct, at its own expense, a double line of tramways in Archway-road, Highgate, between the Archway Tavern and the county boundary at Highgate Archway, to link up with the light railways of the County Council of Middlesex at the county boundary; that the Council shall provide the necessary overhead equipment for the lines; that the tramways shall be leased by the Council to the Metropolitan Electric Tramways, Limited, with the consent of the County Council of Middlesex, for a period of three years; that the lessees shall covenant to repair and maintain, and if necessary to renew, the lines and overhead equipment to the satisfaction of the Council; that the rent to be paid to the Council in respect of the tramways shall be at the rate of £1,500 for the first year, £2,000 for the second year, and £2,500 for the third year; that the paving of the tramway tracks shall be of such a material as may be agreed upon between the Council and the County Council of Middlesex; and that the rolling-stock and the electrical power necessary for working the tramways shall be provided by the Metropolitan Electric Tramways, Limited. These recommendations were confirmed. Another recommendation was that an expenditure of £7,750 be sanctioned for land to form part of the site of the Pimlico generating station. The receipts for the week ended May 13 totalled £14,812, against £10,588 last year, the mileage being 291,222 and 230,054 respectively. The Council's scheme for running tramways across Westminster and Blackfriars Bridges and along the Victoria-embankment came before a Select Committee of the House of Commons last week. Mr. Kearley was the chairman. The opponents to the Bill are the City Corporation, the Metropolitan District Railway Company, the owners and occupiers of property having a frontage to the Embankment, and the Lambeth Borough Council. Mr. Pollock, K.C., for the promoters, said that up to the present there was no means of communication between the northern and southern systems, and it was this want the Bill sought to fill. The new tramways were to be constructed on the conduit system, and the first section would begin at the tramway terminus at Westminster Bridge, cross the bridge, and continue along the Embankment to the subway at Waterloo Bridge, where there would be the terminus of the northern tramway coming from underneath the Strand. A small section would also be constructed to link up the Albert-embankment line. The two sections, the first of which would be one mile and four chains in length, would cost £53,700. The next section, which would be seven furlongs long, would run from the subway along the remainder of the Embankment over Blackfriars Bridge, and make a junction with the existing system there. This would cost £52,700. On each side of the tramway lines on the Embankment there would be a clear space for other traffic of 25ft. Dealing with the necessity for the new lines, counsel said an enormous boon would be conferred on the working classes, a point which could not be better illustrated than by the fact that 21 borough councils out of 28 had passed resolutions in favour of the scheme. Every single borough which would be coupled up was supporting it, except Westminster, which was not opposing the scheme, but which had not passed a resolution in favour of it. The new line would relieve the troublesome and dangerous congestion at Westminster and Blackfriars, the extent of which might be realised by the fact that in one year the cars running to Westminster brought in 53,000,000 passengers, and those running to Blackfriars no fewer than 38,000,000. Coming to the petitions against the Bill, Mr. Pollock described that from the City as a dog-in-the-manger petition. The Metropolitan District Railway were, naturally, in opposition, but the answer to their petition was that these tramways would deposit more passengers at the District Railway stations than they would take away. Counsel then proceeded to read a letter from the Home Office, transmitting another letter from the Chief Commissioner of Police, dealing with the possible effect of the scheme on the general traffic, especially in the neighbourhood of the Houses of Parliament. The Chief Commissioner pointed out that while there was ample room on Westminster Bridge and Victoria-embankment, congestion even now occurred in Bridge-street because of the heavy traffic coming across the bridge, and it was felt that cars from the south turning into the Embankment would cut through the main stream of traffic going in the opposite direction, and thus increase the congestion. Mr. Pollock's reply was that as an electric car would turn the corner quicker than a hansom cab, there was little probability of aiding to the congestion. Mr. Fitzmaurice, the engineer-in-chief to the London County Council, was the first witness examined. He mentioned that there would be a space of over 17ft. between the car lines and the kerb of Westminster Bridge, and a space of 8ft. between the two sets of tramway lines. Sir Ralph Littler suggested to witness that the blocking of the traffic on the south side of the bridge in question might be obviated by the Council buying up some of the houses there and making a "station" terminus. Mr. Fitzmaurice replied that the Council did not want a "station terminus." What they wanted, and what the public wanted, was a circuit route across the bridge and along the Embankment. He stated that there would be no engineering difficulty in running over the tunnels of the Metropolitan Railway. Mr. Allan Baker, the chairman of the Highways Committee of the Council, gave evidence as to the necessity of the proposed tramways, and also as to the erection by the Council of a large generating station at Greenwich. Mr. H. E. Hayward, comptroller to the Council, said that on the estimate of 1s. per car mile, an estimate based on actual experience, there would be a gross revenue of £46,000, and the working expenses at 7d. per car mile would be £27,000. The interest and sinking fund charges would be £10,500, and the renewals, at 1½d. per car mile, £5,700. The surplus for the first year would thus be £2,800, and this would increase as the debt was paid off. Mr. Harper, statistical officer to the Council, gave evidence as to the vehicular and pedestrian traffic along the proposed route. The result of his calculations was that the omnibus service over the bridges was totally inadequate in the busy hours. Observation showed that the tramway termini at Westminster and Blackfriars were not the natural termini. Mr J. K. Bruce, traffic manager of the Council's tramway service, stated that it was proposed to run a one-minute service over the bridges. The scheme would mean a saving of 15 minutes in the journey from Westminster to Islington. He attached great importance to the facilities the route would give for through north and south traffic. Mr. A. Baker, general manager of the Birmingham tramways, formerly manager for the London County Council,

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gave similar evidence, and expressed the opinion that the continuance of the tramways over the bridges was really the only solution of the London traffic problem. Mr. J. R. Tompkins, Mayor of Camberwell, Mr. T. White, Mayor of Lewisham, and Mr. H. R. Barge, member of the Poplar Borough Council, also gave evidence in favour of the Bill on behalf of their respective councils. The Chairman intimated the intention of the committee to inspect the bridges and the Embankment. On Wednesday evidence was given by Mr. A. A. Campbell Swinton, who stated that his objection to trams along the Embankment was that there was no give-and-take about vehicles running on rails. He preferred motorcars for connecting the northern and southern systems, and considered that these would be cheaper, besides causing less interference with other traffic. Mr. John Burns strongly advocated the running of trams over the bridges, on the ground that travelling facilities and the housing problem were inseparably connected. He did not think it necessary to widen Blackfriars Bridge, though, if this were done, it would probably have weight with the City Corporation. This concluded the case for the promoters, after which Mr. Baggallay opened the case for the Embankment frontagers, arguing that traffic along that thoroughfare ought to be kept for light fast traffic. Evidence was given as to the anticipated effect of the trams in depreciating property. The Streatham Tradesmen's Association have petitioned the Wandsworth Borough Council in favour of the extension of the trams from Streatham to Norbury, and the Council have decided to ask the County Council whether they propose to apply for powers for this purpose in the 1906 session.

## LIGHTING AND GENERAL.

**Barnstaple.**—The Council have decided to apply for leave to borrow £4,000 for electric light extension.

**Removals.**—Messrs. Crawford and Cumming, consulting engineers, have removed to 41, George-street, Edinburgh. Their telephone number is now 1,222 Central.

**Sale of Plant.**—For particulars of a sale of plant, comprising Crossley gas-engine, Castle dynamo, E.P.S. accumulators, switchboard, and all accessories, now running nine miles out of London, see advertisement.

**Llanelly.**—The Borough Council, on the advice of Mr. J. C. Howell, have adopted a scheme under which they will purchase electrical energy from the South Wales Power Company, and lay their own distributing mains, at an estimated cost of £6,000.

**Greenock.**—Mr. R. Bartsch, electrical engineer, in his last report, states that during the month of March the amount of electricity generated was 179,158 units, an increase of 61,461 units as compared with the corresponding month of last year.

**Camberwell.**—Notices have been received from the South Metropolitan Electric Light and Power Company of its intention to lay low-tension mains along The Avenue and Farquhar-road, and high and low tension mains along the Croxted and South Croxted roads.

**London Gazette.**—The first meeting in the estate of Alexander Holland, electrical engineer, trading as the Electrical and Mechanical Engineering Company, 13, Bridgwater-street, Farnworth, Lancs., will be held at 19, Exchange-street, Bolton, on May 31 at 3 p.m. An adjudication order has been made out in the estate of Harry John Salter, electrical engineer, 235, High Holborn, London.

**Stock Exchange.**—The Stock Exchange Committee have appointed May 31 a special settling day for Charing Cross, Euston, and Hampstead Railway Company Speyer Bros.' scrip certificates (fully and partly paid) for £800,000 4 per cent. perpetual debenture stock, and Great Northern, Piccadilly, and Brompton Railway Company Speyer Bros.' scrip certificates (fully and partly paid) for £1,200,000 4 per cent. perpetual debenture stock.

**Dewsbury.**—An enquiry has been held into the Town Council's application for power to borrow £10,000 to enable them further to develop their electricity undertaking. During the evidence it was stated that while in 1901 there was a loss on the works of £266, and in the year following one of £378, there had been profits made as under—viz., 1902-3, £286; 1903-4, £1,961; and 1904-5, £1,244. The demand for current was still constantly increasing.

**Bury.**—The profit on the past year's working of the Council's electricity department was £2,931, and it was decided to allocate £1,589 to the relief of general rates, and to carry £1,342 to the credit of the depreciation and reserve fund. In view of the profit made, the application for powers to borrow £400 in connection with the tripling of the engines will be withdrawn. It has been decided to extend the mains to Chesham, and a sub-committee has been appointed to deal with the charges for current for the present year.

**Stafford.**—The promoters of the Shropshire and Worcestershire Electric Power Bill having accepted the clause submitted to them for the protection of the county main roads and bridges, the County Council's petition has been withdrawn. The Parliamentary Sub-Committee have reported that in their opinion the County Council ought to support the Seisdon Rural District Council in obtaining a clause providing that the company should supply electric energy upon reasonable terms within the rural district.

**Glasgow.**—The Corporation have entered into an agreement with the Magneta Company, under which a trial installation of that system of clocks is to be erected in the Bridgeton district of the city. They have also received a letter from Messrs. Barr and Stroud with regard to the Becker system of electric clocks. Mr. Macfee, the manager of the telephone department, and a member of the Bazaar Sub-Committee are to make enquiries and report as to the Normal Zeit system of clocks which is in operation in Berlin and Brussels.

**Briton Ferry.**—An enquiry has been held into the application of the Council for sanction to borrow £3,534 for the purpose of lighting their compulsory area with electric light. The deputy-clerk, Mr. H. H. Ellis, said that the Council proposed to purchase current in bulk from the South Wales Electrical Distribution Company, the agreement being for 30 years, which, at the option of the Council, could be determined at the end of each five years. Mr. Herbert Lewis (Messrs. Lewis and Fletcher, Cardiff), electrical engineer, stated that the estimated expenditure was £761 and the receipts £762 per annum, and that he was satisfied with the agreement.

**Wellingborough.**—With regard to the agreements with the electric light companies of 1900 and 1902, it has been resolved to obtain the services of an electrical engineer to advise on the whole question as to whether the Council would be justified in putting down plant and undertaking the public lighting by means of refuse destruction only, and as to the capital and annual cost thereof. The Council will also ask the County of Northampton Electric Power and Traction Company to make suggestions and submit an estimate of cost of lighting the streets, including the taking over by them of the working of the refuse destructor in an efficient manner under conditions to be approved by the Council.

**Turbines.**—At the fourth annual meeting of shareholders in J. I. Thornycroft and Co. it was stated that, anticipating that the Admiralty would require all the new torpedo-boats and destroyers fitted with turbine machinery, the directors had concluded an agreement with the Parsons Marine Steam-Turbine Company by which they were empowered to manufacture turbines on the payment of royalties. A scheme had been prepared for the purchase of plant and the erection at Southampton of the necessary buildings with all possible speed. Since the report and accounts had been circulated an order had been received from the Admiralty for five coast-line torpedo-boat destroyers fitted with turbine machinery.

**Fulham.**—From April 28 to May 11, 1905, 13 consumers with 330 8-c.p. lamps were added, making a total of 1,477, with an equivalent of 74 336 8 c.p. In settling the new scale of charge for the supply of electric current for private lighting, the reduction in price was made subject to a minimum charge of £2 per annum. Objection has been raised by consumers, and it is felt that the condition is likely to cause disputes and friction. To enforce the proposal would necessitate a very considerable expense and trouble in the preparation and stamping of new forms of agreement, and in consequence it is proposed that the minimum charge of £2 per annum to consumers of electric current for private lighting purposes be waived.

**St Pancras.**—Messrs. Idris and Co., Limited, having complained of noise from the King's-road works since the new turbine has been working, the chief electrical engineer forthwith took steps to stop the noise complained of by having the large windows facing Messrs. Idris and Co.'s premises bricked up. A sub-committee subsequently visited the station whilst the whole of the plant, including the turbine, was running, and afterwards proceeded to the Board-room at Messrs. Idris's, the windows of which were opened, and no noise whatever could be heard coming from the King's-road station. The directors have since stated that they had now no reason to complain of the noise, and have thanked the committee for dealing so promptly with the matter.

**London County Council.**—On Tuesday it was agreed to lend the Woolwich Borough Council £9,267 for electric lighting purposes. Notices under Electric Lighting Acts and Orders were agreed to as follows: from the Notting Hill Electric Lighting Company of intention to lay mains along a portion of Clarendon-road; from the St. James's and Pall Mall Electric Light Company to lay mains along portions of Regent-street, Vigo street, Sherwood-street, and Glasshouse-street; and from the St. Pancras Metropolitan Borough Council to lay mains across Cardington-street and along portions of Ampton-street and Pakenham-street. The receipt of notices, as follows, served under orders granted to local authorities, and under which the Council has no power of approval or disapproval of works, was acknowledged from the St. Marylebone Metropolitan Borough Council to lay mains along a portion of Edgware-road, and from the Stepney Metropolitan Borough Council to lay mains across Bridge-street and along Emmott-street and a portion of Commodore-street.

**London Wiring.**—The two clauses in the General Powers Bill of the London County Council which empower borough councils having electricity undertakings to wire and fit, and supply with wires, fittings, motors, and apparatus, the premises of their consumers or prospective consumers, and to borrow money for this purpose, were passed by a committee of the House of Commons on Wednesday. The metropolitan gas companies objected on the ground of rate-aided competition, and the Association of Electrical Engineers and Contractors asked that the borough councils should be restrained from carrying out this wiring and fitting except through contractors. A proviso had been introduced for the protection of the gas companies, providing that, "so far as reasonably practicable," the councils should so adjust the charges to be made by them as to meet any expenditure on the fittings. It was also provided that the councils should only supply, and not manufacture, these fittings or apparatus. The Chairman said the committee had always insisted on the form "power to supply," but not to manufacture. The qualifying phrase "so far as reasonably practicable" was struck out, in order to make it absolutely certain that no loss shall fall on the rates, and a provision for interest and sinking fund charges will be insisted upon. The committee declined to insert a clause compelling the councils to do the work through contractors.

**Watford.**—The electrical engineer in his last report states that an equivalent of 32,000 8-c.p. lamps was connected to the Council's system at March 31 last, as against 26,000 at March 31, 1904. A pit has been constructed with cement walls, 2ft. thick, to take the condensing plant. This has not been found watertight, and it was recommended that the bottom of the pit be covered with cast-iron plates, and the four sides to a height of 9in., with provision for further

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extension if necessary. This clause has been deleted from the report. The electrical engineer has been empowered to fix a trial gear to the existing arc lamp columns, by means of which the lamps may be lowered by the trimmer without assistance or ladders. The cost of such equipment would be about £3. 10s. per post.

**Wakefield.**—An enquiry was held last week into the application of the Corporation to borrow a sum of £18 000 for electric lighting purposes. The Town Clerk said that the existing outstanding loans on electric lighting undertaking amounted to £49,788. It was intended only to apply for a further loan of £17,700, a sum of £300 for the proposed sub-station having been abandoned. Mr. Newell said the profits on the electric lighting undertaking were as follows: 1900 £129, 1901 £463, 1902 £187, 1903 £914, and 1904 £1,894—about two-thirds being for lighting and one-third for power. It was proposed to extend the boiler-house, the pump-house, etc.—the new plant comprising boiler, stoker, superheated water softener, two high-speed sets, condenser, switchboard, mains, and transformers.

**Yeomanry Camp Lighting.**—The superior convenience and comfort of the electric light as an illuminant for their camp has been much appreciated by the Royal Bucks Hussars I.Y., who are now undergoing their annual 17 days' training under canvas at Stowe Park, Buckingham. A portable plant placed alongside the encampment supplies current for single pendants in each officer's tent, and groups of three-light pendants in the various officers' and sergeants' mess tents, ante-rooms, canteen, etc. Some of the tents, which measure 120ft. long, are additionally illuminated by Verity's single enclosed arc lamps, which are also employed for lighting the parade ground. All the arrangements for lighting the camp were carried out by Messrs. Gillies and Hornidge, of the Buckingham Electric Light Company, London and Buckingham.

**Southend.**—The electrical engineer's last report states that during the month 34 consumers were connected to the mains, with the equivalent of 1,334 lamps. There are now 773 consumers and 48,664 lamps connected to the mains. The units generated for lighting were 60,251, compared with 38,122 for the previous year, an increase of 58 per cent. The tramway receipts for the month were £1,361, as against £1,263 for the corresponding period of last year. The rate per car mile was 10·4d., as against 9·4d. The electrical engineer also called attention to the large increase in the demand for electrical energy, which would necessitate in the near future the committee again considering the question of extensions of plant. The 4½d. flat rate system of charges for electricity, now in operation in respect to private houses, is to be extended to shops and other business premises.

**Electrical Contractors' Association.**—The annual meeting of the northern section of the Electrical Contractors' Association (Incorporated) was held at Blackpool on May 2, Mr. J. McDermott, of Ashton-under-Lyne, in the chair. The following officers were elected for the ensuing year: chairman, Mr. W. Sutton, of Liverpool; hon. treasurer, Mr. T. G. Usher, of Newcastle-on-Tyne; hon. secretary, Mr. W. Cross, 4, St. Nicholas-buildings, Newcastle-on-Tyne. The annual report, which was adopted, stated that the membership for the northern section for the year maintained a steady increase. In May, 1904, the total list of members numbered 69; during the year 12 resigned for various reasons, and 25 new members joined, making a total on May 1, 1905, of 82 members; of these new members eight were in business in Bradford and district, having joined the Leeds branch. The increasing number of applications and the greater interest shown by the trade generally gave the committee confidence that the membership would soon be over 100, and inasmuch as the incorporation only took place on Sept. 16 last, the results were very encouraging.

**Hiring Out of Electric Motors.**—We have received from Mr. Alfred H. Gibbings, M.I.E.E., A.M.I.C.E., the following interesting table showing the effect of the system first introduced by him in 1896 as supplied from the mains of the Bradford Corporation:

| Year. | Number of motors supplied from Corporation mains. Owned by consumer. Not on hire. | Owned by Corporation. On hire. | Total. | Board of Trade units sold per annum. |
|---|---|---|---|---|
| 1895 | 35 | nil | 35 | 35,989 |
| 1896 | 58 | 7 | 65 | 54 972 |
| 1897 | 72 | 46 | 118 | 117,176 |
| 1898 | 99 | 122 | 221 | 205 243 |
| 1899 | 152 | 259 | 411 | 465,630 |
| 1900 | 204 | 405 | 609 | 933 455 |
| 1901 | 229 | 525 | 754 | 1,297,120 |
| 1902 | 272 | 641 | 913 | 1,900 534 |
| 1903 | 297 | 670 | 967 | 2,008,294 |
| 1904 | 451 | 716 | 1,167 | 2,704,663 |

**Burton.**—With regard to the balance-sheet of the electricity department, which appears in another issue, Mr. Pringle, the borough electrical engineer and tramways manager, writes as follows: "During the year we have introduced an alternative 5d. flat rate for lighting, which has meant that about two-thirds of our consumers who got no rebate on the maximum demand system have had their price reduced from 6d. per unit to 5d. per unit. In addition, we are now giving our rebates for lighting quarterly instead of half-yearly, so that during the quarter March, 1905, we have advanced over £400 to our consumers, which in the ordinary course would have been held over as a rebate and given in the June quarter. Although there has been a much larger increase in the lamp connections—*i.e.*, 14·2 per cent. against 12·2 per cent. of last year—we have only had an increase of 5 per cent. in the units sold for lighting against an increase of 18·3 per cent. for last year. The trade this year has been one of the worst known in the town, and the falling off in consumption is directly attributable to this. The concessions mentioned above and the depression in trade therefore accounts for the smaller surplus this year. These adverse conditions, however, may be taken as of a temporary nature only. The progress of motor connections has been distinctly satisfactory, and with 102·5 h.p. in hand, which are about to be connected, brings up the grand total to 306·75 h.p."

**Stockport.**—An enquiry has been held into an application of the Corporation for sanction to borrow £6,125 for the purchase of electric motors for the electricity department. This is the first application made by the Council to enable them to hire out electric motors for various driving purposes. The Electrical Engineer (Mr. Carter) said that motors would range from ½ h.p. to 15 h.p., and would be used for chaff cutting, the driving of sewing machines, printing presses, ginger-beer machines, stone-cutting in connection with buildings, etc. They were now being used on the work of constructing the new town hall, and they had been asked for in connection with several new buildings in course of erection. The charge for hiring out would be 20 per cent. of the total cost of the motors for outside work, and 15 per cent. for inside work. The Town Clerk (Mr. R. Hyde) said the motors would always remain the property of the Corporation. Under the Stockport Corporation Act of 1899 they had power to purchase and hire motors and other apparatus incidental to or connected with the use of electricity. The electricity works were in a flourishing condition. Last year there was a net profit of £1,760 after providing for payment of interest and sinking fund on capital charges. On the small capital invested he considered that a high rate of interest.

**Swansea.**—The balance-sheet of the municipal telephone undertaking for the year ended March 31 shows that the revenue account has been charged with 10 per cent. depreciation on tools and 5 per cent. on office furniture, and with the whole of the cost of the issue of the four years 4 per cent. debenture bonds, amounting to £180. The whole of the rentals, trunk calls, etc., that were considered to be irrecoverable, amounting to £105, have been written off. After bringing these charges into account there remained a gross profit of £1,742, or approximately 8 per cent. upon the amount expended on construction. Carrying this gross profit to net revenue account, and charging this account with interest and sinking fund to March 31, 1905, left a net credit balance of £740. After deduction of a loss of £324, resulting from the five months' working to March 31, 1904, a sum of £416 remained. The committee will ask the Corporation to provide £7 500 for the purposes of further extending the system as required from time to time. The Corporation are being urged by the Local Government Board to provide forthwith for a sinking fund on the customary scale as from the beginning of their electricity undertaking. Although the department is now earning money every year, the sums retained in a suspense account, representing balances credited to the station during the last two years, will now be entirely swallowed up, and the electric lighting accounts for this year will probably show a deficit besides of between £1,500 and £2,000.

**Hastings.**—An application from the Postmaster-General for consent to the placing of an overground telegraphic line along the side of certain public roads has been acceded to. The Council ask that the poles should be of a suitable character and painted green. The Railways and Tramways Committee have agreed to a letter in which Messrs. Kincaid, Waller, and Co. stated, in connection with the conditions imposed by the Council upon approving of the drawings of the proposed feeder system for the supply of electrical energy for the tramways, that they intend that all joints on the three-phase high-tension feeders shall be made in cast-iron boxes under the roadway or footway, and filled in completely with insulating composition; that with this arrangement there is practically no more danger of failure at the joints than at any other portion of the main, but that for the purpose of locating a fault in the cable, which should be a matter of very rare occurrence, they are proposing brick inspection boxes with frames and covers at intervals of about a mile, and in their view this should enable them to locate the position of any fault very closely. The average length of the high-tension cables would be about a quarter of a mile, so that if inspection chambers were to be put at every joint, four to the mile would be required, instead of one to the mile, which they propose. The engineers further affirm that there is no intention whatever on the part of the company to supply electrical energy for any purpose otherwise than for the purpose of the tramway undertaking, and point out that the company's powers would not permit them to so enter into competition with the Corporation for the supply of electrical energy for lighting or power purposes unconnected with the tramways, so that, therefore, this question would not arise in connection with the application they have made under the Act of 1900.

**Bradford.**—The Electricity Committee have approved a report by Mr. A. S. Blackburn, the electrical engineer, on extensions of mains. The cost of the general supply mains to date has been £180,000, and the annual capital costs including depreciation at 1 per cent., amount to approximately £13,800, and for this mains having a capacity of 4,000 kw. have been provided. The engineer estimates the cost of the extensions at £37,500, and the annual capital costs, including depreciation, at 1 per cent., at £2,875, and for this an additional capacity of 2,500 kw. would be obtained. Against this a saving of £1,472 per annum is anticipated owing to increased efficiency of distribution, which would reduce the annual cost of extensions to £1,403. The engineer considers that the economy of carrying out the work simultaneously with the extension of the tramways distributive system will be very great both in cost and as regards the inconvenience of interfering with the busy streets in the centre of the city, and the whole of the work proposed by the scheme will necessitate the opening of 3,790 yards of streets. The engineer has gone into the question of the feasibility of providing a subway between certain points in which the whole of the electricity mains between the town and the works could be accommodated, and the future opening of this part of the route avoided. It was, however, found that the cost would be prohibitive on account of the many obstacles which have to be contended with in the way of gas and water pipes, the beck, sewers, and storm overflows, the latter being especially troublesome. Furthermore, the nature of the soil along the

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valley is such as to necessitate special precautions to render the subway dry. It is proposed to lay 24 ducts embedded in concrete under the town hall to meet present and future demands. It is also proposed to lay the cables considerably deeper than formerly, about 3ft. to 3ft. 6in. under the footway and about 4ft. to 5ft. under the roadway. The engineer advises that permission to borrow a further £60,000 be obtained to meet the cost of the mains extensions that may be necessary from time to time.

**Devonport.**—The accounts of the Council electricity undertaking for the year ended March 31 last show that the income for traction and lighting for the past year was £15,223, compared with £12 412 for the previous year, or an increase of £2,811. The gross profits were £8,684, against £6,409 in the previous year, an increase of £2,275. The committee have decided to dispose of the gross profit as follows: depreciation account, £3,949; net deficit at March 31, 1904, £1,119; interest on loans, £3,295; balance carried to reserve fund, £320. The gross cost of electricity for the year is ·859d. per unit generated, against ·978d. in the previous year. The decrease is partly due to increased demand. The capital expenditure at the end of the year was equal to £58. 19s. 1d. per 1,000 Board of Trade units generated, compared with £67. 17s. in the previous year, and £79. 5s. 4d. in 1903. The number of units actually generated during the three years was as follows: 1905, 1,857,740; 1904, 1,504,085; 1903, 1,181,559. Mr. J. W. Spark (electrical engineer) in his report says: "The number of private consumers supplied up to the end of the year is 221, an increase of 79 for the year, while the private connections for lighting, power, and heating expressed in the equivalent of 8-c.p. lamps have increased from 15,151 to 21,799. The present extensions to the generating plant are nearing completion, and the supply mains have been extended so as to give an additional supply frontage of one mile." Mr. Spark continues as follows: "The public lighting by electricity in the borough has not been extended this year, so that the unremunerative capital of £970 is still a burden on the undertaking's finances, 1,857,740 units have been generated during the 12 months, and the total cost of production, including all materials, labour, management, insurances, and incidental charges, has been ·859d., making a decrease on last year's result of ·119d. per unit, and the total cost per unit sold has been ·972d., making an economy of ·118d. per unit. The units sold for all purposes amount to 1,642,246, and the sale has been as follows: traction (both companies) 80·09 per cent.; private consumers (general), 15·37 per cent.; private consumers (power), 2·62 per cent.; public lighting, 1·92 per cent. The average price obtained per unit sold has increased from 2·193d. to 2,217d., despite the general reduction in charges to private consumers, made at the commencement of the year, and is accounted for by the larger consumption by private consumers, which this year amounts to 17·99 per cent., against a percentage of 12·7 last year of the total units sold. Your engineer does not recommend any alteration in the charges for electricity at present."

## PROVISIONAL PATENTS, 1905.

MAY 15.

**10138. An electrical apparatus for automatically controlling the speed of motorcars and like vehicles.** George Henry Charles Lumsden, 100, Wellington-street, Glasgow.

**10146. Improvements in electrical resistances.** Emile Rousseau, 23, Leonard-street, City-road, London.

**10168. Automatic device for the ignition of gas by electric currents.** Rudolf Keller, 65, Chancery-lane, London. (Complete specification.)

**10187. Improvements in electric couplings.** John Ebenezer Bousfield, 4, South-street, Finsbury, London. (Firm of Julius Pintsch, Germany.) (Complete specification.)

**10197. Improvements in zinc rods for galvanic batteries of the Leclanché type.** Siemens Bros. and Co., Limited, and George William Perry, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**10202. Improvements in or relating to methods of measuring, switching, signalling, and regulating electric current.** Martin Kallman, 111, Hatton-garden, London. (Complete specification.)

**10210. Improvements in direct-current dynamos and electromotors.** Wilhelm Georg Schmidt, 18, Buckingham-street, Strand, London.

**10211. Improvements in safety devices for use with bare suspended electric conductors.** Arthur Green, 47, Lincoln's-inn-fields, London.

**10214. Improvements in electric current rectifiers.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.) (Complete specification.)

**10215. Improvements in vapour electric apparatus.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**10217. Improvements in ropes and means for signalling or transmitting electricity through same.** James Joseph Condon and William Jules Reside, 1, Queen Victoria-street, London.

MAY 16.

**10221. Improvements relating to electric grinders for dynamos and the like.** William Gordon Potter, 13, Mostyn-road, Brixton, London.

**10237. Improvements in connections of metallic and other conduits and tubes.** Albert Edward Hills, Plume-street, Aston, Birmingham.

**10258. Improvements in service, junction, and the like boxes for underground electrical conductors.** Archibald Bruce, 34, Castle-street, Liverpool.

**10265. Improvements in or relating to electrical switches.** Francis Arthur Griffin, 18, Hertford-street, Coventry.

**10288. Improvements in or connected with holders for incandescent electric lamps.** Leo Sunderland and Gilbert Cecil Pillinger, Norfolk House, Norfolk-street, London.

**10291. Improvements in apparatus connected with the multiplication of electric force applicable to machinery of all kinds requiring power.** Thomas James Howell and Edwin Joseph Richardson, 41, Brook-street, Grosvenor-square, London.

**10296. An improvement in electrical fuse boxes.** W. T. Henley's Telegraph Works Company, Limited, and William Henry Nichols, 53, Chancery-lane, London.

**10298. Improvements in electric switches or relays.** Angel Vera and Luis Gonzaga Vera, 7, Southampton-buildings, Chancery-lane London. (Date applied for under Patents Act, 1901, May 17, 1904, being date of application in United States.) (Complete specification.)

**10299. Improvements in and relating to dynamo-electric machines.** La Société Boucherot et Cie., 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, May 17, 1904, being date of application in France.) (Complete specification.

**10304. Improvements in single-phase alternating-current motors.** Allmänna Svenska Elektriska Aktiebolaget, 322, High Holborn, London. (Date applied for under Patents Act, 1901, Sept. 15, 1904, being date of application in Sweden.) (Complete specification.)

**10315. Improvements in resistances for electric circuits.** Henderson Gibson, jun., and William Bickerton, 18, Buckingham-street, Strand, London.

**10320. Improvements in alternating electric current generators.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**10321. Improvements in electric circuit breakers.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

MAY 17.

**10341. An iron standard for fixing guard boards on electric railways.** George Thomas Trinder and Thomas Duncan Cramb, 26, Palmerston-road, Kilburn, London.

**10400. Improvements relating to the application of fire-alarm apparatus in connection with central battery telephone systems.** Isidore Bernard Birnbaum and Francis George Bell, 322, High Holborn, London.

MAY 18.

**10433. Improvements in and relating to electrical governors for the control of gas-engines used for the generation of electricity.** Hubert Elwell Smith, 95, Buchanan-street, Glasgow.

**10446. Improvements in or connected with the trolley poles of electric tramcars.** Joseph Standring Dronsfield and Charles John Josiah Huntley, 5, John Dalton-street, Manchester.

**10480. Night-sights with electric incandescent lamps for artillery sighting or for any instrument in which night-sighting may be required.** Giacomo Augusto Bertalot, 22, Southampton-buildings, Chancery-lane, London. (Teofilo Bonino, Italy.)

MAY 19.

**10495. Improvements in the methods of charging and discharging accumulators by automatic control.** George Soobel Ellis and Alfred Mills Taylor, 12, Ashfield-road, King's Heath, Worcestershire.

**10509. Improvements in coin-freed electricity meters.** John Meany Tourtel, 146A, Queen Victoria-street, London.

**10553. Improvements in electric arc lamps.** William Stone Weedon, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, May 20, 1904, being date of application in United States.) (Complete specification.)

**10554. Improvements in and relating to electric motor-driven pumps.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**10555. Improvements in alternating electric current generators.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

MAY 20.

**10564. Improved system of and apparatus for electric signalling.** William Johnson, Arthur Horton, and William James Berry, Bank-buildings, George-street, Sheffield.

**10573. Improvements in electrical leakage indicators.** Kenelem Edgcumbe, Collindale Works, Hendon, London.

**10581. Automatic switch for electric railways.** Victor Jokscb, Josef Petrik, and Richard Butta, 65, Chancery-lane, London. (Complete specification.)

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**10584. Improvements in or in connection with electric bells.** Thomas Blackburn Lowrance, Joseph Robert Ryder, and William James Lowrance, 3, Brown-street, Market street, Manchester.

**10599. Electromagnetic ignition device for explosion engines.** Willy Roos, 65, Chancery-lane, London. (Complete specification.)

**10601. Improvements in and connected with wireless telegraphy with earth currents.** Ludwig Zehnder, 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1901, May 20, 1904, being date of application in Germany.) (Complete specification.)

**10605. Fraud detector for electric meters.** Wallace Watt Fuller, 81, High Holborn, London. (Date applied for under Patents Act, 1901, May 20, 1904, being date of application in United States.) (Complete specification.)

**10609. Improvements relating to electric advertising signs.** Leonard Kingwill Job, 322, High Holborn, London.

**10610. Improvements in switching devices applicable to electric flash advertising signs.** Leonard Kingwill Job, 322, High Holborn, London.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published June 8.*

1904.

**11233. Electric meters for three-phase alternating electric circuits.** Union Elektricitäts-Ges. (Date applied for under International Convention, May 15, 1903.)

**11264. Electrically-propelled vehicles.** Thayer.

**11364. Electric alternating-current distributing systems.** Merz and Price.

**11443. Electric switches.** British Thomson-Houston Company, Limited. (General Electric Company.)

**11532. Prepayment meters.** British Thomson-Houston Company, Limited. (Allgemeine Elektricitäts-Gesellschaft.)

**11720. Electric switches.** Green and Hallam.

**12245. Electric switches, circuit breakers, and the like.** British Thomson-Houston Company, Limited, and Cubitt.

**13527. Electrical measuring and indicating devices.** Hughes.

**14741. Protecting electric apparatus against reversal of energy flow.** British Thomson-Houston Company, Limited. (General Electric Company.)

**15332. Sliding apparatus for raising or lowering chandeliers, electroliers, gas pendants, and the like.** Lea and Perrins.

**15517. Dynamo-electric machines for hand working.** Lommatzsch and Siegert.

**15633. Hoisting apparatus.** British Thomson-Houston Company, Limited. (General Electric Company.)

**15764. Electricity meters.** Mordey and Fricker.

**15779. Boxes, covers, or containing cases for electric switches, fuses, and the like.** Marsh and Mudie.

**16242. Gas electric lamps and arc lamps** Beck. (Date applied for under International Convention, June 24, 1903.)

**16393. Automatic electric cut-out switch.** Javaux.

**16418. Electrically-driven winding engines.** Raky.

**16603. Electric arc lamps.** Jones and Jandus Arc Lamp and Electric Company, Limited.

**17011. Voltaic cell or element.** Delafon.

**23084. Switches for reversing the current in electric motors.** Whittingham. (Date applied for under International Convention, Oct. 29, 1903.)

1905.

**513. Alternating-current commutator motors.** Zani.

**881. Apparatus for automatically indicating loss or passage of electric current.** Wieland.

**1920. Securing laminated cores of dynamo-electric machines.** Burke.

**1921. Dynamo-electric machines** Burke.

**3401. Resistances for electric current.** Hopfelt.

**7101. Apparatus for absorbing gases by a liquid under the action of the silent electric discharge.** De Hemptinne.

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ⅝ ¼ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 7/16-17/32 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | – | 5¼-6 |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | – | 5¾-6 |
| —— 4½ per cent. Mortgage Debentures | 100 | – | 102-105 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 100-103 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | – | 2 13/16-3 1/16 |
| —— 4 per cent. Mortgage Debenture Stock | 100 | – | 89-91 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 | 2 | – | ¼-¾ |
| —— Non. Cum., 6 per cent. Pref. | 2 | – | 1⅝-1¾ xd |
| —— 4½ per cent. 1st Debenture Stock | 100 | – | 92-93 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | – | 79-82 |
| Callender's Cable, Debentures | 100 | – | 107-109 |
| —— Ordinary | 5 | – | 10¼-11¼ |
| —— 5 per cent. Pref. | 5 | – | 6⅛-6⅜ |
| Crompton and Co. | 5 | – | 12-12¼ |
| —— 5 per cent. Debentures | 100 | – | 85-100 p.c |
| Edison and Swan United, "A" Shares, 1-98,261 | 5 | – | 1¼-1¼ |
| —— "A" Shares, 01-017,139 | 5 | – | 2 2¼ |
| —— 5 per cent. Debentures | 100 | – | 87 92 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 83-88 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | – | ¾-1¼ |
| —— 7 per cent. Cumulative Pref. | 2 | – | 2¼-2½ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | – | 95-99 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | – | 9⅞-10¼ |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | – | 97-101 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | – | 11¼-12¼ |
| —— 4½ per cent. Preference | 5 | – | 5¼-5⅜ |
| —— 4½ per cent. Debentures | 100 | – | 109-111 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | – | 16-17 |
| —— 4 per cent. Debentures | 100 | – | 100-103 |
| Parker, Thos., Limited, Ordinary | 10 | – | 10-10¼ |
| Telegraph Construction and Maintenance | 12 | – | 34 36 |
| —— 5 per cent. Bonds | 100 | – | 103-105 |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary | 10 | – | 11¾-12¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | – | 10 10¼ |
| —— 5 per cent. Cum. Second Pref., 15,001-22,500 | 10 | – | 11-12 |
| —— 4½ per cent. Debenture Stock, Red. | 100 | – | 106-108 |
| Bromley (Kent) Electric Light and Power Co. | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. 1st Debenture Stock, Red. | 100 | – | 102-105 |
| Brompton and Kensington, Ordinary | 5 | – | 9¼-10¼ |
| —— 7 per cent. Preference | 5 | – | 9¼-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-50,000 | 5 | – | 8⅛ 9 xd |
| —— Nos. 50,001-80,000 | 5 | – | 7⅛ 8 xd |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | – | 12¾-13¾ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 105-108 |
| Charing Cross and Strand, 70,001-80,000 | 5 | – | 7¼-8¼ |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5⅛-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 4¼-4⅜ |
| —— 40,001-80,000 | 5 | .. | 4¼-5¼ |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | – | 105-107 |
| Chelsea Electricity Supply | 5 | – | 6¼-6⅜ |
| —— 4½ per cent. Debentures | 100 | – | 109-111 |
| City of London, Ordinary | 10 | – | 10-11¼ |
| —— 6 per cent. Cumulative Pref. | 10 | – | 13¾-14¼ |
| —— 5 per cent. Debenture Stock | 100 | – | 126-128 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | – | 104-106 |
| County of London Electric Supply, Ordinary | 10 | – | 8¼-9 |
| —— 6 per cent. Cum. Pref. | 10 | – | 12-12¼ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 103 105 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. | 100 | .. | 112-115 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | – | 5¾-6¼ |
| —— 6 per cent. Cum. Pref. | 5 | – | 6-6¼ |
| —— 4½ per cent. First Mort. Deb. | 100 | – | 107-109 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 85-91 |
| —— 5 per cent. Debenture Stock, Red. | 100 | – | 86-91 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | – | 5¼-5⅜ |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | – | 101-104 |
| Havana Electricity, Limited, 1-15,000 | 10 | – | 9¼-10¼ |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | – | 7¼-8 |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 100-103 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 | 1 | – | ⅜-⅞ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | | 12-13 |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red | 100 | – | 101-103 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅜-10⅜ |
| London Electric, Ordinary | 5 | – | 2¼-2⅜ |
| —— 6 per cent. Pref. | 5 | – | 5-5¼ |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | – | 93-101 |
| Metropolitan Ordinary | 10 | – | 18 19 |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | – | 103-114 |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5¼-5⅜ |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | – | 97-99 |
| Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb. | 100 | – | 99-101 p.c. |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | – | 98-101 |
| —— Preference | 4 | – | 100-102 |
| Notting Hill Electric Lighting | 10 | – | 14¼-15¼ |
| —— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.) | 100 | – | 100-102 |
| Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,510 | 5 | – | 6¼-6⅜ |
| —— 4 per cent. Debenture Stock | 100 | – | 98-100 |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures | 100 | – | 101-104 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 | – | 2⅜-3¼ |
| —— 4 per cent. Debenture Stock | 100 | – | 79-83 |
| South London, Ordinary | | – | 3¾-4¼ |
| South Metropolitan Electric Light and Power Co., Ord. | 1 | .. | 13/16-15/16 |
| — 7 per cent. Cum. Pref. | 1 | .. | 1 11/32-1 13/32 |
| —— 4½ per cent. 1st Mort. Deb. | 100 | .. | 105 108 |
| —— Ditto, June, 1904 | | – | |
| St. James's and Pall Mall, Ordinary, 101-20,080 | 5 | – | 14-15 |
| —— 7 per cent. Pref. | 5 | – | 8¼-8⅜ |
| —— 3½ per cent. Deb. | 100 | – | 98-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | – | 4¾-5¼ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5¼-5⅜ |
| Westminster, Ordinary | 5 | – | 12-13 |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | – | 5-5¼ |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 | 5 | – | 5¼-5⅜ |
| —— Ord. | 5 | – | 8¼-8¾ |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | – | 141-144 |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 105-107 |
| Barcelona Tramways, Limited, Ord., 1-20,000 | 10 | .. | 11¼-11⅜ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 | 10 | .. | 9⅜-10¼ |
| —— 5 per cent. Deb., Red., 1-600 | 100 | .. | 98-102 |
| —— 4½ per cent. Red. Deb. Stock | 100 | .. | 96-100 |
| Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606 | 1 | .. | ⅜-⅞ |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 | 1 | .. | 15/16-1 1/16 |
| Belfast Street Tramways, Ord., 1-26,600 | 10 | .. | 10¼-11¼ |
| Blackpool and Fleetwood Tramroad | 10 | – | 13¾-15⅜ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | – | ¾-1¼ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | – | 3¾-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 94-98 |
| British Columbia Electric Railway Co., Ord. Def. | 100 | – | 103-106 |
| —— Ord Pref. | 100 | – | 100-103 |
| —— Non. Cum. 5 per cent. Pref. | 10 | – | 10¼-10⅜ |
| —— 4½ per cent. 1st Mtg. Debs., Nos. 1-6,250, of £240 each | 40 | – | 103-105 p.c |
| —— 4½ per cent. Vancouver Power Deb. | 100 | – | 100-103 |
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 | – | 9¼-9⅝ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | – | 10¼-11⅛ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | – | 121-123 |
| —— 4½ per cent. 2nd Deb. Stock | 100 | – | 97-99 |

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| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| | £ | | £ |
| Buenos Ayres and Belgran Tram. | 5 | – | 3⅜-3⅝ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | – | 5 9/16-5 13/16 |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | – | 5¼-5½ |
| —— 5 per cent. Deb. Stock, Red. | 100 | – | 107-109 |
| —— Prov. Cert., all paid | 100 | – | 103-106 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | – | 97-99 |
| Calcutta Tramways, Limited, 1-102,268 | 5 | .. | 8¼-8½ |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | .. | 107-109 |
| Cape Electric Tramways Nos. 1-480,000 | 1 | – | 1¼-1½ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | – | 4⅞-5⅛ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | – | 98-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | | 101-103 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | | 9¼-10 |
| —— 5 per cent. Cum. Pref. | 10 | – | 11-12 |
| —— 4 per cent. Debentures | 100 | – | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | – | 13½-14½ |
| —— 5 per cent. Pref., Nos. within 1-60,000 | 10 | – | 15½-16¼ |
| —— 4½ per cent. Mort. Debs., 1-3,000, Red. | 100 | – | 94-97 |
| Imperial Tramways Ordinary | all | – | 18-19 |
| —— 5 per cent. Cum. Pref. | all | – | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 | – | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 50,001-60,000 | 5 | | 2⅞-3⅛ |
| —— 4 per cent. Debenture Stock | 100 | – | 85-90 |
| Kilmarnock and District Lighting and Traction, Pref. | 5 | – | 8-8½ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | – | 9⅜-10¼ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | – | 99-102 |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 | .. | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016. | 1 | .. | 9/32-11/32 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | .. | 1-1 1/16 |
| —— 4½ per cent. Deb. Stock, Red. | 100 | .. | 105-107 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000 | £1,000 | .. | 106-110 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 | .. | 101-104 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 | .. | 103-105 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000 | 5 | – | ¼-1¼ |

| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| | £ | | £ |
| Oldham, Ashton, and Hyde Tramway, Ordinary | 10 | – | 12 |
| —— 6 per cent Cum. Pref. | 10 | – | 9½-9⅝ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Sk. | 100 | – | 105-108 |
| Potteries Electric Traction, Ordinary 20,001-40,00 | 10 | – | 9 9½ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | – | 9¼-9⅝ |
| —— 4½ per cent. Debenture Stock | 100 | – | 101-104 xd |
| South Lancashire Electric Traction and Power Company —— £250,000 Ordinary | 1 | – | 1 |
| —— £101,132 6 per cent. Preference | 1 | – | |
| —— £597,170 4½ per cent. Debenture Stock | 100 | p.c. | 100 p.c. |

## Electric Railways.—

| | | | |
|---|---|---|---|
| Central London, Ordinary | 100 | – | 91-93 |
| —— 4 per cent. Pref. | 100 | – | 101-103 |
| —— " " deferred | 100 | – | 80-83 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | – | 110-112 |
| City and South London, Consolidated Ordinary | 100 | – | 40-42 |
| —— 4 per cent. Debenture Stock | 100 | – | 107-109 |
| —— 5 per cent. Pref. Stock '91 | 100 | – | 120-123 |
| —— " " " '96 | 100 | – | 118-121 |
| —— " " " '01 | 100 | – | 115-118 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | – | 10-10¼ |
| —— Ordinary, 1-50,000 | 10 | – | 3¾-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700. | – | – | 99-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | – | – | 101-102 |
| Waterloo and City, Ordinary | 100 | – | 91-93 |

## Telephones.—

| | | | |
|---|---|---|---|
| National Telephone, Preferred | 100 | – | 109-110 |
| —— Deferred Stock | 100 | – | 101-103 |
| —— 6 per cent. Cum. First Pref. | 10 | – | 12¼-13¼ |
| —— 6 per cent. Cum. Second Pref. | 10 | – | 11¼-12¼ |
| —— 6 per cent. Non. Cum. Third Pref. | 5 | – | 5⅜-5⅝ |
| —— 5½ per cent. Deb. Stock, Red. | 100 | – | 100-102 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 104-106 |
| —— 4 per cent. Prov. Cert. | – | – | 103¼-105¼ |
| Oriental Telephone and Electric Company | 1 | – | 1¼-1⅝ xd |
| —— 6 per cent. Cum. Pref. | 1 | .. | 1¼-1½ xd |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905. | 1904. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pass'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | May 20 | 1,258 | 1,318 | – 59 | + 5,416*h* | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·14 |
| Ayr Corporation | ,, 20 | 226 | 248 | – 12 | – | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 336,049 | 1·03 | 10·11 | 1,770 | 5·0 |
| Barking Corporation | – | – | – | – | – | 1·33 | – | – | – | – | – | – | – | – | – |
| Birkenhead Corporation | ,, 21 | 1,003 | 1,051 | – 48 | – 80 | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,349,701 | 1·158 | 9·98 | 2,383*b* | 6·1 |
| Birmingham Corporation | ,, 20 | 343 | 261 | + 82 | – | – | – | – | – | – | – | – | – | – | – |
| Birmingham Tramways Co. | – | – | – | – | – | 6½ | 6½ | – | – | – | – | – | – | – | – |
| Blackburn Corporation | ,, 17 | 932 | 923 | + 69 | + 333 | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | – | 10·94 | – | 4·58 |
| Blackpool Corporation | ,, 18 | 625 | 512 | + 113 | + 445 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | – | – |
| Blackpool-Fleetwood Trams. | ,, 20 | 385 | 334 | + 49 | + 124 | 16½ | 16½ | Dec. 31 | 32,021 | 2,258,984 | 600,757 | 3·34 | 12·75 | 2,001 | 7·05 |
| Bolton Corporation | ,, 21 | 1,902 | 1,752 | + 150 | + 650 | 38 | 38 | March 31 | 94,161 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·89 |
| Bournemouth Corporation | ,, 17 | 1,044 | 988 | + 56 | – 116 | 10·15 | 10½ | – | – | – | – | – | – | – | – |
| Bradford Corporation | ,, 13 | 4,260 | 4,055 | + 205 | – | 77 | 41 | – | – | – | – | – | – | – | – |
| Brighton Corporation | ,, 21 | 938 | 910 | + 28 | + 6,812*h* | 9 | 7½ | ,, 31 | – | 10,432,508 | 1,031,928 | 1·00 | 10·10 | – | – |
| Bristol Tramways Company | ,, 19 | 4,872 | 5,105 | – 233 | – | 51½ | 51½ | Dec. 31*g* | 253,150 | 44,391,439 | 6,035,528 | – | – | – | – |
| Burnley Corporation | ,, 20 | 1,102 | 1,011 | + 91 | – | 10·60 | 10 | – | – | – | – | – | – | – | – |
| Burton Corporation | ,, 21 | 307 | 337 | – 30 | – | 8½ | – | March 31*j* | 11,574 | 2,566,134 | 282,378 | 1·08 | 9·84 | 1,570 | 7·57 |
| Cardiff Corporation | ,, 20 | 1,948 | 1,997 | – 49 | – | – | – | – | – | – | – | – | – | – | – |
| Carlisle Tramways Company | ,, 20 | 188 | 205 | – 17 | – 328 | – | – | Dec. 31*g* | 9,987 | 2,805,277 | 334,393 | – | 7·17 | – | – |
| Central London Railway | ,, 20 | 6,715 | 6,549 | + 166 | + 1,930*h* | 6 | 6 | ,, 31 | 362,471 | 44,953,988 | 1,292,674*a* | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 21 | 2,486 | 2,655 | – 170 | – 3,146*h* | 6½ | 6⅜ | ,, 31 | 165,003*a* | 19,069,319*a* | – | – | – | – | – |
| Colchester Corporation | ,, 17 | 176 | – | – | – | 7 | – | – | – | – | – | – | – | – | – |
| Cork E. T. and L. Company | ,, 11 | 505 | 452 | + 53 | – | – | – | ,, 31*g* | 25,657 | 6,353,323 | 919,676 | 1·00 | 6·95 | – | 3·9 |
| Darwen Corporation | ,, 19 | 241 | 265 | – 25 | + 40 | 7·23 | 7·23 | March 31*g* | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 13 | 198 | 195 | + 3 | – | 4½ | 4½ | ,, 31 | 11,265 | 2,871,332 | 280,901 | 0·94 | 9·63 | 2,503 | – |
| Dublin & Lucan Electric Ry. | ,, 19 | 129 | 121 | + 8 | – *h* | 7 | 6½ | Dec. 31*g* | 6,294 | 388,905 | 107,164 | 3·88 | 14·09 | 932 | 7·39 |
| Dublin U. T., electric cars | ,, 19 | 4,321 | 4,064 | + 257 | } – | 47 | 46 | ,, 31*g* | 134,648 | – | 3,429,356 | – | – | – | – *k* |
| Dublin S. District, Electric | ,, 19 | 1,368 | 920 | + 448 | | | | | | | | | | | |
| Dundee City Tramways | ,, 17 | 879 | 880 | – 1 | – | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | – |
| East Ham Corporation | ,, 20 | 837 | 771 | + 53 | + 252 | 10·77 | 10·75 | March 31 | 34,312 | 12,950,269 | 807,002 | 0·63 | 10·2 | – | – |
| Glasgow Corporation | ,, 20 | 15,152 | 14,855 | +1,297 | +40,239*h* | 143 | 123 | May 31*g* | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489*b* | 7·40*d* |
| Gloucester Corporation | ,, 17 | 297 | – | – | – | 5½ | – | – | – | – | – | – | – | – | – |
| Halifax Corporation | ,, 17 | 3,042 | 2,621 | + 418 | + 627 | 33 | 30½ | March 31 | 68,289 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,069 | 8·77 |
| Huddersfield Corporation | ,, 20 | 1,348 | 1,257 | + 81 | + 470 | 35 | 35 | ,, 31 | 65,545 | 11,899,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | – |
| Hull Corporation, E. S. | ,, 20 | 2,019 | 2,095 | – 76 | – | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | April 29 | 546 | 446 | + 100 | – | 10½ | – | – | – | – | – | – | – | – | – |
| Ilkeston Corporation | May 17 | 124 | 138 | – 14 | – | – | – | – | – | – | – | – | – | – | – |
| Kirkcaldy Corporation | ,, 17 | 224 | 216 | + 8 | – | – | – | – | – | – | – | – | – | – | – |
| Leeds Corporation | ,, 20 | 5,678 | 5,579 | + 99 | + 1,921 | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | – |
| Leicester Corporation | April 22 | 1,961 | – | – | – | 7½ | – | – | – | – | – | – | – | – | – |
| Liverpool Corporation | May 13 | 10,518 | 9,976 | + 542 | + 8,050 | 103 | 103 | Dec. 31*g* | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | ,, 21 | 1,522 | 1,643 | – 121 | – 1,382*h* | 6·57 | – | June 30 | 79,252 | 10,466,726 | 986,185*a* | 1·82 | 19·30*a* | 5,110 | – *e* |
| London County Council | ,, 13 | 14,252 | 10,588 | +3,664 | +15,523 | 46½ | 40 | – | – | – | – | – | – | – | – |
| Lowestoft Corporation | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Maidstone Corporation | ,, 18 | 125 | – | – | 2 | – | – | – | – | – | – | – | – | – | – |
| Manchester Corporation | ,, 13 | 12,380 | 11,355 | +1,025 | – | 131½ | – | – | – | – | – | – | – | – | – |
| Nelson Corporation | ,, 20 | 131 | 107 | + 24 | + 101 | 2¾ | – | – | – | – | – | – | – | – | – |
| Newcastle-on-Tyne Corptn. | ,, 20 | 3,572 | 3,640 | – 68 | – | 45 | 38½ | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | – | – |
| Newport (Mon.) Corporation | – | – | – | – | – | 15 | – | ,, 25 | 185,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111*b* | – |
| Oldham Corporation | ,, 14 | 1,558 | 1,106 | + 452 | + 3,018 | 34¾ | – | – | – | – | – | – | – | – | – |
| Portsmouth Corporation | ,, 20 | 1,771 | 1,731 | + 40 | – | 29 | 29 | , 31 | 94,448 | 18,204,426 | 1,828,193 | 1·16 | 12·39 | – | – |
| Reading Corporation | ,, 11 | 622 | 568 | + 54 | – | – | – | – | – | – | – | – | – | – | – |
| Rochdale Corporation | April 29 | 582 | 120 | + 462 | + 1,811 | 4½ | 4½ | 31*g* | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | – | 7·66 |
| Rotherham Corporation | May 18 | 412 | 459 | – 47 | – | – | – | ,, 31 | 20,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·68 |
| Salford Corporation | ,, 22 | 4,115 | 4,082 | + 33 | + 940 | – | – | – | – | – | – | – | – | – | – |
| Scarborough Tramways Co. | ,, 20 | 87 | – | – | – | 7¾ | – | – | – | – | – | – | – | – | – |
| Sheffield Corporation | ,, 21 | 4,677 | 4,629 | + 48 | + 671 | 34½ | – | – | – | – | – | – | – | – | – |
| Southampton Corporation | ,, 17 | 914 | 957 | – 42 | – 307 | 11 | 11 | ,, 25*g* | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southend-on-Sea Corporation | ,, 17 | 314 | 307 | + 7 | + 179 | 6½ | – | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | – |
| Stockport Corporation | ,, 19 | 687 | 587 | + 100 | + 282 | 11½ | – | – | – | – | – | – | – | – | – |
| Sunderland Corporation | ,, 21 | 1,157 | 1,260 | – 103 | – | 19·53 | 18·48 | – | – | – | – | – | – | – | – |
| Swindon Corporation | ,, 3 | 176 | – | – | – | 3¾ | – | ,, 31 | 62,506 | 14,848,958 | 1,433,463 | 1·01 | 10·46 | – | 6·02 |
| Wallasey U.D.C. | ,, 20 | 748 | 682 | + 66 | + 358 | 10·5 | 10·5 | – | – | – | – | – | – | – | – |
| Warrington Corporation | ,, 18 | 332 | 303 | + 29 | + 14·6 | 7½ | – | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·50 |
| West Ham Corporation | ,, 18 | 1,594 | 788 | + 805 | + 4,527 | 8·62 | – | – | – | – | – | – | – | – | – |
| Wolverhampton Corporation | ,, 17 | 754 | 542 | + 212 | – | 7½ | – | – | – | – | – | – | – | – | – |
| | | | | | | | | ,, 31*g* | 20,878 | 4,263,066 | 417,335 | – | 12·006 | – | – |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures. Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**The Electrical Contractors' Association.**—The annual dinner of this association will be held in the King's Hall of the Holborn Restaurant on Tuesday, the 27th inst., at 6.30.

**Wireless Telegraphy.**—It is reported that the Postmaster-General, the Minister of Defence, and Vice-Admiral Sir Arthur Fanshawe, commander-in-chief on the Australia Station, are considering an extensive scheme for installing a wireless telegraphy system to connect Australia, New Zealand, and the outlying islands.

**Canada's Telephone System.**—One of the chief witnesses before the Canadian Telephone Committee last week was Mr. H. Laws Webb, who declared that the Government ownership of telephones was proving a failure, while the Glasgow municipal system was partly obsolete. Mr. Webb's statements are reported to have made a considerable impression upon the committee.

**The Students' Section.**—The students held twelve meetings during the past session, and visits were paid to a like number of works. A party of students paid a visit to Leeds last month, when they inspected a number of important works. The first annual dinner, which was held at the Holborn Restaurant, proved a decided success. The committee desire to express their satisfaction at the results of the past session's work, and trust that the high standard will be maintained.

**Rugby Engineering Society.**—This society paid a visit to the generating station of the London Underground Electric Railways Company at Lots-road, Chelsea, on Saturday, the 20th ult. Seventy-five of the members availed themselves of the opportunity granted through the courtesy of Mr. J. R. Chapman, general manager, of inspecting this extensive station. The whole of the station was thrown open for inspection, and the party were allowed access to practically all parts of the station.

**The Institution.**—At the Society of Arts last week a large company of the Institution assembled to hear Messrs. W. Duddell's and J. E. Taylor's paper on "Wireless Telegraphy Measurements." Mr. Duddell's delivery of the paper was punctuated by frequent and enthusiastic applause. In the brief discussion which followed, Mr. Gavey paid a tribute to the value of the authors' researches into the measurements of wireless currents, and this was echoed by Captain Jackson, R.N., who has had extensive experience of wireless telegraphy in the Navy. Dr. Sumpner was also congratulatory.

**The Pacific Cable Conference.**—From reports in the daily Press it appears likely that this conference, which has several times been postponed owing to the difficulty of assembling all the delegates at the same time, will really arrive at fruition in the course of the present month. The first of the sittings, which are to be held at the Colonial Office, is announced for the 21st inst. The Australian Commonwealth will be represented by Lord Jersey, New Zealand by Sir Sandford Fleming, Canada by Sir William Mulock (Postmaster-General of the Dominion), who is expected to sail for England to-morrow, and Great Britain by the Secretary of State for the Colonies.

**Patents.**—Attention is called by Mr. C. Crossley, of 9, Zenobia-mansions, W., to a measure now before Parliament which our correspondent considers will prevent inventors from availing themselves of expert engineering or similar assistance in preparing their applications, thus forcing them to obtain this assistance through patent agents at additional expense. Mr. Crossley refers to the attempt to pass a similar Bill by the Chartered Institute of Patent Agents some few years ago. This Bill was withdrawn after it had been considered by a committee, who stated in decisive terms their opinion that an inventor should not be compelled to employ any particular class of agent or any agent at all, and that it would be most undesirable to create a monopoly in such matters. The matter is one of great importance, but our correspondent appears to be under some little misapprehension, as the general tenour of the Bill is designed to facilitate rather than to obstruct applications for patents.

**The Metric System in Australia.**—It is reported from Australia that one of the Bills to be introduced in the coming session of the Commonwealth Parliament will have reference to an important phase of economics. It relates, in fact, to the metric system. The Bill is expected to follow the lines of that recently passed by the New Zealand Parliament, under which a proclamation may at any time be issued, giving effect to the metric system throughout the country from the beginning of next year. The measure has for some time been under the consideration of the Minister of Commerce. The powers to be contained in the measure have not yet exactly been defined. The system is for a time to be permissive, but power is reserved to give it compulsory effect after a day fixed by the Governor-General in Council. At one time in the Federal Parliament there was a suggestion that the metric system of weights and measures and decimal system of coinage should be introduced concurrently. This has, however, not been found to be practicable.

**The London Power Bills.**—As mentioned in our last issue, clauses were inserted in both the Administrative County of London and District Power Bill and in the Bill extending the powers of the Metropolitan Electric Supply Company in order to protect the Metropolitan Water Board. The clause as approved provides that the companies in question shall compensate the Water Board for any injury or damage to water-pipes or other metallic pipe structures or substances of the Board which shall prove to have been caused by fusion or electrolytic action by currents generated by the companies. It will be seen that under this clause damage has to be proved, and as the companies in question are most likely to employ three-phase currents, electrolytic action is not so liable to result from leakage. It still leaves open, however, the difficult question of proving how much corrosion on a given pipe may be due to the ordinary electrolytic action which takes place in all buried pipes and how much is due to leakage currents.

**Canadian Electrical Association.**—This institution will hold its annual convention in Montreal on the 21st, 22nd, and 23rd inst., the arrangements for which are rapidly approaching completion. The following is a preliminary list of papers: "Transformers," by Mr. R. T MacKeen, Canadian General Electric Company, Toronto; "Operation of Transformers at Varying Frequencies and Voltages," by Mr. Sammett, Montreal Light, Heat, and Power Company; "Induction Motors," by Mr. Burson, Allis Chalmers-Bullock Company, Montreal; "Economy of Isolated Plants," by Mr. T. L. Aitken, consulting electrical engineer, Toronto; "Carrying Capacity of Enclosed Conductors," by Prof. R. B. Owens, McGill University. The question-box, under the able direction of Mr. A. A. Dion, of Ottawa, is expected to prove a feature of great value. A trip to the Shawinigan Falls is also under consideration, and the laboratories of McGill University will be open to inspection by the delegates during the convention. The social side will also come in for due attention.

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**Electricity in Cotton Mills.**—At a recent meeting of the New England Cotton Manufacturers' Association Mr. Sydney B. Paine contributed a paper giving the result of a test of a cotton mill equipped with electric power. The author had compiled a detailed record of 128 different textile companies which together use some 90,000 h.p. of electrical energy, and it is estimated on a conservative basis that some 175 textile mills in the States are using electrically about 140,000 h.p. The late United States census report shows that 22 mills are driven entirely by current generated by outside companies, while a similar number purchase 5,586 h.p. to supplement the power generated upon the premises. The paper gave charts from a recording wattmeter taken from a 200-h.p. motor operating 52 frames aggregating 11,648 spindles. The spindle speed was about 900 revolutions per minute. Eleven records were obtained, with variations in the conditions, including the temperature and humidity. The average load was in the neighbourhood of 150 h.p., the smallest being 148·5 h.p. and the largest 157 h.p. In the latter case the maximum output of the motor was 190 h.p., the minimum output of the motor 144 h.p., the ratio of average to maximum load 82·7 per cent., and the ratio to the motor rating 78·5 per cent. The average load throughout the test was about 10 h.p. per frame.

**Pneumatic Tube Dispatch.** — The favourable evidence given last week by a number of eminent engineers on behalf of this measure was supplemented by the views of other distinguished witnesses. Mr. C. A. Brereton stated that he had visited America in order to satisfy himself as to its working, and was struck by its extreme simplicity. There would be no difficulty in installing the system in London. In cross-examination, the witness admitted that in times of emergency and pressure of business it might be necessary to send parcels through the tubes by a circuitous route owing to the main tubes being fully occupied. Prof. Carus Wilson considered that as the telephone came to be more generally used in London it would entirely alter the aspect of parcel delivery. In his opinion the more extended use of the telephone would inevitably lead to a demand for quicker delivery of goods. The electrification of railways would lead to the abandonment of parcel delivery by the railways. With the increased knowledge of pneumatics that had been acquired in recent years the essential features of success in a pneumatic delivery system were accurately known, and the Batcheller system possessed those features. Despite this general consensus of opinion, the committee came to the conclusion that the promoters had not proved the preamble of the Bill, and rejected same without calling upon the opposition to state their case.

**The Electrical Engineers R.E.V.**—An exhibition was given by the corps at headquarters last Saturday, when the engines, dynamos, and searchlights were seen in operation under the supervision of Captain Edgcumbe. There are three dynamos of 80 volts, 150 amperes, exact duplicates of those installed at all British forts for searchlight purposes. Two are driven by oil-engines. The third is operated by a steam-engine, which, though this form of prime mover is practically obsolete for such work, is retained for instructional purposes. Great interest and attention was shown by the members of the corps in the performance of their functions. A portable oil-engine and dynamo used in the South African campaign was also on show. After witnessing the searchlight in the emplacement, our representative was conducted to an upper chamber, divided into two compartments, which are being prepared on the plan of a regular fort for searchlight practice, as the view afforded by the lower floor is decidedly circumscribed by the surrounding walls. Another feature on show was the trophy awarded by Prof. B. Hopkinson, son of the founder of the corps, for efficiency in technical work. For this test the engines were taken to pieces and put out of order, and the competitors had to see who could rectify matters in the quickest time, D company proving successful. The corps, it may be remarked, is participating in the Military Tournament at the Agricultural Hall. The various attractions having been inspected by the goodly company assembled, an adjournment was made for tea, after which harmony reigned.

**The Telephone Transfer.**—The Select Committee appointed by the House of Commons commenced its sittings on Tuesday, the first witness being Sir Robert Hunter, solicitor to the Post Office. Sir Robert stated that if an agreement between the Post Office and the company were not consummated at the end of 1911 the company would be unable to work its system, and unless something were done telephone business would come to a standstill. The witness stated that the objection to the Postmaster-General constructing an alternative system in lieu of acquiring the company's, was that it would take at least six or seven years to put down a plant equal to that of the company. Sir Robert Hunter explained at length the details of the terms of purchase by the Postmaster-General of the company's system. The price to be paid was to be what it would cost the Postmaster-General to put up the same plant, subject to reduction for depreciation and subject to the right of objection to certain things which were not suitable for his purpose. Sir Robert stated that the advantages of the agreement were that it provided for the continuance of the company in the meantime; it gave the Postmaster-General a plant at the price which he would have to pay if he constructed it himself (subject to depreciation); and it gave guarantees for the maintenance of the service with the National Telephone Company in the intervening time. In reply to a question, the witness agreed that the effect of the competition in telephones in London had been that the increase in the company's system was equal to the total business of the Post Office system.

**The American Engineering Club.**—The architects of the United Engineering Building for the various American societies have filed plans with the superintendent of buildings giving some of the details of the 15-storey structure, to cost £200,000, presented by Mr. Andrew Carnegie. It is to be erected in West Thirty-ninth-street, and immediately adjoining it in the rear will be the 13-storey clubhouse of the Engineers' Club, which is also part of Mr. Carnegie's gift to American engineers. The Thirty-ninth-street building will be a fireproof edifice, 212ft. high, with a frontage of 115ft. and a depth of 88·9ft. It is to be in the style of the French Renaissance, and light will be admitted through five rows of tall decorated windows, panelled in bronze. The entrance will be adorned with fine doors of decorated bronze, and will be flanked by columns supporting bronze candelabra. Three ornamental balconied doorways, with bronze doors, built just above the entrance cornice, will be flanked by statuary, and the roof cornice and its frieze will be supported by a series of engaged columns and pilasters rising from the thirteenth storey. The façade is to be of granite and limestone trimmed with terra-cotta. The main floor of the building is to have a main central entrance hall, and opening off it at the corners will be the general administration office, the smoking-room, reception-room, and a writing-room. The third and fourth storeys will contain an auditorium, with a balcony having spacious promenades on the north and south. The fifth floor will be fitted with smaller assembly halls, and the sixth floor will contain a series of lecture-

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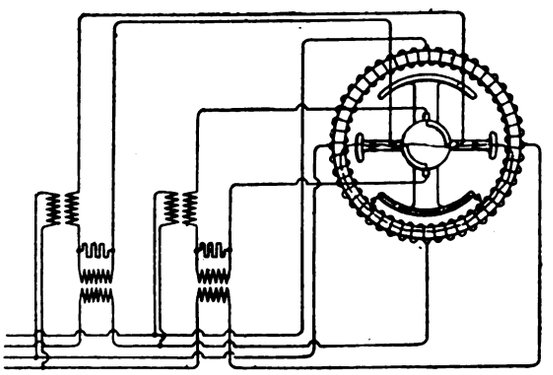
rooms. The seventh to eleventh floors will be devoted to offices for the respective societies. The library will occupy the thirteenth and fourteenth floors. It will be remembered that the American Institution of Civil Engineers decided not to identify themselves with the scheme, but with this exception the movement has received the co-operation of all the important organisations.

**The Embankment Scheme.**—The London County Council have made more progress with their scheme for carrying the trams over Blackfriars Bridge than they were able to achieve at their former attempts, though the Bill has other stages to pass through yet before it becomes converted into an Act. Moreover, the House of Commons committee, in finding the preamble proven, have made certain stipulations, one of which at least is of a decidedly onerous character. The committee came to the conclusion that the widening of Blackfriars Bridge was "imperative." Sir Ralph Littler reminded the chairman that the Council have no powers for this purpose, but the latter replied that he well appreciated the position, and that the committee would take care to see they did not do anything which was *ultra vires*. Whatever be the character of the widening it is pretty certain to entail a pretty substantial outlay, and it is even possible that it may result in again postponing the scheme. A protective clause will be inserted in favour of the Metropolitan Railway Company, who contended that the continuous traffic would endanger the brickwork of their tunnel. The committee do not appear to have attached much importance to the contention that the embankment is not sufficiently well constructed for tramway traffic, and the usual bogey put forward by the æsthetes failed to move them. If the extension does materialise, it will at least afford an opportunity of judging whether the various objections were ill-founded. On Wednesday the committee again met to settle the form of the clause in regard to the widening of Blackfriars Bridge. Mr. Erskine Pollock, K.C., on behalf of the Council, submitted a clause providing for the postponement of the tramway line for six months, during which time the Corporation and the Council should be at liberty to negotiate terms for the widening. If the Corporation failed to give notice of their requirement, or to contribute substantially towards the cost, the clause provided that the Council might construct the tramway over the existing bridge. After considering the matter, the committee intimated that the widening of the bridge must be a condition precedent to the approval of the Bill, and the matter would stand adjourned for a month to give the Council and the Corporation an opportunity of arranging terms.

**Self-Exciting Alternating-Current Generator.**—Two patents have been issued in the United States to Mr. E. F. W. Alexanderson relating to alternating-current generators of the type in which the current for field excitation is obtained from the armature and rectified by means of a commutator. A description of same appears in the *Electrical World*. On a two-part commutator, the segments of which are connected permanently to the terminals of the field coils, pairs of brushes are placed equal in number to the number of phases of the machine. These brushes are subjected to E.M.F.'s derived from the secondaries of potential transformers. To render the exciting circuit practically non-inductive and to compensate for varying power factors and values of the loads on the machine there are placed in series with the potential transformers non-inductive resistances, across which are connected the secondaries of series transformers. The series transformer serves to impress upon the terminals of the resistance connected in the exciting circuit a potential varying in magnitude and phase with the current in the main circuit. A disadvantage found when this scheme is used in its simple form resides in the fact that the proper neutral E.M.F. points on the commutator, at which the brushes should be placed for sparkless operation, vary with the time phase of the exciting voltage, which changes with both the value and power factor of the load. The inventor has observed that the reaction of the armature current on the field magnetism tends to balance this variation, since it shifts the time phase of the generated E.M.F., and consequently of the exciting E.M.F. derived from the potential transformers, relatively to the mechanical position of the poles and of the commutator segments. In order to make the counterbalancing more effective, the inventor provides small auxiliary poles placed between the usual field poles so as to offer a low reluctance path for the armature flux at points between the poles produced by the



field winding, as indicated in the accompanying illustration.

**The Value of Advertising.** — A lecture upon publicity as an aid to industry was delivered at the annual dinner of the Manufacturers' Advertising Club, Cleveland, U.S.A., by Mr. Arthur Warren (manager of the Allis-Chalmers Company's advertising department), who recently created a considerable stir across the Atlantic by his candid remarks upon technical and commercial journalism, to which we referred in our issue of March 24. The Cleveland Manufacturers' Advertising Club, which was established a year and a half ago, is the only organisation of its kind in the States, but it appears likely that its lead will be followed before long. Mr. Warren remarked that a department of publicity is a trade scout. It goes out in advance, a long way in advance, of the army of salesmen, and stirs up the possibilities of business. Publicity brings business. Manufacturers who do not buy publicity as liberally as they buy other selling facilities will some day have to take their places at the rear of the procession. The manufacturer who does not provide a publicity department of his own, small or large, and push it and develop it as he does any other branch of his business, is neglecting a great and profitable opportunity. "Everybody, once in a while, is curious," he proceeded, "regarding 'follow-up systems.' I am trying to invent one. It is not perfect, but it has its good points. I have never known a perfect system, whether of 'following-up' or of anything else. No system, whether it be of business, of government, or philosophy, is better than the men who work it. Most 'follow-up systems' are too complicated: they entail too much clerical labour. A 'follow-up system' that produces results without complexity is a good trade-getter. But it must be adapted to the special needs of a business. The reason so many systems break down is because they are imitations of what other people do. No system is effective without brains behind it. You must not only 'follow up' your public, but you must follow up your system.'" Further advice of the lecturer's was:

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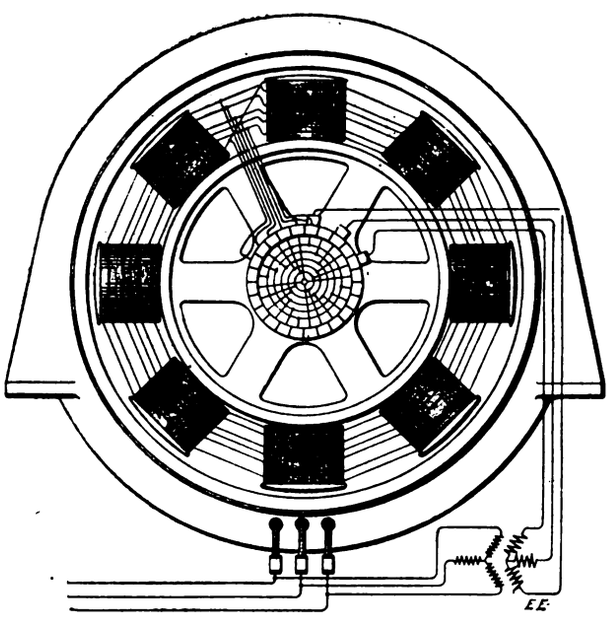
"Don't take a narrow view of publicity. Don't swamp productive work with clerical work. A general in command cannot fire the guns, cannot count the ammunition used in battle, and cannot tabulate the list of slain and of wounded—on the other side. Advertising, whether direct or indirect, must be done generously if it is to bring results. The chief thing is to let the world know who you are, where you are, and what you are doing; and you cannot do this on a large scale by stopping to take a census every time you fire a volley." Mr. Warren concluded: "I am a believer in direct advertising as well as in indirect; in the mailing list as well as in the best trade journals. Each does what the other cannot do. Each is essential."

**Alternating-Current Generator with Polyphase Excitation.** — An interesting form of self-exciting generator is comprised in a patent granted in the United States to Mr. M. C. A. Latour, of which a description appears in the *Electrical World*. The winding of each individual field coil is in six sections. The corresponding sections of all of the field coils are connected in series with each other, so as to form six groups. These six groups are then placed in series in a closed circuit, the end of group No. 6 being connected to the beginning of group No. 1, as will be seen in the accompanying diagram.



The six junction points between the groups are connected to a rectifying commutator containing six segments per pair of poles, interconnected in sets corresponding to the number of pairs of poles, as will also be seen in the accompanying illustration. Polyphase E.M.F. is impressed upon the commutator by means of suitable transformers. The number of turns in each group of coils is so selected that the resultant magnetomotive force of the currents in all of the groups due to the alternating E.M.F.'s impressed upon the several groups will remain at all times unidirectional and of a practically constant value. The inventor states that the successive groups should contain the number of turns represented by the following expressions: number of turns in first group $= k \sin a$; number of turns in second group $= k \sin \left(a + \frac{2\pi}{n}\right)$; number of turns in third group $= k \sin \left(a + \frac{4\pi}{n}\right)$, etc., $k$ being a constant, $a$ being any chosen angle, and $n$ being the number of groups.

**Electric Lighting in New York.**—During the recent investigation into the electric lighting service of New York some interesting features were brought to light at the instance of the New York Edison Company. The service from the series arc lighting systems had become less and less satisfactory, and during 1902-3-4 the city street lamps were gradually changed over to the low-tension, direct-current, enclosed arc system. In 1903 and 1904 the series arc lighting systems were operated at an actual loss, the cost of a city arc lamp of 2,000 c.p. per year averaging £33, as against the price to the city of £30. In 1903, owing partly to the cost of effecting these changes, the cost of the low-tension enclosed arc lamps was £28, allowing only a small margin—less than 5 per cent.—of profit. In 1904 the conditions improved somewhat, but the margin above actual cost did not allow more than a reasonable profit considering the character of the business. In the meantime most of the old, unsightly wooden lamp-posts, prescribed by the old Board of Electrical Control for high-tension lamps, had been removed, and these were substituted by ornamental iron posts. In the case of the lamps in two large streets, the average cost of the service for the three years 1902-3-4 was £34 per lamp per year. The price charged the city for this service (£37) seems reasonable enough, allowing only a fair margin of profit. The price of arc lamps in the borough of the Bronx, of which there are over 1,100, was voluntarily reduced in 1902 from 1s. 10½d. to 1s. 8d. per lamp per night, and a number of lamps in particular localities in the borough of Manhattan, for which the city had previously paid 2s. 1d. and 1s. 10½d. per lamp per night were reduced at the same time to the uniform rate of 1s. 8d. per night. The history of the lighting rates in New York City for private consumers began with a maximum charge of 11d. a kilowatt-hour, without discounts other than those obtained through special contracts. After several years of this method of charge, the price was reduced to 10d. a kilowatt-hour, with certain graduated discounts. For some time, however, the companies failed to offer adequate inducements to the long-hour consumer, but eventually they adopted a maximum charge of 10d. a kilowatt-hour during the first hour only of average use, thereafter making a reduction, not because of the quantity used, but because of better average use, of 25 per cent. for the second hour of average use, 50 per cent. for the third and fourth hours, 75 per cent. for all in excess of four hours. This was the retail rate upon the establishment of the New York Edison Company in 1901. Recognising the benefits, existing and prospective, that had accrued to the company from consolidation, this price was voluntarily reduced to a maximum of 7½d. during the first hour as well as the second hour of average use, representing in its aggregate a reduction of some £200,000 annually upon the present revenues of the company.

**The Mercury Arc.**—At the recent meeting of the American Electrochemical Society Dr. E. Weintraub presented a paper detailing the results of his investigations into the nature of the conductivity of the metallic vapours, as the result of which the author has devised a new method of starting an arc discharge in mercury vapour. According to the author's conception, an arc discharge in metallic vapours is a discharge deriving its carriers at least in the immediate neighbourhood of the cathode from the material of that cathode. The application of a moderate E.M.F. is of itself insufficient to start the process by which these carriers are formed out of the material of the cathode. The new fact discovered was that this formation of carriers (the "ionisation" process) is started and the arc discharge made possible if a spark or a small arc is produced at the surface of the cathode. The operation is graphically described thus: The tube is represented in Fig. 1. K is a cup filled with mercury. A and B are electrodes of graphite,

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iron, or mercury. In the figure they are shown as mercury cups. The tube is exhausted by a Sprengel pump to the highest possible vacuum, and by some means, such as heating from outside, or by the arc itself, the gases are driven off from the walls of the tube and the anode material. Two different sources of direct current are used, one applied to K and B, the other to K and A, in such a way that K is the negative pole of both. If, now, the little arc, B K, is started by bringing the electrodes into contact, and separating them, the other arc, K A, starts instantaneously. If the connections are changed in such a way that K is the common positive pole of the two sources, the arc B K does not cause the starting of the arc A K. The fundamental importance of the cathode in the process of starting an arc is illustrated by this experiment in a simple and striking way. In the tube shown in Fig. 1 the use of two different sources can be dispensed with, and the same source used with different resistances in the two branches. In Fig. 2, B is the cathode, D and A are both connected to the positive pole; $r$ is a large resistance; $r$ is a small resistance used for the purpose of regulating the current in the main arc, B D.

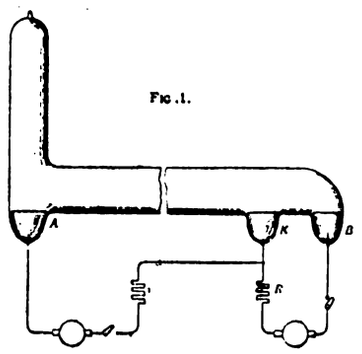

FIG. 1.

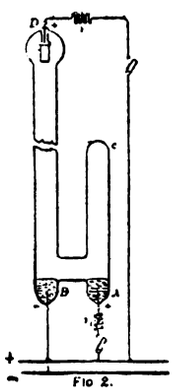

FIG. 2.

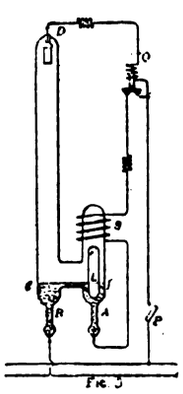

FIG. 3.

By slightly shaking the tube, the arc B A starts, whereupon the arc B D can then be opened and the auxiliary arc disconnected. For the practical use of this starting method, the operations of separating the electrodes B and A and discontinuing the auxiliary arc the moment the main arc is started, must be performed automatically by the cutrent itself. One of the arrangements that have been devised is represented in Fig. 3. K L is an iron plunger, S a solenoid, and O a magnetic cut-out. The solenoid, S, in pulling up the plunger, K L, produces the auxiliary arc. The current in the main arc flows through the magnetic cut-out, and automatically opens the circuit of the auxiliary arc. It will be seen that this method of starting an arc by contact through excitation of the cathode is similar to the old method, the only difference being that instead of having one arc instantaneously formed by another, there is a continuous growth, a short arc producing a longer one. Of the devices used by the author special mention is made of two. In both of them the tube contains three electrodes, one of mercury, the others of graphite, iron, or mercury. The one electrode of mercury serves as the cathode, the two others serve as anodes of the rectified arcs. In the first arrangement, represented in Fig. 4, a transformer is used, the ends of the secondary of which are connected to the two graphite anodes. A wire taken out from the middle of the secondary is connected to the cathode. One half-wave takes then in the arc the direction A K, the other the direction B K, and both are superposed in the same direction in the neutral wire of the transformer. The current derived is pulsating, and if the rectified voltage or current is low, usually a small direct-current arc, springing from the same cathode, is necessary to keep the cathode alive during the zero point of the current. If a constant-current transformer is used, this direct-current arc can be dispensed with. In the second method the alternating voltage is directly applied to the two graphite electrodes, and two reactance coils are connected in the way shown in Fig. 5. The reactances store up energy, while the current flowing in them increases and discharges through the arc in such a direction as to keep the cathode, K, alive. In this case, as in that of the one previously described, a great number of modifications and combinations have been devised for both monophase and polyphase currents. Voltages up to 15,000 have been thus rectified, giving unidirectional E.M.F. as high as 6,000 to 7,000 volts. Starting from the hypothesis developed by a number of modern scientists, according to which the conduction in

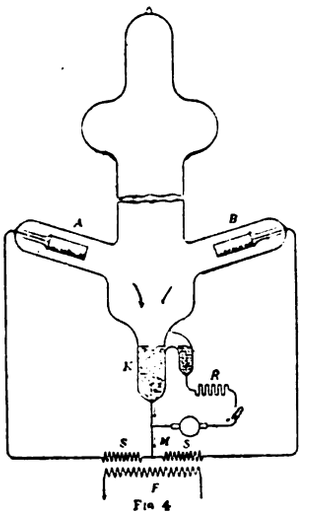

FIG. 4.

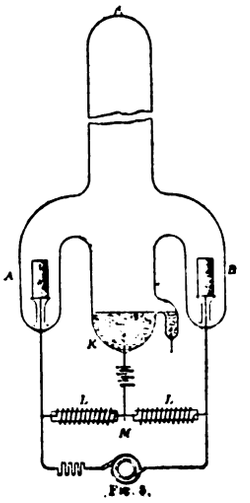

FIG. 5.

metals is due mostly to the negative electrons, and from the postulate that the mechanism of conduction in different states of matter must have the same general characteristics, the author assumes that the mechanism of the conduction in the arc is similar to that in metals, and that an arc is, electrically considered, in the main a flow of negative electrons directed from the cathode toward the anode. While in the metal the number of electrons is a given quantity and the conductivity accordingly constant, the number of electrons crossing the surface of the cathode and entering into the arc must be proportional to the current. Accordingly, the conductivity of the arc is proportional to the current. The process of starting an arc serves to initiate the process by which the electrons are driven out from the metal into the space. The starting is probably produced by purely electrical causes. If this process, by means of which the negative electrons are projected out of the metallic mass, is started, it goes on of itself so long as a sufficient amount of energy is applied. The disintegration of the cathode is a mechanical accompaniment of this electrical process. The light emitted by the arc is not due directly to the radiation of the electrons. These negative electrons are probably the same in all arcs, and the light emitted changes according to the molecular material through which these electrons move. We abstract the foregoing from the *Electrical World* of New York,

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## ELECTRICALLY-DRIVEN WINDING ENGINES.

Englishmen are proverbially slow to adopt new methods, and in no home industry, perhaps, is this characteristic more marked than that of mining. It has been left to the Continent to do all the pioneering work in regard to improved winding engines, while over here many a machine is still called upon for service whose fabric would be deemed of interest by the antiquarian, and whose rightful place is, therefore, the museum. But the question of economical winding increases in importance with the depth and output of the mines worked, whence it follows that mine-owners who have hitherto been unprogressive will be compelled by necessity to seek improved methods in the future. And they will have Continental experience to guide them. In every case where electrical driving has been adopted, the cost of winding has been considerably reduced. We have it on the authority of Dr. Herzfeld that the amount of steam consumption per horse-power hour on mineral raised is in some cases as low as 24lb. to 26lb. The constant turning moment of an electric motor is more favourable to the life of the ropes than that of a steam-engine, where the torque varies from 0 to a maximum. It prevents dangerous waves in the ropes, while it is well known in mining circles that the variations of torque in a steam-engine cause "dancing," and consequent overstrains. Another great advantage of electrical winding engines, and one of the reasons why the energy required is less than in steam plants, is that steam winding machinery requires a very heavy drum to balance the varying torques. It is only necessary to mention the principal consequences of the heavy weight of the drum—viz., the high initial expenses, the large amount of energy consumed during the acceleration period, and the extraordinary size of the driving engine, which possesses all the disadvantages of machines having a greater capacity than their average load.

One of the first essentials for economical winding is constancy of load at the generating station. For a long time past, therefore, the builders of winding engines have taken care to balance the varying weights of the winding ropes, and several systems have been developed, the oldest of all being the bobbin system, which consists of two guides, between which the rope, generally flat, coils itself. This system, however, has not come into use in this country, on account, it is suggested, of the difficulty of obtaining the flat ropes—not a very adequate reason, it may be thought. An arrangement of conical drums for balancing the weights of the ropes, in which the gradient is so determined that the resulting turning moment due to the weights of the ropes, cages, and trains is zero, is therefore preferred to the former system. But this arrangement is an expensive one, and some mine-owners prefer cylindrical drums and balancing the weight of the rope by a tail-rope. Both of the latter methods are much used in this country. Some 20 odd years ago another system was developed on the Continent, known by the name of the "Koepe wheel," which compares very favourably with those above mentioned. In this system a grooved pulley is fitted on the shaft of a winding engine, and around this the rope, to the ends of which the cages are attached, is passed, the load being lifted by the friction between the rope and the pulley only. The weight of the rope is in every case balanced by a tail-rope attached to the cages, forming an endless system.

In considering what system and what type of motor should be applied for winding plants, it is of importance to know whether an electric supply of one or other kind is already available, or whether a new power-house is to be laid down. If there be an existing supply of polyphase current, the periodicity will, of course, influence the choice. The use of special starting arrangements for the winding motor has also to come into consideration. This becomes the more necessary if the winding plant is to be connected up to public supply mains. One of the systems which has been successfully installed to meet the latter condition consists of a converter set working in combination with the winding motor. It is known, after its original inventor, as the Ilgner converter system, and is a combination of a flywheel and a polyphase or continuous-current motor driving a continuous-current generator, being so arranged as to take an almost steady current from the supply network, although the actual supply of current to the winding motor will vary enormously. There are also other patent forms of control in use for the winding motors where the ordinary resistance control is inadvisable. These include systems with "buffer" batteries, counter-voltage control with balancing flywheels, Leonard control, etc., all of which have for their object the minimising of power losses in starting, stopping, and speed regulating, and the employment of less costly resistance apparatus, through which the main motor current need not pass. In the Leonard arrangement of plant, the generator used for supplying and starting the winding motor, as also the motor itself, are separately excited. The starting and speed of the winding motor, then, depends solely on the changing of the excitation in the continuous-current generator. This variation of the exciting current, which only amounts to a few per cent. of the main current, is effected by ordinary resistance regulation in a small controller operated by the driver, which is so arranged that any desired speed between zero and maximum can be obtained. By altering the direction of the exciting current the motor

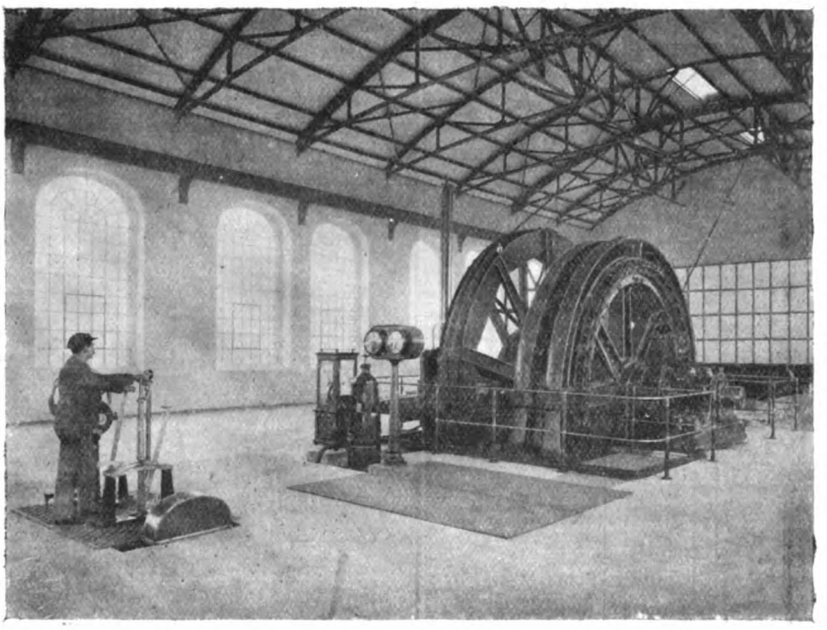

FIG. 1.—Winding Plant at "Preussen II." Pit.

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can also be reversed. This form of control of the starting and speed regulation of the winding motor is also always used with the Ilgner system.

We will now proceed to describe some typical installations erected by the Allgemeine Elektricitäts-Gesellschaft, Berlin, to whose representative on this side, the Electrical Company, Limited, 121-125, Charing Cross-road, London, W.C., we are indebted for the particulars here given.

### Winding Plant at "Preussen II." Pit.

The accompanying illustration (Fig. 1) is a view of the winding plant at the "Preussen II." pit of the "Harpener Bergbau" Company's coal mines near Dortmund, while the diagram (Fig. 2) explains in detail the working of the plant and gear. This plant deals with an output of 100 tons of coal per hour, mined from a depth of 2,310ft. The installation, suiting the requirements of the case, was designed on the three-phase system with liquid resistance control for the winding motor. The generating plant consists of three three-phase revolving-field machines, each of 550 kw. output, working at 2,100 volts, with a frequency of 25, and at 94 revolutions per minute, the armature

For inspection of the shaft and rope, etc, any desired speed, ranging down to about 20in. per second, can be easily obtained. The winding drum is direct coupled to an A.E.G. three-phase induction motor with slip-rings. The 2,000-volt current is brought to the motor through insulated cables. From the diagram (Fig. 2) it will be seen that the current from the supply station goes through high-tension fuses to an emergency switch. Beyond the latter is arranged the reversing switch for altering the direction of rotation of the winding motor. This switch is actuated directly from the controlling lever, and the lever is set up for the driver in precisely the same way as in the case of a steam winding engine. In the mid position of the lever the current is switched off, and the motor electrically disconnected. By movement of the lever to left or right the current is sent through the stator of the motor for one or the other direction of rotation. The actual starting of the motor, as also its speed regulation, is controlled through the rotor windings and by means of a patented arrangement of liquid starting and regulating resistances.

Each of the three phases of the rotor is led to the resistance plates, which are insulated and suspended in the

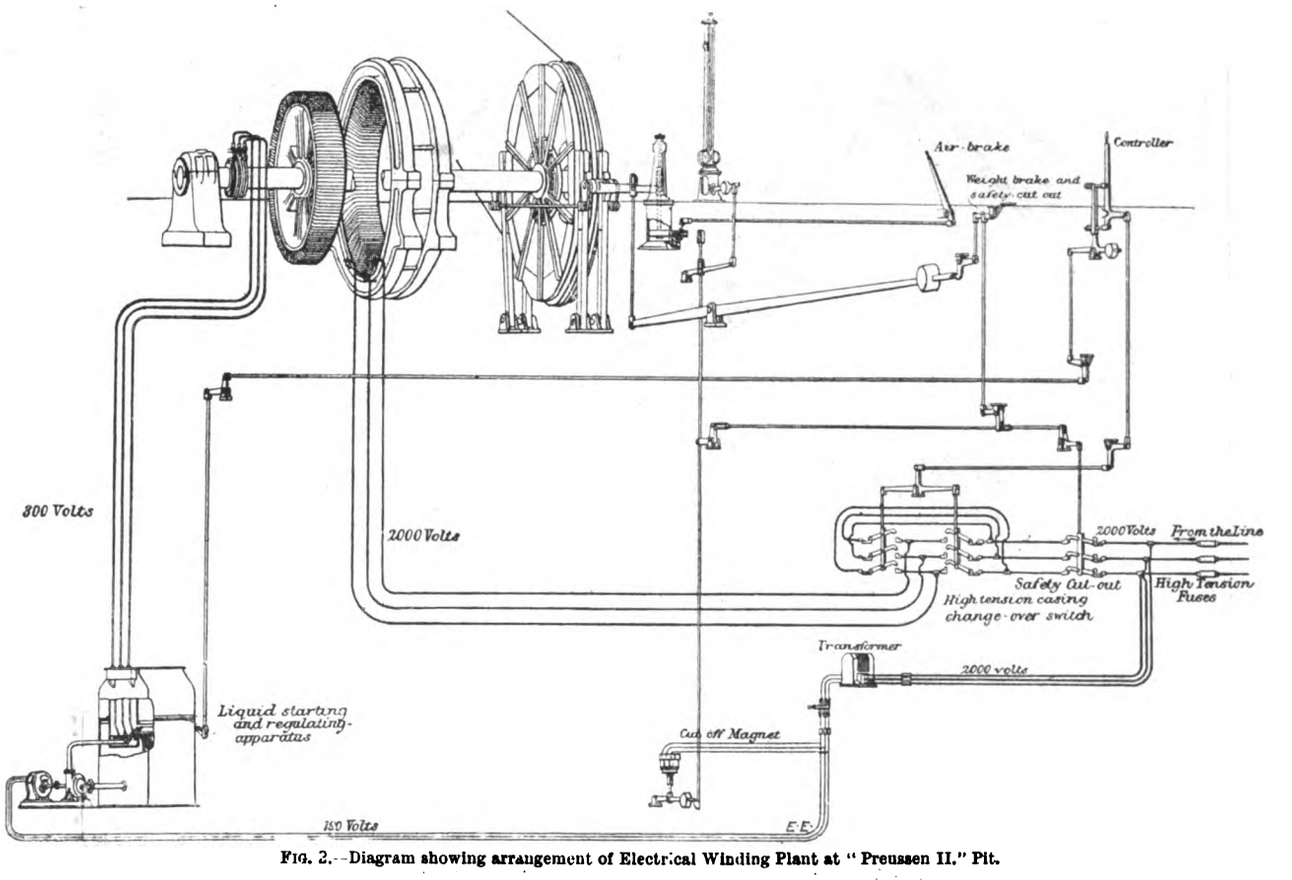


Fig. 2.—Diagram showing arrangement of Electrical Winding Plant at "Preussen II." Pit.

frames being of the A.E.G. patented type, with tie-rods. To drive these generators, there are installed three twin compound engines of 800 h.p. per set. The winding plant (see Fig. 1) includes a Koepe pulley of 20ft. diameter, the winding rope being 1¾in. diameter. Details of the winding are as follows:

| | |
|---|---|
| Coal lifted per journey ..... | 2 tons 3cwt. |
| Speed (for coal) ..... | 52½ft. per second. |
| Speed (for miners) ..... | 16ft. per second. |

The winding cycle for coal is:

| | | |
|---|---|---|
| Starting ..... | 16 seconds | 78 seconds. |
| Normal full speed ..... | 27 ,, | |
| Slowing down ..... | 18 ,, | |
| Changing ..... | 17 ,, | |

Horse-power at starting, up to 1,380 h.p. Horse-power during running, 650 h.p.

| | |
|---|---|
| Weight of cage, 3 tons 16cwt. | Total weight, 12 tons 6cwt. |
| ,, tubs (4), 1 ton 8cwt. | |
| ,, coal, 2 tons 4cwt. | |
| ,, rope, 4 tons 18cwt. | |
| Depth ..... | 2,310ft. |

Revolutions per minute of motor and Koepe pulley, 50.

containing tank shown, with which is combined a reservoir below. Through both of the latter there is kept up a constant circulation of soda solution, and as soon as the regulating valves at the bottom of the upper vessel are shut the liquid begins to rise, and allows a passage of current between the resistance plates, thus speeding up the motor. The higher the liquid rises and the greater the surface of the plates covered, the smaller becomes the resistance in the rotor circuit, and therewith the speed of the motor advances towards its full value, which occurs when the liquid has reached the overflow point.

The actuation of the regulating valves is carried out from the same hand lever referred to above, which controls the direction of rotation of the motor. After the lever sets the stator switch back or forward for one or other direction of running, it can be moved through a certain arc without the reversing switch being affected. This intermediate path allows of the adjustment of the regulating valves to bring the liquid resistance to the correct height so as to run the motor at the required speed. Only when the lever reaches a point near the mid position is the stator reversing switch again actuated and the current interrupted. A special point of the arrangement is that the rise in speed of the

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motor by decrease of the resistance is also controlled by the water supply of the pump feeding the resistance, so that the driver cannot possibly start faster than the arrangement of the water supply, made with due regard to the friction of the rope on the Koepe pulley, or the overload capacity of the plant, will allow. By this compulsory graded rise of the liquid and the progressive speed which it ensures, all shock or unsteady movements at starting are entirely avoided.

In order to obtain an immediate start of the motor when the hand-lever is set out to its limit, the resistance plates are so arranged that they are always immersed to a certain depth in the liquid traversed by the current, so that on switching in the stator the necessary current to enable the motor to start traverses the rotor windings. All current-bearing parts of the plant are railed off from contact, but, at the same time, are fully visible for inspection. The braking arrangements are laid out on a plan similar to that obtaining with steam winding engines, but are yet safer. The Koepe pulley carries on either side a brake run of some 20ft. diameter, on which four brake blocks work. These can be thrown in through compressed-air gear by a hand-lever, and so serve as a brake when winding. The same brake is also thrown in, in case of overwinding, by the action of the depth-indicating gear shown in the diagram (Fig. 2), and at the same moment the emergency switch opens, thus cutting off all current from the plant. In case of accidental interruption of the current due, for instance, to the blowing of a fuse in the main leads, an electromagnetic braking device is fitted which releases a weight and so actuates the connecting rod of the compressed-air brake and opens the emergency switch. For the further contingency that the pneumatic brake might refuse to act, a reserve braking device is provided in the form of a foot-lever, by depressing which the driver can also open the emergency switch.

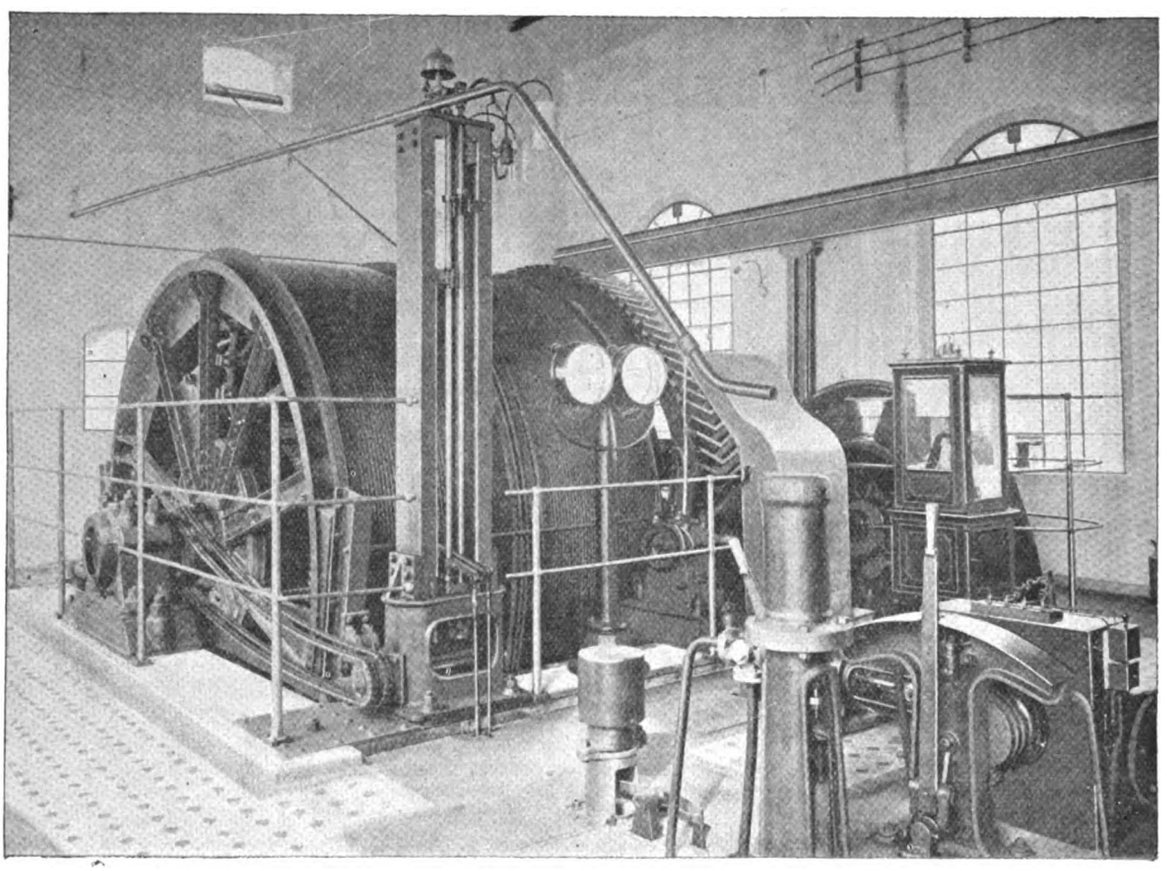

FIG. 3.—Winding Plant at the "Donnersmarckhuette" Collieries, Zabrze.

### WINDING PLANT AT THE "DONNERSMARCKHUETTE" MINES AND STEELWORKS, ZABRZE, OBERSCHLESIEN.

This plant (Fig. 3) is an illustration of the Ilgner system already referred to, with three-phase supply. Two 892-kw. three-phase machines in the power station generate current at 1,500 volts pressure, the speed of the machines being 94 revolutions per minute. These generators are direct coupled to Korting gas-engines operated by furnace gas. A third generator set is used as a reserve. On account of the speed variations inseparable from gas-engine working, the generators have "damper" windings in order to obtain perfect parallel running. They are excited with current at 220 volts. The frequency of the supply is 50 periods per second. The weight of coal lifted per journey is 1 ton 5cwt. from a depth of 1,650ft. and with a maximum speed of 16½ft. per second. The drums are each 12ft. 6in. diameter and 3ft. 7in. over-all width. The load is divided between two tubs, each weighing 7½cwt. empty, and the weight of the cage empty is five tons, it being designed to eventually take much heavier loads, according as the mine is deepened. A 1in. circular winding rope is used.

The continuous-current shunt-wound winding motor (Fig. 3) is separately excited at constant voltage from the exciter, E (shown on the diagram, Fig. 4), and runs at 150 revolutions per minute, with a normal output of 230 h.p. during winding, and an output up to 400 h.p. during starting. It drives the winding drum in this plant by means of toothed-wheel gear with reduction ratio of 1 to 6. The drum is fitted with brake blocks. Under normal working conditions the brake is actuated through compressed air by means of a hand-lever, but a drop-weight serves as a safety brake, and is actuated through the depth-indicating gear, or, in the case of the current being interrupted, by a magnetic brake, BM. The drop-weight is kept balanced by a compressed-air cylinder, but can also be released by hand.

The Ilgner converter plant includes a three-phase induction motor connected to the supply mains, giving at a theoretical speed of 500 revolutions per minute an output of 125 h.p. It will be noticed, therefore, that while the winding motor must work up to 400 h.p, the three-phase induction motor in this case is only of about one-third this output. The induction motor is coupled by means of a flexible coupling to a shaft carrying a cast-steel flywheel, weighing 15 tons, with a diameter of 11ft. (maximum peripheral speed about 280ft. per second), and mounted on the same shaft is a compensated continuous-current generator (Déri system) for an output of 72 kw. Beyond the left-hand outer bearing is an exciter set consisting of an 8-kw. 220-volt compound-wound machine, which excites the

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fields of the continuous-current generator and the winding motor. The starting and speed control of the winding motor is effected by means of the Leonard system, already referred to, by alteration of the excitation through the reversing and controlling switch, R C R, as shown on the diagram (Fig. 4). One of the special features of the switching arrangements in this system is that the controlling lever of the resistance, R C R, is so designed that for each position to which it can be put by the driver there is a definite fixed speed for the winding motor, no matter what the load may be which is being lifted or lowered. Also, the driver can electrically brake the winding motor either quickly or slowly by suitably adjusting the lever so as to make the winding motor run as generator, and so help to speed the flywheel.

The Ilgner converter works in the manner described below. The energy in the form of three-phase current from the network is brought to the induction motor coupled to the flywheel and continuous-current generator. The latter, especially when the winding motor first begins to run, must commutate a current many times greater than the normal full-load current, with almost no volts pressure and with the brushes in neutral position. For this reason its having given off some of its energy; in other words, it is made capable of again supporting the demands of the winding motor. The flywheel has the further advantage that it safeguards the plant against any breakdown due to a fuse in the station or circuits giving out, as it alone has sufficient energy stored in it to drive the generator, C C G, for a considerable time. The speed variations of the converter in this installation lie between 490 and 432 revolutions per minute.

In order to produce these flywheel effects over the necessary range—that is, in order to ensure that the energy taken up by the three-phase motor from the network will not exceed a certain figure, carefully designed in each case with regard to the working conditions of the winding—the liquid starting resistance, S S R, used for the induction motor is provided with an automatic "slip" regulation, depending in action on the current being taken from the mains. This works in such a manner that at the moment of starting of the winding machine—that is, at the moment when the tendency of the motor is to take a higher current than its normal current—resistance is automatically inserted in the rotor, and *vice versâ* when releasing the load, during the slowing down and changing periods of the winding—

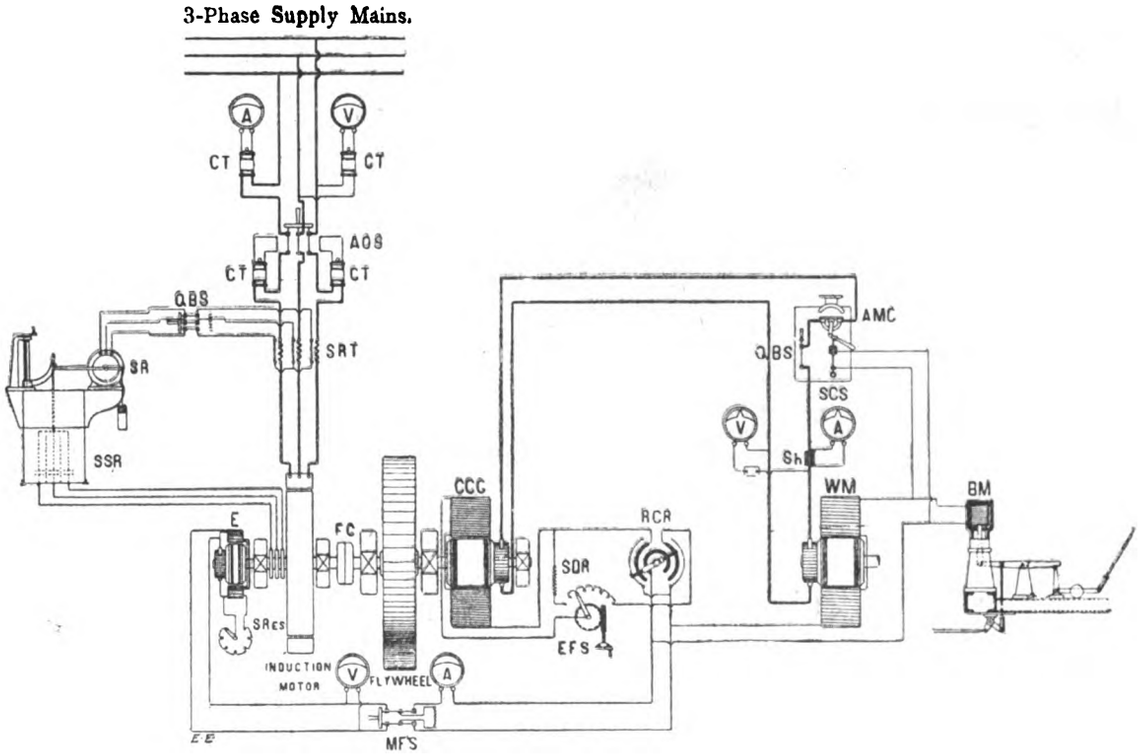


FIG. 4.—Diagram showing arrangement of Electrical Winding Plant at the "Donnersmarckhuette" Collieries. A, ammeter; A O S, automatic oil switch; A M C, automatic maximum cut-out; B M, magnetic brake connecting with compressed-air brake and depth-indicating gear; C T, current transformer; C C G, continuous-current generator (compensated Deri system); E, exciter; E F S, emergency field switch; F C, flexible coupling; M F S, main field switch; Q B S, quick-break switch; R C R, reversing and controlling resistance; S R, "slip" regulator; S R T, "slip" regulator transformer; S S R, starting and "slip" resistance; S C S, short-circuiting switch; S D R, spark discharge resistance; S Res, shunt resistance; Sh, shunt; V, voltmeter; W M, winding motor.

a so-called "compensated" continuous-current generator (Déri system) is used, and in this machine, by means of a special winding, any cross magnetic action of the armature is completely negatived, and perfectly sparkless working is attained for all loads and voltages.

The converter serves two purposes; firstly, it converts the high-tension three-phase current to continuous current; and, secondly, its still more important function is to secure an almost complete avoidance of the otherwise heavy "peaks" of current on the supply mains, brought about through the starting of the winding plant, and to thus make the actual current demand on the supply works uniform, and also proportional to the load dealt with by the winding plant. This is effected by the arrangement that at the starting of the winding motor and during its acceleration period the extra demands of the winding motor are supplemented by the energy stored up in the flywheel which drives the generator, C C G, and assists the induction motor. During the changing intervals and periods of slower or less loaded winding the supply from the power station is used in order to again accelerate the flywheel, which has meanwhile been slowed down due to that is, when the current tends to decrease the resistance is automatically diminished. As a result of this insertion of resistance, not only is the "slip" increased (up to about 12 per cent.), in other words, not only is the flywheel slowed down and forced to give up a considerable store of its energy, so helping to drive the generator, C C G, feeding the winding motor, but also as the resistance of the rotor circuit is increased in proportion as the speed falls, the rise in current in the induction motor is impeded. At the speeding up of the flywheel when the load on the winding motor is reduced, the reverse action takes place, when, by the gradual switching out of the resistance, a sudden sinking of the current in the induction motor below its normal value is prevented and it is gradually sent up again to its correct speed. In order to bring the converter set to a stop quickly when required, a brake block is arranged below the flywheel rim, and this can be applied by means of a hand-wheel and spindle and is fitted with water cooling, conveniently controlled by a tap near the brake spindle. The converter set is kept continually running during the hours of winding.

All necessary precautions, such as maximum cut-outs,

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fuses, emergency switches, etc., as shown on the diagram (Fig. 4) in addition to the brakes already mentioned are provided. The switch, E F S, has for its object the immediate cutting out of the field excitation of the generator, C C G, in order to be able, if necessary, to stop the winding motor at once by this means. Near to the driver is also erected a cast-iron column bearing the ammeter and voltmeter, etc., which guide him when starting up, together with the pressure gauge to indicate whether the correct air pressure is available for the brake.

The important ends which are therefore achieved by this system, in addition to the advantages already mentioned, are as follows: (*a*) that while the current from the generator, C C G, to the winding motor, W M, will have to vary over a very wide range, and will have heavy "peaks" at the starting and accelerating periods, the current from the supply mains to the induction motor but very slightly oscillates above and below a constant value during a given winding cycle, and is proportional to the load being dealt with by the winding motor; (*b*) that the starting and stopping of the winding motor takes place with practically no loss of energy.

COAL MINES, GRAND HORNU, BELGIUM.

In several respects the installation at these mines esembles that at "Preussen II." pit already described. Three-phase current is generated at a pressure of 1,250 volts, and with a frequency of 23½ periods per second, being distributed by means of underground cables to the different high-tension motors.

In the power station there are installed two three-phase generators, one being designed for an output of 2.000 kw. at 88 revolutions per minute (flywheel effect, 4,100 foot-tons), and the other for 4,000 kw. at the same speed (flywheel effect, 11,200 foot-tons). These generators are driven respectively by a Carels tandem engine (Sulzer system) and a Carels double-tandem engine. A paralleling switch is provided for transferring the load from one set to the other. Jet condensers are installed, the double-tandem engine being provided with two separate plants, so that either half can be run as a simple tandem machine. The condensers work in conjunction with a water cooler of 130,000 gallons capacity, feed water for the boilers being taken from the condensers through an oil filter. The A.E.G. feed pump has a capacity of about 44,000 gallons per hour when running at 225 revolutions per minute, and is driven by a motor wound for 1,150 volts pressure. Körting injectors serve as a reserve for boiler-feed purposes. There are six Meunier boilers installed in the boiler-house, each having a heating surface of 2,000 square feet. Steam is generated at 140lb. pressure and superheated to 260deg. C.

In addition to the main generators, a three-phase direct-current transformer set has been installed. This consists of a three-phase motor wound for 1,200 volts, and a frequency of 23½, designed for an output of about 330 h.p. at 460 revolutions per minute, direct-coupled to a continuous-current dynamo on either side. One of the latter—a shunt-wound machine capable of an output of 90 kw. at 230 volts—is connected to a balancer, serves to supply exciting current at 110 volts, and maintains a pressure of 2 × 110 volts between the outers of the three-wire lighting network. The other, a compound-wound machine capable of an output of 130 kw. at 600 volts, supplies current to an electric locomotive used for haulage purposes, besides to a small power transmission system.

In order to maintain the exciting current at a constant pressure, a buffer battery of 130 cells is connected in circuit with the outer leads of the shunt-wound dynamo. This battery has a capacity of 144 ampere-hours for three hours, and also serves to supply starting excitation for the three-phase generators. Two dynamos wound respectively for 220 volts and 600 volts, belt driven from a steam-engine placed in an adjoining room, are provided as a reserve for this transformer. The main switchboard is erected on a gallery and consists of 12 panels. All the high-tension gear is placed in the basement. Both generators are provided with oil switches, and all high-tension cables are connected to the switchboard. The current passes through remote-control cut-outs, which can be operated from the main switchboard by means of press-buttons.

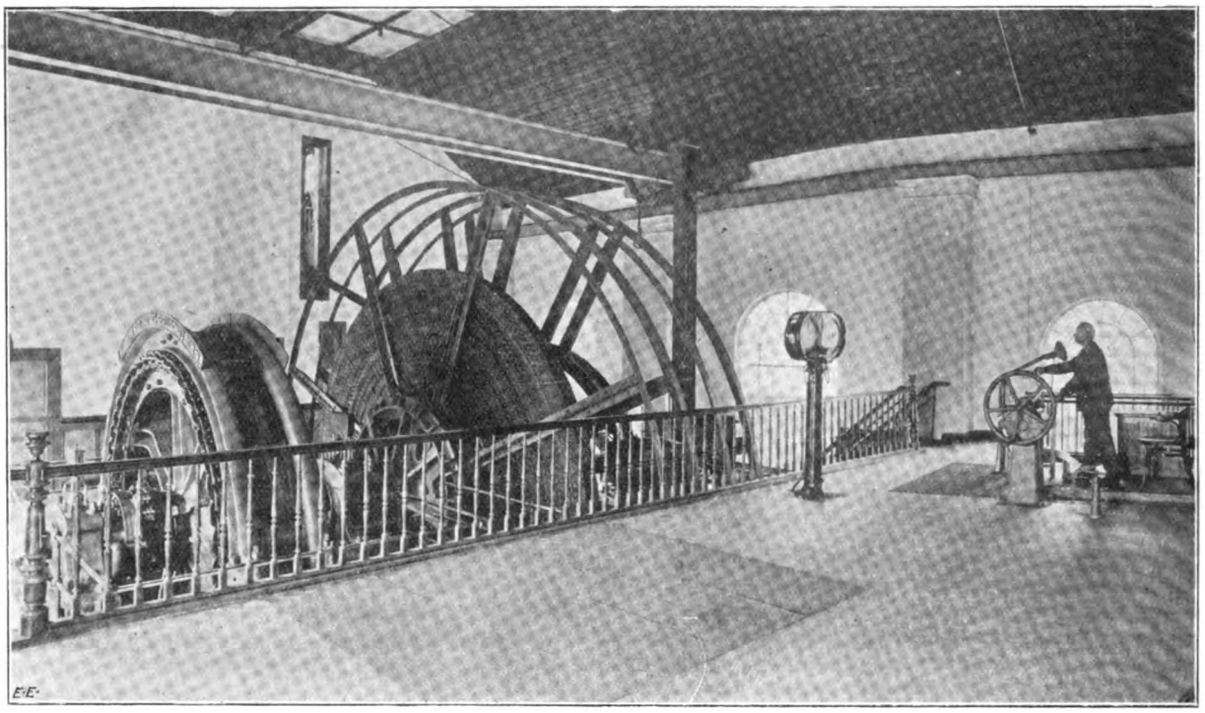

FIG. 5.—Winding Plant at the Grand Hornu Collieries, Belgium.

Supply is given to three main winding engines. These work on the bobbin principle, a pair of drums (Fig. 5) being provided for each shaft. Flat tapered winding ropes are employed. For the winding motor, the special form of liquid starting resistance as described in connection with "Preussen II." pit is used, the motor being direct connected, and the controlling arrangement in general as for "Preussen II." p't. Details of the winding are as follows

*For each of the Shafts VII. and XII.*

| | |
|---|---|
| Coal lifted per journey | 2 tons 12cwt. |
| Total lift (including rope) | 14 tons 6cwt. |
| Coal lifted per hour | 65 tons. |
| Depth | 3,300ft. |
| Max. speed (reducible to 20in. per second) | 45ft. per second |

The winding cycle (for coal) is as follows:

| | | | |
|---|---|---|---|
| Starting | 15 | seconds | 144 seconds. |
| Normal full speed | 78 | ,, | |
| Slowing | 12 | ,, | |
| Changing | 39 | ,, | |

Revolutions per minute of winding drums ..... 42

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Horse-power up to 935 h.p. at start, 475 h.p. to 530 h.p. during running.

*Shaft IX.*

| | |
|---|---|
| Coal lifted per journey | 2 tons. |
| Coal lifted per hour | 56 tons. |
| Depth | 1,864ft. |
| Maximum speed | 41½ft. per second. |
| Revolutions per minute of winding drum | 43. |

It should be mentioned that other services in these mines, such as pumping, ventilating, coal screening, etc., are also worked electrically, and absorb about 1,000 h.p.

We note that "Preussen II." pit is to be visited by the Verband Deutscher Elektrotechniker during their forthcoming annual meeting, June 4-8.

## THE BERLIN-ZOSSEN TESTS AND THEIR RESULTS.*

An interesting paper on this subject was presented by his Excellency Dr. Schulz, president of the Imperial German Railway Department, also chairman of the German investigation committee (Studiengesellschaft) on high-speed electric railways. It was in this second quality that Dr. Schulz presented the report upon the experiments on the Berlin-Zossen road. The investigation committee on high-speed electric railways was organised at Berlin in 1899, and in the trial runs speeds of 200-210 km. (124-130½ miles) per hour were reached, velocities far exceeding any other speeds before attained. The permanent way, consisting of steel rails 12m. long, each carried on 18 wooden ties, had a total weight of 224 kg. per metre (454·5lb. per yard), including the guard rails. There were no curves of a radius smaller than 2,000m., and the super-elevation of the outer rail was 80mm. The grades were few and inconsiderable. The experiments proved that the standard type of permanent way, when sufficiently strengthened, is amply sufficient for speeds of 200 km. per hour and more. The two motorcars were of similar design to the latest types of European express train cars. Each car had accommodation for 50 passengers, with a length of 22m, two trucks of three axles each and of a wheel base of 5m.; the total weight was 90 tons, uniformly distributed over the axles. Even at a speed of 210 km. per hour the cars ran quite smoothly. This experience proves, in the words of Dr. Schulz, "that the general design of our express train cars can be applied to extra high speeds, if the wheel base is increased accordingly. It will be possible in future construction to reduce the dead-weight of the cars."

Dr. Schulz then described the collecting devices, which are familiar to the readers of this paper, and which he said gave excellent success, and which "safely supplied the cars running at a speed of nearly 60m., or 200ft. per second, with as much energy as 2,000 kw., and this even in unfavourable weather." The motors were designed for a normal output of 250 h.p. each, and overload capacity of 750 h.p., and were coupled directly, or by means of a spring coupling, to the driving axles. The trials showed that motors for a three-phase current are well suited for the operation of high-speed trains on main lines. To determine whether the motors could be run directly by the high-tension current, Siemens and Halske built an electric locomotive fitted with two motors for a tension of 10,000 volts. This locomotive with a dead-weight of 40 tons, coupled to a train of 70 tons, reached a speed of 100 km. per hour; when coupled to a train of 100 tons, 50 km. per hour were made as a regular run. The current had an E.M.F. of 8,000-11,000 volts and 40-48 cycles. These motors gave satisfactory results on the trials.

*Train Resistance.*—The total resistance in the car, consisting of the different kinds of mechanical friction and of the air resistance, was measured, and the following results were obtained: (*a*) The friction resistance was found to be not more than 1·5 kg. per ton of weight of the car at a speed of 5 km. per hour. It slowly increased as the speed increased, and reached 300 kg. with a speed of 200 km per hour. (*b*) The air resistance increased much more and at a much higher rate with the increase in speed. The numerous observations gave the uniform result that the air pressure on one square metre of front surface, or that measured at right angles to the direction of travel, is equal to the square of the velocity in kilometres per hour multiplied by the constant 0·0052. Assuming 7·5 square metres to be the front area of a car, the air pressure on this surface with different speeds was as follows:

| | | | |
|---|---|---|---|
| At | 50 km. (31 miles) per hour | | 98 kg. |
| | 100 ,, (62 ,, ) | ,, | 390 ,, |
| | 150 ,, (93 ,, ) | ,, | 878 ,, |
| | 200 ,, (124 ,, ) | ,, | 1,560 ,, |

The air pressure on the sides of the car is relatively small, and depends a great deal on the direction and strength of the wind. The air suction on the rear of the car has no importance, and does not increase much with increasing velocity. The air resistance on the car might be reduced by giving the car a parabolic head; if, however, the train speed should be increased considerably above 200 km. per hour, the air resistance would increase at least to such an amount that the motors in the cars would no longer be able to supply the necessary power to overcome it. Dr. Schulz states, therefore, that it is the air resistance which determines the limit of the attainable speed. The resistance of a trailer is considerably less than that of a motorcar, for the greater part of the front area of the second car is covered by the first, and it was observed that the air resistance on the trailer was but one-seventh of that of the motorcar. The amount of energy, the current and the voltage applied were observed at the feeding point, of the experimental line, and also in the car itself. On the level and with no wind, the following average values were obtained for a motorcar weighing 80 tons:

| Speed | | Energy supplied. | Output. |
|---|---|---|---|
| Km. | Miles. | Kw. | H.P. |
| 100 | 62 | 193 | 218 |
| 150 | 93 | 546 | 613 |
| 200 | 124 | 1,190 | 1,340 |

With trailers weighing 40 tons, and with an accommodation for 50 persons, the output for the same speed was only 49 h.p., 116 h.p., and 233 h.p. Hence it follows that it is considerably more economical to care for a crowded traffic by means of trains consisting each of several cars than by many single motorcars of the same capacity running in short intervals, although the latter would be much more desirable for the conditions of general traffic.

*Brakes.*—Westinghouse air-brake equipment and hand brakes were used. The brake shoes were hollow, and were cooled with water to prevent the rims and the brake blocks from becoming overheated. At speeds of 170 km. and 180 km. the brakes stopped the car within a distance of 1,300m. and 1,400m., which corresponds to an average retardation of nearly 1m. per second². The admissible retardation can be increased to 1·5m. per second², without danger to the passengers, by raising the brake pressure, whereby trains running at speeds of 160 km. and 200 km. per hour can be stopped within 660m. or 1,000m. For speeds of more than 120 km. per hour the signals in cloudy weather could not be seen sufficiently soon. This was remedied by an electromagnetic device arranged in the car, which, by means of contacts along the line, presented a red disc before the eyes of the driver when the signal was at danger. This device has never failed, even at the highest speeds.

*Conclusion.*—In conclusion, Dr. Schulz makes the following remarks on the subject of safety: "As at the introduction of the steam locomotive, danger to the health of travellers was feared from very high speeds before these electric tests were conducted. I can state, however, from my own experience, that the passengers were in no way affected by the speed of 200 km. per hour or more, which we often reached. Each engineer was at his place, occupied in making his observations, and the silence in the car was only interrupted every 10 seconds by a bell signal to take readings on the instruments. The duty of the engineer, however, was more arduous, as he had uninterruptedly to observe with the greatest accuracy the run of the car, the line, and the signals. Surrounded as we were by apparatus and wires which carried a current of 14,000 volts, we, nevertheless, felt per-

* Abstract from the *Street Railway Journal* of paper read at the meeting of the International Railway Congress at Washington, May 11, 1905.

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fectly safe; no personal injuries were ever sustained in spite of the short-circuits which occasionally occurred. It was possible during the run to observe the scenery comfortably, but persons standing on the platforms of the stations we passed could hardly be recognised. No injurious effects due to air pressure were ever felt when trains passed on the neighbouring line, and spectators standing near the line had no uncomfortable sensations. More than 300 runs were made, and all without a single accident. Nobody was killed or injured, and no damage to property occurred. Bloody remains, however, of small birds who were killed were observed on the front of the car. These birds, doubtless, thought they could avoid the approaching train, but the electric car moved faster than any bird can fly, and killed them. These were the only accidents that happened.

"The investigation committee on electric high-speed railways has thus accomplished its work; the conditions have been determined under which electric main railways can be operated with high speeds, and it has been proved that such operation is not more dangerous than the present railway practice. Here is a vast field for work open to railway men associated with electrical engineers, and may the time not be far off when a real high-speed electric railway will be an accomplished fact!"

## ELECTRIC TRACTION IN FRANCE.*

BY F. PAUL-DUBOIS, ENGINEER OF ROLLING STOCK AND MOTIVE POWER, ORLEANS RAILWAY OF FRANCE

Reviewing the status of electric traction in France, the author points out that the system of continuous-current traction with third rail can now be considered as well established, and leaves but little to be desired from the technical point of view, although further improvement is always possible and desirable. Continuous-current motors are economical, convenient, and reliable. The system of electric traction by direct current, however, has one very grave defect for railroad operation, as it is not suited to the use of high-voltage currents. Up to the present, hardly anything beyond 700 volts has been used in practice for operating continuous-current motors for traction, and the transmission of energy at such a moderate voltage results in a prohibitive cost for the mains as soon as the amount of energy or the distance over which it is to be transmitted become at all large. From this point of view there is a radical difference between tramways and railways. The method usually adopted for railways has been the use of transformer sub stations receiving a supply of high-voltage current from a central station and feeding the different sections of line with continuous current. This system has been applied more particularly on the line from Les Invalides to Versailles, on the line from the Quai d'Orsay to Juvisa, and on the Paris Metropolitan, and is to be applied on the extension of the Fayet-Chamonix line to the Swiss frontier. This arrangement, which at present is in general favour, makes it possible to extend the field of action of continuous current very largely. It would evidently be a great advantage from the economic point of view to increase the voltage at which the energy is transmitted and at the same time reduce the number of connecting links between the central station and the motors on the trains.

Numerous attempts in this direction have been made. Some of them are also based on the use of continuous-current motors. As belonging to the latter class, may be mentioned the "three-wire" system applied in France on the Grenoble-Chapareillan tramway, and on a section of the St. Georges de Commiers-La Mure. This system, which makes it possible to double or even quadruple the voltage of distribution while retaining the same voltage at the motor terminals, can be installed in several ways, either with a single wire divided into sections of alternate polarity, which makes it necessary to distribute the trains so that the load on all sections is practically the same, a condition which is impracticable on railways, or with two wires, one positive and one negative. In both cases the track performs the office of a neutral wire.

In the two applications made in France, the motors on the same vehicle are connected on opposite sides of the three-wire system, so as to balance the demand for energy. The lines in question, which are single-track lines, have two insulated conductors, showing a difference of potential of 1,200 volts in the first case and 2,400 volts in the second; the motorcars of the Chapareillan line have two 600-volt motors in series, and the La Mure locomotives have four motors of the same voltage also connected in series.

The use of 2,400 volts in the distribution has the result of reducing the loss in the mains to one-quarter of what it is with the ordinary voltage. Thus there is already a considerable economy in the first cost of the conductors.

However, this solution has its defects. In the first place, there is the complication of having two conductors at different voltage, particularly at switches and at crossings; then the motors have to be coupled up permanently in series, and consequently the "series-parallel" control has to be abandoned; finally, as there may be a difference of potential of as much as 1,200 volts between the different parts of the locomotive and the ground, there is greater difficulty in maintaining the insulation, particularly that of the motors.

*Polyphase Current Motors.*—Up till lately the only alternating-current motors capable of being utilised for traction were asynchronous polyphase motors. These motors have received in Europe, principally in Italy and Switzerland, a certain number of applications, some of them being important ones. The type generally used is the three-phase. On the Valtellina line the current is supplied at 3,000 volts, and on the experimental Marienfelde-Zossen line even at 10,000 volts. Although these motors give an interesting and advantageous solution in certain cases, they do not appear capable of general application. Against them, in the first place, is the fact that each track requires at least two working conductors at different voltages, and even three if the track rails are not used as a conductor; the resulting complication becomes very inconvenient at switches and crossings; moreover, the maintenance of the insulation becomes more difficult. Then the polyphase induction motor is essentially a constant-speed motor; any other speeds than those near synchronism can only be obtained at the cost of rheostatic losses, or by means of more or less complicated devices, the usual one being that known as "concatenation." This latter arrangement makes it possible to obtain a good efficiency at two different speeds, but its realisation is not without practical difficulties. With motors of this type the power stations and the lines carrying the current must have a greater capacity for an equal service than with continuous-current motors, owing to the greater power required, both in order to haul trains up gradients without reduction of speed, and also for starting, and, again, owing to the comparatively low power factor of three-phase traction systems. This increased capacity results in a corresponding reduction in efficiency, which is all the greater because it is not possible in this case to reduce the variations of load by using accumulators, so that the amount of energy consumed, other things being equal, is about the same as in the ordinary system with continuous current and transformer sub-stations. Hence the cases in which the system of three-phase motors is distinctly superior are comparatively rare. It may be stated in a general way that the conditions most favourable to its use are when the lines are long, when there are long intervals between the trains and they have few stops, or when the lines have long and regular gradients, particularly if there is plenty of motive power, and it is cheap; under such conditions it is cheaper both to instal and to maintain than the preceding system. In the case of mountain railways, three-phase motors have another valuable advantage, which is the automatic limitation of the speed and the return of the energy to the line while running down hill, when the motors act as generators. The existing applications of polyphase motors to traction mostly belong to one or other of these classes.

*Single-Phase Current Motors.*—A much more extended field seems to be available for single-phase alternating-current motors, long forgotten in this connection, but which recent improvements have once more brought into notice. The only monophase alternating-current motors at present existing which have the speed and torque properties suit-

* Abstract from the *Street Railway Journal* of a paper read before the International Railway Congress.

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able for application to traction are the "commutator" motors. The question of applying motors of this kind to traction purposes has lately been taken up in several different countries simultaneously—thus in America by Mr. Lamme, in Italy by Mr. Finzi, in Germany by Messrs. Winter and Eichberg, in France by Mr. Latour. The motors tried are either of the series type with laminated poles, or of the repulsion type, or are a combination of both these types. The results already obtained raise the hope that it will not be long before there will be a monophase motor which will work satisfactorily, give a good torque at starting, a high power factor under normal conditions and an efficiency similar to that of the best continuous-current motors. Under these conditions the simple alternating-current motor is of very great interest, but it is necessary to wait for further results before any definite conclusions as to this system can be reached.

*Summary.*—In summarising the situation, the author believes that the use of electric traction on railways is already practicable in all cases where its use would be considered advisable from the economic point of view. Short-distance passenger traffic seems to offer the most favourable field for electric traction. Moreover, it is almost exclusively to this class that the applications already made on railways belong. Electric traction for freight trains exists only as an exception justified by peculiar local conditions. It may be said in a general way that in services of this kind the economy of the system increases with the reduction in the weight of the trains and with the increase in their number. Leaving out of consideration metropolitan railways, which form a special class for which electric traction is now a necessity, the suburban lines of some large towns may offer conditions favourable to the use of electricity. The latter, in the case of service with many stops, has the great advantage that it makes it possible to increase the average speed materially, owing to the rapidity of starting electric motors. The absence of smoke, the better lighting of carriages and stations are other advantages, which, although only of a secondary character, yet also contribute considerably to the general improvement of the service.

Similar conditions will be found to occur on sundry busy lines connecting large centres not very far apart in industrial districts, where the service must assume as nearly as possible the character of a tramway service. On lines of this kind, and even on certain secondary railways, the increased facilities of transport made possible by electric traction may lead to important increases in the traffic and in the receipts. Another case where the adoption of electric traction is worthy of consideration is that of lines which are worked up to their full capacity. For electric traction indeed makes it possible, under certain conditions, to increase the capacity for traffic, while avoiding more costly measures, such as quadrupling the track or enlarging the terminal stations. This possibility is due, in the first place, to the greater speed of the train, resulting from quicker starting and less loss of speed up gradients; and, secondly, to the reduced blocking up of the terminus stations owing to the smaller number of operations necessary to receive a train, and then clear the siding for the next train.

The great capacity of electric motors is especially advantageous on mountain railways, whether adhesion or rack railways. An electric locomotive need not weigh more than 40 kg. to 50 kg. per horse-power (89lb. to 112lb. per British horse-power), and the equipment of a motorcar not weigh more than 20 kg. to 25 kg. per horse-power (45lb. to 56lb. per British horse-power). Electric traction, moreover, makes it possible to obtain the maximum adhesion by making all the car wheels driving wheels. It therefore makes it possible to locate lines with sharper curves and steeper grades (for instance, the Fayet-Chamonix line, Paris-Lyons-Mediterranean Railway), which are cheaper to build. The saving effected may in some cases be so large as to cover, or even more than cover, all the additional expenditure for the installation of power stations and transmission lines.

The relative lightness of electric vehicles also makes them suitable for obtaining very high speeds. The large amount of power required to run a train at from 150 km. to 200 km. (93 miles to 124 miles) per hour can more easily be furnished by electric motors fed from outside than by a steam locomotive, the weight of which increases rapidly with the speed to be attained. The recent experiments made in Germany have proved (if, indeed, it was necessary) the superiority of electricity from this point of view.

The most serious objection to such a great increase in speed is the expense. In the first place, on very busy lines, which alone could serve as a motive for the use of high speeds, it would be impossible to run trains at 200 km. (124 miles) per hour, between ordinary trains, without disturbing the whole time-table and making the ordinary traffic impossible. It would, therefore, be necessary to build new lines, either by adding new tracks to the existing ones, or, better, by building entirely new lines with curves of large radii and a wider road-bed so as to have a greater distance between trains. The track itself would have to be strengthened materially. In the interests of safety it would also be necessary to absolutely prohibit level crossings, junctions, and other dangerous features. Taking it altogether, such a road would cost much more than the existing lines, quite apart from the electric equipment. Moreover, as a high-speed line would also be of considerable length, for it would scarcely be worth while to incur such a large expenditure merely in order to save one-quarter or half an hour on a journey, the capital required for construction would be enormous.

To earn dividends on such a capital and to meet the working expenses, which also would be very high, were it only on account of the great increase in tractive effort at higher speeds, one could only depend upon passenger traffic, and, perhaps, on some additional receipts from parcels traffic. No doubt cases will occur, sooner or later, where the development of the communication between two large centres may justify, from the economical point of view, the building of such a line. But in France, at least, this case does not seem to be likely in the immediate future.

*Conclusions.*—On the whole it seems to us that electric traction should at present be looked upon as a useful auxiliary to steam traction, capable of operating certain parts of railway traffic with advantage and economy. The principal cases in which its adoption may at present be feasible are: firstly, on lines which are chiefly underground, then on metropolitan and on suburban lines, on interurban lines of limited length and with much traffic, on railways with steep gradients, and on lines which are worked up to their full capacity.

It is impossible to indicate in a general report in any more definite a way the cases in which the system of working may lend itself to the application of electricity; it is essentially a question of degree, and each individual case requires special examination. In this examination special consideration must be given to the cost of the electric equipment, the principal factors of which are, in the first place, the conditions of working, the number and weight of the trains, and, secondly, the conditions under which the line is built; its length, profile, and plan; then the charges for interest and sinking fund of the capital outlay required must be compared with the economy which electric traction will give as compared with steam traction.

If it is a question of a new line, the adoption of electric traction may in certain cases result in a lower cost of construction, whereas in the case of existing lines the value of the rolling-stock which will be rendered useless by the introduction of electricity has to be taken into consideration and written off. Among the conditions in favour of electric traction are naturally the proximity of easily utilisable water power or of other cheap sources of energy, such as coal pits and blast furnaces.

In comparing the cost of traction, we must allow in the case of electricity, in addition to the eventual economy realised in the production of energy, for the reduction of dead weight resulting from the smaller weight of electric locomotives, the reduction in the cost of driving and of maintenance, as well as for the accessory economies capable of being effected in shunting operations at stations, in lighting the stations and trains, etc.

Finally, if so happens, the increased receipts which may result from the improved service have also to be taken into consideration. In any case, the problem becomes in the end a financial and economic one.

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In an appendix Mr. Paul-Dubois gave an extended account of electrified steam roads in Europe, to which reference has been made above.

## THE INTERNATIONAL RAILWAY CONGRESS.

The two papers which we reproduce in abstract in this issue by Messrs. F. Paul-Dubois and Dr. Schulz were discussed before the International Congress at Washington, with two other papers. The first of these was by Mr. W. D. Young, who dealt with the progress of electric traction in the United States. Mr. E. Gerrard took up the same subject as far as Great Britain and Belgium are concerned, and to his paper some information was added by Mr. Victor Tremontani as to the progress of electric traction in Italy. In the discussion which followed some most interesting opinions were expressed.

Amongst the speakers from England was Mr. J. A. F. ASPINALL, of the Lancashire and Yorkshire Railway, who gave some details as to the electric line from Liverpool to Southport. Electric traction was not adopted on this line for the sake of economy, but to increase the receipts. Since the 12 months during which the line has been operated electrically the results are most satisfactory as to increase in traffic, but the operation is more expensive than with steam. The cost of coal per ton-mile especially is greater; the running expenses, however, are less, because of the greater mileage run by the crews. After describing the trains and service, Mr. Aspinall explained that one of the reasons for introducing electric traction on the line was the necessity of decreasing the crowding of the Liverpool terminus during the busy hours; the handling of an inbound steam train and its redispatching requires four distinct switching operations and eight signal operations, while for an electric train two switching and four signal operations are sufficient. It has, therefore, just doubled their terminal capacity. Further, as their terminal facilities for handling traffic on four tracks has increased, they are enabled to do all their passenger work on two tracks, leaving the other two for freight. Since electrification, however, the traffic has increased so much that they are preparing all four tracks for using electricity. The cost of the electric installations on the Liverpool and Southport line was as high as £20,000 per mile, or about 3½ times the installation of a steam locomotive service. If the interest and sinking fund charges of this sum are added to the cost of operation, it is not surprising that electric traction costs more than steam. Mr. Aspinall added that the weight of electric equipment of the trains on the Liverpool Southport line is not less than the weight of corresponding locomotives, and that the same will hold true for trains on main lines.

A discussion followed on the question of high-speed railways. Mr. T. H. LAURENT, of the Paris-Orleans Railway, commented upon the enormous consumption of energy required on the Berlin-Zossen trials. In order to run at 125 miles per hour on the level with a single motorcar weighing 30 tons and carrying 50 passengers, no less than 1,340 h.p. was needed. On his railway, with the high-speed trains running at from 62 to 75 miles per hour, a train carrying 400 first-class passengers was pulled by a 1,200-h.p. to 1,300-h.p. locomotive. He raised the question as to whether the economical problem of running such a high-speed service could be solved.

In reply, Dr. SCHULZ gave some information as to the proposed high-speed line between Berlin and Hamburg. He considered that the scheme was commercially feasible, and there were two large firms seeking the concession. The distance between the two cities is 179 miles, and the trains now took 3½ hours to do the journey. It is proposed with the high-speed line to do it in 1½ hours.

Mr. A. WILSON, of the North-Eastern Railway Company, gave some information on the use of electric traction on the suburban lines of that company near Newcastle-on-Tyne. He also furnished some data on the cost of operation of these lines, stating, however, that there was considerable difficulty in making a satisfactory comparison with steam traction. Electricity permits a better utilisation of the existing lines, and experience shows that the improved service which follows generally leads to increased receipts. The cost of electric traction for the month of February, 1905, was as follows:

| | |
|---|---|
| Mileage of trains | 92,541 |
| Mileage of cars | 254,938 |
| Average number of cars per train | 2·75 |
| Total energy consumed (kilowatt-hours) | 647,140 |
| Energy consumed per train mile (kilowatt-hours) | 6·993 |
| Energy consumed per car mile (kilowatt-hours) | 2·538 |
| Average cost of power per car mile (pence) | 1·601 |
| Engineer's pay per car mile (pence) | ·297 |
| Conductor's pay per car mile (pence) | ·217 |
| Total cost of traction per car mile (pence) | 2·115 |
| Total cost of traction per train mile (pence) | 5·7 |

In another discussion at the same congress, Mr. WILSON said that his company operated for the past year an electric suburban service in the Newcastle district with the object of regaining the traffic from the competing tramways and to increase its amount. All the traffic has not been regained from the tramways, but the amount handled has been considerably increased. The reduction in expenses has resulted in a net revenue which more than covers the interest on the extra cost of installation necessitated by the introduction of the electric power.

Mr. K. STEINBISS, of the Royal Prussian Railway, gave some information as to the running of the single-phase motors on the Niederschoeneweide-Spindlersfeld line near Berlin. The motors employed are of the Winter-Eichberg system, and the speed is from 25 to 37 miles per hour. Trains are made up of one or two auto-motorcars, with or without trailers; the heaviest train contains five cars and weighs 150 metric tons. Encouraged by the results given by this trial, German engineers are applying the same system to a line connecting Hamburg, Altona, and Blankenese, which is 15¼ miles long. The trains in ordinary service will consist of two cars, with three axles each (one two-axle truck and one independent axle), with a total of 100 seats. These trains will be run at a speed of 37 miles per hour, with three minutes' headway between trains. The work of equipping the line has been begun; it is to be opened to traffic Oct. 1 of next year.

Mr. W. D. YOUNG also gave more information on the subject of single-phase motors in order to supplement his report. He also referred to the third rail, which he did not believe was as dangerous as people said. Ten years ago there was installed in Baltimore, to avoid the third rail, a system of overhead wiring which proved very expensive, and gave a great deal of trouble, particularly in the tunnels, which extend over half the length of the line. The corrosion caused by the sulphurous smoke and vapour from the locomotives finally made it necessary to renew this line throughout. As all the changes and repairs had to be made without interrupting the service, and working with live wires, the expense was very great. Consequently his company decided three years ago to replace this overhead wiring with a third rail. This third rail is protected between stations by guard boards; at stations the third rail is entirely enclosed, except at the top, where a slot is left for the contact shoe. As an additional measure of safety, a system of automatic switches has been installed at the stations and at points where the workmen most frequently cross the tracks, but this system works irregularly, and therefore is not very reliable. Last year the line was extended across the North Baltimore Station; where passing this station the third rail has merely been omitted for a distance of 700ft., over which the trains are carried by momentum. Finally, Mr. Young pointed out the importance of the different railroad companies arriving at a definite agreement on the question of the location of the third rail. On the Baltimore and Ohio Railroad the horizontal distance between the axis of the third rail and the axis of the track rail nearest to it is 31½in.; the height of the third rail above the track rail is 3½in. This height is almost the same everywhere, but the horizontal distance varies greatly with the different companies, and it would be very desirable to make these dimensions uniform.

After discussion, the following conclusions were adopted by the congress:

### CONCLUSIONS.

The section recognises that electric traction should be

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considered at present as an important auxiliary of steam traction, being capable of handling certain portions of railway traffic with advantage and economy.

It is impossible in a general exposition to point out the exact service to which electricity can be most readily applied, the application being essentially a question of local conditions, each particular case requiring special study. In this study there must be taken into account the expense of electrification, and the following points: first, condition of service—that is, the frequency and weight of trains; second, the physical conditions of the line, such as length, profile, and plan. In comparing the expenses of operation by electricity and by steam, the interest and depreciation on the electrical installation must be considered.

The increase in revenue which the improvements in service will generally produce should also be given consideration. An important point in the use of electricity is the increase in the present station facilities resulting from the reduced number of movements in the stations by the use of electric traction.

From the information furnished to the congress it would seem that with the third rail, as now used, security can be assured under favourable conditions without it being necessary to cover or protect the third rail for its entire length.

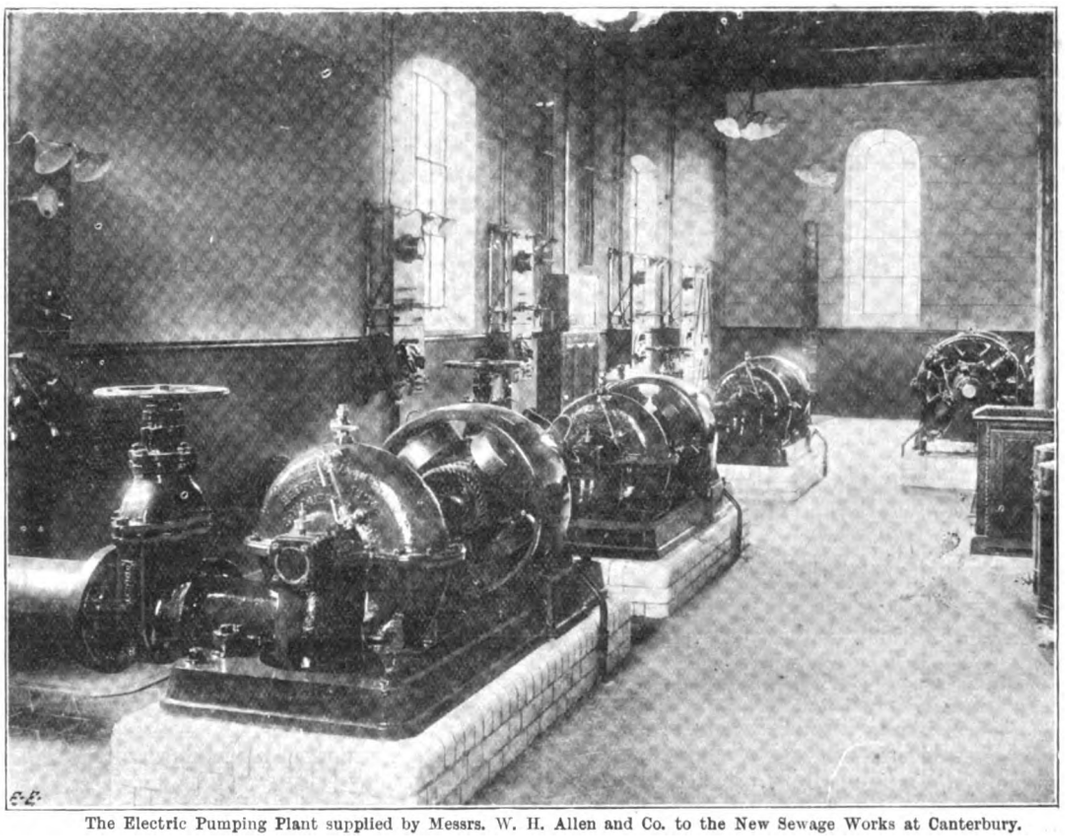
The congress has heard with much interest the results experienced with high-speed electric traction between Marienfeld, and Zossen, and also of the tests and first application for traction purposes of the alternating-monophase motors in several countries.

Finally, the congress recommends that, on account of their future usefulness, exact data on the cost of electric traction be obtained.

## ELECTRICALLY-DRIVEN PUMPS AT THE CANTERBURY SEWAGE WORKS.

The new sewage-disposal works of the Canterbury Corporation have recently been opened, and a few words as to the extensive use made of electrically-driven pumps will be opportune. The contract for this part of the new works was placed with Messrs. W. H. Allen, Son, and Co., Limited, of the Queen's Engineering Works at Bedford. The complete contract includes four motor-driven sewage pumps of Messrs. Allen's Conqueror type, having suction and discharge branches each 10in. diameter, each pump being capable of delivering 100,000 gallons of sewage per hour against a head of 20ft. when running at a speed of 525 revolutions per minute and absorbing approximately 20 b.h.p. In addition to these four pumps, the firm have also installed two storm-water motor-driven centrifugal pumps, each having suction and discharge branches of 14in. diameter, and each capable of delivering 200,000 gallons of water per hour against a maximum head of 20ft. when running at a speed of 425 revolutions per minute and absorbing approximately 37 b.h.p. The centrifugal pumps are of Messrs. Allen's standard pattern, the casings being cast in two halves and bolted together along a horizontal diameter. The impellers are likewise of cast iron, and are securely keyed to a steel spindle. The bearings are of cast iron lined with white metal, and lubrication is effected by "Stauffer" spring grease cups.

The motors for driving both sewage and storm pumps are mounted on the same base-plate as the centrifugal pump in each case, and are of the company's standard four-pole shunt-wound type, designed for the speeds named when supplied with continuous current at about 450 volts. The field magnets are cast from high-permeability steel, with four poles of the same material bolted to the inner periphery on faces which are accurately bored to receive them. The pole-shoes, which are of laminated steel plates, are screwed to the pole-face, and retain in position the field coils, which can be easily removed for inspection. The armatures are of the slotted barrel-wound type, and are provided with the usual ventilating ducts. The commutators are built of hard-drawn copper bars of specially deep section, insulated with micanite sheets, and securely clamped in position. The armature shafts are mounted in standard pedestals provided with self-oiling bearings, the brush arms being carried from the outer bearing and fitted with hand worm gear for adjusting the angular position of the brushes. The pumps are provided with the usual suction foot-valves, delivery valves, charging valve, and water gauges to show the height of water in the pump when charging. Each motor is provided with a separate switch panel mounted on the wall, each panel consisting of a patent starter with no voltage and overload automatic releases, and independent shunt regulator interlocked with the starting switch in such a manner that the field resistance is all cut out at starting. Also each switch panel is pro-



The Electric Pumping Plant supplied by Messrs. W. H. Allen and Co. to the New Sewage Works at Canterbury.

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vided with a suitable ammeter, a double-pole switch and two lamp brackets, the lamps being coupled across the terminals of the double-pole switch in such a manner that they are lighted only when the switch is closed. A main fuse board has also been installed, which consists of three panels of oiled slate separated by insulating fillets. These panels are provided with the necessary 'bus bars, fuses, and terminals. The illustration shows the arrangement of the four sewage pumps and motors, together with their switch panels, the arrangement being a neat one and well adapted for the purpose.

## THE COVENTRY LOG-SHEET.

In our issue for May 19 we printed an interesting lecture on the supply of cheap electrical energy for industrial purposes by Mr. J. A. Jeckell. In it reference was made to a log-sheet which Mr. Jeckell has prepared for giving a ready means of comparison between the cost of working in two successive periods. At the request of several of our readers, and with the permission of Mr. Jeckell, we reproduce herewith one of these log-sheets. They are supplied bound in book form with two such sheets facing each other, and are copyright. Each book contains sheets for 12 months, four quarters, two half-years, and one year bound up together.

## THE GLOVER SELF-LOADING CABLE-DRUM CARRIAGE.

The following two photographs show a new cable-drum carriage of unique design which has recently been made by Messrs. W. T. Glover and Co., of Trafford Park, Manchester. The object of the new carriage is to reduce the heavy labour charges frequently incurred in loading up cable drums on to the older types of carriages or on to lorries. This has often involved the sending of a number of men to a railway station where the work to be performed can

ending .....

| Street Lamps. | Private Lamps. | Total Lamps connected. | Units generated. | Station units. | Loss in distribution. | Sold to Consumers. | Street Lighting. | Total sold. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

| | Amount. £ s. d. | Total Amount. £ s. d. | Per Unit Metered. | Total per Unit Metered. |
|---|---|---|---|---|
| **A. GENERATING CHARGES.** | | | | |
| Salaries ... ... ... ... ... | | | | |
| Wages ... ... ... ... ... (Tons cwt. qrs.) | | | | |
| Coal ... ... ... @ Ton. | | | | |
| Water ... ... ... ... ... | | | | |
| Engine Room Stores ... ... ... ... | | | | |
| **MAINTENANCE.** | | | | |
| Boilers ... ... ... ... (Material) | | | | |
| (Wages) | | | | |
| Engines ... ... ... (Material) | | | | |
| (Wages) | | | | |
| Alternators ... ... ... (Material) | | | | |
| (Wages) | | | | |
| Pumps and Pipes ... ... (Material) | | | | |
| (Wages) | | | | |
| Buildings ... ... ... (Material) | | | | |
| (Wages) | | | | |
| **B. DISTRIBUTING CHARGES.** | | | | |
| Salaries ... ... ... ... ... | | | | |
| Wages ... ... ... ... ... | | | | |
| Repairs to High Tension Cable Work (Material) | | | | |
| (Wages) | | | | |
| Repairs to Low Tension Cable Work (Material) | | | | |
| (Wages) | | | | |
| Repairs to Apparatus on Consumers' Premises (Material) | | | | |
| (Wages) | | | | |
| Repairs to Distributing Stations (Material) | | | | |
| (Wages) | | | | |
| Work's Costs Carried forward ... ... £ | | | | |

| | Amount. £ s. d. | Total Amount. £ s. d. | Per Unit Metered. | Total per Unit Metered. |
|---|---|---|---|---|
| Brought forward ... | | | | |
| **D.—ROYALTIES** ... ... ... | | | | |
| **E.—RENT, RATES AND TAXES** | | | | |
| **F.—MANAGEMENT EXPENSES.** | | | | |
| Salaries—Engineer's Department ... ... | | | | |
| Clerical Staff ... ... | | | | |
| Accountant's Department ... ... | | | | |
| Printing and Stationery ... ... | | | | |
| Establishment Charges ... ... | | | | |
| **G.—LAW EXPENSES** ... | | | | |
| **H.—INSURANCES** ... | | | | |
| **CERTIFICATION OF METERS** | | | | |
| Total Work's Costs ... £ | | | | |
| Interest ... ... ... ... ... | | | | |
| Redemption ... ... ... ... ... £ | | | | |
| **C. PUBLIC LAMPS.** | | | | |
| Attending to Lamps ... ... (Material) | | | | |
| (Wages) | | | | |
| Repairs to Lamps ... ... (Material) | | | | |
| (Wages) | | | | |
| Renewals of Lamps ... ... (Material) | | | | |
| (Wages) | | | | |
| Grand Total ... ... £ | | | | |

| **REVENUE.** | £ s. d. | Actual. £ s. d. |
|---|---|---|
| Private Lighting ... Units ... ... ... | | |
| Less due to N. E. C. Co., Ltd. | | |
| @ d. | | |
| Motive Power ... Units ... ... ... @ d. | | |
| Street Lighting ... Units ... ... ... @ d. | | |
| Rental of Meters and other Apparatus on Consumer's Premises @ d. | | |
| Other Items ... ... ... ... ... ... @ d. | | |
| Total Revenue ... ... ... ... ... @ d. | | |
| Total Cost ... ... ... ... ... ... ... ... | | |
| Profit or Loss ... ... ... ... ... | | |

Revenue per 8 c.p. £ ... Record Load to date ... Load Factor ... Selling Load Factor ...

Lbs. of Coal per Unit generated ... Lbs. of Coal per Unit sold ... Average Price obtained per Unit Sold, exclusive of Meter Rent and lamp attendance ... d.

Average Price obtained per unit Street Lighting (less attendance) ... d.

Running costs per unit sold = (Winter Works costs—Summer Works costs) / (Winter Units sold — Summer Units sold) ... d. Total Running costs £ ... Number of Consumers ...

Total Standing by charges = Total Charges to Revenue Account—Total running costs = £ ...

Max. Load on Station in kwt ... Sum of Consumers' maxima in kwt ... + Street Lighting in kwt ... = Total kwt demanded ...

Divergency factor ... Standing by charges per kwf demanded ...

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be done in a time which is small compared with the time taken by the men on the to and fro journey. With the apparatus as now illustrated the driver of the carriage is able to do all that is required himself. The operation is briefly as follows. He first backs the carriage over the drum, and then puts the usual bar through the centre of the drum, with its ends engaging in the scrolls, which form a portion of each wheel. The horse is then started forward, and the action of the wheels and scrolls revolving gradually lifts the drum until it reaches its final position in the centre of the scrolls. When this has been done, the end caps, which are seen in one of the illustrations, are added, and lock the bar in the central position. In order to unload the drum, all that is needed is to reverse the movement. This is done by backing the horse, which causes the drum axle to run in the reverse direction round the scroll work until the drum reaches the ground. The fixed scroll on either wheel is connected to the shaft portion of the carriage by means of the knife-edge wheel supports, which are shown in the illustration, and which act as the bearings. The design in the illustration shows a somewhat heavier construction than is found to be necessary after trial. The carriage in question is an interesting application of a very ancient device, and Messrs. W. T. Glover and Co. are to be congratulated on having utilised it for modern cable work. We need hardly say that they are prepared to supply these carriages to any electrical engineer requiring the same for his mainlaying department.

FIG. 1.—The Glover Self-Loading Drum Carriage.

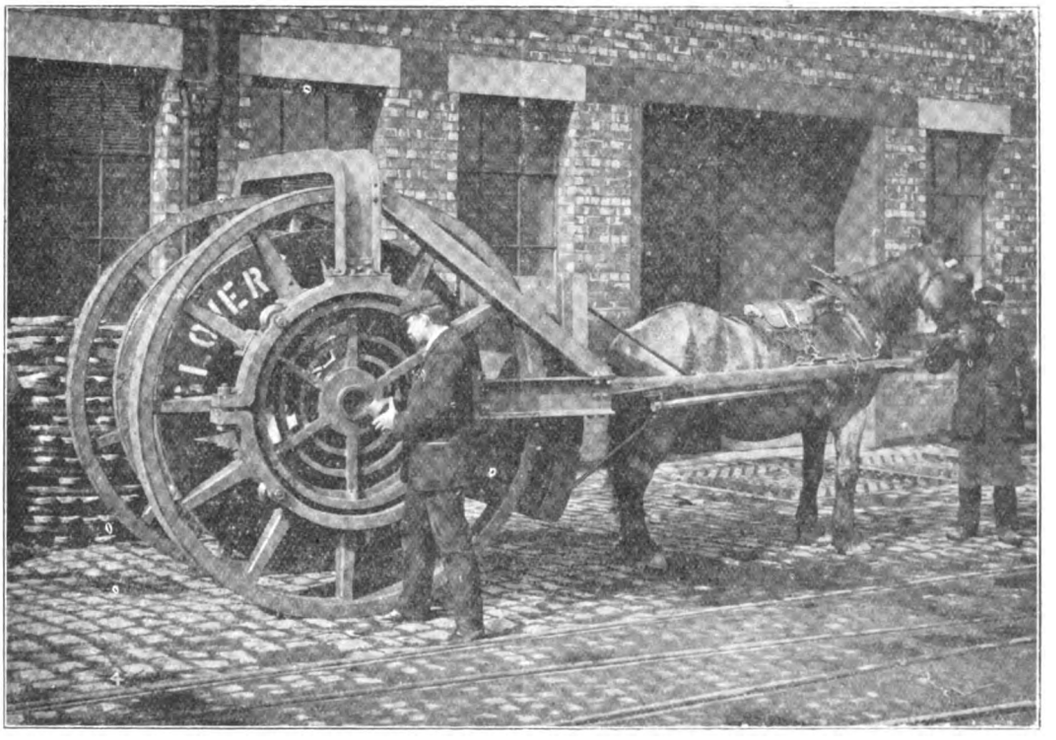

FIG. 2.—The same Carriage with Drum in Position.

**Personal.**—We are informed that Mr. J. R. Williams has been appointed power station superintendent to the Sheffield Corporation Tramways Department, but not chief mechanical engineer as well, as stated in our last issue.

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### TO CORRESPONDENTS.

*All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

*All communications intended for the Editor should be addressed* C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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## WIRELESS TELEGRAPHY MEASUREMENTS.

The communication on the above subject from Mr. W. Duddell and Mr. J. E. Taylor to the Institution of Electrical Engineers marks a great step forward in the development of wireless telegraphy. Up to the publication of this paper there had been a great deal of matter available as to different methods of etheric wave transmission, but there were hardly any quantitative data. From the paper and the further information which was given by the authors to the Institution, it is clear that the energy required both for sending and receiving messages need no longer be unknown. The preliminary tests made by the authors in Bushy Park last year were carried out for the Postal Telegraph Department at the request of the engineer-in-chief, Mr. J. Gavey, C.B. The essential feature of the investigation is the apparatus by which the very small current received can be accurately measured. Until recently there was no satisfactory instrument at the disposal of the electrical engineer for the measurement of extremely small alternating currents. This want has been met by Mr. W. Duddell by his thermo-galvanometer, which in the experiments described actually measured currents whose average values were as small as 0·0000383 of an ampere. This thermo-galvanometer is an ingenious combination of a resistance connected in series with the receiving wire of the system and a delicately suspended thermo-electric couple. The resistance is wound to form a small cup, into which one end of the thermo-junction dips. The current in the thermo-couple circuit produces a deflection which is read by means of a reflected beam of light in the usual way. The apparatus is thus of the laboratory type, and in the experiments described the receiving station was fixed, while the sending station was moved to various distances from the same. The investigations as to the connection between the value of the current received with the distance under various conditions are fully described in this paper. The sending circuit was usually arranged to give constant current, and then the resistance in the receiving circuit was varied. From the curves obtained under two conditions—*i.e.*, when the receiving circuit was tuned and when it was untuned—valuable information is obtained as to the laws governing Hertzian wave transmission. It is proved, for instance, that both these curves follow the well-established formula for determining the current flow in an alternate-current circuit. For the conditions which obtained when the experiments at Bushy Park were conducted, the formula for the current with untuned conditions became $\frac{0{\cdot}12}{\sqrt{(185)^2+(56+r)^2}}$ where $r$ equals the added resistance in the receiving circuit. When the circuit was tuned, the term $(185)^2$ vanished, and the equations of the curve became $\frac{0{\cdot}12}{56+r}$ It is interesting to note that under these conditions it would seem as though an E.M.F. of 0·12 volt was induced in the receiving aerial conductor. As is pointed out by the authors, this represents the square root of the mean square voltage over the whole time, and not over the time each set of oscillations last. To get, therefore, the actual voltage during the time the oscillations exist, one has to allow for the interval between its discharges. The authors state that it is improbable that the groups or sets of effective oscillations (taken on a basis of fifty effective cycles per train) last much more than one three-thousandth of the time interval between them. If this is so, the root of the mean square voltage induced during the oscillations cannot be much less than $0{\cdot}12 \times \sqrt{3{,}000} = 6{\cdot}6$ volts under the conditions of the very strong signals used for these tests.

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This correction shows the extreme difficulty of arriving at the exact determination of the quantities involved in wireless telegraph signalling due to the intermittent oscillations of current. Further experiments were made in Bushy Park from which curves were plotted to show the connection between the value of the current received and the distance from the sending station. The distance available was comparatively small, but the general conclusion foreshadowed was that the product of the distance into the current received was constant if obstacles were eliminated. This conclusion was amply confirmed by further experiments made on the Irish Sea. In these the sending apparatus was erected on a steamer, and the receiving station was installed on shore. With the current in the sending circuit constant, Mr. Duddell proved that the product above mentioned of current received into the distance was constant up to sixty miles. The curve, however, rose in the immediate neighbourhood of the sending station, which was also the case in the Bushy Park experiments. In conclusion, congratulations are due to the authors as the successful pioneers of exact measurements of wireless telegraphy currents.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### INDUCTION MOTORS.

SIR,—Referring to "Student's" questions dealing with certain points in connection with my article on induction motors, I have pleasure in answering them as follows:

*Question I.*—R = reactance of coil C, and $c^2$ = resistance of the non-inductive resistance.

*Question II.*—As "Student" does not give sufficient data to enable the resultant currents taken by the two chokers when in series or parallel to be determined, it will be necessary to first deal with each choker separately, as it is impossible to determine the resultant currents from the information given.

"Student" states that the current and power taken by the choke coils separately on a 500-volt circuit are

4 amperes, 1,600 watts, on, say, No. 1 coil.
6 „ 2,000 „ „ 2 „

In the case of No. 1 coil $\cos\phi = \frac{1,600}{2,000} = \cdot 8$,

and $\sqrt{R^2 + p^2 L^2} = \frac{E}{C^1} = \frac{500}{4} = 125$ impedance of No. 1 coil.

For coil No. 2 we have $\cos\phi = \frac{2,000}{3,000} = \cdot 66$,

also $\sqrt{R^2 + p^2 L^2} = \frac{E}{C_2} = \frac{500}{6} = 83\cdot 3$ impedance of No. 2 coil.

With the chokers in series, the same current will flow in each. Let $e^1$ = volts across No. 1 coil, and $e_2$ = volts across No. 2 coil. Then $e^1 = C\sqrt{R_1^2 + p^2 L_1^2} = 125 \times C$, and $e_2 = C\sqrt{R_2^2 + p^2 L_2^2} = 83\cdot 3 \times C$. We now require to know the value of $\cos(\phi_2 - \phi_1)$ which represents the phase difference between $e_1$ and $e_2$. This quantity has been worked out by means of a clock diagram, and found to have a value = ·978 If E = resultant E.M.F. across both coils in series, we have

$$E^2 = e_1^2 + e_2^2 + 2 \cdot e_1 \cdot e_2 \cdot \cos(\phi_2 - \phi_1),$$

and substituting the values above

$$= (125 \cdot C)^2 + (83\cdot 3 \cdot C)^2 + 2\,(83\cdot 3 \times C)\,(125 \times C)\,(978).$$

$$\therefore E^2 = C^2 \times 42,914, \text{ and } C = \frac{E}{\sqrt{42,914}} = \frac{500}{206\,5} = 2\,4 \text{ amps.},$$

the resultant current with the two chokers in series.

With the "chokers" in parallel, the voltage between the terminals of each will be the same—*i e*, $e^1 = e^2 = 500$. If $C_1$ = current in No. 1 coil, and $C_2$ = current in No. 2 coil, we have

$$C_1 = \frac{e^1}{\sqrt{R_1^2 + p^2 L_1^2}} = \frac{500}{125} = 4 \text{ amperes};$$

also $$C_2 = \frac{e^2}{\sqrt{R_2^2 + p_2 L_2^2}} = \frac{500}{83\cdot 3} = 6 \text{ amperes.}$$

If C = resultant current when the two chokers are in parallel

$$C^2 = C_1^2 + C_2^2 + 2 \cdot C_1 \cdot C_2 \cos(\phi_2 - \phi_1),$$

and substituting known values we get

$$C^2 = 4^2 + 6^2 + 2 \cdot 4 \cdot 6 \cdot \cdot 978 = 98\,9$$

$$\therefore C = 9\cdot 9 \text{ amperes},$$

being the resultant current when the two chokers are in parallel.

So far as the rule for finding the resultant current with the series or parallel combination of two choking coils is concerned, it would follow from the working out of this example that the total impedance = the sum of the reactances and resistances respectively in each choker for the series combination, and the sum of the reciprocals of these respective quantities for the parallel combination. As regards the third question, the no-load magnetising current is found by running the motor light at its normal voltage. As the magnetic leakage, together with the magnetising current, determine the power factor, the former cannot be neglected. I must apologise for taking up so much valuable space, but the absence of anything like a fair amount (to me) of data in connection with Question II. has necessitated my trespassing on your columns to such a length.—Yours, etc, W. ROGERS.

Swansea, May 30, 1905.

### LIGHTNING.

SIR,—When writing the letter that appeared in your last issue I made a clerical error in asking what were the cases that the Lightning Research Committee excluded from Appendix A. I intended to have written "6," not "16."

Since that letter was written I challenged these figures in the course of the discussion that followed Mr. Killingworth Hedges's paper before the Society of Arts on the 24th inst., and elicited the fact that, notwithstanding the statement that the committee received reports of 40 cases of damage to "protected" buildings, the list of 34 contains *all* the cases sent in by reporters; but no explanation was forthcoming as to why seven cases of damage to "unprotected" buildings were included in a list that professed to be one of lightning conductor failures only! As regards the eighth case, there was a lightning conductor, but the damage, if caused by lightning—I have reasons for thinking it was not—occurred long before the committee were formed. Its inclusion in the list is no doubt excusable, as the committee were not informed of the whole facts.

In the course of the three years that this committee were collecting details, 27 cases of damage to (so-called) protected buildings occurred, out of which particulars of 26 were sent in. That this number was exaggerated to 40 may be a mistake or not. I cannot help saying that it may be business, but it is not science.

In his reply to my remarks at the Society of Arts, Mr. Hedges complained that I was trying to throw cold water on the committee's work, and said that if I thought the work was being done wrongly I ought to have come forward earlier and given the results of my experience. This is a reasonable charge, and as the rules of debate did not permit me to reply at the time, I shall be obliged if you will allow me to state in your columns that at first I did point out two or three cases in which the reports were at fault; but being somewhat "behind the scenes" I came to the conclusion—justified, I think, by the ultimate report—that there was a desire to throw discredit on a subject in which I am greatly interested, quite apart from business connections, and I therefore declined the request that I should examine and report to the committee on all the cases that occurred.—Yours, etc.,

May 29, 1905. ALFRED HANDS.

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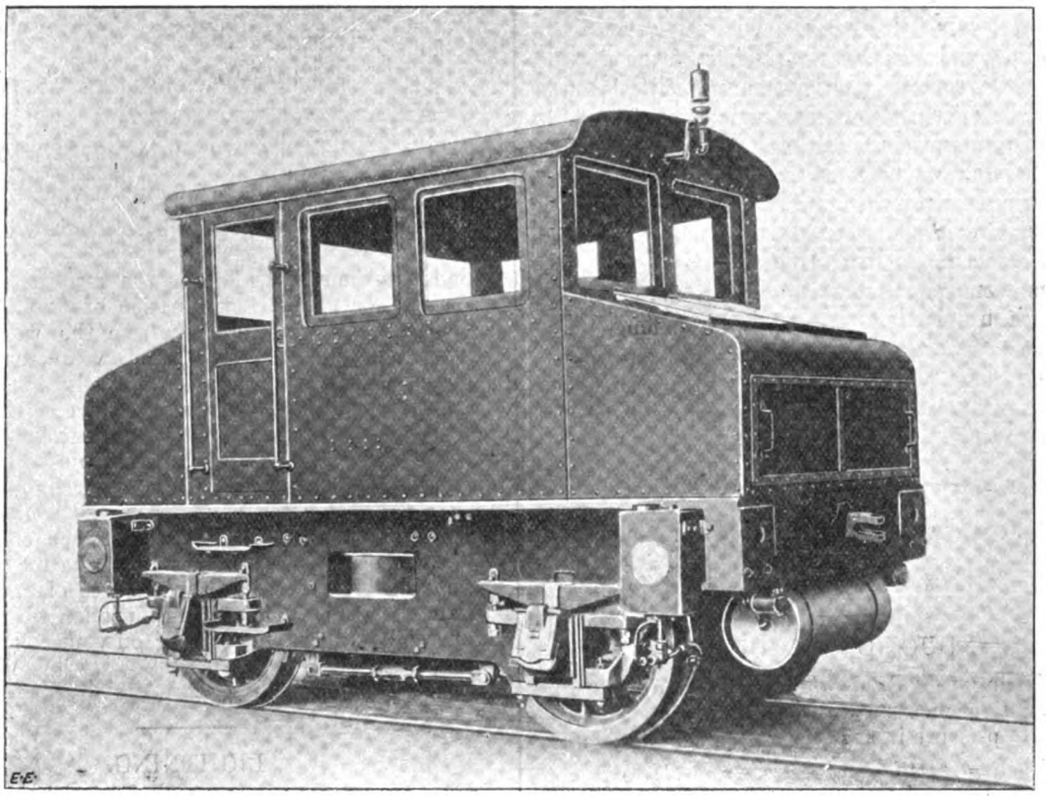
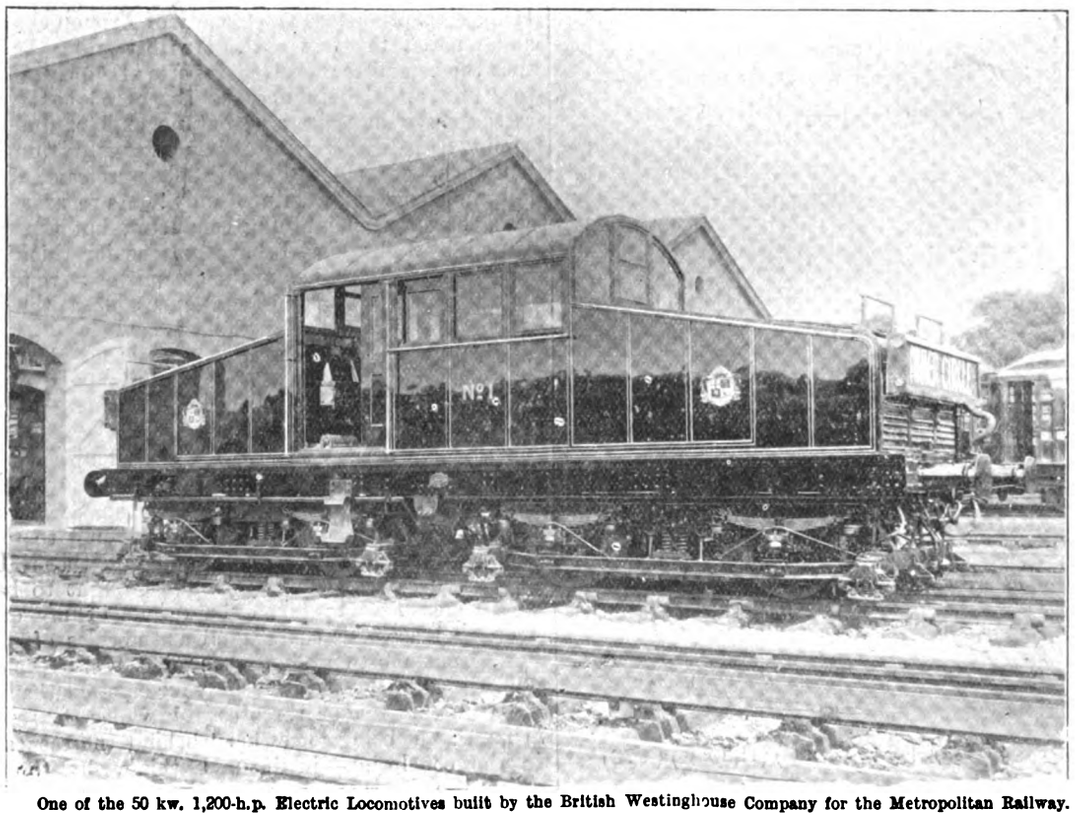
## SINGLE-PHASE ELECTRIC LOCOMOTIVE FOR SWEDISH STATE RAILWAYS.

The illustration shows a single-phase electric locomotive supplied by the British Westinghouse Electric and Manufacturing Company for the Swedish Government. One of the interesting features is the high trolley voltage for which the equipment is designed—18,000 volts—though connections are supplied for operating at several voltages lower than this, the minimum being 3,000 volts. This high voltage necessitates the use of an oil-cooled main auto-transformer and an oil-break circuit breaker, oil having insulating properties which have been amply demonstrated by service in high-tension transmission. The intention is to experiment at various line pressures with a view to ascertaining the highest working pressure suitable for the conditions prevailing upon the Swedish State Railways.

The control system is electro-pneumatic, and consists of an air-compressor driven by a single-phase alternating-current motor, an air-motor on the induction regulator, air-cylinders on the circuit breaker and reverser, and the necessary magnet valves. The air-brakes and air-sanders are also to be supplied by the above compressor. There are two connectors at each end of the locomotive, so that two locomotives can be coupled together and operated by



View of a Westinghouse 300-h.p. Single-Phase Locomotive as built for the Swedish State Railways.




One of the 50 kw. 1,200-h.p. Electric Locomotives built by the British Westinghouse Company for the Metropolitan Railway.

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one motor switch. The master switch is in the middle of the cab, and is so situated that the operator has a clear view in all directions without leaving his seat. The weight of the locomotive and equipment is 25 tons, all of which is on four 41in. drive wheels. Two 150-h.p., 25-period, single-phase motors are geared, one to each axle, with a gear reduction of 18 to 70, and have shown an ability to handle a 70-ton train at 40 miles per hour without exceeding the rise of temperature for which they were designed. The equipment has been so installed on the locomotive as to permit ready access to all parts. Only the small operating devices have been placed in the cab, and the lay-out is such as to allow of the greatest convenience in operation with a maximum of safety to the operator.

The illustration shows the locomotive as sent out from the makers' works, and it should be noted that buffers and collecting device, etc., are being fitted at the railway shops in Stockholm. This locomotive has been built to the requirements of Mr. Robert Dahlander, director of the electrical department of the Swedish State Railways, who is about to carry out a most interesting series of experiments upon the application of electric power to main-line railway service.

In this connection it is to be noted that this is by no means the most powerful single-phase locomotive manufactured by the Westinghouse Company. Thus during the visit of the delegates to the International Railway Congress at the Westinghouse Works at Pittsburg on May 16 a great deal of interest was attracted to the new 1,500-h.p. Baldwin-Westinghouse single-phase alternating-current electric locomotive in use on the Westinghouse Interworks Railway. This locomotive has just been completed by the Westinghouse Company and the Baldwin Locomotive Works, and is in two parts, which, when connected together, are connected by the unit-switch system. The weight of the locomotive complete (both halves) is 135 tons, and the total length over buffers is 45ft. The maximum height with trolley down is 17ft. The driving wheels are 60in. in diameter, and the distance between centres of drivers is 6ft. 4in. The extreme width of the locomotive is 9ft. 8in. The locomotive is equipped with six single-phase, single-reduction motors, one for each axle, having a normal capacity of 225 h.p. each, with gear reduction of 95 to 18. Induction regulator control is used and a pneumatically-operated trolley. The air-brake equipment is a combination of the automatic and straight air types, and pneumatic sanders are used to sand the tracks in both directions. The locomotive is designed to operate on 6,600 volts trolley voltage, with a voltage of 140 to 320 on the motors. The locomotive has a draw-bar pull of 50,000lb. at a speed of about 10 miles per hour, and a maximum speed of approximately 25 to 30 miles per hour.

## ELECTRIC LOCOMOTIVES FOR THE UNDERGROUND.

The first of ten 50-ton electric locomotives has just been supplied to the Metropolitan Railway by the British Westinghouse Company. They will be used for hauling the main-line trains between Harrow and Baker-street, the steam locomotive that brings them up from Aylesbury, etc., being taken off at the former point and put on at the return journey. The trains used on this portion of the line are 120 tons in weight, and the new locomotives (as illustrated herewith) will propel them at a speed of 36 miles an hour. The same locomotives will be used on the Metropolitan half of the Inner Circle for goods traffic and for hauling the steam trains of other companies possessed of running powers over it. The electric locomotive will pick up the train at Edgware-road, being replaced by a steam locomotive at the point where the train leaves the Circle. The new locomotives will be equipped with four motors of 300 h.p. each, and a feature of interest is that owing to the terminus facilities being somewhat restricted it has been necessary to use motors of a smaller size than usual equipped with forced ventilation, so as to keep down the length of the locomotives to convenient limits for handling at the termini.

## INSTITUTION OF ELECTRICAL ENGINEERS.

The following extracts from the report of the Council presented at the annual general meeting, held on Friday last, May 26, shows a healthy state of progress. Since the last annual general meeting to May 25, inclusive, there have been elected 12 members, 156 associate members, 20 associates, and 273 students, making in all a total of 461 accessions. Candidates have been approved for ballot at this annual general meeting. To the class of members there have been transferred 31 associate members and 13 associates. To the class of associate members there have been transferred 57 associates and 10 students, and up to the end of December, 1904, five students had been transferred to the class of associates. The increase in membership during the past year may be seen from the following approximate tabular statement, which gives the number of members on the roll of the Institution at the end of the session 1904, and at the corresponding period in the current year:

| | 1904. | 1905. |
|---|---|---|
| Honorary members | 6 | 6 |
| Members | 955 | 990 |
| Associate members | 1 435 | 1,593 |
| Associates | 1,761 | 1,635 |
| Students | 1,107 | 1,322 |
| Foreign members | 136 | 131 |
| Total | 5,410 | 5,677 |

It has been thought desirable by the Council to pass standing orders that no candidate shall in future be elected or transferred to the class of associates who may be eligible for election or transfer to the class of members, associate members, or students Students or candidates professionally engaged as electrical engineers can, therefore, no longer join the class of associates, which, in accordance with the terms of Article 15 of the articles of association, is reserved for persons who are so associated with the application of electricity that the Council consider their admission as associate would conduce to the interests of the Institution.

After referring to honours conferred on members of the Institution during the past year, the report deplores exceptionally heavy losses by death of distinguished members. Amongst these was the late Major-General C. E. Webber, C.B., past president, honorary member, and one of the founders of this Institution.

A long list of papers read at the London meetings, and of those of the local section papers which are printed in the *Proceedings*, is given. The premiums awarded are as follows:

The Institution premium, value £25, to Mr. E. H. Rayner for his paper "On the Effect of Heat on the Electrica and Mechanical Properties of Dielectrics," and "On the Temperature Distribution in the Interior of Field Coils."

The Paris Electrical Exhibition premium, value £10, to Prof. H. S. Hele-Shaw, F.R.S., Dr. A. Hay, and P. H. Powell, for their paper, "Hydrodynamical and Electromagnetic Investigations regarding the Magnetic Flux Distribution in Toothed-Core Armatures."

The Fahie premium, value £10, to Mr. D. Murray, for his paper, "Type Setting by Telegraph."

Three extra premiums, value £10 each, one to Mr. R. Goldschmidt, for his paper, "Temperature Curves and the Rating of Electrical Machinery"; one to Mr. Miles Walker (Manchester Local Section), for his paper, "Compensated Alternate-Current Generators"; and one to Messrs. D. K. Morris and J. K. Catterson-Smith (Birmingham Local Section), for their paper on "Some Uses of the Oscillograph."

One extra premium, value £5, to Messrs. J. B. Henderson and J. S. Nicholson (Glasgow Local Section), for their paper, "Armature Reaction in Armatures."

An original communication premium, value £10, to Mr. A. B. Field, for his communication on "The Dissymmetry of a Three-Phase System."

An original communication premium, value £5, to Mr. T. Baker, for his communication, "The Magnetic Properties of Some Alloys of Iron and Silicon."

STUDENTS' PREMIUMS.

The first students' premium, value £8, to Messrs. E. A. Biedermann and J. B. Sparks, for their paper on "E.M.F. Wave Forms."

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The second students' premium, value £5, to Mr. J. W. Anson, for his paper, "The Present Electrical Equipment of the London County Council Tramways."

The third students' premium, value £5, to Mr. A. C. Anderson, for his paper on "The Applications of Electricity in Mines."

An extra premium, value £4, to Mr. A. E. Jepson, for his paper on "Electric Heating."

An extra premium, value £3, to Mr. R. F. Chaffer, for his paper on "The Equipment of a Modern Generating Station, with Special Reference to the Chelsea Station of the Underground Railways."

The Council has awarded three Salomons scholarships, value £50 each, to Mr. A. E. Clayton, of King's College; Mr. E. A. F. Goodfellow, of the Central Technical College; Mr. F. C. Prentice, of University College.

Two David Hughes Scholarships, value £50 each, have also been awarded to Mr. E. A. Biedermann and Mr. J. B. Sparks, both of the Finsbury Technical College.

The American visit is referred to in the report, as is also the St. Louis Congress. As a result of a resolution of the Chamber of Government Delegates at the International Congress at St. Louis, the Institution of Civil Engineers directed the Engineering Standards Committee to consider and report on the proposal to endeavour to secure international electrical standardisation. The main committee presented their report in due course to the Institution of Civil Engineers with the request that they confer with the Institution of Electrical Engineers. The President, Mr. Alexander Siemens, has accordingly conferred with the president of the Institution of Civil Engineers, and as the outcome of the conference, a sub-committee of the Engineering Standards Committee, with the President of the Institution, Mr. A. Siemens, as chairman, has been formed for the purpose of entering into correspondence with foreign countries with a view to ascertain their attitude towards the question of international standardisation, and, if favourable to the idea, to procure their support to the proposal to form an international commission on standardisation.

The Council has been in communication with the departments of the Board of Trade and Home Office with regard to the revision of the regulations affecting the use of electricity, and they were invited during the recess by the Board of Trade to send in any observations they might wish to offer on the draft revised regulations for securing the safety of the public and for ensuring a proper and efficient supply of electrical energy. The consideration of the Council was also invited by the Home Office for the revised provisions of the Factory Act. The president-elect, Mr. Alexander Siemens, was chairman of the special committee to which the two questions were referred, and in due course the committee reported to the Council, and recommendations were made to the Board of Trade and the Home Office embodying the amendments proposed.

On the invitation of the Mining Association of Great Britain the Council in May, 1905, agreed to discuss mutually with that body the draft rules of the Home Office relating to electricity in mines. The consideration of the drafting of amendments was referred to the Traction, Light, and Power Committee, with Mr. W. H. Patchell, vice-president, as chairman, and much time and care were devoted to the work. Finally, the committee was empowered to hold a joint meeting with the Mining Association in order to exchange views, and the deliberations resulted in the inclusion of many important amendments in the recommendations of the Mining Association to the Home Office.

It is by such committees that the Institution does so much to advance the true interests of the profession. In the latter part of the report much of the other work of the Council is referred to, and we are pleased to note that the appeal for more support for the benevolent fund was most successful. Annual donations to this fund, which has already been of service in four cases, are asked for.

The financial position of the Institution continues to be a matter for congratulation by the Council. The excess of income over expenditure for 1904 amounts to £2,125. 15s. The surplus is not so large as that of the previous year, owing to certain exceptional items of expenditure.

At the annual meeting, at which the report was passed, the formal election of the new officers and Council for the next session was completed. As there were no further nominations, the gentlemen proposed by the Council take office without a ballot. The names were announced in a previous issue.

## TRADE NOTICES AND NOVELTIES.

### Electric Fans.

The new list of "Freezer" electric fans just issued by the General Electric Company, Limited, is very seasonable, being

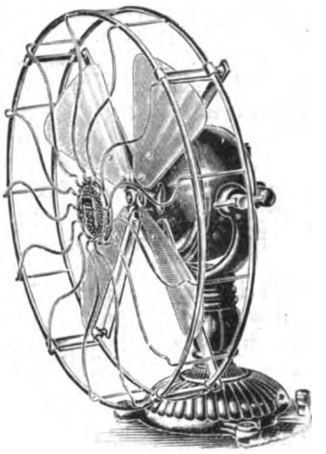

FIG. 1.

so suggestive of that refreshing breeze for which one has been longing lately. We illustrate herewith several of the patterns included. The new one (Fig. 1) is claimed to represent the most advanced ideas in the development of fan motors, com-

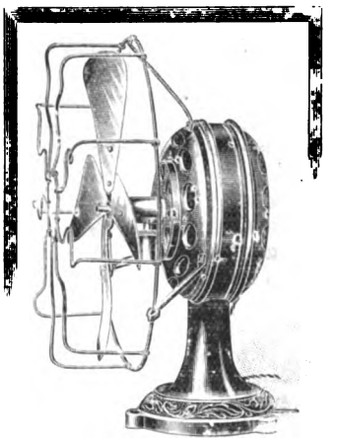

FIG. 2.

bining in one unit the three styles known as desk, trunnion, and bracket fans. It can be adjusted to propel the air in any direction without the use of special tools. The regulator with which it is provided gives three speeds. No doubt there will

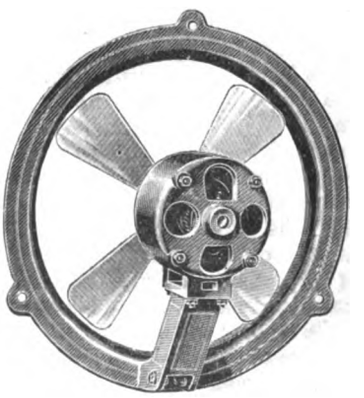

FIG. 3

be a large demand for this particular type. Fig. 2 is an example of some patterns arranged for alternating current. These are fitted with switches, but not speed regulators, their speed varying from 1,150 revolutions per minute at 40 cycles up to 1,400 revolutions per minute at 60 cycles. Something

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new in the way of small ventilating or porthole fans is also listed. Fig. 3 illustrates such a fan fitted with an alternate-current motor, and specially designed for ventilating small rooms and offices. For further particulars of the above-mentioned and other useful types of "Freezor" fans we must refer the reader to the list under notice.

## Relays for Automatic Switches.

We have received a well illustrated descriptive pamphlet of relays for automatic switches in alternate-current installation from Messrs. Richardsons, Westgarth, and Co., Limited, Hartlepool, agents for Messrs. Brown, Boveri, and Co., Limited, of Baden. The action of the automatic overload relay (Fig. 1) herewith is based on Ferraris's well-known principle. A light aluminium disc is arranged to revolve between the poles of a laminated electromagnet. The electromagnet is energised by alternating current taken from the secondary side of a transformer, the secondary current being proportional to the main current of the machine. The necessary rotatory field to produce the torque on the disc is obtained in a very simple manner by adding a short-circuited copper ring to cover half the cross-section of the magnet. In this way one obtains two alternating fields differing in phase, these two fields giving a resultant rotating field, which sets up Foucault currents in and induces a torque on the aluminium disc. The spindle of the disc is horizontally pivoted, and carries a small drum on which a silk cord with a weight suspended at the end is wound up. At normal load and up to a predetermined current strength, the weight prevents the disc from turning. If the working current now exceeds the prearranged figure, the torque on the disc increases and the cord with the weight suspended at its end is wound up on the drum. When the weight rises a certain height, it closes a circuit by bringing

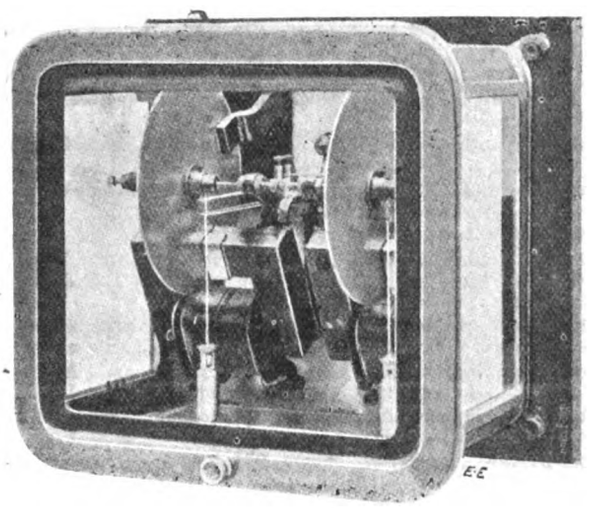

FIG. 1.—Two-Pole Overload Time-Limit Relay.

together two very light contact springs arranged in an horizontal position. A strong permanent magnet, between whose poles the aluminium disc rotates, serves to damp the action of the disc and prolongs the time taken in lifting the weight. The contact springs are connected to the circuit of the tripping solenoid arranged on the switch. When the contacts are brought together the solenoid attracts its armature, and the main switch, due to its own weight and to the action of the springs, operates. The tripping current is about two amperes, and is generally taken from the exciters, or from a small accumulator battery. Platinum, silver, or carbon is employed for the contact points.

By regulating the lengths of the cord on which the weight is suspended the time limit can be varied, and by adjusting the weight itself the current at which the time-limit device should commence to operate can be varied. The time which elapses from the moment the disc commences to rotate until the circuit for the solenoid is made depends also on the extent of the overload, so that the time is long when the overload is small and short when the overload is large. For various normal working currents the ratio of transformation of the current transformer is altered so that the secondary current is always one ampere when the pointer of the ampere-meter gives its maximum deflection, this latter being usually selected so that it is about 30 per cent. above the normal working current. Every relay is built for this current strength—*i.e.*, one ampere—and the same relay can be employed for any circuit, provided that the corresponding current transformers are made use of, no matter what the current strength in the circuit may be. The normal type of relay is single-pole, but same can be connected up to form two or three pole relays, if required. In single-phase installations a two-pole relay is generally employed; a single-pole relay is, however, sufficient. In two-phase installations two-pole and in three-phase installations two or three pole relays are used. In three-phase plants with a neutral a three-pole relay must be adopted. The tripping contacts in the multipole arrangements are connected up in parallel.

In the dispositions described above it is necessary to have continuous current for the tripping coil of the switch. Continuous current is always available in a central station, but, on the other hand, it can happen that this current is not at one's disposal, as, for instance, in a transformer sub-station, and to obtain which one prefers not to employ an accumulator battery. For such cases Brown, Boveri, and Co. have put on the market a tripping device to be operated with alternating current. This device has, we understand, met with great success. It is evident that it is not possible to actuate the tripping coil by employing a tension transformer only fed from the network, for at the very instant that the relay should operate, for instance, on a dead short-circuit, the drop in the voltage is very great or the tension disappears altogether. The tripping device must, therefore, on this account be actuated by a current transformer. In a three-phase system it can happen that the overload, or short-circuit, occurs on one phase only, and it is for this reason necessary to feed the tripping device from at least two phases of the system. As current transformers are always available for the standard type of overload time-limit relays, the former can at the same time be employed for the tripping device of winding a second coil on the core of the current transformer. This winding generally remains open, but is switched on to the tripping coil mounted on the main switch by means of the time relay as soon as the latter starts to operate, so that the mechanism of the tripping device opens the switch. In order to keep the phases separate from one another, two or three

FIG. 2.—Automatic Switch with Mechanical Relay.

separate tripping coils, mounted on the core of the tripping device, are employed in connection with a two or three pole relay respectively.

In certain cases—that is to say, when the relay is not required to operate with great accuracy, and more so when a very simple arrangement is required for tripping the switch without having to employ a separate tripping circuit—Brown, Boveri, and Co. have made use of a most successful mechanical relay, which is based on the same principle as the one just described, but is so constructed that it trips the switch directly. This relay also consists of an aluminium disc which rotates between the poles of a laminated iron core carrying a current coil, and is also with a short-circuited ring. A weight attached to the end of a lever which can be rotated is employed instead of the cord with the weight suspended at the end, and this weight is raised by the spindle of the aluminium disc operating through mechanical reduction gearing. On the weight being lifted to a certain height, it is released and falls back to its original position, striking the pawl arranged on the tripping mechanism of the switch, and enabling the switch to open. This relay is also a time relay, but the time element cannot be varied as in the case of the one previously described, in which the time element is varied by adjusting the length of the cord carrying the weight. Moreover, this relay is not so sensitive since the reduction gearing consisting of two small spur wheels has a certain amount of friction. Fig. 2 shows such a relay mounted direct on a two-pole 8,000-volt switch. The current coil is fed with low-tension current from a current transformer, which, at the same time, serves for the ammeter. This arrangement is employed in carbide works when the transformers are

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subject to very heavy overloads, and the relay switches out in 30 seconds with an overload of 50 per cent., or in five seconds when the overload is 2½ times that of the normal load.

Another use to which the overload relay, when constructed as a "no-voltage" and overload relay, can be advantageously put is in connection with large alternate-current motors. Owing to a very ingenious combination, the employment of a special tripping circuit has been avoided. On the switch there are arranged as the case may be—viz., single, two, or three phase motors—one, two, or three magnet cores respectively, which are held up by means of tension coils, these latter being energised directly from the leads to the motor. As soon as the tension on these leads, owing to some reason or other, disappears, the magnet cores fall, and in dropping release a pawl and trip the switch. Now, in order to also make use of this "no-voltage" switch as an overload switch, one, two, or three pole overload time-limit relays are connected up in the motor circuit, and these relays are so arranged that, on the relay operating, a circuit is opened and not closed, as in the case of the standard apparatus—that is to say, the circuit of the "no-voltage" coil is opened so that this latter again releases the pawl of the tripping mechanism on its particular switch. If the corresponding driving gear of the switch is now combined with that of the starter of its corresponding motors, so that the switch after it has been switched out can no longer be switched in till the lever of the starter has been brought back to its original position, one obtains a switching arrangement such that the motor is fully protected against an overload which would be too large, or against a wrong manipulation, or also to allow it to remain switched in when the tension disappears.

Further particulars of these interesting devices will be found in the pamphlet under notice; also a description of a reverse-current relay. Several useful diagrams are included.

## FORTHCOMING EVENTS.

FRIDAY, JUNE 2.

**Optical Convention.**—Continued at the Northampton Institute till to-morrow.

SATURDAY, JUNE 3.

**Association of Municipal and County Engineers.**—Meeting at Gloucester.

MONDAY, JUNE 5.

**Society of Engineers.**—"Improvement of London Traffic."

THURSDAY, JUNE 8.

**Royal Institution.**—At 5 p.m., "Electromagnetic Waves," by Prof. J. A. Fleming (Tyndall Lecture III).

**Physical Society.**—June 16, "The Ratio between the Mean Spherical and Mean Horizontal Candle-power of Incandescent Lamps," by Dr. J. A. Fleming; "The Electrical Conductivity of Flames," by Dr. H. A. Wilson; "Contact with Dielectrics," by Mr. R. Appleyard; "The Pendulum Accelerometer, an Instrument for the Direct Measurement and Recording of Acceleration," by Mr. F. Lanchester; "A New Form of Pyrometer," by Mr. N. V. Stanford; and an exhibition of a refractometer by Mr. R. Appleyard.

**Electrical Contractors' Association.**—Dinner at the Holborn Restaurant, June 27.

**Incorporated Municipal Electrical Association.**—June 27-30, annual convention.

## PHYSICAL SOCIETY.

At the meeting of this society on May 12, Dr. C. Chree, F.R.S., vice-president, in the chair, Dr. A. D. DENNING described a simple method of determining the radiation constant, suitable for a laboratory experiment. The apparatus consists of a hemispherical copper cap to the outside of which is affixed a jacket through which steam or water can be passed. The receiving surface consists of a silver plate, and the rate of rise of temperature of the plate is measured by means of a silver-constantan thermo-junction. When performing the experiment, a non-conducting pad is placed between the hemisphere and the silver disc till the temperature of the jacket is uniform. Then the pad is slid out, and the deflections of the galvanometer in the thermo-junction circuit are noted every few seconds. By plotting these deflections on a curve, the initial slop of the curve—*i.e.*, the initial rate of temperature of the silver disc—is obtained; and from this, knowing the constants of the disc, etc., the radiation constant can be calculated. The author gives some numbers which indicate that a very fair degree of accuracy can be obtained.

Prof. CALLENDAR asked what steps had been taken to protect the area of the edges of the silver disc, which appeared to be about half the area of the upper surface, from the oblique radiation of the hemisphere. The upper surface alone was taken as the effective area in the calculation. He had found this difficulty in applying the Crova disc method to the measurement of radiation in a previous case, although the radiation was nearly parallel and normal to the disc, instead of being distributed over a hemisphere. He thought that greater sensitiveness would be obtained by using a single short constantan wire for the couple. It was necessary that this wire should be exceedingly fine to prevent error in the temperature measurement owing to cooling of the end near the junction by conduction. A copper disc appeared preferable to a silver disc as reducing the number of junctions of different metals. The constantan wires used by the author did not appear to be fine enough to eliminate this source of error, which, however, would tend to compensate the error introduced by the neglect of the area of the exposed edges of the disc.

Mr. CAMPBELL asked whether the convection currents do not introduce considerable error. The effect of the rim of the disc could be made of relatively less importance by increasing the diameter of the disc.

The AUTHOR, in reply, said that from the form of the radiator the amount of radiation received by the edges of the disc was only a very small fraction of that received by the horizontal surface, whilst the method of placing the radiator over the disc would probably not cause any great changes in the condition of the air directly under the radiator.

Another paper by Prof. H. L. Callendar on "A Bolometer for the Absolute Measurement of Radiation" is unavoidably held over.

## APPOINTMENTS VACANT.

**General Manager,** Johannesburg, £2,000; Station Engineer, £1,000, with house. Applications to Mordey and Dawbarn, 82, Victoria-street, Westminster.

**Chief Assistant Electrical Engineer,** Battersea Borough Council. Commencing salary, £200 per annum. Applications by noon on June 6.

**Assistant Borough Electrical Engineer,** Poplar. Salary, £200 per annum, rising by annual increments of £10 to a maximum of £300 per annum. Applications by June 14. See advertisement in last issue.

**Articled Improver,** Maidenhead Electricity Works. Applications before June 9. See advertisement in last issue.

**Junior Engineer,** Dundee Electricity Department. Applications to H. Richardson, A.M.I.E.E., general manager and engineer. See advertisement in last issue.

**Jointer,** experience with electric light cables, East Sussex County Asylum, Hellingly. See advertisement in last issue.

**Director,** with £5-10,000, large electrical supply company on the Riviera. See advertisement in last issue.

**Partnerships (two).** See advertisements in last issue.

**Assistant Engineer,** Newcastle City Asylum, Gosforth. Wages, 36s. weekly and house on the estate. Applications by June 3. See advertisement in last issue.

**Switchboard Attendants (three),** North of England. Wages to commence 35s. per week of 56 hours. See advertisement in last issue.

**Draughtsman,** Trowbridge. Salary, £100 per annum. Applications to Mr. R. W. Merriman, County Offices, Trowbridge, by June 10.

**Electrical Engineer's Assistant,** Bray, Ireland. Salary, £60 per year. Applications by June 5.

**Fitter-Driver,** Clesthorpes. Wages, £2 per week. See advertisement.

## A NEW AUTOMATIC POINT SHIFTER.*

BY J. P. TIERNEY, STUDENT.

The point shifter which I am about to describe is that which is used on the Dublin United Tramways system. It is the outcome of experiment in connection with a previous point shifter which was discarded in favour of the present one on a point of cheapness in first cost, maintenance, and more efficiency in working. The first arrangement just mentioned necessitated a magnet being placed on each car, which, when energised, operated a switch box in the street, the lid of which being non-magnetic had no influence on the magnet of the car, but beneath the lid was hinged a soft-iron plate which was lifted upwards against the lid of the box by the magnet on the car, the lifting of the iron plate closing the circuit from the overhead line to the electromagnet which operated the point tongue.

This apparatus was installed at the London Bridge-road junction of the Sandymount line on May 23, 1903, and worked satisfactorily until Aug. 29 of the same year, when the present point shifter was installed in its place; the present point shifter, as will be seen, only requiring a contact on the trolley globe of the car as against an electromagnet in the former arrangement. It may be of interest here to note that the electromagnet on the car gave a pull of 2lb. at an air-gap of 2in., the pole-pieces being elongated and fitted with shoes so that the period of time during which the magnet exerted its influence on the switch box was extended as much as possible.

The point shifter at present in use can be applied to any existing system of points in either of two different methods. The first method consists in having each point always set for one particular line; the cars on this particular line will thus not have to move the point, but the cars going on the other line

* Paper read before the Dublin Section of the Institution of Electrical Engineers, May 11, 1905.

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will always move the point for themselves and set it back again after they have gone through. The second method is one in which the points will not be fixed for any particular line, but each car approaching it will move the point for itself irrespective of whatever route it desires to go should the point be set against it. In this case the cars need not throw back the point to its original position. It is equally applicable to all systems of electric traction. whether operated on the trolley, conduit, surface-contact, or accumulator systems.

I will now describe the first method of operation, which I will do under four different headings—first, the point or street equipment; secondly, the car equipment; thirdly, the overhead line equipment; and fourthly, the general method of operation. The street equipment of a point with the apparatus is identical for either methods of operation. It consists of two cast-iron boxes mounted one on either side of the point, each containing a special design of stopped solenoid. The plungers of these

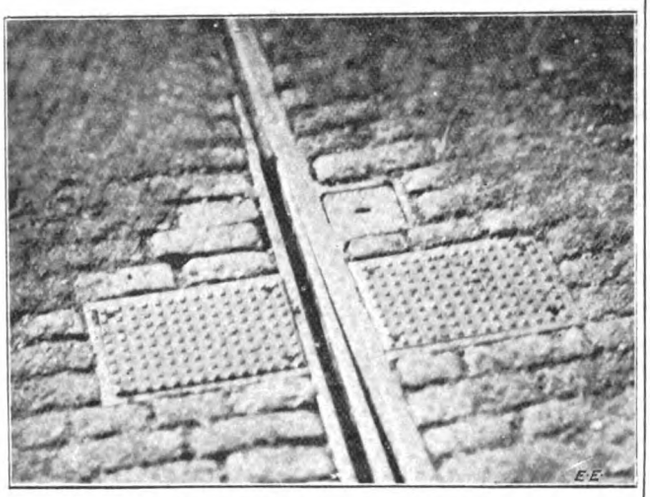

FIG. 1.—Automatic Point Shifter at Dublin.

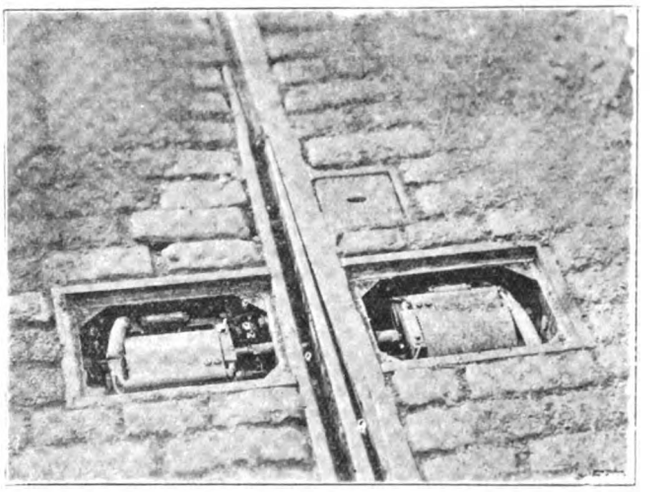

FIG. 2.—Automatic Electric Point Shifter.

solenoids operate on a special forging which, when pushed one way or another, operates the point as desired. These cast-iron boxes measure 14in. by 12in., and are 9in. deep, and constitute the only alteration in the permanent way. The solenoids used are of the stopped type, but instead of the plungers pulling their work after them when sucked into the coil, as is the general practice, the stop of the solenoid is bored out and a brass rod screwed into the plunger passes through the top. By this means the solenoid plungers are used to push instead of to pull their work. This arrangement has the advantage that the plunger rod pushing against the rod which passes through the point acts as one buffer of a railway car to another, and need not necessarily be in line with one another, which would be required if both were screwed or otherwise securely fastened together.

The mechanical details of the point equipment consist of a rod which passes through the casting of the point beneath the floor of the switch; on both ends of this rod are securely fastened two castings, each of which carry a pin $\frac{5}{8}$in. diameter. One of these pins passes through the running head of the point casting and one through the check rail. The point tongue lies between those two pins, but it is not bored or altered in any way. The tongue of the point lying between these two pins cause the movement of the pins to control the movement of the point. The advantage of this arrangement lies in the fact that the tongue of a point can be replaced at any time without disconnecting or interfering in any way with the gear of the point shifter. From this it will be seen that the solenoid plungers moving the rod which passes beneath the floor of the point also move the point tongue. By this arrangement, to remove a solenoid it is only necessary to disconnect the wire coming from the line contacts and lift the solenoid out, the solenoids only sitting at the bottom of the street box, and not being mechanically secured to same, the other end of the solenoid coil being permanently grounded on the magnet case. The solenoid coils are enclosed in a hermetically-sealed zinc case, this in turn is placed in a cast-iron cup-shaped covering, the stop of the solenoid and this cup-shaped covering being in the one piece. This cast-iron covering completely encloses all parts of the solenoid, the plunger rod working through a gland in the cover. This ensures the solenoid being absolutely waterproof, which is a necessity, as they must frequently work under water during periods of very heavy rain. The solenoid coils are wound to operate on the 500-volt line pressure direct without any resistance.

The car equipment consists of a contact piece mounted on the trolley globe of the car (Fig. 4). This contact piece is insulated from the globe, and is connected by a wire brought down the trolley pole of the car to a switch on the driver's platform; the driver, by operating this switch, can make this contact piece electrically alive. The driver's switch can only be operated by a special handle, which can only be removed when the switch is brought to the "off" position. This prevents the switch on the rear end of a car being interfered with by passengers, and also ensures that the switch on the rear end is left in the off position, each driver only being supplied with one handle.

The overhead line equipment consists of an ordinary ear with two hubs (Fig. 5) soldered in the usual manner on to the trolley wire. Each of these hubs carry a special insulator, which in turn carry between them a contact strip. This strip is so suspended and placed that when the trolley head of the car is passing under the ear, the contact piece on the trolley head will rub against and make contact with this contact strip on the line. This contact strip is connected to one of the solenoids in the street boxes through a suitable switch and fuse placed in a box on the nearest street pole. The car carrying this contact strip is placed about 48ft. distant from the point, so that the front of the car is 20ft. from the point when same is operated. This gives the driver full opportunity of seeing that the point has been properly operated before he goes through. A second contact strip is placed on the trolley wire in an exactly similar manner to the first which I have just described. This is placed directly over the point, so that when the wheels of the car have cleared the point a few feet the trolley of the car will pass through this second contact. This contact is electrically connected to the second solenoid of the point in a similar way as the first contact strip was connected to the first solenoid. When the driver of a car approaches a point which it is necessary to move, he closes the switch on his platform, thereby making the contact piece on the trolley head of his car electrically alive. When the trolley of the car passes under the first contact strip on the overhead line, the contact piece on the trolley head rubbing against the contact strip on the line makes same electrically alive, thereby sending a current to one of the solenoids at the point, which solenoid on becoming energised will shift the point to the desired position. When the trolley of the car has passed from under the first contact strip, the current is cut off this solenoid. The car having passed through the point the

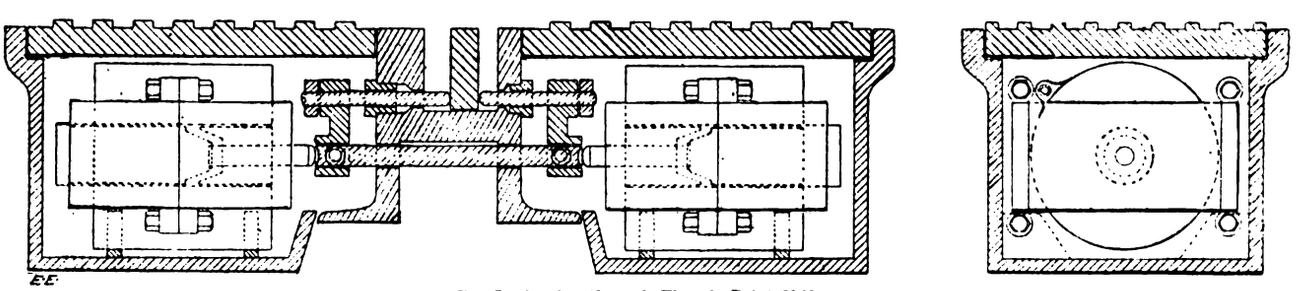

FIG. 3.—Section through Electric Point Shifter.

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trolley passes under the second contact, which is now made electrically alive, thereby sending the current to the second solenoid, which throws back the point to its original position. If the driver of the car does not want to move the point, he leaves the switch in the off position.

On the Dublin United Tramways the car equipment has been reduced to the placing of a non-insulated contact piece on the trolley globe of the car. By fitting the cars of certain routes

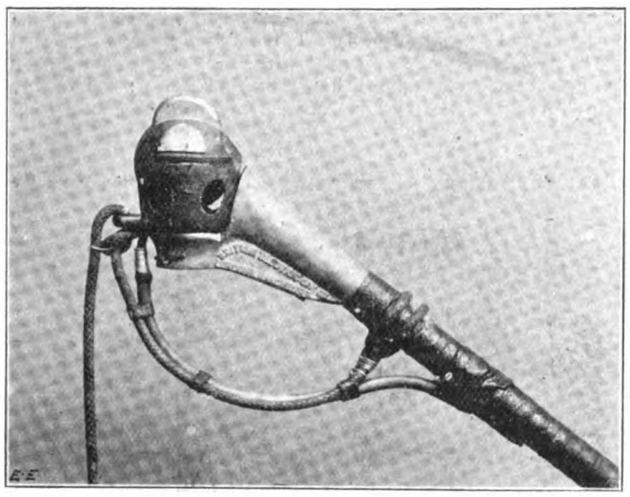

FIG. 4.—Trolley Head with Special Contact Piece.

in this manner the satisfactory operation of the points has been accomplished. To briefly explain how this has been done, I will take a specific example with which you are all doubtlessly acquainted. The points at the bottom or Nassau-street end of Dawson-street and the top or Stephen's-green end of Dawson-street are electrically operated. The contact strips for operating the point at the Nassau-street end are placed on the right-hand side of the line in the direction of travel. The Terenure,

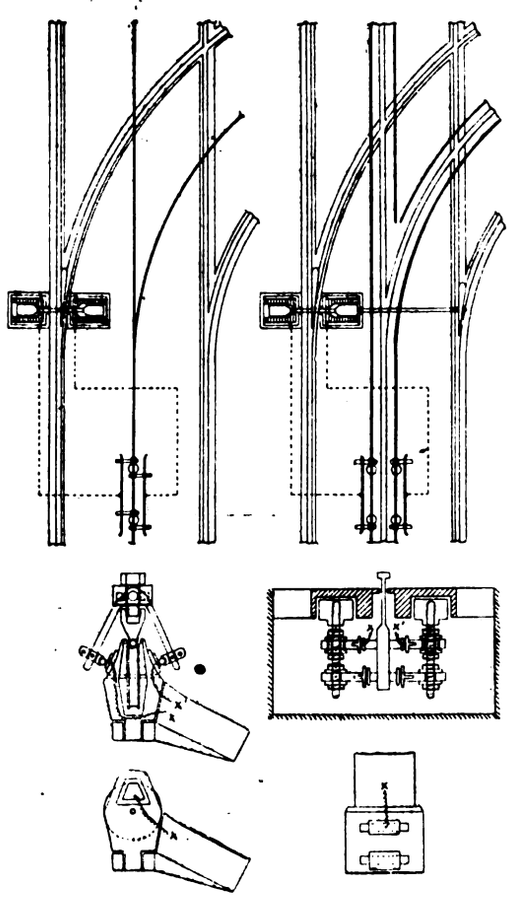

FIG. 5.—Details of Point-Shifting Contacts as applied to both Trolley and Conduit Systems of Traction.

Dartry, and Clonskea cars are fitted with contacts on the right-hand side of the trolley globe, so that they open this point for themselves and close it after they have gone through, leaving the point set right for the Dalkey and Donnybrook cars. The contact strip for operating the point at the top of Dawson-street is placed on the left-hand side of the line, the Clonskea cars being fitted with contacts on the left as well as on the right-hand side of the trolley globe, so that they open this point for themselves and close it after they have gone through, leaving the point set right for the Terenure and Dartry cars. Although at first sight the use of this arrangement of car equipment may appear limited, but having gone into the working of the routes of the Dublin tramways, which is one of the largest networks in the United Kingdom, I find that the arrangement can be practically used throughout the system.

In the second method of operation, in which this point shifter can be fitted to a point, the street equipment is identically similar to the first method which I have just described, so I will pass to the overhead line and car equipment, where the difference exists. The overhead line equipment consists of a double-hubbed ear carrying the two insulated hangers, which, as before, is mounted on the overhead line about 48ft. from the point. In this case the two insulated hangers carry two contact strips one on either side of the line, each of which are insulated from the line and from one another, and each one is connected to one of the solenoids as in the first method. In this case there are no contacts over or after the point, as each car having perfect control for either route, it is not necessary for the cars to throw back the point after they have gone through. The car equipment in this method consists in having an insulated contact piece on each side of the trolley globe; each of these contact pieces is connected to a two-way switch on the driver's platform whereby he can make either of these contact pieces electrically alive, but he is unable to make the two contact

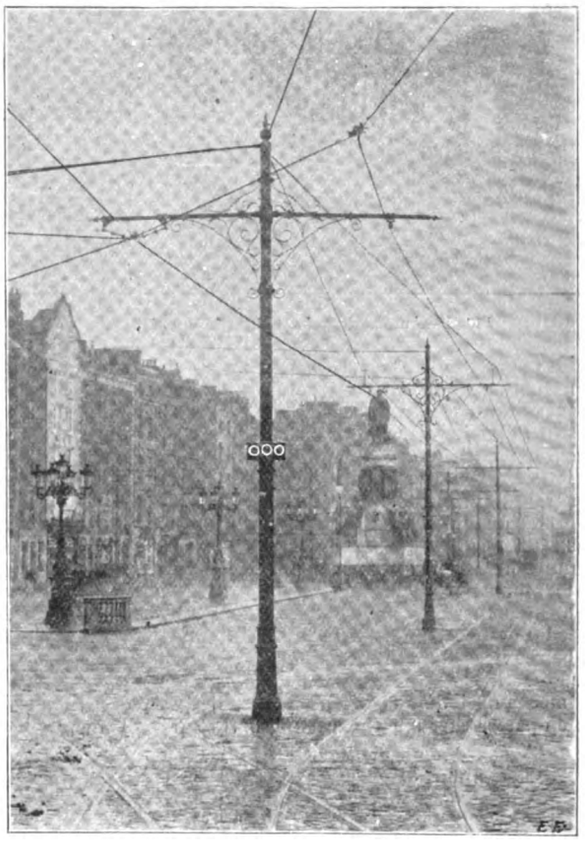

FIG. 6.—Signal Lamps to show position of Points.

pieces alive together; otherwise the details of the switch are identical with that described in the first method of operation. When the driver of the car approaches a point which it is necessary to move, he turns his switch handle on platform to the right or left, according as he desires to go on the right or left track. If he puts it to the right, he makes electrically alive the insulated contact piece on the right-hand side of the trolley globe of the car. When the trolley of the car passes under the contact strips on the overhead line, it makes electrically alive the contact strip on the right-hand side of the line, which is connected to the solenoid in one of the street boxes at the point which, when energised, moves the point for the right-hand road. If the driver desires to go to the left, he puts his switch on the platform to the left, and the operation is the same as in the former case, except the other solenoid now gets the current, thereby moving point for the left-hand road. It will, therefore, be seen that the putting of the driver's switch to the right or to the left controls which solenoid in the street boxes at the point becomes energised, and, therefore, controls for which line the point will be moved.

At night-time motormen of cars experience difficulty in seeing if their points are properly set. To obviate this difficulty, signal lights are placed on some pole convenient to the point, these lights indicating the exact position of the tongue of the point, whether being set for the right or left hand point, or if it is jammed in a midway or neutral position. The signal arrange-

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ment consists of three lights placed horizontally in a row (Fig. 6), the centre one being green and the two outside ones red. If the point is set for the right-hand route, the left-hand red light and the green light are lighting. This shows a green light or "all clear" signal for the right-hand route, and a red light or "danger" signal for the left-hand route, indicating that the point is set in the proper position for the right-hand route. If the point is set for the left-hand route, the right-hand red light and the green light are lighting, which shows a green light or "all clear" signal for the left-hand route and a red light or "danger" signal for the right-hand route, showing the point to be set for the left-hand route. These lights are controlled by a switch in one of the boxes containing the solenoids at the point, and is operated by the tongue of the point itself, consequently they are *entirely* and solely controlled by the point. This switch is so set that should the tongue of the point accidentally get jammed midway in a neutral position, all lights will go out, which will indicate the state of affairs to the motorman.

# LEGAL INTELLIGENCE.

## BIRMINGHAM CORPORATION V. BIRMINGHAM CANAL COMPANY.

Mr. Justice Farwell last week delivered his reserved judgment in this case, of which we have already given a report.

His Lordship said that the question turned on the true construction of Section 82 of William IV. of 1834. The plaintiffs contended that their generating station was a manufactory within the meaning of the section. The defendants contended that the only manufactories entitled to the benefit of the Act were manufactories belonging to persons who at the date of the Act possessed steam-engines used for the purposes of such manufactories, or, in other words, that additional steam-engines were allowed to manufactories then using steam-engines and nothing more, and that if even this was not so a generating station was not a manufactory within the meaning of this particular Act. *Prima facie* the words "the above manufactures" must mean the manufactures mentioned above, and that only the manufactories so mentioned were those having steam-engines in existence at the date of the Act. It was said that the reference to the future acquisition of land and the future extension of the canals excluded this view, but it had to be observed that it was the future erection of the manufactories which was mentiond as contemplated, and it was quite possible that engines might be erected after the Act on land thereafter acquired within 200 yards of canals thereafter cut and yet be for the use of manufactories existing at the date of the Act. Further, the Act distinguished in the face of it between manufactories and cornmills, and collieries, ironworks, and other works. The manufactories were qualified by the use of the word "above." Cornmills had no such qualification, and collieries, ironworks, and other works had no claim to draw water for any new fire-engines at all. The section undoubtedly contemplated the existing state of things, and that only in reference to collieries, ironworks, and other works, and there was therefore no apparent reason why the existing state of things should not be equally intended with respect to manufactures. The inference he drew was that steam-engines had been erected and were in use for some manufactories and cornmills under an Act of George III., and also for some ironworks, and without any statutory authority, and that the *status quo* was preserved as to all these with additional rights in the case of existing manufactories to erect and use further and other engines for such manufactories on the existing canals and also on canals thereafter to be made, while all cornmills within the limits had the right whether erected before or after the Act. He saw nothing unreasonable in this construction, but even if he did this apparent unreasonableness would not justify him in striking out the "above" or altering the plain words of the section. Even if he could read "above manufactories" as equivalent to "any manufactories similar to those mentioned above" he did not think that a generating station could fairly be deemed to be included therein. The result was that the plaintiffs' claim failed.

Judgment for defendants, with costs.

## BOGOTA TELEPHONE COMPANY.

Mr. Justice Swinfen Eady, in the Chancery Division on Saturday, had before him a petition presented by the Bogota Telephone Company, Limited, for the sanction of the Court to an alteration of its memorandum, by giving the company power to issue debentures.

His Lordship remarked that the memorandum was in peculiar form, and the company was, perhaps, justified in desiring to make the alteration. He would, therefore, sanction the addition to the memorandum, as asked.

## AN ELECTRICAL ENGINEER'S CLAIM.

In the King's Bench Division last week Mr. Justice Wills had before him the case of Pressland *v.* Edmundson's Electricity Corporation, Limited, in which the plaintiff, an electrical engineer, claimed commission or remuneration for professional services in connection with the establishment of electric supply stations in the neighbourhood of Wigan. Defendants denied liability, or, alternatively, if they were held liable, brought a sum of money into court as sufficient to meet the claim.

In October, 1903, defendants, to whom the scheme had been introduced by the plaintiff, entered into a contract for carrying out the works for £300,000, and on an agreement, dated Aug. 6, 1897, plaintiff claimed 5 per cent. commission, £15,000, or, alternatively, reasonable remuneration for his services. For the defence it was denied that plaintiff introduced or promoted the scheme or that they requested him to do any work; or, if plaintiff did any work, it was under another agreement, by which defendants, in partnership with two other companies, were to pay plaintiff out-of-pocket expenses, and when the Bill to carry out the scheme became an Act he was to receive such further remuneration as the partnership might consider reasonable.

Plaintiff, in his evidence, described the work he did in connection with the promotion of local Bills for electric power, and said he was continually travelling about seeing public authorities, and making arrangement for provisional orders. There were no less than 122 local authorities, and 18 000 factories and a number of quarries in the area were supplied with electric power. In cross-examination, plaintiff said in the course of five years he had received £20,000 from defendants, but had spent a third of that sum in travelling and hotel expenses.

Mr. C. A. Russell, K.C., said the defendants went into the matter apart altogether from Mr. Pressland, who had never done any work on the scheme. The partnership syndicate had spent £19,200 on the promotion of the Bill, and up to the present they had not received any sort of profit at all. All plaintiff had done was to canvass local authorities.

His Lordship, in giving judgment, said he had come to the conclusion that the work done by the plaintiff did not come within the agreement of 1897, but he thought, having regard to all circumstances, that a jury would have awarded him £1,200.

Mr. Wallace informed his Lordship that £1,100 had been paid into court.

Judgment was entered for plaintiff for £1,200, with costs.

## WORKMEN'S COMPENSATION ACT.

### Stevens v. Leicester Corporation.

At the Leicester County Court last week Judge Wightman Wood heard an action brought by David Stevens against the Corporation under the Workmen's Compensation Act. The plaintiff was employed by the Corporation in the construction of the electric tramways in Leicester. On Aug. 28, 1903, he met with an accident. It appeared that he was engaged in the operation of shooting cement, and that a gust of wind blew some of the cement into his eyes. He suffered great pain at the time, and there was no doubt that he sustained serious injury. Stevens struggled on with his work for a few hours that day and the next morning tried to continue, but he suffered such acute pain that he was sent by his foreman to the infirmary. He was there examined and the doctors came to the conclusion that he had been so seriously injured that he could not work. They gave him a certificate to that effect. He took the certificate and his infirmary book, which contained a written notice of the accident, to the head foreman. Stevens was put on half-pay for 17 weeks, after which the Corporation gave him light employment, paying his original rate of wages. The Corporation sent him to an eye specialist at Nottingham, and in consequence he had to discontinue his light work, the Corporation discontinuing the former half-pay allowance on the ground that it was voluntary.

Confirmatory evidence having been given on behalf of the plaintiff, the Town Clerk, on behalf of the defendants, said there had been an arrangement in force in all the departments of the Corporation for many years that if a man met with an accident and was incapacitated from work he was put on half-pay. This pay went on during a workman's incapacity, but the case was revised from time to time for obvious reasons.

The Judge said this was a very clear case. The plaintiff was engaged in employment definitely protected by the Workmen's Compensation Act. By force of that Act plaintiff became entitled to compensation—of half the wages he was earning. If the position taken up by the Corporation was a correct one, it would set up a local law which would be over-riding the general law brought into force for the protection of workmen, under which workmen were not allowed to contract themselves out.

Judgment for plaintiff.

## PRODUCTION OF TRAMWAY TICKETS.

At Bradford Police-court, John Wilkinson was summoned for failing to show his ticket on an electric car when requested to do so.

It was stated that when the inspector went round to examine the tickets the defendant said that his was on the floor. He did not show it, and refused to pay the fare.

The Stipendiary drew attention to a Sheffield appeal in a similar case. A passenger pointed to his ticket on the floor, but refused to pick it up to show it. The case was taken to the High Court, and the decision was against the Corporation, as the Court held that the man was not bound to handle the ticket.

The case was adjourned for a week in order that the prosecution might consider the point raised.

# COMPANIES' MEETINGS AND REPORTS

## REUTER'S TELEGRAM.

The annual meeting of this Company was held on Wednesday, Admiral Sir J. C. Dalrymple Hay presiding.

The Chairman stated that great expense had been incurred in reporting the Far East campaign. Latterly, at any rate, this heavy

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expenditure had not been covered by the receipts; indeed, during one month, at least, a not inconsiderable loss was incurred. This was due to the fact that little or no news was being received while expenses were going on all the time. The other branches of the Company's activity, which the Board had carefully fostered, made up for the deficiency, and indifferent results in one department were counterbalanced by profitable business in another. The Board's chief preoccupation during the past 12 months had been the service from Russia, where the collection of news had become a reality owing to the abolition of the censorship, which had existed from time immemorial. In order to be able to do full justice to the new state of things the directors lost no time in strengthening the staff in that country, and the Company were now in a position to furnish their supporters with detailed and accurate accounts of the important events transpiring in the Russian Empire. They were taking advantage of the establishment of direct telegraph communication with Abyssinia to extend their organisation to that country. The Company's operations in South Africa have been placed on a satisfactory footing.

## WEST INDIA AND PANAMA TELEGRAPH.

The fifty-sixth ordinary general meeting of the shareholders of this Company was held last week at Winchester House. Particulars of the report appeared in our last week's issue.

Mr. W. B. KINGSFORD, who presided, stated that the traffic receipts for the current half-year showed considerable increase at the time when the report was issued. Since then a return had been received stating that the estimated receipts showed a marked improvement. The traffic receipts at the British West India station had remained stationary, and this was disappointing, because they had reason to anticipate that there would certainly be some increase, owing to the failure of the Continental beetroot crop and the higher prices obtained for West Indian sugar, and also to the reported improvement generally in the commercial prospects of the colony. During the early part of last year they were in communication with the Government with reference to an extended cable system in the West Indies, and certain proposals were made by them which involved, if carried out, the grant of an Imperial subsidy. They had all read of the new national defence scheme for the Empire, and of the announcement that the Government had decided to withdraw white troops from the West Indies, and also to reduce the naval forces in those waters, and to discontinue the maintenance of St. Lucia as a coaling station. The Colonial Office had recently informed them that the proposals made by the Company could not be entertained.

In reply to a question, the CHAIRMAN stated that the directors were carefully watching wireless telegraphic developments in the West Indies.

The report was unanimously adopted.

## WORCESTER ELECTRIC TRACTION.

The second ordinary general meeting of this Company was held at Donington House, Mr. H. S. Day (chairman of the Company), presiding.

The CHAIRMAN, reviewing the position generally, remarked that the major portion of the line was opened on Feb. 6; the London-road was opened in April, and the six furlongs in the Bath-road in June. The amount of revenue from the cars was £11,640, and the amount of expenditure £6,308, giving a profit of £5 332. With the 'buses the revenue was £3,970, the expenditure £4,134, and the net revenue loss £164. The Board of Trade have extended the time for the completion of the whole of the remaining lines until Dec. 17, 1906. There was some likelihood of the proposed St. John's route extension being revived in the future. The Bath-road section had not yet realised expectations.

The report was unanimously adopted, as were the following resolution: "That the following resolution, which was passed at an extraordinary general meeting held on Dec. 17, 1902, be rescinded: 'That the capital of the Company be divided into 12,000 shares of £5 each to be called ordinary shares, and 12,000 shares of £5 each to be called preference shares, and to confer on the holders thereof the right to a fixed cumulative preferential dividend at the rate of 6 per cent. per annum on the capital for the time being paid up on such shares, and such preference shares to rank as regards dividend in priority to the other shares, and not to confer any further right to participate in profits or surplus assets.'"

## CALLENDER'S CABLE AND CONSTRUCTION.

The ninth general meeting of this Company was held last week at Hamilton House, Victoria-embankment. Particulars of the report appeared in our issue of the 26th ult.

Mr. HENRY DRAKE, who presided, stated that during the year the Company had had a considerable amount of trouble to do business. In no year since the inauguration of the undertaking had it been more difficult to obtain orders or to get them at satisfactory prices. The work was largely with municipalities, and the financial stringency, together with the new views which were taken about municipal trading, had had a considerable influence on the amount of work carried out by the local authorities. It had therefore been difficult for them to borrow money as freely as they had been in the habit of doing, and even the most necessary extensions in many cases had to stand over until better times. With the advent of improved financial conditions, orders which had been under consideration for many months were being given out. The business of the Company had never been in a healthier condition than it was at present. The Board had no uneasiness as to the future. They objected to the prices which the Company were getting for their work, but they recognised the existing condition of affairs, which they believed would shortly pass away. They had been especially busy in the East, which they had made their own field, and in which they hoped to maintain their ascendancy. They had made several endeavours to open up trade with Continental countries, but tariff difficulties stood in the way, preventing them from submitting tenders which could be of the slightest use. The Company were getting considerable trade in the important business of power distribution. The fact that they had been in the business from the beginning and had pioneered the work had given them a very strong position in the field, and one which they would do their utmost to retain. Their policy in acquiring the undertaking of the Anchor Company had been amply justified.

The report was adopted.

## NEW COMPANIES REGISTERED.

**"Otto" Electrical Manufacturing Company (1905), Limited.**—Capital, £75,000. Object: to acquire the business of the "Otto" Electrical Manufacturing Company, Limited, to adopt an agreement with A. C. M. Jenkins and Co., and to carry on the business of electricians, suppliers of electricity, etc.

### Liens Registered.

**Blackpool, St. Annes, and Lytham Tramways Company, Limited.**—Lien registered May 22, for £5,000 5 per cent. debentures, part of £15,000; amount previously issued, £10,000; no trustees; charged on the undertaking and all the property, present and future, including the uncalled capital.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Palermo.**—The Sicilian Railway Company require tenders for electric wires and cables. Tenders by June 11.

**Darlington.**—The Corporation invite tenders for switchboard extension and booster. Tenders by June 19.

**Cataqueses (Spain).** — The local light and power company require tenders for electrical plant. Tenders by July 1.

**Grays Thurrock.**—The Urban District Council invite tenders for switchboard extension, storage battery, etc. Tenders by June 17.

**Partick.**—The Town Council invite tenders for the supply of various plant at their electricity works. Tenders by 12 noon on June 6.

**Edinburgh.**—Tenders are invited for steam and exhaust pipework at McDonald-road electricity supply station. Tenders by 10 a.m. on June 6.

**Madrid.**—The Public Works Department require tenders for carrying out a scheme for an electric tramway for goods transport along Bilbao quays.

**Madrid.**—The Post and Telegraphs Department require tenders for construction and working of a telephone line at Matron (Baleares). Tenders by June 5.

**Cardiff.**—The Asylum Visiting Committee invite tenders for the electric lighting of their new asylum at Whitchurch. Tenders by June 14. See advertisement.

**Bracebridge (near Lincoln).**—Tenders are invited for the installation of fire alarms, telephones, bells, and tell-tale clocks at the Bracebridge Asylum. Tenders by June 7.

**Liria.**—The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

**Brussels.**—The Belgian Government Railways require tenders for a number of lamps and accessories. Specification No. 97 may be obtained from their office at Brussels. Tenders by June 14.

**Laventhem (Belgium).**—The Municipality require tenders for erection of central station, laying of mains, etc. Particulars (3s. 4d.) may be obtained from the Secretary of the Mayor of that place.

**Bristol.**—Tenders are invited for single-phase alternating-current transformers and three-phase to direct-current motor-generators. Full particulars from the City Electrical Engineer, Temple Backs, Bristol.

**Talgarth (Wales).**—Tenders are invited for (1) wiring of the new farm buildings, including the supply and fixing of motors and (2) fire-alarm installation at the Brecon and Radnor Asylum. Tenders by June 7.

**Edinburgh.**—Tenders are invited for the supply of lead-sheathed, paper-insulated copper cables for electricity supply conductors for the year ending May 15, 1906. Tenders by June 5. See advertisement in last issue.

**Moxley (near Bilston).**—The South Staffordshire Joint Small-pox Hospital Board invite tenders for the electric wiring and lighting (including main cables, fittings, etc.) at the small-pox hospital. Tenders by 9 a.m. on June 7.

**London.**—The London County Council invite tenders for the purchase of the modern electricity generating machinery and plant at the generating station, 8 to 16, Sardinia-street, Lincoln's-inn-fields, W.C. Tenders before 3 p.m. on June 5. See advertisement.

**Madrid.**—The Post and Telegraphs Department require tenders for 50 tons 4mm. zinced iron wire and 5 tons 3mm. bronze wire. The maximum price for the iron wire is 580 pesetas and that for the bronze wire 3,400 pesetas per ton. Tenders by June 5.

**Stalybridge.**—The Stalybridge, Hyde, Mossley, and Dukinfield Tramway and Electricity Board require tenders for the supply, delivery, and erection at the Stalybridge sub-station of a 400-kw. motor-generator, together with the necessary switchgear for same.

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**Lugano (Switzerland).**—Tenders are invited for the erection of an electric power station at Zordola, to be worked by water power. Particulars may be obtained from the town clerk. Tenders by June 9.

**Ossett (Yorks).**—The Town Council invite tenders for the following plant: (Section No. 1) quick-speed engines for direct coupling to dynamos; (2) dynamos, boosters, and balancers; (3) storage battery; 4) switchboard; (5) travelling crane; (6) cables. Tenders by June 14.

**Switzerland.**—M. R. Vontobel, of Winterthour, and M. Charles Probst, of Lucerne, have obtained a concession for the construction of a narrow-gauge electric railway from Meiringen to Gletsch. The total cost of the enterprise is estimated at £241,600; £19,600 is to be expended on rolling-stock.

**Esh (Durham).**—Tenders are invited for erection of electric lighting plant on the road leading from Cornsay Lodge by Commercial-street, Cornsay Colliery, and then by the low road to Hawsteels crossing, being a distance of about 1,600 yards. Tenders to the Esh Parish Council by June 13.

**Glasgow.**—The Corporation invite tenders for the construction of tramway in Dalmarnock-street and Springfield-road from Great Eastern-road to Dalmarnock-road. Specification, etc., can be had on application to Mr. James Dalrymple, general manager, 46, Bath-street, Glasgow. Tenders by 10 a.m. on June 13.

**Bristol.**—The Docks Committee invite tenders for the construction, delivery, erecting in place, fitting, testing, and maintenance for 12 months after completion, of four two-ton movable electric jib cranes, and one three-ton movable electric jib crane to be erected on the adjoining wharf at Canons Marsh. Tenders by June 7.

**Hammersmith.**—The Council are about to supply all electricity to the stands at the Olympia Electrical Exhibition, and invite propositions from bona fide British manufacturers for the hire of the necessary materials for the distribution inside the hall. The materials required will consist of (A) meters; (B) lead-covered and armoured cables; (C) distribution pillars; (D) fuse and switch boxes for exhibitors' stands; (E) continuous-current plant (motor-generators, rotary converters, or steam driven). Tenders by June 2. See advertisement in last issue.

## RESULTS OF TENDERS.

**Islington.**—The Electricity Committee recommend the acceptance of the contract of the Union Electric Company for the supply of 42 Excello flame lamps at a cost of £388. 13s.

**Shoreditch.**—The Borough Council have accepted the tender of W. T. Glover and Co., at £3,234. 6s. 4d., for the supply of 3,800 yards of ·75 high-tension concentric, paper-insulated, lead-covered cable.

**St. Marylebone.**—The Council have ordered from the St. Helens Cable Company 10 miles of ·03 concentric cable at £154. 12s. per mile, 3 miles of ·03 triple-concentric cable at £287. 4s. per mile, 2 miles of ·05 triple-concentric cable at £362. 8s. per mile, and 1 mile of ·1 triple-concentric cable at £474. 8s. per mile.

**Bournemouth.**—The Town Council have received the following tenders for Contract No. 6—11 electric cars: Dick, Kerr, and Co., Limited; British Thomson-Houston Company, Limited; British Westinghouse Electric and Manufacturing Company, Limited (withdrawn); Brush Electrical Engineering Company, Limited. No tender has been accepted so far.

**Birmingham.**—The following tenders have been accepted for the necessary materials and the works of reconstruction of the tramways: Bolckow, Vaughan, and Co., Middlesbrough, 1,660 tons of tramrails with fishplates, £5. 10s. per ton; Hadfield's Steelfoundry Company, Sheffield, special tramway work, £1,708. 10s.; Dick, Kerr, and Co., Preston, reconstructing permanent way, £42,261. 15s. 1d.*; Dick, Kerr, and Co., 200 electric cars, including provision of spare parts and contingencies, £110,411. 12s. *This amount is exclusive of the cost of paving the sides of the roads, which will be carried out by the same firm at the same time for the Public Works Committee; it is also exclusive of the cost of the overhead electrical equipment.

# BUSINESS NOTES.

## TRACTION.

**Swinton.**—The Swinton Tramways (Extension of Time) Bill has been read a third time in the House of Commons.

**Bristol.**—A meeting of the inhabitants of Westbury unanimously resolved to ask the company to substitute electric cars for 'buses.

**Blackpool.**—The receipts from the trams for the period between April 1 and May 18 totalled £4,985, as against £4,539 last year.

**Leven-Kirkcaldy.**—The Commissioners under the Private Legislation Procedure (Scotland) Act have found the preamble of this Bill proved.

**Gilmerton (N.B.).**—A meeting of inhabitants decided to petition the Mid-Lothian County Council to support the proposed electric tramway.

**Doncaster.**—The *plébiscite* on the question of Sunday running has resulted in an adverse vote, the figures being: against Sunday running, 1,536; in favour of same, 564.

**Garcia Renault Electric Cars Co.**—An order for compulsory winding-up has been made with respect to the Garcia Renault Electric Cars and Accumulators, Limited.

**Hastings.**—The Hastings Tramways Bill (except the portions dealing with the Bexhill tramways) has now passed through all the committee stages of the House of Lords.

**Nottingham.**—The Corporation are experimenting with a 20-h.p. Wolseley motor 'bus with a view of testing the respective merits of such vehicles and electric trams for Sneinton.

**Lampeter.**—At a meeting of the inhabitants a resolution supporting the light railway scheme to New Quay was carried with enthusiasm, and it was decided to ask the Cardigan Town Council and the rural district councils to contribute towards the cost.

**Bournemouth.**—The work of constructing the electric tramways to Christchurch and through the suburb of Southbourne has just begun. This will, doubtless, be welcomed by the inhabitants, as at present the journey, which is scarcely four miles, costs 6d. by 'bus.

**Bradford.**—At the meeting of the Tramways Committee the city treasurer reported a profit of £70,000 on the tramways, and after the repayment of sinking fund there remains a disposable balance of £16,000. This is the largest balance which the committee has had.

**Whetstone and Barnet.**—At a meeting of the East Barnet Urban District Council the plans submitted by the Herts County Council for the light railway between these places were considered, and it was decided to forward the County Council certain recommendations as to street widening.

**Halifax.**—The Corporation having obtained powers to construct tramways to Wainstalls, an out-of-the-way district, they decided to apply to the Board of Trade for leave to substitute motor 'buses. A reply from the Board has been received, stating that the Board are not empowered to give the authority desired.

**York.**—The Wolseley Motorcar Company recently conducted some tests with one of their vehicles, and the results are reported to have been highly favourable. There is expected to be an interesting discussion on the part of the Corporation at an early date in regard to the electric tram *versus* motor 'bus question.

**Edinburgh.**—It has been announced officially that the Mid-Lothian County Council has now withdrawn its objections, and consented to the provisional order of the Edinburgh Suburban Electric Tramways Syndicate, Limited. As Dalkeith and Bonnyrigg have also granted their consent, the approval of the whole local authorities on the route has now been obtained.

**Wellingborough.**—The House of Commons Committee on Wednesday rejected the Wellingborough and District Tramroads and Electricity Supply Bill, promoted by the British Electric Traction Company. The company sought powers for an extension of time for the construction of authorised tramways and for power to establish generating stations and supply electric power in portions of Northamptonshire, Bedfordshire, and Huntingdonshire.

**Darlington.**—As the result of the introduction of ½d. fares, the tramway receipts have shown a fall, notwithstanding an increase in the number of passengers. During the four weeks the ½d. fares have been in operation the passengers have averaged 60,000 a week (in a population of 48,000); the receipts, amounting to about £778, show a decrease of some £100 as compared with last year. The inference appears to be that resort should not be had to ½d. stages until a tramway system is well established.

**Metropolitan Railway.**—Orders for 10 electric locomotives, each developing 1,200 h.p., have been placed with the Westinghouse Company for use on their newly-electrified line between Harrow and Baker-street. Experiments with the discarded "Tube" locomotives proved that these engines were not sufficiently powerful for the work on the Metropolitan line. The same locomotives will be used on the Metropolitan section of the Inner Circle for goods traffic and for the steam trains coming off the Great Western and Hammersmith lines, *viâ* Bishop's-road.

**London Southern Tramways Co.**—Several witnesses having been examined in support of this company's Bill seeking power to reconstruct their system electrically, the chairman (Mr. T. G. Ashton) intervened, and said there was no necessity to proceed further, as the committee were of opinion that the preamble was not proved. Mr. Vesey Knox protested that it was contrary to the Standing Orders and the practice of the House to decide against a Bill before hearing the whole of the promoters' case, but the committee adhered to their decision, and the scheme was rejected.

**Seaham Harbour.**—At the monthly meeting of the Seaham Urban District Council, the Finance and General Purposes Committee reported that negotiations with the tramways company had resulted in the company deciding to promote a Bill enabling them to construct a line through Murton Colliery and Seaham Colliery to Seaham Harbour, in lieu of the line which they proposed to construct from South Hetton, around by Easington, to Seaham Harbour, and that the company proposed also to make a line of tramways from Seaham Harbour to Ryhope.

**Bury.**—On account of the increased demand for energy, the Tramway Committee in November appointed representatives to confer with the Electricity Committee on the question of price. The result of the negotiations was a decision to charge 1½d. per unit for the half-year ending September last, 1·4d. per unit for the quarter ending December, and 1·3d. per unit for the quarter ending March 31. A further reduction to 1·2d. per unit came into force on April 1. The difficulty in the way of a further concession appears to be the abnormal traffic on the occasion of football matches, which necessitates additional generating plant for such days only.

**Ramsgate.**—An accident occurred to one of the trams at Ramsgate last week. Apparently, on descending a hill leading to the harbour, the brakes failed to act, and the car ran at a great speed and dashed into a grocer's shop. The passengers jumped from the car and escaped serious injury. The shop was wrecked, and a seven-year-old daughter of the manager was found with her head terribly injured. Her life is despaired of. The driver of the car was taken to a surgery in an unconscious condition, having sustained head and chest injuries, and the conductor was also removed with his cheek bone laid bare and a scalp wound. There were a number of other injuries of a less serious character suffered by passengers.

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**Birmingham.**—The Tramways Committee of the City Council in their report state that, under the terms of the agreement with the City of Birmingham Tramways Company, the latter have informed the committee that the order in which they desire the reconstruction of the undermentioned tramways under lease to them to be proceeded with is as follows: (1) Saltley and Nechells route; (2) King's Heath route; (3) Moseley-road route; (4) Stratford-road route. The accounts for the year ended March 31 last show a gross profit on the Steelhouse-lane route of £8,764 1s. 2d., and after providing for interest on capital and contributions to sinking fund, there remains a net profit of £5,800. 17s. 9d., which the committee have carried to the reserve fund.

**Belfast.**—At the meeting of the Tramway Committee on Monday, a deputation from the National Telephone Company attended. They stated that the company were willing to meet the committee so far as they could, but they asked the latter not to adhere to their decision that all the telephone wires along the tramway routes must be placed underground, as this would entail great hardship and expense. A lengthened discussion ensued, but ultimately it was decided that in order that the position of the Corporation on the question might be accurately ascertained, the town clerk should submit a case to counsel. The Lord Mayor reported on behalf of the sub-committee which had visited the depôts that the work was proceeding satisfactorily, and the city surveyor intimated that the reconstruction of the tramways system was being carried out in a manner which met with his approval. The consideration of the question of fares was further adjourned.

**Blackburn.**—The sixth annual report of the Corporation tramways shows receipts amounting to £48,875 against working expenses of £30,580, leaving a gross profit of £18,295. Interest on loans absorbs £8,599 and sinking fund £12,488, showing a deficit on the year of £2,792. The mileage passengers receipts and receipts per car mile for the past and the preceding year respectively are as follows: 986,953 and 951,484 miles; 8,661,720 and 7,742,692 passengers; receipts, £47,118 and £43,374; receipts per car mile, 11·46d. and 10·94d. The cost of maintaining the rolling-stock shows a marked decrease as compared with last year. The consumption of power shows a slight decrease, being 2·77d. per car mile against 2·81d. for the previous year. This is attributed to the bonus system to drivers. The joint managers (Messrs. Johnston and Cowell) do not think the general expenses can be materially reduced, except in regard to the charge for energy, which represents over 30 per cent. of the total expenditure.

**Inquest.**—An inquest was held at Gateshead on Monday into the death of John Henry Fenwick, a bricklayer's labourer, employed on the North-Eastern Railway, who met his death by taking hold of a live wire at Gateshead railway shop. Matthew Waller, an electric crane driver, said he shut off the current to the electric crane at 4.45 on Friday afternoon. He tried the switch, and everything was safe when he left at five o'clock. Another witness, who was working with the deceased, said that on the side of the walls on which they were working were three wires that conveyed the current to the crane. After deceased had gone up the ladder he heard a shout, and saw him grasping one of the wires in his right hand. He was standing on the electric crane. He did not know what the deceased was doing to get hold of the live wire. He thought that whilst standing on the crane he must have grasped the wire to save himself from falling. Dr. Robinson said that death was the result of shock due to the passage through the body of the electric current. A verdict of accidental death was returned.

**Municipalisation in the States.**—Mr. Dalrymple, the manager of the Glasgow Corporation tramways, is on his way to Chicago to assist the mayor of that city in the work of taking over the tramway systems. The decision of the Chicago Corporation to municipalise the trams created something of a sensation in the States. Mr. Dalrymple was met at New York by several members of the Municipal Ownership League of Chicago, who came from that city to welcome him, and also by a deputation of New York city officials. He was given a public reception at the Hoffmann House last night, at which Mr. McClellan, mayor of New York, presided. In an interview Mr. Dalrymple said that he was going to Chicago without delay, as he was anxious to make his absence from Glasgow as short as possible. On being asked his opinion of the tramways system of New York he criticised it severely. He did not think they were worthy of a great city, and declared that they were not nearly as good as Glasgow possessed. Much of his criticism was directed to the lack of discipline on the part of the tramway employés.

**Leicester.**—At a special meeting of the Corporation on Tuesday Councillor Flint moved the adoption of the report of the Tramways Committee, which included the report of the borough surveyor on the cost of the electric tramway scheme. The total expenditure authorised by Parliament was £580,747. The amount estimated to be spent on the work which had been actually done was £475,000, and the actual cost had been £469,746. This was a saving of £30,219, but there were other items in which they had exceeded the original estimate, amounting to £24 000, and the net saving on the estimates was £5 274. The total amount unexpended of the original estimate was £111,000, this including the saving on the work done. The parliamentary estimate was for 42 miles of track and 90 cars. The routes actually constructed totalled 36½ miles of track. The figures, worked out on the basis he had given, came out at £12,869 per mile, while the borough surveyor's estimate was £13 014 per mile, the total saving being £5,275. Councillor Flint remarked that, considering the admirable system they had acquired, he thought the result must be deemed highly satisfactory. The report was adopted.

**Railway Motor 'Buses.**—At the meeting of the Municipal Tramways Association at the Westminster Palace Hotel the committee considered the amendments made by the House of Commons Committee in the North-Eastern Railway Bill, with a view to the protection of the Hull and Newcastle Corporations regarding the running of railway motor omnibuses. The committee of the association decided that the amendments did not go far enough to satisfy the requirements of corporations owning tramways. Under the circumstances it was resolved that when the Bill is set down for consideration on the report, an attempt should be made to still further limit the powers of railway companies with regard to motor omnibuses, and a motion is to be made in the House of Commons on that subject to the effect that "notwithstanding the powers granted by Section 54 of the Bill, nothing contained in that section shall authorise a company to run any railway omnibuses in a borough or urban district provided with a system of tramways, otherwise than for the conveyance of railway passengers, passengers' luggage, and mails to or from a station or hotel of the company, without the consent in writing of the local authority for such a period as may be therein specified."

**Proposed Electric Railway.**—A meeting will be held in Manchester early in June with a view to ascertaining whether or not sufficient local support will be forthcoming to justify the promotion in the next session of Parliament of a Bill asking for powers to construct the South Manchester Electric Railway to connect the outer Cheshire suburbs and the city. The proposed railway will be an express suburban cross-country "belt line" of standard gauge and constructed as a light railway, the main line being about 16½ miles long, and the branches bringing the total mileage up to about 26 miles. The line is intended for both passenger and goods traffic, and will transversely intersect and connect all the existing southern trunk lines from Manchester to London. It will commence from a proposed new centrally situated terminal station on the southern outskirts of the city, thence running about seven miles south-westwards direct into Cheshire, and thence through the outer belt of North Cheshire suburban residential districts, at an average radius of nine miles from the Manchester Town Hall, and terminating at a proposed new station at Hazel Grove, adjacent to the Stockport Corporation tramways terminus, and to the Midland Railway Company's new main-line station.—*Macclesfield Courier.*

**South Staffordshire Tramways Co.**—At an extraordinary general meeting last week, the agreement with the Corporation of Wednesbury for the sale to the latter of the portion of the company's undertaking within the borough was confirmed. The length of line concerned is about four miles. It was also resolved that the proposed agreement between the company and the South Staffordshire Tramways (Lessee) Company be approved. The Chairman said that the net result of the agreement was that the claim of the lessee company had been reduced from a possible £55,000 to £51,500, but some reconstruction work still remained to be carried out. The fifteenth ordinary general meeting followed, when the Chairman stated that the revenue for the half-year amounted to £1,257. After deducting all expenses chargeable to revenue, there remained a profit of £663, which it was proposed to apply in the payment of a dividend of 1s. 8d. per share on the preference shares, which would absorb £633, leaving £35 to be carried forward. This dividend was against a dividend of 1s. 4d. to June 30 last. Certain arrangements had been made which would give them a saving of about £550 a year in expenses of administration, or enough to increase the dividend on the preference shares by 1s. 5d. per share. The only other municipal authority besides Wednesbury with which they were in negotiation was Dudley, and he hoped to be able to report something definite as to that by the next meeting. The report was unanimously adopted.

**London County Council.**—At the meeting of the Council on Tuesday the Highways Committee recommended that sanction should be sought in the parliamentary session of 1906 for laying temporary tramway tracks. Another recommendation was that £7,150 should be voted for the erection of the Streatham sub-station. An important subject on the agenda was the construction of the following new tramways: (1) from Camberwell-green, *via* Denmark-hill, Champion-park, Grove-lane, Dog Kennel-hill, and Grove-vale, to the junction of Lordship-lane and Crystal Palace-road; (2) from the terminus of the authorised tramways in Lordship-lane, *via* Lordship-lane and London-road, to Dartmouth-road, Forest Hill; (3) from Grove-vale, *via* Goose-green, East Dulwich-road, and Peckham Rye, to Stuart-road, Peckham; (4) from the existing London County Council tramways in New Cross-road, *via* Lewisham High-road, Loampit hill and vale, and High-street, Lewisham, to Rushey-green; (5) from the existing London County Council tramways terminus in Trafalgar-road, Greenwich, *via* Blackwall-lane, to a point near Blackwall Tunnel. The estimated cost is £302 950 for the track, including cables and ducts, £26 200 for cars, £18 500 for car-sheds, and £14,300 for sub-stations. Owing to the amount involved, a decision was adjourned for a week in accordance with standing orders. The Finance Committee are in communication with the Highways Committee on the matter, as the former think that, owing to the expense involved in the approaching reconstruction of the northern system, other outlays should be curtailed as much as possible. The receipts for the week ended May 20 totalled £14,345 against £11 451 last year, and for the period from April 1 to May 20 the amount was £100 182, against £78,458.

**New York.**—The Rapid Transit Commission at its meeting on May 12 adopted all the tunnel routes informally chosen a week ago, with the exception of that for a four-track subway in Thirty-fourth-street. The commission decided to run the new Lexington-avenue route through Thirty-fifth and Thirty-sixth streets, as originally proposed, and leave Thirty-fourth-street as a route for an independent cross-town line or moving platform. This modification was brought about by a letter signed by Max E. Schmidt, Stuyvesant Fish, and Cornelius Vanderbilt, representing the Continuous Transit Securities Company. The letter said that, subject to possible damages to abutting property owners, the Interborough Rapid Transit Company would be glad to have a moving platform on the Forty-second-street spur of the Third-avenue elevated road. The engineers for the New York City Railway Company said they did not longer desire a four-track route through Thirty-fourth-street, but preferred the route as originally laid down, with

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two tracks in Thirty-fifth and two in Thirty-sixth street, between Lexington and Fifth avenues. The Thirty-fourth-street cross-town line will be built in two sections, one section being from the East River to Ninth-avenue, and the other from Ninth-avenue to the North River. The commission authorised the extension of the Interborough system from the present northern terminus on the west side to Van Cortlandt Park, Mr. Bryan saying the cars would be running there in a year's time. Acting-engineer Rice said that trains would be running down Broadway to the Battery within six weeks. Mr. Rice also said that as soon as leaks were stopped in the tunnel under the Harlem in about three weeks, it would be put in operation. The Interborough Company's proposition to four-track the Second-avenue elevated track was rejected. On the four-tracking of the Fulton-street, Brooklyn, subway, a letter was read from August Belmont saying that the Interborough was willing to pay half the cost if the city would pay the cost of the connection. This offer was accepted The city will pay £300,000 and the company £100,000.—*Electrical World* (New York).

## LIGHTING AND GENERAL.

**Halifax.**—The Corporation last year made a profit of £5,825 from their electricity works.

**Sale of Plant.**—Particulars of a sale of a complete direct-coupled steam set appear in another column.

**Penrith.**—The Urban District Council have decided to transfer their electric lighting order if a suitable offer is received.

**Rubber.**—An association has been formed in France to promote rubber production in the Congo and other French colonies.

**Grangetown-in-Cleveland** —Plans have been prepared for the erection of an electric power station here for the supply of Tees-side district.

**Malton.**—The Town Council's contract with the gas company having expired, it is now proposed to ask for tenders for lighting by gas or electricity.

**Blackburn.**—Last year's working of the electricity department shows a net profit of £251, after providing for £14,297 interest and sinking fund.

**Johannesburg.**—An international exhibition is to be held in 1907, under the patronage of the Government and the Chambers of Mines, Commerce, and Trade.

**Elgin.**—The Town Council have remitted to a committee to report on the best method of taking the necessary steps for the introduction of electric light to the burgh.

**Argentine.**—There is said to be a good opening at Rosario for electric plant and appliances. The Harbour Works Company are just constructing a central station.

**Batley.**—The loss in the electricity department of the Corporation has been reduced to £340 for the past year, as compared with £854 for the previous eight months.

**Pitlochry.**—Enquiries are being made with the view of ascertaining what local support can be obtained in connection with the proposal to introduce the telephone to the district.

**Hanley.**—In consequence of the electrical engineer's report on the expenditure necessary for mains, tools, meters, etc., application is to be made for sanction to borrow £11,000.

**Nicaragua.**—The Government have granted a monopoly for utilising the Tipitape Falls for generating electricity to the Nicaraguan Finance and Improvement Company.

**Western Telegraph Co.**—An interim dividend has been declared, payable on June 24, of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended March 31.

**Barnstaple.**—The Town Council are advertising in the local papers to the effect that where, during alterations in premises, it is found necessary to interfere with any electric apparatus, notice thereof must first be given to the electric engineer.

**Dunfermline.**—The Fife Electric Power Company's station at Townhill has been completed. The streets in the northern part of Dunfermline are being opened up for cable-laying. The company are under contract to supply several factories in the city and collieries in the district.

**New Works.**—The Simplex Steel Conduit Company inform us that, owing to enormous increased demand for their conduits and fittings, they have found it necessary to build entirely new factories at Garrison-lane and Maxstoke-street, Birmingham, and have made special arrangements for quick delivery.

**Newtown Telephones.**—The Urban District Council have rescinded the following resolution: "That inasmuch as the Council have consented only to be liable for £120, to be made up in Newtown, they cannot now see their way to increase their liability, which the new guarantee proposes to do."

**Electrical Plant for Japanese Dockyards.**—A Reuter's telegram announces that contracts to the amount of 5,000,000 dol. have been placed in the U.S.A. for shipment with all dispatch of electrical equipment machines, tools, and installation in the Japanese Government shipyards and arsenals.

**Hessle.**—The Court of Referees of the House of Commons on the 30th ult., after hearing an objection taken by the promoters of the Hessle electric lighting provisional order to a petition which the Hessle Gaslight and Coke Company sought to present in opposition, decided to allow a *locus* on the ground of competition.

**London County Council.**—On Tuesday it was agreed to lend the Hackney Borough Council £11,083 for electric light installation and the Poplar Borough Council £3,660 for electric lighting purposes. Sanction was also given to the borrowing of £1,782 by the Islington Borough Council for electric lighting purposes.

**Swansea.**—The Council have decided to ask the National Company what steps they are taking with regard to Justice Buckley's decision on the question of intercommunication. The Postmaster-General is enquiring as to the number of present Corporation exchanges, the number of subscribers, and the amount of capital expended.

**Cape-to-Cairo Rail and Telegraph.**—Messrs. Pauling and Co., contractors for the extension of the Cape-to-Cairo Railway beyond the Victoria Falls, have received a cable from their representatives in Rhodesia to the effect that the railway and telegraph lines have reached Kalomo, the headquarters of the North-Western Rhodesia Administration.

**Walsall.**—An enquiry has been held into the application of the Town Council for sanction to borrow £5,500 for electric lighting. The loan is mainly required to replace the present plant at the station in the centre of the town by larger machinery, the demand having so increased that the plant is already overtaxed, and will be quite unequal to the demand of the coming winter.

**New Branch.**—The Weston Electrical Instrument Company, of Newark, N.J., U.S.A., have opened a branch office and laboratory at Audrey House, Ely-place, Holborn, E.C., under the management of Mr. A. Davy. We are informed that catalogues describing the firm's standard voltmeters, ammeters, wattmeters, ohmmeters, etc., for portable testing work, laboratory standard instruments, switchboard instruments, etc, will be posted on request.

**Finchley.**—The fire which broke out in the boiler-house of the electricity works on Wednesday morning last week damaged the woodwork, and the roof collapsed. The whole of the works are insured, and the damage is roughly estimated at about £1,500. The facts having been greatly exaggerated in the London Press, Mr. Calvert, the electrical engineer, caused the public lamps to be switched on in the course of the day, so as to show that there was no need for alarm.

**Anglo-Chinese Telegraph Convention.**—A convention was signed at the Wai-wu-pu on May 23 on behalf of China and Great Britain by Sir Ernest Satow and Na-tung renewing Article 16 of the Burma Convention of 1894 respecting a junction between the Burma and China telegraph lines, with a modification of rates to meet the general lowering of rates of submarine cables. The negotiations were conducted by Mr. Berrington, of the Indian Telegraphs, and Chu Pao-fay, of the Chinese Telegraphs.

**Hammersmith.**—The last report shows that the premises of 13 additional consumers, representing a maximum of 315 8-c.p. lamps, have been connected to the mains, 10 consumers have been disconnected, making the present number of consumers 1,585. An application of the Postmaster-General for permission to the placing of an underground telegraphic line along the south side of Uxbridge-road, from the existing line at the east corner of Godolphin-road to 101, Uxbridge-road, has been agreed to.

**Shipley.**—The accounts of the Urban District Council electricity department for the year ended March 31, 1905, with which we will deal more fully in another issue, give the total costs at £3,490, an amount which is arrived at by deducting £500 for the cost of repairs, renewals, and attendance to public lamps, and £320 the cost of materials sold, etc., making a total of £820 to be deducted from the amount of £4,310, representing the actual total costs. The net profit of £562 on the year's working is carried forward to provide for bad debts.

**Sunderland.**—The annual report of the Corporation's electricity undertaking states that on March 31 an equivalent of 289,800 8-c.p. were connected, as compared with 197,683 the previous year, an increase of 46 per cent. The number of units sold was 4,772,913, as against 3,508,139, equivalent to an increase of 36 per cent. These were distributed as follows: lighting, 1,080,330; power, 1,661,586; tramways, 1,707,261; and public lighting, 323,736. The total cost of production per unit was reduced by 10 per cent. as compared with the previous year.

**Hull.**—The Chairman of the Electric Lighting Committee (Mr. Millington), in a recent report on the electric light undertaking, states that there are at present 2,453 consumers. Electric light consumers increased by 185 and motor users by 65. The gross receipts for the year amounted to £39,867, and the balance £22,700, with the actual profit of £4,980. During the year negotiations were completed for the supply of large quantities of electricity in bulk. The Hull Chamber of Trades have appointed a sub-committee to watch the telephone question.

**Private Bills.**—In the House of Lords the following Bills have been read a third time: Weybridge-upon-Thames Electric Supply, Chelsea Electric Supply, North Metropolitan Electric Power Supply, Gosport and Fareham Tramways, Hastings Tramways, South Lancashire Tramways, Baker-street and Waterloo Railway, Edgware and Hampstead Railway, Charing Cross, Euston, and Hampstead Railway, and the London United Tramways (Extension of Time). In the House of Commons the following Bills were read a third time: Great Northern, Piccadilly, and Brompton Railway (No. 1) and the Mexborough and Swinton Tramways Extension.

**Blackpool.**—The electrical engineer (Mr. C. Furness) in his report for the month of April shows a decrease in total works output over the corresponding month last year of 14,039 units, made up as follows: Private lighting—1904, 72,418; 1905, 76,864; increase, 4,446. Public lighting—1904, 13,785; 1905, 12,801; decrease, 984. Corporation tramways—1904, 103,222; 1905, 90,238; decrease, 12,984. Lytham and St. Annes Tramways—1904, 10,269; 1905, 5,742; decrease, 4,517. Total for month—1904, 199,684; 1905, 185,645; net decrease, 14,039. The engineer attributes the decrease in output to the Corporation tramways to the service along Lytham-road being suspended.

**Stock Exchange.**—The Stock Exchange Committee have ordered the undermentioned securities to be quoted in the official list: British

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Columbia Electric Railway Company's £115,000 5 per cent. cumulative perpetual preference stock, in lieu partly of the 5 per cent. cumulative perpetual preference shares now quoted; South Metropolitan Electric Light and Power Company's further issue of 35 368 7 per cent. cumulative preference shares of £1 each, fully paid, Nos. 200 001 to 235 368, and £48 292 4½ per cent. first debenture stock. An application has been renewed to allow the City of Wellington Electric Light and Power Company's £75 000 5 per cent. registered first debentures of £50 each, Nos. 1 to 1,500, to be quoted in the official list.

**Shoreditch.**—Some interesting proposals are before the Lighting Committee with regard to erection, in connection with the refuse destructor, of a clinker crushing and sorting apparatus. This would save the cost of carting clinker from the destructor yard, and at the same time turn the clinker into a saleable article. The committee, in conjunction with the Highways Committee, have inspected a similar plant at work at Stepney, which consists of a crushing mill, elevator, and three-grade sifter. The estimated cost, including erection, is £975. Judging from the experience of those authorities who have such an apparatus at work, it is estimated that the capital cost of the plant will be covered in the first year by the saving on cartage of clinker and revenue from the sale of sorted clinker. It is also proposed to increase the stock of demand indicators.

**Tottenham.**—The tender of Messrs. Graham, Morton, and Co., Limited, has been accepted by the Tottenham and Edmonton Gas-light and Coke Company for the supply and erection, to the designs of Mr. Arthur Edward Broadberry, the company's engineer, of a new retort-house, a coke storage tank, an overhead coal storage tank with measuring chambers and hydraulic actuating gear, piping valves, etc., also a coke storage tank in the coke yard at the north end of the house, and the supply and erection of coal and coke handling plant, comprising: (1) coal-handling plant from truck into coal tanks; (2) auxiliary plant for putting coal into store; (3) gravity bucket conveyor for conveying coke from storage tank in yard to storage tank for C.W.G. plant; (4) hot-coke conveyor from retorts to coke storage tank; (5) coke-screening plant; (6) conveying plant from coke storage tank top to coke yard; (7) engine in duplicate for driving the above plant.

**Electrical Supply.**—The Croydon Corporation Bill was before Lord Newton's Select Committee of the House of Lords on the 26th ult. The Bill authorises the construction of certain linking-up tramways in Croydon, and makes further provision for the sanitation and good government of the borough. It has been amended and passed by the Police and Sanitary Regulations Committee of the House of Commons, and one clause was opposed. Under it it was proposed that if the local authority for any district adjacent to the area which the Corporation were for the time being authorised to supply with electrical energy, or any company were authorised to supply energy within such district, the Corporation and these authorised undertakers "may enter into and carry into effect agreements for the supply of electrical energy in bulk by the Corporation to such local authority or company." The County of London Electric Supply Company, the South Metropolitan Electric Tramways and Lighting Company, and the South London Electric Supply Corporation successfully opposed the clause. The other clauses were adjusted, and the preamble having been proved, he Bill was ordered to be reported to the House for third reading.

**Eastbourne.**—An enquiry has been held into the Council's application for sanction to a loan of £2,518 for the purpose of laying two additional feeder cables and making alterations to the switchboard and sub-stations, necessitated by the growing demand on the electric lighting works. The electrical engineer, Mr. J. Kempe Brydges, stated that the load last year on the plant was 743 kw., and it would be 870 in 1905 if progress was maintained at the same rate as hitherto. The four existing feeders between the works and the town were fully loaded last winter. The Electric Lighting Committee proposed to lay two additional feeders of the same size as the existing ones, in order to avoid future excavations under the path from the works to the town, a distance of 1½ miles. Increased capacity is to be provided for future demands. Instead of only laying these two feeders and drawing them into a two-way pipe, allowance has been made for an eight-way pipe for a part of the distance and a six-way pipe for the remaining part. Right up to the town there would be four ducts into which feeder cables could be drawn as they were required in future. This would obviate taking up the road again for some years. The ducts were of glazed stoneware, and suitable manholes had been provided at intervals. He submitted the following estimate: estimated cost of ducts, £750; trench work and laying ducts, £326; inspection boxes, £90; 5,500 yards of cable, £1,100; drawing-in and joining cable, £68. 15s.; extension of switchboard and two sub-sections, £90; contingencies, £93. 5s.—total, £2,518.

**St. Marylebone.**—The Finance Committee reported at the last meeting of the Borough Council that they had received a memorandum from the Electric Supply Committee with a report from the consulting engineer and accountant, with reference to the probable further requirements on capital account, from which it appeared that to provide for such expenditure it would be necessary to take up further instalments of the sanctioned loan of £433 800 from the London County Council as follows: A third instalment of £50,000 in June next, and a fourth instalment of £100,000 in July prior to the summer vacation. They were making application to the London County Council for such further advances, and informed the Council accordingly. The committee's recommendation that the seal of the Council should be affixed to mortgages of the general rate to secure the repayment to the London County Council of the sums at £3. 7s. 6d. per cent. within the period sanctioned by the London County Council was agreed to, as was also a proposal of the committee to continue the present rates of charges for current until the end of the year, or until such time as they shall have obtained sufficient data to revise the same. In answer to a question, the Town Clerk said the Central Electric Company had not obtained any powers by their Parliamentary Bill to supply electricity in the borough, but they had power to lay additional trenches for their generating stations. With regard to the Metropolitan Electric Supply Company, they also had no power to supply current, except for traction purposes to any railway that might pass through.

**Leeds.**—The receipts of the electric lighting department of the Corporation for the past year from sales for lighting were £73 597, and for power £10 819 a total of £84,416, as compared with £75,720 the previous year. The working expenses, taxes, and costs incidental to change of system amounted to £28,364, as against £25,183 a year ago. The gross profit of the department was £56 052, a large increase on the previous year's figures, which were £49,537. Interest and redemption fund charges increased from £46 106 to £55,770, making a net surplus of £282 for the year, against the surplus of £3 430 in 1903 4. The total number of units sold last year was 7,030 681, and the average price paid per unit was 2 88d. As the expenses per unit, including interest and sinking fund, amounted to 2 87d., there was a surplus of only ·01d. per unit, as against ·13d. in the previous year. Capital to the amount of £64.795 was expended during the year, and the total capital consumed by the undertaking to date has been £822,122. The 35-watt lamps have been increased during the year by 29,355, the total number now installed being 264,628. The units sold for private lighting amounted to 4,871.731, and for street-lighting to 217,997, the revenue from the purely lighting department being £73,597, or 5s. 10·55d. per lamp installed. The units sold for power and heating amounted to 1,940,953, the revenue in this branch being £10.819, or £3. 5s. 8d. per horse-power installed. The aggregate horse-power installed at the end of the year was 3 904, an increase of 1 001 over the previous year. The accounts were presented to the Electricity Committee yesterday, Alderman E. Matheson presiding.

**London Wiring.**—When the Police and Sanitary Regulations Committee of the House of Commons (Mr. J. W. Wilson in the chair) resumed consideration of the electricity clauses of the General Powers Bill of the London County Council on the 25th, the Chairman stated that the committee's decision (reported in our last issue) had been entirely unanimous. Mr. Freeman, K.C., on behalf of the London County Council, stated that, in consequence of the committee's decision, the words "whether directly or otherwise," having relation to the manner in which a borough council might charge for wiring, fittings, and apparatus, had been struck out of Clause 63. The County Council and the gas companies had agreed to the following provisos to the clause: (1) Provided also that every such council shall so adjust the charges to be made by them as aforesaid as to meet any expenditure by them under the powers of this section, including interest upon any moneys borrowed under and for the purposes of this part of this Act and payments to sinking funds in respect of such moneys; (2) every sum charged by any such council to a consumer in respect of the wiring and fitting of the premises of such consumer and the supplying of wires, fittings, motors, and apparatus shall be clearly stated on every demand note by such council for payment for electrical energy supplied to such consumer distinct from the charge for such energy. The total sums received and expended by any such council under this part of this Act in each year, including the amount required for interest on and payments to sinking fund, in respect of any moneys borrowed, shall be separately shown in the published accounts of the electric lighting undertaking of such council for such year. The committee assented to the amendment in Clause 63 and the new provisos, and inserted them in the Bill.

**Gloucester.**—The annual report of the city electrical engineer, Mr. W. J. Bache, M.I.E.E., which was presented at a meeting of the City Council on Tuesday, stated that 71 new consumers have been added, and the number of 8-c.p. lamps now connected is 37,276, an increase during the year of 8 378 The capital expended on the undertaking has increased from £67,276 to £75,240. and this is almost entirely on account of the light railways plant. The amount set aside for interest and sinking fund is £797 higher than in the previous year, and is just under 6 per cent. on the capital. The total expenditure on revenue account, apart from financial charges, is £4,872. 0s. 8d. The total cost of generation and distribution has largely decreased, owing to the increase in the number of units sold. Last year the average cost per unit was 1·68d., and it has now fallen to the very satisfactory amount of ·997d. There are very few stations of similar output producing current so cheaply, and it is entirely due to this fact that, in spite of the very low scale of charges, the undertaking shows such a substantial profit. The revenue of the undertaking has amounted to £10,409. 7s. 9d., and the gross profit is £5 537. 7s. 1d., or 7½ per cent. on the capital outlay. Financial charges rose to £4,448. 12s. 4d., leaving a balance of £1,088. 14s. 9d., which is net profit, and will go to reduce the accumulated deficit of £1,858. 13s. 10d. This now stands at £769. 19s. 1d., and there should be no difficulty in entirely wiping this out next year. The total amount of capital repaid out of revenue is now £5,078. 19s. 5d. An enquiry has been held into an application by the Council for sanction to borrow £12,100 for extensions at the electricity works, consisting chiefly with the enlargement of the station and the installation of three new boilers and other plant. The proceedings were purely formal.

**Burnley.**—The financial returns of the electricity works for the past year ending March make a very satisfactory show. At the beginning of the 12 months it was estimated that the surplus would be £7,598, including a charge of 1½d. for traction, but after then the charge was reduced. Out of that estimated profit it was proposed to place £3,000 to the reserve and depreciation fund, put aside £500 for contingencies and hand over £4,098 towards the borough fund in reduction of the rates. It transpires now that the actual profits of the department were £11,000. Out of these, a further remission of a farthing per unit has been granted to the Tramways Committee for the current used during the year, equal to £2,400. The same provisions of £3,000 for reserve and depreciation and £500 for contingencies are made, leaving £5,100 to go towards

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the rates instead of £4,098, as anticipated. Mr. R. Birkett, the electrical engineer, is to be congratulated on the results, which are due to a reduction in the works cost per unit. These he has brought down from 1·02d. per unit to under ·7d., and with perhaps one exception this average will be the lowest in the country. The profits of £11,000 on a capital expenditure of £92,000 gives a gross surplus of 12 per cent., which also is unsurpassed except by one or two towns in Great Britain. Mr. Birkett, who is leaving next month for Southend-on-Sea, leaves behind him a magnificent record, and takes a good recommendation to his new office. Already the reduction in charges recently decided upon, and which place Burnley amongst the lowest in Great Britain, are: for light, 3½d. from 4d. per unit; motive power and heat, 1¾d. per unit for first hour, from 3d. and 1d. after; 1½d., from 3d., for public lighting; whilst the tramway current is also further reduced to 1·45d. per unit. Since Mr. Birkett took charge the surpluses have gradually increased from £700 to £11,000.

**Birmingham.**—The Electric Supply Committee in their last report state that the number of units sold during the year ended March 31, as compared with the previous year, was as follows: units sold year ended March 31, 1905, 4,645,027; year ended March 31, 1904, 4,367,164; money value, £77,195 (£69,421). This means an increase of 6·36 per cent. in the units sold, and an increase of 2·56 per cent. in the money value. The small increase in money value is partly due to the fact that, while this year the reduced charges approved by the Council were in force during the fall year, they were only in force during the last three quarters of the previous year. The revenue account shows a credit balance of £39,573. 12s. 7d., as compared with £36,939. 17s. 8d. for the previous year. It is seen from the revenue account that the works cost again show an improvement. The total cost of production works out at 1·584d. per unit, as against 1·742d. in the preceding year, a reduction of 0·158d. per unit. The net result of the year's working, after paying interest and sinking fund charges amounting to £28,784. 5s. 3d., is a surplus of £10,789. 7s. 4d., compared with £10,412. 4s. 7d. in the preceding year. The committee, following the course approved by the Council last year, have carried this amount to the statutory reserve fund. Having regard to the committee's heavy commitments in connection with the extension of the undertaking, necessarily involving some payment of interest and sinking fund before the capital becomes profit earning, they still feel that it would not be wise to recommend any other method of disposing of the profit. The total length of new mains laid during the year was 11,050 yards, as compared with 10,051 last year. The lamp and motor connections during the year were equal to a net addition of 16,168 16-c.p. lamps, against 12,499 last year. The committee report that the following tenders have been accepted in connection with this work: Sapcote and Sons, foundations £15,777, buildings £88,689; Bellis and Morcom, engines £52,599. 17s., extensions of galleries, etc., £478; Dick, Kerr, and Co., direct-current generators, £6,685; British Westinghouse Company, alternating-current generators, £3,765; Jessop and Appleby, cranes, £1,770; New Conveyor Company, coal and ash conveying plant, £5,840; British Thomson-Houston Company, direct-current switchboard, £13,685. 10s.; Babcock and Wilcox, boilers, £15,638; F. Green and Son, fuel economisers and flue damper, £2,294; Stewarts and Lloyds, Limited, pipework, £4,761. 18s.; W. H. Allen, Son, and Co., Limited, circulating-water pumps, £1,430. It is not expected that, taken as a whole, the cost will materially exceed the estimate submitted to the Council. Satisfactory progress has been made both in the erection of the buildings and in the manufacture of the plant. The builders' contract provides for the completion of the building by Nov. 30 next.

**South Shields.**—The annual report of Mr. J. H. Cawthra, the borough electrical engineer, contains the following figures of the working of the Council's electricity department: The amount expended up to March 31, 1904, was £149,366, and during the past 12 months additional expenditure out of the capital account amounted to £2,481, making the total to date £151,838. The gross income for the year amounted to £13,132, an increase of £967 over 1905, and the working expenses were £6,935, an increase of £300, leaving a gross profit of £11,196. Out of this amount the following statutory requirements had to be met: Interest on loans, £4,893, and sinking fund, £4,231, a total of £9,130. Deducting these amounts from the gross profit, there is left a balance on the year's working of £2,065. There is a further deduction to be made of £77, representing loss on Holborn Quay, thus reducing the balance to £1,988, as compared with £1,603, at the end of the previous 12 months. The number of units sold to consumers was 1,385,393, as against 1,299,289 during the previous year, an increase of 86,104. The kilowatt capacity of the plant installed is the same as 12 months ago, and quite sufficient to meet the requirements of the borough, as far as energy for lighting purposes is concerned, for some two or three years, and the number of lamps connected have been increased by 5,372, making a total of 59 209. There are now 1,117 consumers, as compared with 1,010 12 months ago. The maximum load in the station at any time during the past winter was on Dec. 31, when it was 953 kw. The number of arc lamps in use for purposes of public lighting is 91, this being an increase of three, while the number of ordinary gas standards which have been converted into electric make a total of 462, an increase of 30 during the past 12 months. The average price per unit obtained for current supplied to private consumers was 3·8d., while the price obtained for street-lighting was 1·61d. per unit. Respecting the works costs, the electrical engineer points out that in South Shields, with an output of 1,385,893 units, it works out at ·61d., and therefore can claim to be the third lowest of all electrical undertakings in the United Kingdom, either companies or municipal, supplying electric energy for lighting and power purposes only. No portion of the past year's profits have been allocated to the reserve fund, which now stands at £2,491, and the engineer strongly recommends the committee to place the whole balance of the net revenue account, £2,094, to reserve. He states that an ample reserve fund is very necessary, and taking into consideration the fact that the works have been running nearly nine years, there could be no doubt whatever that the reserve fund was abnormally low. Every opportunity, he says, should be taken of building up the fund to an adequate figure. The report states, in conclusion, that in all probability in next year's accounts there will be shown revenue for the supply of electric energy to the tramway department.

**Bury.**—The annual report of the borough electricity engineer (Mr. S. J. Watson) shows that the number of consumers and lamps connected on March 31 was 420, with 44,199 candle-power lamps. The units sold during the past three years ending March of the year named are as follows:

| | 1903. | 1904. | 1905. |
|---|---|---|---|
| Private lighting | 228,288 | 250,301 | 297,202 |
| Public ,, | 55,582 | 54,664 | 61,887 |
| Public clock | — | 778 | 914 |
| Motors and heating | 141,123 | 299,538 | 258,208 |
| | 424,993 | 605,281 | 618,211 |
| Tramways | — | 67,630 | 662,250 |
| | 424,993 | 672,911 | 1,280,461 |
| Maximum load, kilowatts | 319·7 | 487·3 | 1,158 |
| Load factor | 15·17% | 15·7% | 12·6% |

Compared with the previous year, the output for private lighting shows an increase of 46,901 units, or 18·7 per cent.; public lighting an increase of 7,223 units, or 13·2 per cent.; public clock an increase of 136 units, or 17·5 per cent.; and motors and heating a decrease of 41,330 units, equal to 13·8 per cent. Excluding tramway supply, the increase is 12,930 units, equal to 2·1 per cent. Including tramway supply, the increase is 607,550 units, equal to 90 per cent. The decrease in the units sold for motors and heating is entirely due to the partial disuse of the motors used with the ice-making plant at the abattoirs, the units during the year having been 30,856, compared with 87,833 for the previous year, a decrease of 56,997 units. The output for different purposes, with the corresponding maximum load and load factor, is as follows:

| | Units. | Maximum load. | Load factor. |
|---|---|---|---|
| Lighting | 297,202 | 310 kw. | 11·0% |
| Public lamps | 62,801 | 21 kw. | 34·2% |
| Motors and heat | 258,208 | 112 kw. | 26·3% |
| Total light and power | 618,211 | 443 kw. | 15·9% |
| Tramways | 662,250 | 715 kw. | 10·6% |
| | 1,280,461 | 1,158 kw. | 12·6% |

The load factor for lighting and power, which stands at 15·9 per cent., indicates that the maximum load has been used for an average of 3 hours 49 minutes a day, compared with 4 hours 9½ minutes for the previous year, when the load factor was 17·3 per cent. The reduction is due to the decrease in the units sold for power purposes. The comparatively low load factor of the tramway supply has been partly caused through the system not having been completed and opened until September, and also on account of the abnormal loads put upon the generating plant when the special traffic is being dealt with in connection with football matches. Thirty-six arc lamps are in use for lighting the main streets of the borough, one additional lamp having been fixed in the middle of the Market-place and one by the parish church. To reduce the number of obstructions to traffic on the footpaths, it was decided to transfer 14 of the cast-iron pillars to adjacent tramway poles. This work was carried out, and the cost equally divided between the Electricity, Lighting, Sewering and Paving, and Tramway Committees. Eighteen incandescent fittings, each consisting of two 16 c.p. lamps, are in use in Spring-street and Heywood-street. Further progress has been made in the use of motors for driving small workshops. During the year 15 motors, equal to 101 h.p., have been hired out, and three motors, equal to 18 h.p., have been put in by consumers at their own cost. One motor of 8 h.p. belonging to a consumer has been disconnected. There are now 61 hired motors in use, amounting to 381 h.p., and 38 motors owned by consumers of 200 h.p., giving a total number connected of 99 motors, equal to 581 h.p. The total motors connected up to March, 1905, number 99. The length of street mains laid equal 15 miles 846 yards. The following analysis of costs is given: Total cost to March, 1903, £5,986, per unit 3·38; to March, 1904, £7,357, per unit 2·62; to March, 1905, £8,240, per unit 1·54. Profit to March, 1903, £21, per unit 01; to March, 1904, £566, per unit ·20; to March, 1905, £2,931, per unit ·55. Average price obtained to March, 1903, £6,007, per unit 3·39; to March, 1904, £7,923, per unit 2·82; to March, 1905, £11,171, per unit 2·09. The quantity of fuel used per unit sold has been reduced 26½ per cent. The average price has been 6s. 5d. per ton, compared with 6s. 6½d. per ton for the previous year. The cost of generating has been reduced by ·47d., equal to 36 per cent., and the total costs by 1·08d., equal to 41 per cent. per unit sold. The average price obtained has been less by ·73d. per unit, a reduction of 26 per cent. on the price for the previous year. The revenue for the year has increased by £3,248, or 41 per cent., and the generating costs by £777, or 21 per cent. The gross profit is £6,740, equal to 9 per cent. on the average capital employed, compared with £4,270, or 6¼ per cent. for the previous year. The net profit, after payment of all charges, is £2,931, equal to nearly 4 per cent. on the capital, compared with less than 1 per cent. for the previous year. An expenditure of £4,064 has been made on capital account, principally on new mains and services, motors for hiring, and balances on account of contracts for new generating plant. The total outlay is now £77,553. The alteration in the charges made from July 1 last has reduced the average price obtained from private lighting from 4·73d. to 4·17d. per unit sold, equal to 12 per cent.; for motor

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power the reduction is from 1·54d. to 1·44d. per unit, equal to 6½ per cent.; and for public lighting from 2·14d. to 1·87d. per unit. During the present year there will be an increase in tramway consumption of nearly 250,000 units, and applications are in hand for the supply to 150 h.p. of motors, which will use at least 125,000 units per annum.

## PROVISIONAL PATENTS, 1905.

MAY 22.

2310A. **Improvements in electric switches.** Wallace Fairweather, 65, Chancery-lane, London. (The National Electric Company, United States.) (Date applied for under Patents Rule 9, Feb. 6, 1905. (Complete specification.)

10629. **A new or improved system or apparatus for automatically releasing electric telegraphs.** Eugène Ducretet, 77, Colmore-row, Birmingham. (Complete specification.)

10639. **Improvements in apparatus for use in regulating the load on direct-current electrical generators.** Ernest Sherwood Woollard Moore and William Guthrie Strang, Prince's-chambers, Wolverhampton.

10644. **Improvements in or connected with automatic electromagnetic sanding gear, for use on electric railway and tramway vehicles.** Mark Cummins, 8, Peel-terrace, Chester-road, Old Trafford, Manchester.

10647. **Improvements in telephones.** Percy Adolphus Vaile, 3, Whitehall-court, Westminster, London.

10653. **Improvements in vapour electric apparatus.** Percy Holbrook Thomas, the Westinghouse Patent Bureau, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, May 25, 1904, being date of application in United States.) (Complete specification.)

10669. **Improvements in combined electric switches and fuses.** Callender's Cable and Construction Company, Limited, and John Charles Augustus Ward, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

10694. **New or improved means for neutralising static electricity.** William Henry Chapman, 18, Buckingham-street, Strand, London. (Complete specification.)

10695. **New or improved apparatus for neutralising static electricity.** William Henry Chapman, 18, Buckingham-street, Strand, London. (Complete specification.)

10696. **A new or improved apparatus for neutralising static electricity.** William Henry Chapman, 18, Buckingham-street, Strand, London. (Complete specification.)

10707. **Improvements relating to switching devices for use in electric flash advertising.** Leonard Kingwill Job, 322, High Holborn, London.

10708. **Improvements in receivers for wireless telegraphy.** William Phillips Thompson, 6, Lord-street, Liverpool. (Ges. für drahtlose Telegraphie m. b. H., Germany.) (Complete specification.)

10709. **Improvements in receiver connections for wireless telegraphy.** William Phillips Thompson, 6, Lord-street, Liverpool. (Ges. für drahtlose Telegraphie m. b. H., Germany.) (Complete specification.)

10710. **Improvements in transmitters for wireless telegraphy.** William Phillips Thompson, 6, Lord-street, Liverpool. (Ges. für drahtlose Telegraphie m. b. H., Germany.) (Complete specification.)

MAY 23.

10728. **Improvements in suspension devices for electric arc lamps.** Adolph Wunderlich and Gwylim Anwyl Hughes, trading as the London Electric Firm, 18, Southampton-buildings, Chancery-lane, London.

10793. **Improvements in electrical signalling apparatus.** Leon Byron Woodworth, 4, South-street, Finsbury, London.

10794. **Improvements in electrical signalling apparatus.** Leon Byron Woodworth, 4, South-street, Finsbury, London.

MAY 24.

10816. **Improvements in and relating to clutch mechanism for detachably connecting an arc lamp, or other appliance or apparatus, to a post, pillar, or other high-up support at a point out of reach.** Verity's Limited and Frederic Stanhope Worsley, 11, Burlington-chambers, New-street, Birmingham.

10818. **Improvements relating to self-contained travelling cranes with oil, gas, and electric motors and dynamos.** William Gordon Potter, 13, Mostyn-road, Brixton, London.

10819. **Improvements in and relating to apparatus for determining the presence and nature of electric currents in a circuit and for ascertaining the voltage of such currents.** Frederick Henry Varley, 57, Chancery-lane, London.

10828. **An improved overhead travelling hoist or "jenny" for electric or other power.** Ashley Crosthwaite Peake and John Robinson Crosthwaite, 6, Finkle-street, Stockton-on-Tees. (Complete specification.)

10888. **Improvements in or relating to primary batteries.** Kenneth Costley White and Joseph Cowley, Birkbeck Bank-chambers, Chancery-lane, London.

10830. **Improvements in apparatus for starting and for regulating the speed of compensated single-phase electric motors.** Engelbert Arnold and Jens Lassen La Cour, 34, Castle-street, Liverpool. (Date applied for under Patents Act, 1901, May 24, 1904, being date of application in Germany.) (Complete specification.)

10887. **Improvements relating to magneto-ignition devices of internal-combustion engines.** Stephen Dewar Holden and Frederick Vernon Russell, 8, Quality-court, Chancery-lane, London.

10892. **Improvements in systems of electric motor control and apparatus therefor.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

10893. **Improvements in and relating to systems of electric motor control and in apparatus therefor.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

10895. **Improvements in and relating to electric motor control systems and in apparatus therefor.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

10896. **Improvements in and relating to systems of electric motor control and in apparatus therefor.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

10897. **Improvements in and relating to dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.) (Complete specification.)

MAY 25.

10910. **Improvements in or relating to electrical switches.** William Herbert Isherwood, Carlton Mills, Woodhouse-lane, Leeds.

10928. **Improvements in fan ventilators.** Crompton and Co., Limited, and Claud Crompton, Arc Works, Chelmsford.

10949. **Improvements in insulation for commutators.** Max Meirowsky, 65, Chancery-lane, London.

10959. **Improvements relating to electrical measuring instruments.** Harry Hertzberg, William Prescott Snyder, James Henry Griffin, and Harry Irvin Bernhard, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

10970. **Improvements in or connected with insulated electric wires.** Walter Osmond, 40, Chancery-lane, London.

10973. **Improvements in terminals for electrical apparatus.** Harold William Smith, 322, High Holborn, London.

MAY 26.

11012. **Improvements in terminal clips for electric cables.** Mortimer Arthur Codd, 167, Oakwood-court, Addison-road, London.

11036. **Improvements in alternating-current measuring instruments.** Frank Conrad and William Maple Bradshaw, Westinghouse Patent Bureau, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, May 27, 1904, being date of application in United States.) (Complete specification.)

11040. **Improvements in electric batteries.** Dyson Fuller, 33, Chancery-lane, London.

11056. **Improvements in and connected with electric accumulator plates.** Henry Fairbrother, 33, Cannon-street, London.

11057. **Improved means applicable for use in transmitting and receiving communications by wireless telegraphy.** John Groeme Balsillie, Clun House, Surrey-street, London.

11061. **Improvements in brush-holders for dynamo-electric machines and the like.** Charles William Speirs and Julius Frith, 4, South-street, Finsbury, London.

11074. **Improvements in and relating to the regulation of the voltage of alternating-current systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

11075. **Improvements in electric heaters.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

11076. **Improvements in brush-holders for dynamos and motors.** Henry Francis Joel, sen., 74, Windsor-road, Forest Gate, Essex.

MAY 27.

11082. **An improved means of speed control and voltage regulation for electric motors and dynamos.** William Arthur Stevens, Victoria Works, St. Peter-street, Maidstone.

11120. **Improved system of electric wiring for electric lighting and power installations.** Herbert James Read, Chalford, Stanhope-road, St. Albans, Herts.

11142. **Improvements in insulating tapes.** Callender's Cable and Construction Company, Limited, and George Barnard, 24, Southampton-buildings, Chancery-lane, London.

11146. **Improvements in the manufacture of electrical resistances.** The Electric Equipment and Securities, Limited, and Charles Ruzicka, Clun House, Surrey-street, London.

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## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published June 15.*

1904.

**6959A. Form of carbon specially suitable for filaments of electric incandescent lamps and the manufacture thereof.** Levis. (General Electric Company.) (Date applied for under Patents Rule 9, March 22, 1904.)

**11522. Commutator brushes.** Morgan Crucible Company, Limited, and Speirs.

**11884. Safety device for overhead electric conductors.** Hayward and Fox.

**11887. Rotary electric switch.** Dugdill.

**12545. Alternating-current electric meters.** Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, June 2, 1903.)

**13353. Electrically-propelled railway and tramway vehicles.** Colling.

**13570. Controlling switches for electric circuits.** British Thomas-Houston Company, Limited. (General Electric Company.)

**13736. Apparatus employed for measuring wave lengths in wireless telegraphy.** Fleming.

**14111. Self-locking electric contact maker or switch for fire-alarm and other purposes.** Golding.

**14195. Electric tramways worked on the conduit system.** Watkins.

**14250. Dynamo-electric machines and the like.** Torda.

**14717. Insulating electric conductors especially suitable for the firing plugs of internal-combustion engines.** Leighton and Hacking.

**15070. Control of electric motors and machines driven thereby.** British Thomson-Houston Company, Limited. (General Electric Company.)

**15303. Enclosed electric fuses.** British Thomson-Houston Company, Limited. (General Electric Company.)

**15495. Dynamo-electric machines for regulating the charge and discharge of storage batteries used in combination with main generators.** Lancashire Dynamo and Motor Company, Limited, and McLeod.

**15648. Electrical resistances.** Veritys Limited and Gott.

**15879. Alternating electric current meters.** Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, July 17, 1903.)

**16026. Vapour electric apparatus.** Carolan. (General Electric Company.)

**16109. Reverse electric current switches or circuit breakers.** British Thomson-Houston Company, Limited. (General Electric Company.)

**16241. Electric arc lamps.** Brockie.

**16260. Electric controllers.** British Thomson-Houston Company, Limited. (General Electric Company.)

**16409. Electric measuring instruments.** British Thomson-Houston Company, Limited. (General Electric Company.)

**17133 Electric governor for internal-combustion engines.** Roberts.

**29125. Switching devices for electric lamps especially adapted for use in "flash" advertising.** Job.

1905.

**392. Controlling the luminosity of electric lamps and their consumption of electric current.** Hunter.

**1231. Apparatus for operating gas taps and electrically igniting the gas.** Lorrain. (Soc. Anon. des Allumeurs-extincteurs Automatiques.)

**2632. Burnishing tools for use in the electro-deposition of metals.** Jobling and Harrison.

**2982. Line selectors for telephone and like systems.** Hardegen.

**5836. Electric glow lamps.** Scholvien. (Date applied for under International Convention, Sept. 29, 1904.)

**7295. Alternating-current electric motors.** Lamme. (Date applied for under International Convention, May 3, 1904.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ½-¼ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 7/16-17/32 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | – | 5½-6 |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | – | 5¾-6¼ |
| —— 4½ per cent. Mortgage Debentures | 100 | – | 102-105 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 100-102 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | – | 2 17/16-3 1/16 |
| —— 4 per cent. Mortgage Debenture Stock | 100 | – | 89-91 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 | 2 | – | ½-¾ |
| —— Non. Cum., 6 per cent. Pref. | 2 | – | 1¼-1⅝ xd |
| —— 4½ per cent. 1st Debenture Stock | 100 | – | 92-95 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | – | 79-82 |
| Callender's Cable, Debentures | 100 | – | 107-109 |
| —— Ordinary | 5 | – | 10¼-11¼ |
| —— 5 per cent. Pref. | 5 | – | 5⅛-5⅜ |
| Crompton and Co. | 5 | – | 1½-2¼ |
| —— 5 per cent. Debentures | 100 | – | 95-100 p.c |
| Edison and Swan United, "A" Shares, 1-99,261 | 5 | – | 1½-1¾ |
| —— "A" Shares, 01-017,139 | 5 | – | 2 2¼ |
| —— 5 per cent. Debentures | 100 | – | 88 93 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 83-88 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | – | ⅞-1⅛ |
| —— 7 per cent. Cumulative Pref. | 2 | – | 2¼-2½ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | – | 96-99 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | – | 9⅜-10¼ |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | – | 97-101 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | – | 11¼-12½ |
| —— 4½ per cent. Preference | 5 | – | 5⅜-5⅝ |
| —— 4½ per cent. Debentures | 100 | – | 109-111 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | – | 15½-16½ |
| —— 4 per cent. Debentures | 100 | – | 100-103 |
| Parker, Thos., Limited, Ordinary | 10 | – | 10-10¼ |
| Telegraph Construction and Maintenance | 12 | – | 33 35 |
| —— 5 per cent. Bonds | 100 | – | 103-105 |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary | 10 | – | 11⅜-12¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | – | 10 10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | – | 11-12 |
| —— 4½ per cent. Debenture Stock, Red. | 100 | – | 106-108 |
| Bromley (Kent) Electric Light and Power Co. | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. 1st Debenture Stock, Red. | 100 | – | 102-105 |
| Brompton and Kensington, Ordinary | 5 | – | 9½-10¼ |
| —— 7 per cent. Preference | 5 | – | 9½-10⅜ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 | 5 | – | 8½ 9 xd |
| —— Nos. 60,001-80,000 | 5 | – | 7½ 8 xd |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | – | 12¾-13¼ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 105-108 |
| Charing Cross and Strand, 70,001-80,000 | 5 | – | 7½-8¼ |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5⅝-5⅞ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 4⅞-5¼ |
| —— 40,001-80,000 | 5 | .. | 4⅝-5¼ |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | – | 106 108 |
| Chelsea Electricity Supply | 5 | – | 6 6½ |
| —— 4½ per cent. Debentures | 100 | – | 109-111 |
| City of London, Ordinary | 10 | – | 10½-11¼ |
| —— 6 per cent. Cumulative Pref. | 10 | – | 13¾-14¼ |
| —— 5 per cent. Debenture Stock | 100 | – | 124 128 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | – | 104-106 |
| County of London Electric Supply, Ordinary | 10 | – | 8¼-9 |
| —— 6 per cent. Cum. Pref. | 10 | – | 12-12¼ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 103 105 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. | 100 | .. | 112-115 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | – | 5¾-6⅛ |
| —— 6 per cent. Cum. Pref. | 5 | – | 6-6⅛ |
| —— 4½ per cent. First Mort. Deb. | 100 | – | 107-109 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 2½-3 |
| —— 5 per cent. Debenture Stock, Red. | 100 | – | 86-91 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | – | 5¼-5⅜ |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | – | 101-104 |
| Havana Electricity, Limited, 1-15,000 | 10 | – | 9¼-10½ |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | – | 7¾-8¼ |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 100-103 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 | 1 | – | ¾-⅞ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | | 12-13 |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red | 100 | – | 101-103 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅜-10¼ |
| London Electric, Ordinary | 5 | – | 2-2½ |
| —— 6 per cent. Pref. | 5 | – | 5-5¼ |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | – | 99-101 |
| Metropolitan Ordinary, 100,001-300,000 | 5 | – | 9¼-9⅜ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | – | 109-114 |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5¼-5⅜ |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | – | 97-99 |
| Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb. | 100 | – | 99-101 p.c. |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | – | 98-101 |
| —— Preference | 4 | – | 100-102 |
| Notting Hill Electric Lighting | 10 | – | 14¼-15¼ |
| —— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.) | 100 | – | 100-102 |
| Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,510 | 5 | – | 6¼-6⅜ |
| —— 4 per cent. Debenture Stock | 100 | – | 98-100 |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures | 100 | – | 101-104 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 | – | 2⅝-3¼ |
| —— 4 per cent. Debenture Stock | 100 | – | 79-83 |
| South London, Ordinary | | – | 3¾-4¼ |
| South Metropolitan Electric Light and Power Co., Ord. | 1 | .. | 13/16-15/16 |
| —— 7 per cent. Cum. Pref. | 1 | .. | 1 11/32-1 13/32 |
| —— 4½ per cent. 1st Mort. Deb. | 100 | .. | 105 108 |
| —— Ditto, June, 1904 | | – | |
| St. James's and Pall Mall, Ordinary, 101-20,000 | 5 | – | 14-15 |
| —— 7 per cent. Pref. | 5 | – | 8¼-8⅜ |
| —— 3½ per cent. Deb. | 100 | – | 98-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | – | 4¾-5¼ |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5¼-5⅜ |
| Westminster, Ordinary | 5 | – | 12-13 |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | – | 6-6¼ |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 | 5 | – | 6-6¼ |
| —— Ord. | 5 | .. | 8⅜-8⅝ |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | – | 141-144 |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 105-107 |
| Barcelona Tramways, Limited, Ord., 1-20,000 | 10 | .. | 12¼-12⅜ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 | 10 | .. | 9⅜-10¼ |
| —— 5 per cent. Deb., Red., 1-600 | 100 | .. | 99-102 |
| —— 4½ per cent. Red. Deb. Stock | 100 | .. | 96-100 |
| Bath Elec. Tramways., Ld, Pref. Ord. Shs., 75,001-150,606 | 1 | .. | ¾-⅞ |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 | 1 | .. | 15/16-1 1/16 |
| Belfast Street Tramways, Ord., 1-26,600 | 10 | .. | 10¼-11¼ |
| Blackpool and Fleetwood Tramroad | 10 | – | 13⅜-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | – | 1-1¼ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | – | 3¾-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 91-98 |
| British Columbia Electric Railway Co., Ord. Def. | 100 | – | 104-107 |
| —— Ord Pref. | 100 | – | 100-103 |
| —— Non. Cum. 5 per cent. Pref. | 10 | – | 10¼-10⅜ |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each | 40 | – | 103-103.5 p.c |
| —— 4½ per cent. Vancouver Power Deb. | 100 | – | 100-103 |
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 | – | 9¼-9⅜ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | – | 11-11¼ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | – | 122-124 |
| —— 4½ per cent. 2nd Deb. Stock | 100 | – | 97-99 |

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| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| | £ | | £ |
| Buenos Ayres and Belgrano Tram. | 5 | – | 3⅜-3⅝ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | – | 6¼-6½ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | – | 6¼-6½ |
| —— 5 per cent. Deb. Stock, Red. | 100 | – | 107-109 |
| —— Prov. Certs., all paid | 100 | – | 105-106 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | – | 97-99 |
| Calcutta Tramways, Limited, 1-102,268 | 5 | .. | 8⅛-8½ |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | .. | 107-109 |
| Cape Electric Tramways Nos. 1-480,000 | 1 | – | 1¼-1½ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | – | 4⅞-5⅛ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917) | 100 | – | 99-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | | 101-103 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | | 9½-10 |
| —— 5 per cent. Cum. Pref. | 10 | – | 11-12 |
| —— 4 per cent. Debentures | 100 | – | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | – | 13½-14¼ |
| —— 5 per cent. Pref., Nos. within 1-60,000 | 10 | – | 15½-16½ |
| —— 5½ per cent. Mort. Debs., 1-3,000, Red. | 100 | – | 94-97 |
| Imperial Tramways Ordinary | all | – | 13-13 |
| —— 6 per cent. Cum. Pref. | all | – | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 | – | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cm. Pref., Nos. 30,001-60,000 | 5 | | 3-3½ |
| —— 4 per cent. Debenture Stock | 100 | – | 85-90 |
| Kilmarnock and District Lighting and Traction, Pref. | 5 | – | 8-8½ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | – | 9⅞-10½ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. | 100 | – | 99-102 |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 | .. | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016 | 1 | .. | 9/32 11/32 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | .. | 1-1 1/16 |
| —— 4½ per cent. Deb. Stock, Red. | 100 | .. | 105-107 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000 | $1,000 | .. | 106-110 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 | .. | 101-104 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 | .. | 103-105 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 54,001-74,000 | 5 | – | ¼-1½ |

| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| | £ | | £ |
| Oldham, Ashton, and Hyde Tramway, Ordinary | 10 | | 12 |
| —— 5 per cent Cum. Pref. | 10 | – | 9½-9⅝ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk. | 100 | – | 105-108 |
| Potteries Electric Traction, Ordinary 20,001-40,00 | 10 | – | 8¾ 9¼ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | – | 9¼ 9⅝ |
| —— 4½ per cent. Debenture Stock | 100 | – | 101-104 xd |
| South Lancashire Electric Traction and Power Company | | | |
| —— £250,000 Ordinary | 1 | | 1 |
| —— £101,152 5 per cent. Preference | 1 | | |
| —— £597,170 4½ per cent. Debenture Stock | 100 p.c. | – | 100 p.c. |

## Electric Railways.—

| | | | |
|---|---|---|---|
| Central London, Ordinary | 100 | – | 91-93 |
| —— 4 per cent. Pref. | 100 | – | 101-103 |
| —— " deferred | 100 | – | 80-85 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | – | 110-112 |
| City and South London, Consolidated Ordinary | 100 | – | 40-42 |
| —— 4 per cent. Debenture Stock | 100 | – | 107-109 |
| —— 5 per cent. Pref. Stock '91 | 100 | – | 120-123 |
| —— " " " '96 | 100 | – | 118-121 |
| —— " " " '01 | 100 | – | 115-118 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | – | 10-10¼ |
| —— Ordinary, 1-50,000 | 10 | – | 3¾-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | – | – | 99-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | – | – | 101-102 |
| Waterloo and City, Ordinary | 100 | – | 90-92 |

## Telephones.—

| | | | |
|---|---|---|---|
| National Telephone, Preferred | 100 | – | 110 111 |
| —— Deferred Stock | 100 | – | 101-103 |
| —— 6 per cent. Cum. First Pref. | 10 | – | 12¼-13¼ |
| —— 6 per cent. Cum. Second Pref. | 10 | – | 11¼-12¼ |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | – | 5⅛-5⅜ |
| —— 3½ per cent. Deb. Stock, Red. | 100 | – | 100-102 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 103-105 |
| —— 4 per cent. Prov. Cert. | – | – | 103½-104¼ |
| Oriental Telephone and Electric Company | 1 | – | 1 3/16-1 5/16xd |
| —— 6 per cent. Cum. Pref. | 1 | .. | 1¼-1¼ xd |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905. | 1904. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pass'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | May 27 | 1,249 | 1,376 | – 125 | — h | 19¼ | 19¼ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·14 |
| Ayr Corporation | ,, 27 | 329 | 304 | + 25 | + 44 | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 336,049 | 1·03 | 10·11 | 1,770 | 5 0 |
| Barking Corporation | — | — | — | — | — | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 28 | 978 | 1,171 | – 193 | – 253 | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,319,701 | 1·158 | 9·98 | 2,383b | 6·1 |
| Birmingham Corporation | ,, 27 | 319 | 300 | + 49 | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | — | — | — | — | — | 6¼ | 6¼ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 24 | 953 | 1,155 | – 201 | + 200 | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10·94 | — | 4·58 |
| Blackpool Corporation | ,, 25 | 625 | 1,666 | –1,041 | – 384 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 27 | 458 | 1,597 | –1,139 | – 1,014 | 16½ | 16½ | Dec. 31 | 302,021 | 2,258,984 | 600,757 | 3·34 | 12·75 | 2,001 | 7·05 |
| Bolton Corporation | ,, 28 | 1,874 | 2,383 | – 514 | + 135 | 38 | 38 | March 31 | 94,161 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·89 |
| Bournemouth Corporation | ,, 24 | 1,027 | 1,384 | – 357 | – 471 | 10·15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 27 | 4,102 | 5,947 | –1,845 | – 2,303 | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 28 | 780 | 1,192 | – 212 | + 2491 | 9 | 7½ | ,, 31 | — | — | — | — | — | — | — |
| Bristol Tramways Company | ,, 27 | 4,929 | 6,202 | –1,273 | — | 51½ | 51½ | Dec. 31g | 253,150 | 44,391,439 | 6,036,528 | 1·00 | 10·10 | — | — |
| Burnley Corporation | ,, 27 | 1,045 | 1,190 | – 145 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 28 | 305 | 426 | – 121 | — | 8½ | — | March 31j | 11,574 | 2,566,134 | 282,378 | 1·08 | 9·84 | 1,570 | 7·57 |
| Cardiff Corporation | ,, 27 | 1,687 | 2,576 | – 639 | – 613 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 27 | 183 | 230 | – 47 | – 376 | — | — | Dec. 31g | 9,987 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 27 | 6,715 | 6,693 | + 22 | + 2,012k | 6 | 6 | ,, 31 | 362,471 | 44,953,938 | 1,292,674a | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 28 | 2,473 | 2,673 | – 200 | – 3,348k | 6¼ | 6⅜ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Colchester Corporation | ,, 24 | 172 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 25 | 560 | 509 | + 51 | — | — | — | ,, 31g | 26,657 | 6,353,323 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | ,, 26 | 233 | 241 | – 8 | + 31 | 7·23 | 7·23 | March 31a | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | ,, 13 | 198 | 195 | + 3 | — | 4½ | 4½ | ,, 31 | 11,265 | 2,871,332 | 280,901 | 0·94 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | ,, 26 | 121 | 199 | – 78 | — h | 7 | 6½ | Dec. 31g | 6,234 | 388,905 | 107,164 | 3·88 | 14·09 | 932 | 7·39 |
| Dublin U. T., electric cars | ,, 26 | 4,033 | 4,427 | – 394 | } — | 47 | 46 | ,, 31g | 134,643 | — | 3,429,356 | — | — | — | — h |
| Dublin S. District, Electric | ,, 26 | 1,089 | 1,197 | – 103 | | | | | | | | | | | |
| Dundee City Tramways | ,, 24 | 835 | 860 | – 27 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 27 | 814 | 942 | – 128 | + 124 | 10·77 | 10·75 | March 31 | 34,312 | 12,950,269 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 27 | 15,524 | 14,993 | + 531 | +40,770h | 145 | 123 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Gloucester Corporation | ,, 24 | 287 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 17 | 3,042 | 2,624 | + 418 | + 627 | 33 | 30½ | March 31 | 68,289 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,069 | 8·77 |
| Huddersfield Corporation | ,, 20 | 1,348 | 1,267 | + 81 | + 470 | 35 | 35 | ,, 31 | 65,545 | 11,899,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | ,, 27 | 2,035 | 2,420 | – 385 | – 372 | 26 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | April 29 | 546 | 446 | + 100 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | May 24 | 114 | 207 | – 93 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 24 | 214 | 223 | – 9 | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 27 | 5,675 | 6,979 | –1,306 | + 501 | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | April 2 | 1,961 | — | — | — | 7¼ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | May 20 | 10,884 | 10,354 | + 334 | + 8,414 | 103 | 103 | Dec. 31g | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | ,, 28 | 1,518 | 1,908 | – 390 | – 1,772k | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — e |
| London County Council | ,, 20 | 13,796 | 11,451 | +2,345 | +17,868 | 46¼ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | ,, 25 | 111 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 27 | 12 405 | 14,712 | –2,309 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 27 | 124 | 139 | – 15 | + 87 | 2½ | — | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newcastle-on-Tyne Corptn. | ,, 27 | 3,583 | 4,031 | – 449 | — | 45 | 38½ | ,, 25 | 185,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111b | — |
| Newport (Mon.) Corporation | — | — | — | — | — | 15 | — | — | — | — | — | — | — | — | — |
| Oldham Corporation | ,, 28 | 1 595 | 1 314 | + 281 | — | 34½ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 27 | 1,761 | 2,387 | – 626 | — | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·16 | 12·39 | — | — |
| Reading Corporation | ,, 25 | 565 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Rochdale Corporation | April 29 | 582 | 120 | + 462 | + 1,811 | 4½ | 4½ | 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | May 25 | 409 | 737 | – 328 | — | — | — | ,, 31 | 23,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·68 |
| Salford Corporation | ,, 29 | 4,287 | 5,344 | –1,057 | — | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 27 | 93 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 28 | 4,906 | 5,560 | – 653 | + 17 | 34½ | — | ,, 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 17 | 914 | 957 | – 42 | – 307 | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 24 | 313 | 440 | – 127 | — | 6½ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 26 | 600 | 708 | – 108 | + 174 | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 21 | 1,157 | 1,260 | – 103 | — | 19 51 | 18·48 | ,, 31 | 62,506 | 14,848,958 | 1,433,463 | 1·01 | 10·46 | — | 6·02 |
| Swindon Corporation | ,, 24 | 175 | — | — | — | 3½ | — | — | — | — | — | — | — | — | — |
| Wallasey U.D.C. | ,, 27 | 711 | 880 | – 169 | + 189 | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·50 |
| Warrington Corporation | ,, 18 | 332 | 303 | + 29 | + 146 | 7¼ | — | — | — | — | — | — | — | — | — |
| West Ham Corporation | ,, 25 | 1,535 | 1,247 | + 288 | + 5,095 | 8·62 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 24 | 719 | 972 | – 253 | — | 7½ | — | ,, 31g | 20,878 | 4,263,066 | 417,335 | — | 12·006 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. c Train mile. Per mile of single track. e Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures. Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**King's College.**—The forty-fifth annual dinner of this college will be held at the Hotel Cecil on Monday, the 26th inst., with Col. Richard H. Jelf, C.M.G., in the chair.

**Municipal and County Club.**—This club will entertain Mr. W. H. Grenfell, M.P., chairman of the Thames Conservancy Board, as their guest at the house dinner on the 29th inst.

**Wireless Telegraphy.**—It is reported that the Cunard liner "Campania" has been in continuous wireless communication with land throughout her voyage from Liverpool to New York. In mid-ocean she had simultaneous communication with America and Europe.

**Royal Institution.**—A general monthly meeting of the members of this institution was held on the 5th inst., the Duke of Northumberland, K.G., F.R.S., president, in the chair. Mr. E. Hurry Fenwick, F.R.C.S., and Mr. Oswald Lewis were elected members. The special thanks of the members were returned to Mr. L. F. Everest for his present of a portrait of Colonel Sir George Everest, C B., F.R.S.

**North-East Coast Institution.**—The issue dated May of the *Transactions* of the North-East Coast Institution of Engineers and Shipbuilders contains the Board of Trade regulations for certificated marine engineers, the resumed discussion on Mr. Frank Little's paper on "Petrol Motorcars," and the resumed discussion on Mr. J. F. C. Snell's paper on "The Application of Electricity to Industrial Purposes."

**The American Institute.**—The *Proceedings* of the American Institute for May contains Mr. G. F. Chellis's paper on "Time-Limit Relays"; Mr. H. W. Buck's paper on "Duplication of Electrical Apparatus to Secure Reliability of Service"; and Mr. Thorburn Reed's paper on "Limits of Injurious Sparking in Direct-Current Commutation," with the discussion on "Line Construction for High-Pressure Electric Railroads" and "High-Pressure Line Construction for Alternating-Current Railways." We learn, by the way, that Dr. S. S. Wheeler, whose career we briefly described in a recent issue, has been elected president for the ensuing year.

**Rose Polytechnic.**—We have received the twenty-third annual programme of this institution, which is situated at Terre Haute, Ind. The foundation provides higher education in engineering, its course of instruction embracing civil, electrical, and mechanical engineering and cognate subjects. The system in vogue is a judicious blending of laboratory work with lectures. There is an excellent library, over 10,000 volumes and 2,000 pamphlets being included, and additions are constantly being made. The students of all grades total 219. There is an extensive staff of instructors, and we infer that the institution is performing good work in the American engineering field.

**Electricity for Training Horses.**—The *Swiss Artillery and Engineers' Review* describes the use of electricity in training horses at the depôt of remounts for the Swiss cavalry. The electric shock is used as a corrective, the apparatus employed being a battery and circuit. The battery is contained in a little leather case, which the officer carries on his shoulder, and a special system permits him to localise the effect of the discharge at any particular part of the horse's body. Although the current generated by the battery is very weak, it produces upon the horse a remarkable and enduring effect, which, it is claimed, enables a bad habit to be speedily overcome. Several successful applications of the kind are reported, and in no case has the use of electricity proved injurious.

**Attracting Traffic.**—The American's penchant for advertising is well known, and, despite the dictum that there is nothing new under the sun, he often contrives to achieve novelty. The Rochester and Sodus Bay Railway, U.S.A., is an interurban line of 40 miles which traverses territory rich in fruit and flowers. When May comes round and the apple blossoms are in their glory, the line is advertised as the "Apple Blossom Route—40 miles of Apple Blossoms," etc. A car with accommodation for 40 to 50 people can be chartered for this trip at the rate of £10, or single daily excursion tickets can be had for 3s. In the case of private parties souvenir cards, decorated with apple blossoms and containing an alluring invitation to see the real thing, are sometimes issued. Enterprise of this sort would probably be advantageous to the lines of this country.

**The Institution.**—The issue of the *Journal* dated May contains Mr. G. L. Addenbrooke's paper on "The Value of Overhead Mains for Electric Distribution in the United Kingdom," with the discussion; Mr. Donald Murray's paper on "Setting Type by Telegraph," with the discussion; Mr. E. H. Rayner's paper comprising a report on temperature experiments carried out at the National Physical Laboratory; and Mr. R. Goldschmidt's paper on "Temperature Curves and the Rating of Electrical Machinery," with the joint discussion; Mr. H. B. Maxwell's paper before the Glasgow Section on "Street-Lighting by Electric Arc Lamps," with the discussion; Mr. H. W. Wilson's paper on "The Electrical Operation of Textile Factories" (Manchester Section); and Mr. J. Lord's paper on "Tramways Permanent-Way Construction and Maintenance." In future the *Journal* will consist of two volumes annually instead of one.

**Electric Furnaces.**—We have received from the publisher, Mr. A. Hermann, of 6-12, Rue de la Sorbonne, Paris, an interesting book entitled "Le Four Electrique," which relates to the origin, transformations, and applications of electric furnaces, and is from the pen of M. Adolphe Minet. The volume in question contains portraits of eight of the pioneers in electro-metallurgy and a large number of illustrations. The development of the electric furnace is traced from the earliest laboratory experiments, and a large number of furnaces are described which have not actually led to commercial results. The volume is a useful one as a book of reference, and we think that it would be rendered more valuable if further details of the actual results obtained in the most modern commercial undertakings were given. The last part of the book deals with the theory of the subject, and is useful to the electrical engineer entering this department of the profession.

**Motor 'Buses.**—The North-Eastern Railway Company scored a success in the House of Commons last week, when their Bill authorising the running of motor 'buses was ordered for third reading. An amendment designed to prevent the vehicles from taking up passengers at intermediate points between stations was rejected, so that the efforts of the Municipal Tramways Association were unavailing on this occasion. The remarks of Mr. Bonar Law are interesting, as reflecting the views of the Board of Trade. He stated that it would be a disastrous thing to pass the amendment. The "drum municipal" had been beaten again. They were told that this traffic would injure tramways, but when it was proposed to bring a tramway over Westminster Bridge it was said that motor 'buses could not compete with tramcars. The Board of Trade had constantly to see that the railway companies carried out the obligations imposed on them by Parliament, and the Board were bound to use its influence to prevent the companies from being unfairly treated. It was becoming a question of whether Parlia-

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ment was to control the municipalities or whether they were to control Parliament.

**Electricity in Mining.**—We observe from the annual report of the Tredegar Iron and Coal Company, Limited, that, despite unusual conditions of an adverse character, the company maintained practically continuous working, with the result that the directors are able to recommend a dividend of 5 per cent., after placing £25,300 to capital account and carrying forward £1,353. The output of coal aggregated 1,421,230 tons. Of special interest to electrical engineers, however, is the circumstance that the electrical plant, the installation of which was commenced about four years ago, has now been working in its entirety for a sufficient period to enable the directors to state, after exhaustive tests and minute enquiry and comparisons, that the results fully justify the expenditure in adopting electricity as the motive power for hauling, pumping, and lighting the collieries. With such definite results as this to guide them, there should be a distinct impetus to the employment of electricity on the part of colliery owners.

**Copper Production.**—From an approximate report upon the world's copper production, it appears that the total for 1904 was about 632,166 metric tons, against 578,876 for 1903. The United States easily heads the list with 349,866 tons, Mexico being second with the comparatively modest record of 52,500 tons. Spain and Portugal constitute the most prolific of the European representatives with 50,000 tons. Germany is credited with 30,000 tons, and Russia with 10,000. The output of the other European countries is insignificant, Great Britain being deemed unworthy of mention. The world's copper production has risen progressively during the past century from 91,000 tons for the decade 1801-10 to the 632,166 recorded for 1904. Spain, which 25 years ago ranked first among the nations as a copper-producing country, now takes third place. Japan turned out 32,000 during the past year, and Australia and Canada are credited with the respectable records of 30,000 and 21,500 tons.

**Association of Municipal and County Engineers** The annual meeting of the members of the western district of the above association was held at Gloucester on Saturday, when, after a reception by members of the Corporation, the party, to the number of about 75, were conveyed by special trams to the works and new offices of the Gloucester Railway Carriage and Wagon Company, through the many departments of which they were shown by Mr. B. Allen, assistant manager, and other officials. Thence they journeyed to the municipal depôt and the electric depôt. After lunch the party inspected the Corporation electric light and power station under the guidance of Mr. W. Bache. Later in the afternoon the annual meeting was held at the Guildhall. Mr. Pickering was unanimously re-elected hon. secretary of the western district, and two papers, the first by Mr. R. Read on "The Municipal Works of the City," and the second by Mr. W. Bache, electrical engineer, on "Gloucester Electricity Works," were discussed. The papers are reproduced elsewhere in this issue.

**Board of Trade Organisation.**—A discussion took place in the House of Commons on Tuesday as to the reorganisation of the Board of Trade. Sir Albert Rollit drew attention to the urgent desirability of the appointment of a minister of commerce and industry if we desired to maintain our commercial pre-eminence. Mr. Bonar Law, permanent secretary to the Board, recognised that the feeling of the House was unanimous in favour of some change in the constitution of the Board, and stated that a Bill had been drafted in order to carry out the promise contained in the King's Speech. He concurred in the desirability of bringing the Department into closer touch with men engaged in commerce, and thought it could be best done through the agency of the Commercial Intelligence Department. There were, however, difficulties in the way in connection with getting permanent officials to run in harness with outsiders, and in preventing the Department from entering upon thorny controversial ground. He could not promise action with regard to differential railway rates, pending the report of the committee now considering the subject.

**Electricity in Egypt.**—The *Bulletin* of the French Chamber of Commerce on electricity contains an interesting article and analyses of the various applications of electricity which are possible in Egypt. This points out in the first instance that agriculture and irrigation are the principal operations carried on in Egypt, and that it is in irrigation that electricity is most likely to be of service. There are large numbers of small pumps now used for this purpose which could frequently be replaced by a smaller number of electrically-driven pumps. These could be supplied with energy by means of overhead wires carried a considerable distance to the source of power. The report considers that in Upper Egypt this application of electricity will be found most useful, and that the Falls of the Nile should be used as a source of power. Information is also given as to the extent to which electricity is now used in the larger Egyptian towns, and in factories which have sprung up in the neighbourhood. For electrical purposes it is said that the oil-engine is a strong competitor with electricity in certain districts, owing to the cheapness of oil. After indicating a number of ways in which an extended use of electricity is to be looked for, the report concludes with a strong plea for better representation of French firms in the country.

**Inductance in Telephone Circuits.**—When inductance coils are introduced at regular intervals through a telephone cable, the electrostatic capacity is neutralised by sections, but the conductors of sections between the inductance coils are free from any characteristic tending to counteract the electrostatic condition that may arise between the inductance coils. Prof. D. C. Jackson, according to a patent recently issued to him in the United States, and described in the *Electrical World*, proposes to form the conductor which is to carry the current in a helix

to create inductance, this helical formation being practically continuous throughout the entire circuit. The core for the helix may be of air, or magnetic material may be used for this purpose. The accompanying diagram illustrates a grounded telephone circuit, the major portion of its metallic part being in the form of an inductance helix. On the assumption that the highest voice harmonic which must be preserved for satisfactory telephonic transmission has a frequency of 1,000 periods per second, the inventor develops formulæ for determining the amount of inductance necessary to neutralise any given amount of electrostatic capacity.

**Electricity in India.**—Licenses have been granted by the municipalities of Delhi and Lahore to Messrs. Arthur Grey, Thomas Wilson, and L. R. Windham-Forrest for electric lighting and tramway schemes in the respective cities. The Delhi scheme provides for a low-tension con-

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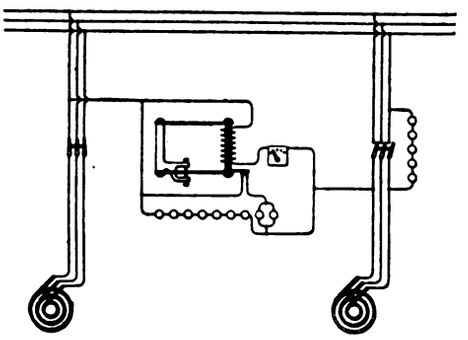
tinuous current, a separate distributing system being employed for the tramways, with the return circuit through the rails. Energy will be supplied to the car motors at 500 volts. For lighting, current is to be generated at 500 to 550 volts, and distributed by a three-wire system with 250 volts difference of potential between the neutral and outer wires at the consumer's premises. Regarding the tramways, the licensees shall commence the construction of same within two years, and shall complete same "with all reasonable speed." Exemption from wheel-tax on all vehicles to be used on the track, and from octroi on all plant, machinery, rolling-stock, and other materials imported during the first two years, is accorded to the licensees. The municipality is to receive a yearly rent of Rs.800 per mile of double track and Rs.500 per mile of single track, such rent not to begin until the net profits shall have reached 6 per cent. per annum. The license provides that the charge to consumers of current for lighting shall not exceed Rs.20 for any quantity up to 20 units, or 10 annas for each unit over 20. A low-tension continuous-current system, with a three-wire distribution for lighting, will likewise be employed at Lahore. Slightly lower voltages will be generated both for lighting and traction. Similar exemptions regarding wheel-tax and octroi are granted, and the clauses in the license concerning the charges on the tramway and the tariff for lighting are identical with those in the case of Delhi.

**Indiarubber.**—The *Bulletin*, just issued, of the Imperial Institute contains two interesting reports on samples of indiarubber received from Rhodesia. The first of these was obtained from the "Muteke" plant, which, the report states, is a large creeper, its stem reaching to 1ft. in diameter. It is said to be common all over the Abercorn division of North-Eastern Rhodesia. The samples of the rubber sent to the institute were collected by the administrator of the district, but, unfortunately, the quantity was not sufficient to enable full information of the commercial value of the rubber to be obtained. Two samples were submitted, one obtained from the stem of the creeper and the other from the root It appears that the stem contains considerably more rubber than the root. From the specimens of the leaves, flowers, and fruit of the creeper submitted to the Kew Garden authorities, it appears that the Muteke plant is likely to prove to be an entirely new species of *Landolphia*. Analyses show that the rubber is of fair quality, though the amount of resin present is rather higher than is desirable. Larger samples are being asked for in order to ascertain the exact value of this rubber. In the other instance referred to the sample was of "Dande" rubber, obtained from the Umtali district of Rhodesia. Analyses show that this contains 80·7 per cent. of caoutchouc and 12·6 per cent. of resin when dry. The sample as received contained, however, some 15·5 per cent. of moisture. The commercial value of the rubber was ascertained to be about 3s. 6d. per pound. It seems clear, from the results obtained, that the "Dande" plant yields a marketable rubber of good value, and, if the plant is abundant in Rhodesia, it should prove a valuable source of that material. The exact order of the plant could not be determined at Kew, as insufficient means of identification accompanied the sample.

**Synchronism Indicator.**—A patent has been granted in the United States to Mr. P. L. Clark, of Chicago, for a synchronism indicator, which he has assigned to the General Electric Company. The invention, which is briefly described in the *Electrical Review* of New York, relates to devices for indicating the proper instant for closing the line switch of an alternating-current generator, synchronous motor, or rotary converter which is to be connected in parallel with another similar machine already in operation. It is understood that this is to be done when the machines are in step, it being uncertain under ordinary conditions when this instant occurs. The machines are never thrown together when the indicating lamps are fluctuating with short beats, and as the beats grow longer the interval of darkness or brightness extends over so long a period that it is difficult to guess just the right instant to close the switch. This invention aims to eliminate any possible doubt on this score, and it consists of a signalling device, such as an indicating lamp controlled by a switch, which is kept open so long as the phase displacement is at a maximum and is closed by a solenoid only when the beats become very long,



and at the middle portion only of each beat. The connections of this device are shown in the illustration.

**Rural Railway Lines.**—Before the Chicago branch of the American Institute of Electrical Engineers, Mr. J. R. Cravath recently read an interesting paper, entitled "Light Electric Railways." The paper was designed to show that by modifying the type of construction, many rural districts now unserved from financial considerations might be made to yield a fair profit. Approximately the cost of the typical interurban electric railways of the Central Western States is £4,500 per mile of single track, requiring for financial success a gross revenue of £600 to £800 per track mile per annum. The author outlined a narrow-gauge system, suggesting a gauge of 28in. and the use of 30lb. T-rails. An estimate in detail is given of the cost per mile of such a line and its equipment on the basis of a 15-mile road. Excluding expenditure for right-of-way, the total for the track is given at £870 per mile; for general roadway items, £60 per mile; overhead line, £178 per mile; rolling-stock, buildings, etc., £465 per mile, the total being £1,570 per mile of track. This provides for three passenger motorcars, two passenger trailers, one freight motorcar, and 15 miscellaneous freight car trailers. An estimate of the ordinary operating expenses per train mile of such a road is 4¼d. per train mile, and for a traffic of 135,000 train miles per year, including interest on cost of construction, the total annual charge would be £260 per track mile. The author gave an interesting analysis of rural passenger and freight traffic, upon which is based an estimate of the traffic possibilities of a strictly rural territory. Estimates were obtained from several farmers as to the amount of farm products consigned and supplies received. Upon these data it is estimated that the total freight revenue from an average rural district in the Central Western States would be about £16 per square mile. After discussing in detail the question of passenger traffic, Mr. Cravath considers that a total gross earning of £330 per track mile is possible. Subtracting the charges previously estimated, this would leave a surplus of £80 per track mile.

**Mining Engineers' Conference.**—The members of the Institution of Mining Engineers held their annual two days' session last week. Sympathetic reference to the decease of the president, Sir Lowthian Bell, was made

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by Mr. H. C. Peake, one of the past-presidents. Three papers were read dealing with winding engines and gears, and a long discussion took place on the relative merits of steam and electric winding. Several speakers favoured the electric system in use in Germany and the North of France, but the majority appeared to think that the economies to be effected by electricity scarcely justified the large outlay on new electric plant. The view of the latter seemed to be that electric winding might do very well for the small and slow systems of the Continent, but the initial outlay would be enormous if electricity were applied to the deep shafts and rapid working in this country. Two interesting papers were presented dealing with mining education in America and New Zealand. Prof. Howard Eckfeldt, U.S.A., stated that there were about 45 schools in America which conferred the degree of "engineer of mining." Formerly the technical graduate was looked upon as being almost entirely useless to the industrial world, and at best was little better than the average labourer. He was classed as one who had his mind full of ideas and theories, which would not stand against the old cut-and-dried rules of years of practice. Now, however, when the mineral resources of the country were being exploited everywhere, nearly every State had its special school where men got a three or four years' training. In the vacations most of the students secured positions at practical work. Last year in some places a mine was loaned and worked by students, under the supervision of the teaching staff, and the practical results were highly satisfactory. Prof. James Park stated that six schools in the New Zealand goldfields are subsidised by the Government, and managed by councils elected by local subscribers. The schools are generally well attended, and have already exercised a marked influence in raising the general intelligence of the mining community. The combination of theory and practice in the schools has been attended by the most happy results.

**Scotch Water Power.**—The British Aluminium Company have this week offered to the public a further issue of shares, and a brief *résumé* of the work performed by them will be opportune. It was the first concern to put down an extensive water-power plant in the United Kingdom for electrometallurgical purposes. The company was formed in 1894, and the construction of the necessary works at Loch Ness was commenced early in 1895. An interesting feature in the working of the company is that it purchased a large estate, including the Falls of Foyer, and thus acquired water-power rights which might otherwise have been difficult to obtain. The works were so far completed that the production of aluminium was commenced towards the end of 1895. During the next few years the manufactory was continued upon a small scale, but a considerable amount of calcium carbide was turned out. In 1902, following a change of policy and considerable reduction in price, there was a great improvement, and since then there has been a steady increase in the tonnage sold. Owing to the expansion in sales, which still continues, the maximum capacity of output of the Foyers works is now inadequate to satisfy the demand for the company's metal, and consequently further water power is imperatively required. It has therefore been decided to exercise the powers secured by the company under the Loch Leven Water Power Act, 1901, and the Loch Leven Water Power Amendment Act, 1904, to carry out water-power works at the head of Loch Leven in Argyllshire. It is expected that some 12,000 h.p. to 15,000 h.p. can be developed there, which is approximately double the amount of power the company now has at Foyers. These Acts are held by the Loch Leven Water and Electric Power Company, the whole of whose issued capital, amounting to 4,000 shares of £10 each, is held by this company, which will also subscribe for a further 46,000 shares of £10 each, being all the shares it is at present intended to issue. It is believed that the amount thus furnished will suffice for the completion of the scheme. The progressive improvement in sales has produced a steady growth in the profits. The profit for the year 1904 was £55,411. 3s. 11d., an increase of £21,267. 18s. 1d. over that of 1903. Last December an extension of the Foyer water power was completed, and this year the output of aluminium will be much larger. The directors, therefore, confidently anticipate that the profits for the current year will be materially increased.

**Patents in 1904.**—The report of the Comptroller-General of Patents, Designs, and Trade Marks for 1904 states that the applications accompanied by complete specifications were more numerous than in any previous year, and exceeded the number received in 1903 by 602, an increase of 9·1 per cent. The applications received in 1904 numbered 29,678, as compared with 28,853 in 1903, an increase of 825, or 2·3 per cent. Of these applications 22,442 were accompanied by provisional specifications, and 7,236 by complete specifications. On the other hand, the number of complete specifications filed after provisional specification was only 8,684, as compared with 9,187, a decrease of 503. The total number of specifications was 38,362, as compared with 38,019, an increase of 343, or ·9 per cent. The most remarkable development is shown in the class rotary engines (including turbines), in which the general increase is 40 per cent., and the increase in turbines alone is more than double that amount. A marked growth appears also in the class air and gas engines, which has advanced to the extent of 27 per cent. The number of inventions relating to reciprocating steam-engines and to electric motors (class dynamo-electric generators, etc.) has also advanced, though to a less extent. The number of inventions for cycles continues to diminish, and is now less than one-fourth of the number for 1897, although the number of motor-cycles has increased 36 per cent. from the previous year, and is more than three times as many as in 1897. The number of wheels for vehicles has risen, although it is still only 40 per cent. of the number for 1897. Both road vehicles and railway and tramway vehicles have diminished, but locomotives, etc., have increased slightly, owing to the development of motorcars. About two-thirds of the whole number, and no less than 85 per cent. of the motor-cycles, are of British origin. The remarkable development of the motor vehicle industry in this country is shown by the fact that the total number of British inventions has doubled since 1900, when less than one-half of the whole and only a little more than one-half of the cycles were of British origin. The oil or gas engine type of motor finds most favour. Electricity receded as a medium of power for motorcars and cycles. The activity in the motorcar industry still continues. Though the number of applications pertaining to motorcars reached a maximum in the previous year, this number was almost reached in 1904, while in the details, such as wheels (including tyres), lamps, variable-speed gearing, and oil motors, the numbers of 1903 have been considerably exceeded. The attention that is being given in engineering circles to turbines is significantly illustrated by the fact that more applications for patents were made for this class of motor than for all classes of reciprocating steam-engines put together. The actual numbers under turbines show a considerable increase on those of 1903, while there is a corresponding decrease in the number of steam-engines and also of steam generators. The keenness of the competition

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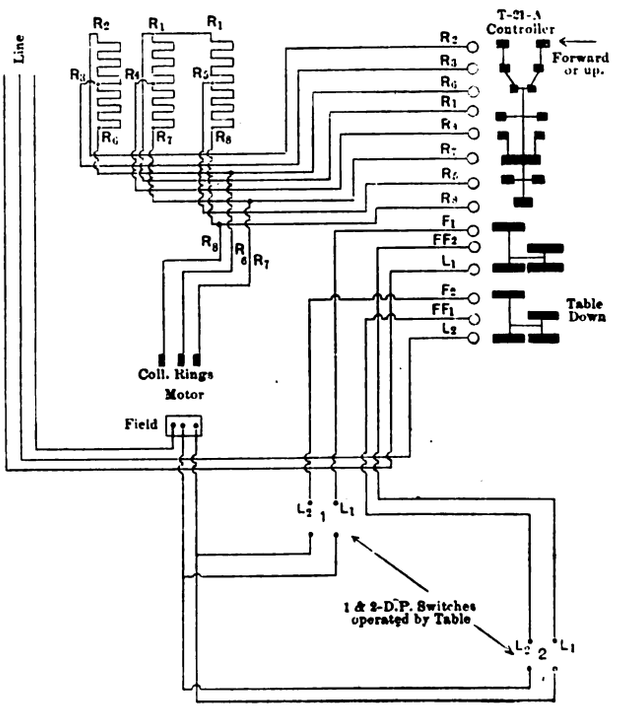
between gas and electricity as illuminants is vividly reflected by the figures for 1904. On the one hand, the number of applications bearing upon dynamos and both arc and incandescent electric lamps is greater than that for 1903, but there is at the same time a marked increase in the number relating to gas lamps and the manufacture and purification of gas. The subject of mercury vapour lamps, to which reference was made in the last annual report, has received increased attention during the year, especially from American inventors, but the inventions have been mainly directed towards the adaptation of such lamps to a variety of novel purposes other than lighting, such as switching, rectifying, controlling, and distributing electric currents.

**Moving Platform Subway.**—A description of the moving platform subway proposed to be constructed in New York City to provide additional means of transit across town is given in the *Scientific American*. It was originally proposed to have the subway below Thirty-fourth-street. The Rapid Transit Commission are apparently opposed to this, but are prepared to agree to the system being constructed below Twenty-third-street. The subway is planned to be divided into halves, the whole section of the tunnel to be 30ft. wide by 14ft. in height. The moving platform proper consists of three continuous lines of steel plate, covered with rubber to ensure a safe footing. The plates overlap laterally at their edges. The fourth platform is an auxiliary, which will be run at a speed of three miles an hour, and used only for a few hours after midnight, when travel is lightest, at which time the main moving platform will be stationary. The first moving platform will run at a constant speed of three miles an hour, the second at six miles, and the third platform at nine miles an hour. The first two platforms will be known as stepping platforms, and the third, which is considerably wider, will be provided with transverse seats. To assist passengers in moving from one platform to another, the two stepping platforms will be provided with lines of vertical posts, placed at frequent intervals. The platforms will be built in sections, each of which will be about 6ft. long, and the abutting ends of the sections will be struck to a radius which will permit of the platform curving around the terminal loops at First and Ninth avenues. Extending longitudinally beneath each platform is a pair of I-beams, the upper flanges of which are riveted to the bottom of the platform, while the lower flanges serve to support the weight of the platform upon pairs of wheels which are carried upon transverse shafts mounted at intervals of 2ft. 9in. upon concrete piers. Between each pair of longitudinal I-beams is carried a pair of horizontal guide wheels, which engage a guide rail that serves to keep the platform in proper alignment. At every 75ft. 10-h.p. motors are mounted on the floor of the subway, and are connected by a chain drive with the transverse shafts, which carry what might be called the driving wheels of the platform. The gradation in the rate of speed of the sections of the platform is secured by varying the diameter of these driving wheels, which are 8in. in diameter for the three-mile, 16in. in diameter for the six-mile, and 24in. in diameter for the nine-mile platform. The driving wheels are covered with rubber, as are the horizontal central guide wheels, and consequently the motion of the platform will be both smooth and silent. The successive sections of the platform are coupled together by means of links, 46in. in length, and the coupling pins are placed at the centre from which the curves of the abutting ends of the platform sections are struck; consequently, the opening between the joints may be reduced to a minimum, and a smooth and continuous surface presented for walking.

**Electrical Equipment of a Railway Shop.**—An interesting description appears in the *Electrical World* of the repair shop of the Great Northern Railway Company at St. Paul, U.S.A., which, unlike many such establishments, was initially designed for electrical driving on the three-phase system with General Electric induction motors. On account of their isolated position many of the machines were equipped with individual motors, but a general effort was made to use a single motor to drive groups of the smaller machines requiring frequent starting and stopping. The motors in these instances are placed overhead on the structures which support the line shafting. Many of the machines are directly geared to the motors. In other instances, however, the Renold chain drive is employed, and in some cases leather belting of the usual type is used. One of the chief features of interest in the plant is the successful operation of variable-speed induction motors. The cranes, transfer table, wheel lathes, and several other machines are driven by motors capable of speed variations. In one instance—that of a 96in. driving-wheel lathe—the controller is located within easy reach of the operator. In all the variable-speed installations the different speeds are obtained by inserting resistances in the secondary circuits.




The controller also permits of reversal of direction of rotation, this being accomplished by interchanging two of the three leads to the stator. In the case of the wheel lathe, the rheostats in connection with the control circuit are immediately behind the controller. These are provided with sufficient radiating surface to permit continuous operation of the motor at any speed without undue heating. Another special feature is the equipment used in connection with the drop-table in the machine shop. The 20-h.p. motor which operates the table is installed in an adjacent pit. The interesting point in regard to the electrical equipment is the arrangement by which the motor is stopped automatically when the table reaches certain limits of travel. When the motor is stopped by the device it cannot be started until reversed. The connections of the controller by which this is accomplished are shown in the accompanying diagram, which we reproduce from the *Electrical World* of New York. Lugs permanently attached to the moving table operate dogs which, in turn, open the switches. If the upper switch, shown in the diagram, be opened, the motor cannot be started through $F_1$ and $F_2$. To start it through $FF_1$ and $FF_2$ it is necessary to reverse the motor, which lowers the table.

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## GLOUCESTER ELECTRICITY WORKS.*

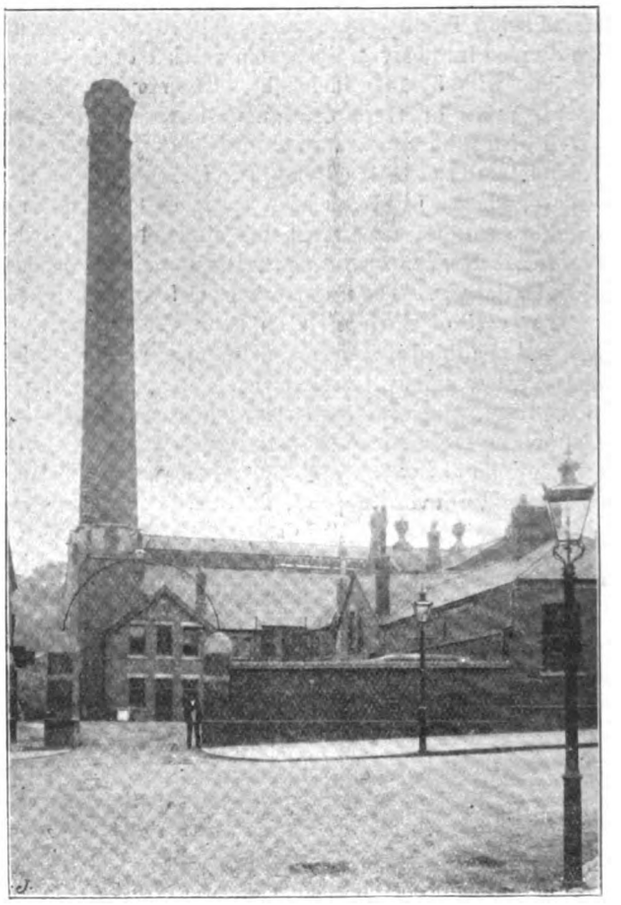
BY WALTER J. BACHE, M.I.E.E, ELECTRICAL ENGINEER.

The Gloucester municipal electricity works were authorised by a provisional order granted in 1896, in response to an application by the Corporation, who lost no time on the receipt of the order in taking steps to erect their works. In 1897 the Council instructed Mr. Robert Hammond to prepare a preliminary report, and in the following August they decided to establish electricity works in combination with a refuse destructor, on the lines advocated by Mr. Hammond, and instructed him to draw up a detailed scheme. It is interesting to note that the present arrangement of the works was designed eight years ago, and although this is a considerable period in the history of electricity supply, the works may be considered, even now, up-to-date and of modern design. It would not be difficult to find works designed later than 1897 of which the same could not be said at the present time. The scheme submitted provided for a three-wire, direct-current, low-tension system of generation and distribution, with Lancashire boilers, two generating sets, each consisting of two dynamos in tandem direct coupled to a high-speed engine, and a triple-concentric network fed at various points by triple-concentric feeders. The architect's work was placed in the hands of Mr. Harry A. Dancey, of Gloucester, who carried out the ideas of the engineer in a successful manner, and provided a very suitable and pleasing set of plans.

MR. W. J. BACHE, CITY ELECTRICAL ENGINEER, GLOUCESTER.

The combined electricity works and refuse destructor were designed as one scheme, but owing to delays in obtaining possession of the site, and other causes, the electricity works were running two years before the completion of the refuse destructor. The selection of a suitable site for the works demanded careful consideration from many points, as the conditions vary greatly as regards network in the residential and manufacturing parts of the same town. The general characteristics have to be reviewed, the location and probable lamp density of the more important areas of supply must be estimated, and the immediate vicinity of the suggested site must be examined in order to avoid placing the works where a nuisance may be created. Facilities for obtaining coal and water for condensing are essential to economical working, and require due consideration. The terms on which the site can be acquired, and the cost of rendering it suitable by excavation, removal of old buildings, etc., will also have a bearing on the choice of the site. All these considerations were carefully gone into in the Gloucester works, with the result that the site is particularly well chosen. The works are situated in the south-west part of the city, and are most conveniently placed, within 600 yards of the Cross, which is the business centre. They are also close to the docks, which afford an abundant supply of water for condensing purposes, while the railway lines in the docks provide connection with the Midland and Great Western Railways. At present there is no siding into the works, but should one be required in the future it could be laid down without any difficulty. The ground on which the buildings stand consists of "made soil," and during the excavations for the foundations many traces of the Roman occupation were brought to light. The foundations are carried down to the blue lias clay, which was found at a depth of 11ft. below the surface. Underneath the condenser pit the contractor encountered a portion of the old bed of the Severn, and two underground watercourses traverse the site diagonally from north-east to south-west, and are separated by a distance of about 30ft. to 40ft. A bed of quicksand in the boiler-house and a series of extraordinary pockets or depressions in the lias clay under the refuse destructor and the chimney stack added to the builder's difficulties, and called for special methods of construction.

The buildings are of brick with stone dressings, and consist of two large bays for the boiler-house and engine-room respectively, a small bay containing the test-room and switch-room with the battery-room over, and a well arranged suite of offices and stores. The refuse destructor is placed at a right angle to the boiler-house, and between the latter and the chimney stack. Provision has been made for the extension of the engine-room and boiler-house. The chimney stack is 150ft. high from the ground level. It rests upon a solid bed of concrete, 30ft. square and 10ft. deep. The brickwork footings are 6ft. deep. The chimney is built square for the first 37ft., and from this height to the top it is octagonal in shape. The internal diameter is 6ft. throughout, inside the firebrick lining, which is carried to a height of 60ft., with a 4½in. air space between the lining and the outer brickwork. The chimney has an ornamental moulded stone cap. The theoretical capacity of the chimney is approximately 1,100 h.p., and it accommodates six boilers at the present time, which, if all were steaming together, would exceed its full capacity. Three new Lancashire boilers are being laid down this year, and it is probable that when the next boiler extension is



Main Entrance to Electricity Works, Gloucester.

* Paper read before the Western District meeting of the Incorporated Association of Municipal and County Engineers held at Gloucester on June 3.

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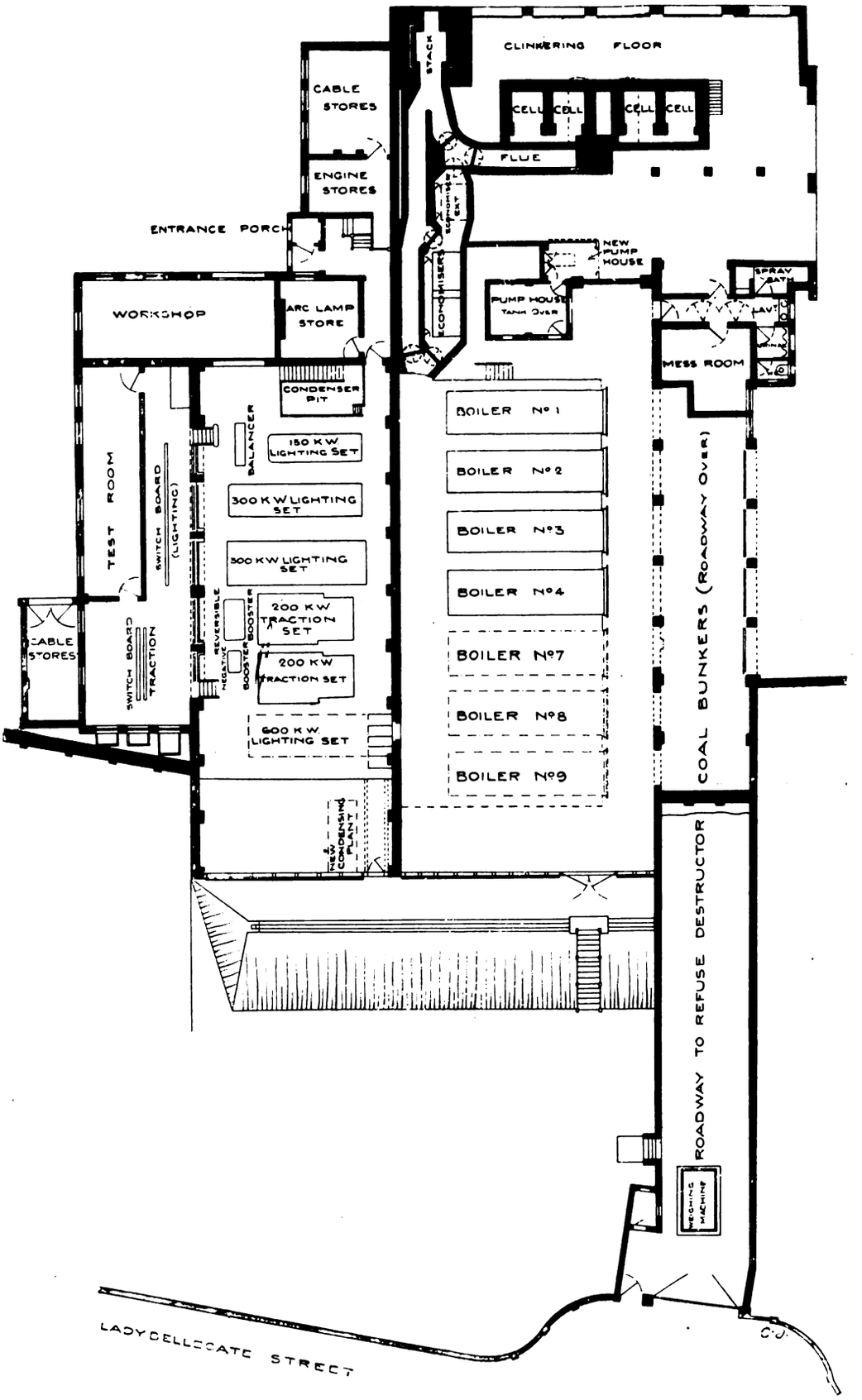
made it will be necessary to provide for an increased draught. It is interesting here to compare the relative costs of the various methods of obtaining draught for boilers on the horse-power capacity basis as above stated. Taking first the cost of an ordinary brick chimney, of which Gloucester is a typical example, the price may be stated at £1,500. An Alphons Custodis chimney of the same capacity would cost about £900. Coming now to mechanical draught, and assuming that conditions similar to those in Gloucester have to be met, the capital outlay, including the necessary short steel stack, is only about £350. Forced draught has many advantages over induced draught, for the former has only to push the air through the fire, while induced draught has to do this and also to draw the products of combustion along the flues, and thus obviously requires more power. Further, the induced-draught fan has to deal with gases at a high temperature, and containing a good many destructive constituents. Therefore, its life must be considerably shorter. Again, the induced-draught fan sucks in cold air through every crack and crevice in the boiler setting and elsewhere. Forced draught, on the other hand, tends to seal up such cracks with flue dust, or make them permanently or aggressively visible by forcing smoke through them.




Plan of Electricity Works and Refuse Destructor, Gloucester.

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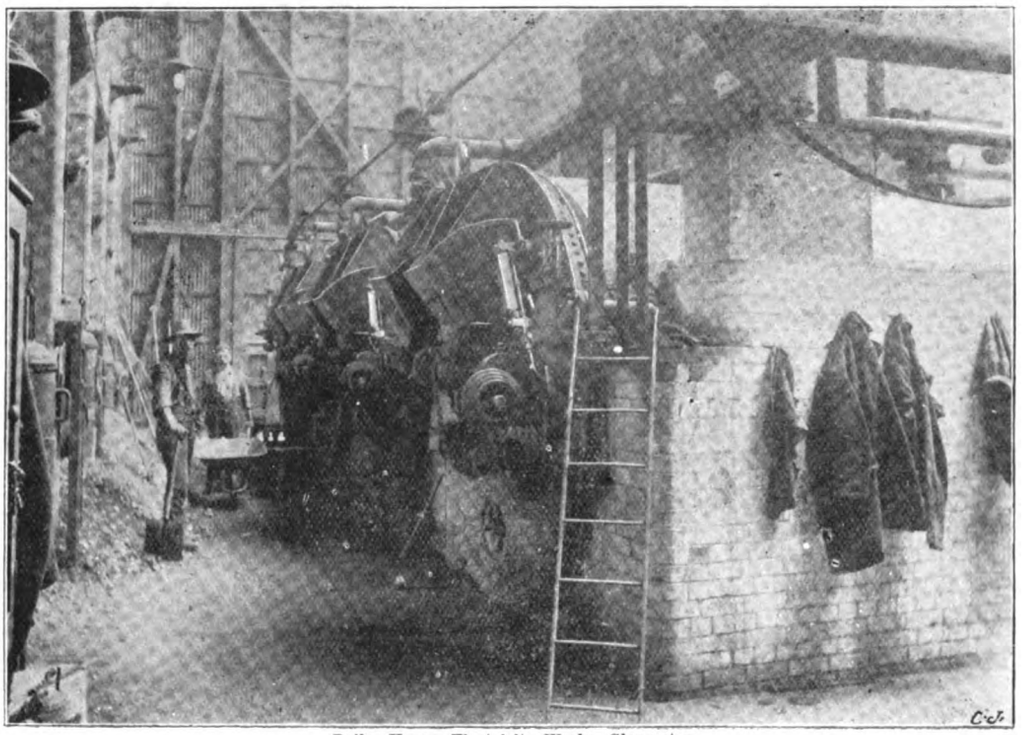
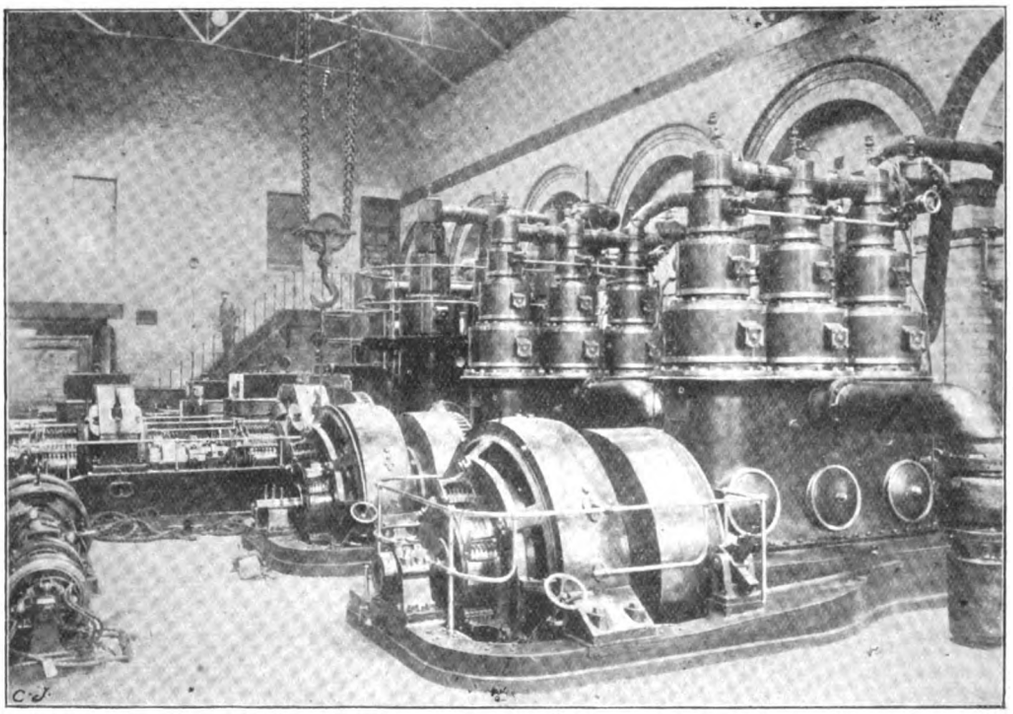
As regards annual upkeep, taking the cost of a brick chimney at £1,500, and allowing 6½ per cent. for interest on capital expenditure, depreciation, etc., an annual expenditure will be incurred of £97. 10s. For a forced-draught system the above charges may be taken at 8 per cent., which on a capital expenditure of £350 means an annual payment of £28. The cost of running the motor which would be required to drive the fan, and using 54,000 units per annum at ¼d., is £56. Thus the forced-draught system is £13. 10s. cheaper, annually, than the chimney stack. This does not take into account the other advantages, such as greater control over fires, and therefore economy in coal consumption. If the air be heated on its way to the fires no additional expense is incurred, except a slight increase in the capital cost, while the conditions under which combustion takes place are so much improved that a reduction in the coal bill amounting to 7½ or even 10 per cent. may be effected.

The boiler-house is 61ft. in length, 48ft. wide, and 41ft. in height, and contains at present three boilers, each 30ft. long by 8ft. in diameter, and one 30ft. long by 8ft. 6in. The smaller boilers have a grate area of 38 square feet and a heating surface of 1,015 square feet, while the larger one has 37 square feet of grate area and a heating surface of 1,160 square feet. The respective evaporations are 6,500lb. and 8,000lb. of water per hour. The Lancashire boiler is eminently suitable for Gloucester, which possesses a clear, bright atmosphere and experiences few fogs. There are, therefore, no sudden demands for steam, such as occur in many manufacturing towns. Where these rapid demands are prevalent the water-tube boiler undoubtedly possesses advantages, but for ordinary steady conditions of working it cannot compare with the Lancashire type, which has the very considerable advantages of low first cost, economical steaming, and low repairs costs, not to mention the freedom from anxiety it ensures for the engineers who have to work



Boiler House, Electricity Works, Gloucester.



Engine Room, Electricity Works, Gloucester.

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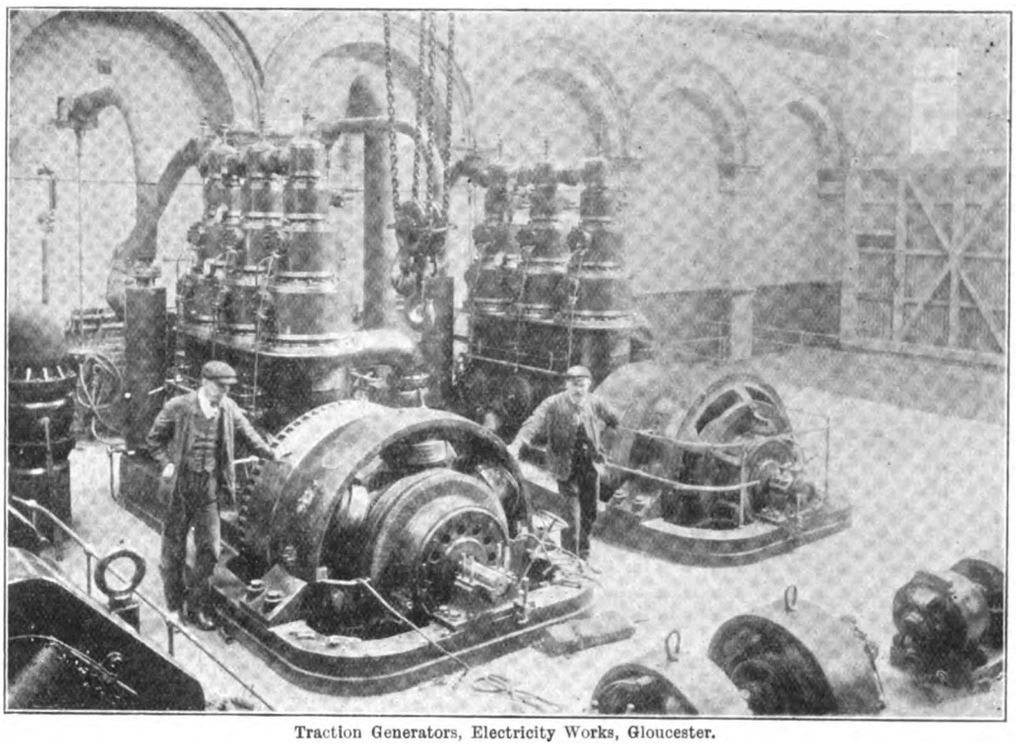
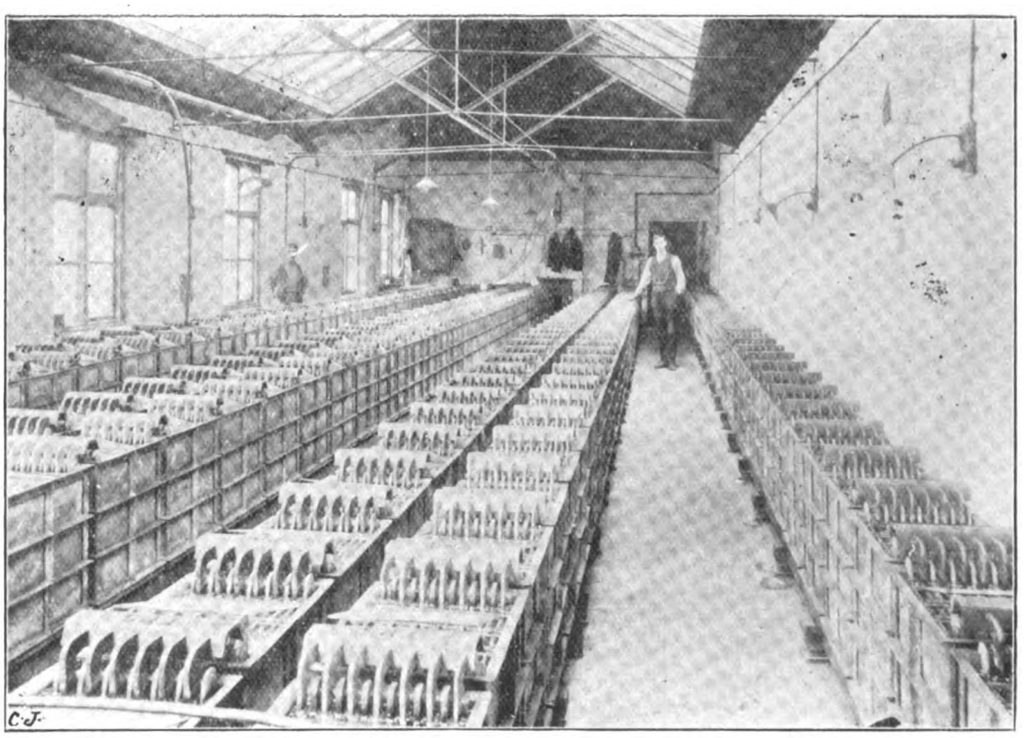
the boilers, which cannot be said of the water-tube boiler, with its rapid evaporation and small water space. All four boilers work at a steam pressure of 160lb. per square inch, and contain the usual fittings of Hopkinson's make. The main flue is provided with a Green's economiser, having 192 tubes in two sections and a by-pass flue. The scraping gear of the economiser is driven by a 5-kw. Bruce Peebles enclosed motor. Previous to passing through the economiser the feed water is heated in a Berryman feed-water heater. The latter is operated by the exhaust steam from the auxiliary plant.



Traction Generators, Electricity Works, Gloucester.

The pump-house is situated at the west end of the boiler-house, and contains two pumps, one an Evans compound double-acting flywheel pump, the other being of Messrs. Weir's manufacture, and of the type associated with their name. Both pumps draw their water direct from the feed tank, which is placed above the pump-house, and has a capacity of 3,500 gallons. The feed water consists of a mixture of canal water and condensed steam, and gravitates from a branch on the condenser discharge pipe to a sump near the boiler-house. From the sump it is lifted through a Mather and Platt feed-water filter to the feed tank. The water is raised from the feed sump and elevated to the tank by means of a 1½in. centrifugal pump driven by a 1½-h.p. motor, also of Mather and Platt's make. The motor is started and stopped automatically by a patent switch, operated by the water-level in the overhead tank. The action is very simple. A wooden float in the tank is connected by a chain to the switch lever, the chain passing through a slot in a flat lever, with an iron weight on each side of it attached to the chain. When the water in the tank is low the float falls, pulling the chain and the lower weight, which raises the switch lever and starts the motor. When the water rises to its normal level again, the top weight pushes the switch lever down and stops the motor. The main steam-pipe in the boiler-house is



Accumulator Room, Electricity Works, Gloucester.

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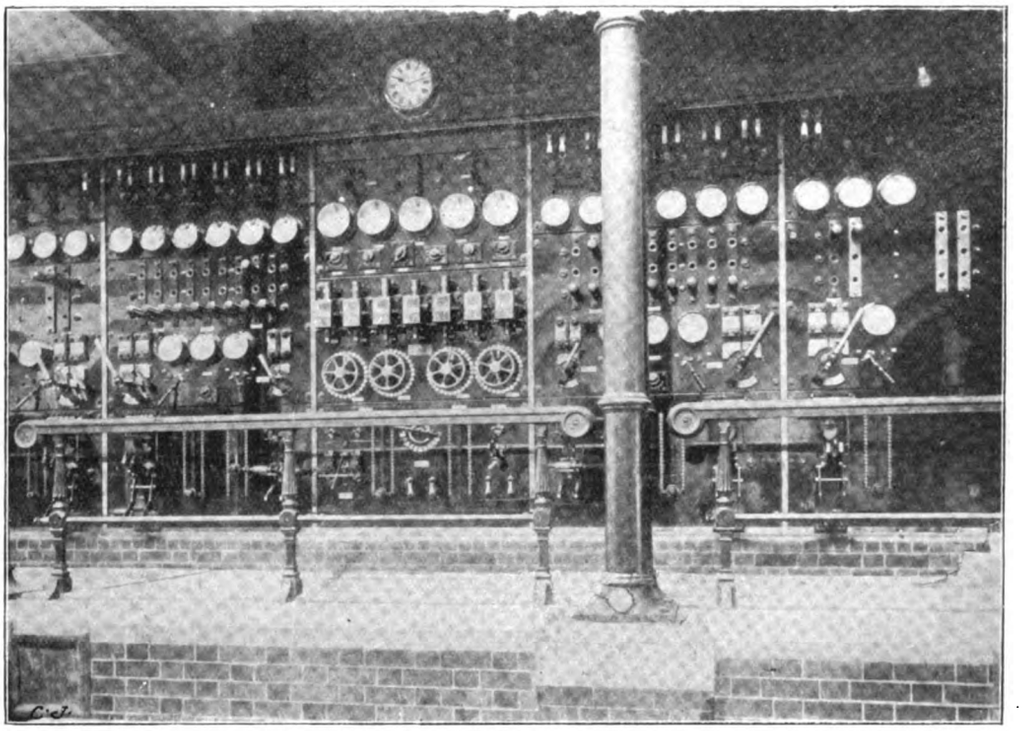
8in. in diameter, increasing to 10in., the connections to each boiler being of 6in. diameter. Water-pockets are fitted at the junction of each engine branch with the main steam-pipe. There are no steam-traps on the main range, or, indeed, in the station, which is, perhaps, an unique feature.

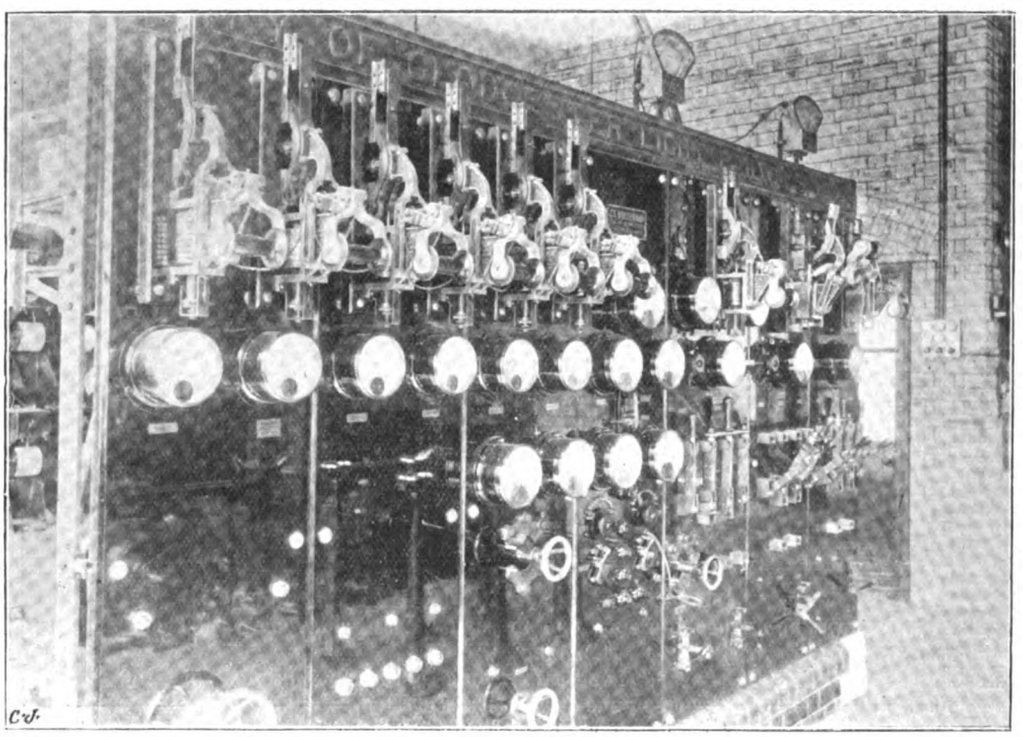


Main Lighting Switchboard, Electricity Works, Gloucester.

The feed system is duplicated, so that in the event of a breakdown to the hot feed pipe, or the economiser, the boilers could be fed through the cold feed pipe. A 3in. auxiliary steam range supplies steam to the condensing plant, pumps, etc. All the steam and exhaust pipes are lagged with removable magnesia covering, and the pipe joints are fitted with Lonsdale's removable steel flange boxes packed with felt.

The engine-house is 96ft. in length, 37ft. wide, and 38ft. high. The interior walls are built in buff bricks, with a dado of brown glazed bricks. The floor is laid with the Papyrolith Company's patent paving. The switch-room runs along the south side of the engine-room, and is open to it. The condenser pit is situated at the west end of the engine-room. The chief engineer's and chief assistant's offices overlook the engine-room, and access to them from it is provided by means of an iron staircase.

A 10-ton overhead travelling crane spans the engine-room. It was made by James Spencer and Co., and is operated by hand from platforms running the whole length of the crane girders. The engine-room contains at present three lighting and two traction sets, a balancer, a reversible booster, and a negative booster. The lighting sets consist of one 250-i.h.p. compound, two-crank Belliss engine direct coupled to two 75-kw. Silvertown dynamos of inverted horseshoe type; one 500-i.h.p. triple-expansion three-crank Belliss engine coupled to two 150-kw. Silvertown dynamos of the same type as the smaller set; and one 500-i.h.p. triple-expansion three-crank Willans engine direct coupled



Traction Switchboard, Electricity Works, Gloucester.

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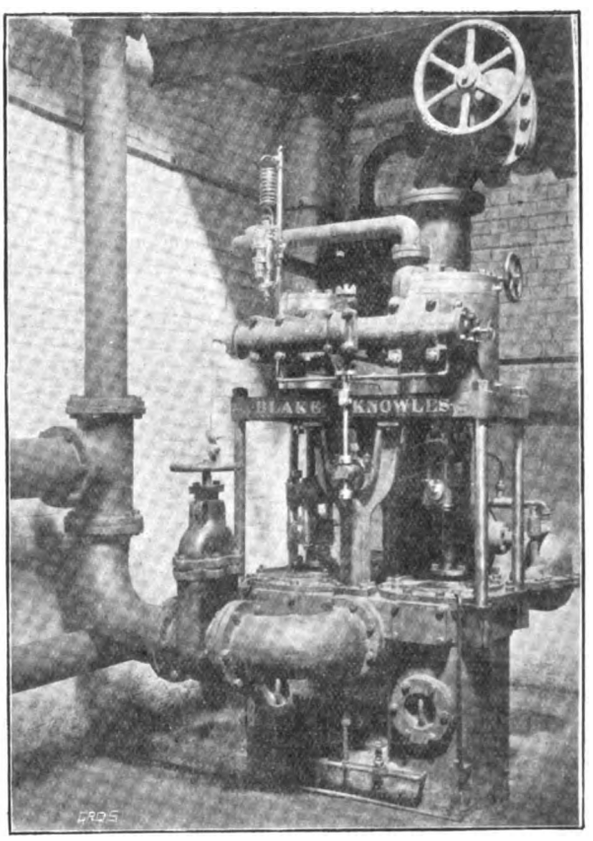
to two 150-kw. Mather and Platt four-pole dynamos. The dynamos are all shunt wound to give from 220 volts at no load to 250 volts each at full load. The first two generators have smooth drum bar armatures, small commutators, and copper gauze brushes. When the traction plant was designed the possibility of adapting the existing lighting sets was considered, but the design of the sets rendered them totally unsuitable for this work. It may be pointed out that although the smaller engine was designed to work with a steam pressure of 130lb., it has never worked under these conditions, as it always takes its steam from the main range at a pressure of 160lb. This adaptability speaks well for the soundness of manufacture. The two traction sets, which are of equal size, each consist of a three-crank triple-expansion Willans engine of 300 i.h.p. direct coupled to a 200 kw. multipolar generator of the General Electric Company's make. The latter are compound wound to give from 500 volts on open circuit to 600 volts at full load. They are also arranged so that the series winding may be cut out of circuit, and the machines are then capable of running on the lighting load if required. A reversible booster, used in conjunction with the battery, is placed in the engine-room. It is of Crompton make, with Crompton-Macintosh winding, and is coupled in series with the battery, the object of the combination being to take the peaks of the load, and thus by equalising the work on the generator, it has been possible to instal a machine of smaller output than would be required if the generator had to deal with the whole of the fluctuations in the load. The regulation is performed automatically. The motor side of the combination takes its current from the lighting 'bus bars at a pressure of from 440 to 480 volts, and the generator side is capable of giving an output of 120 volts charging and 60 volts discharging, with a maximum current of 300 amperes for 10 hours. The negative booster is placed near the reversible booster, and consists of two open protected type four-pole machines, direct-coupled, and mounted on the same bed-plate. The motor side takes its current from the traction 'bus bars at a pressure of from 500 to 550 volts, and the dynamo side can give, at constant speed, an output of 400 amperes at eight volts continually. The battery consists of 260 cells of the E.P.S. Company's "P" or traction type. It is connected in series with the reversible booster, and in parallel with the generators.

The switch-room, as mentioned above, is open to the engine-room, but its floor is raised 4ft., and thus an uninterrupted view of the machinery, etc., is provided for the engineer-in-charge and the switchboard attendant. This is a distinct improvement on a gallery, owing to the absence of a long flight of steps, as, in case of emergency, the engineer can be in the engine-room with the least possible delay. The switch-room contains the lighting and traction switchboards. The former was made by Crompton and Co., and is of handsome appearance. It is divided into three main panels, the neutral and instrument panel in the centre with the positive and negative panels on the right and left respectively. The board is constructed of slate slabs fixed in a wrought-iron framework, which rests on a plinth of glazed bricks. Each set of two dynamos is coupled in series by a lead from each machine taken to the neutral bar, and the two outer leads are run to their respective sides of the board. Thus each set is self-balancing. Modern practice in three-wire systems is to run single generators, and obtain the balance of current by means of small units which are either steam dynamos or motor-generators. This method may be preferable in large stations where there are several sets running, but in small stations where the out-of-balance current is comparatively light the advantage lies distinctly with self-balancing sets, both from an economical and working point of view. The annual cost of running separate balancers is probably more than the interest on the additional capital outlay necessary to provide self-balancing sets, and in case of breakdown the result is usually a total failure of supply. This is not the case with self-balancing sets, as, should one machine break down, the other can usually maintain its own supply until another set can be switched into circuit, and thus only half of the town is in darkness. All the dynamos are coupled up to the 'bus bars on both sides of the board through minimum-current automatic cut-outs, designed to break circuit when the current falls below 10 per cent. of the full load. Duplex fuses are also inserted with two-way single-pole switches. In circuit with each dynamo is a Crompton shunted ammeter, and a dead-beat voltmeter is common to all the machines on each side of the system. The shunt-regulating switches and shunt-breaking switches are placed on the panels below the instruments. The feeders are taken off the top of the board. Each has an ammeter and a two-way switch with quick-break action and a duplex fuse. Below the feeder instruments are the vertical dynamo and feeder bars, which are connected to the main 'bus bars, at the back of the board, by screwed gunmetal plugs. In the central panel are the Kelvin voltmeters for pilot wires and main station 'bus bars. The neutral bar is earthed by a lead taken to the intake tank. In circuit with this connection is an automatic cut-out. It is arranged to short-circuit the ammeter when the earth current exceeds 10 amperes, leaving a direct connection from the middle wire to earth.




Blake-Knowles Condensing Plant, Electricity Works, Gloucester.

The traction switchboard, which is also constructed of slate, contains seven panels, the Board of Trade panel being placed in the centre with the three feeder panels on the left and the battery and two generator panels on the right. Each generator panel contains a reverse-current circuit breaker, designed to break circuit on the reversal of the current to the extent of 10 per cent., and in this event only. An ammeter, a single-pole main switch, and a double-pole change-over switch, are also provided. The latter is designed to enable the machine to be coupled either to the traction 'bus bars as a compound machine, or to the lighting 'bus bars as a plain shunt machine. There is an equaliser switch on each machine for paralleling. The battery panel is arranged in a very similar manner, but maximum breakers are used instead of the reverse-current type. The Board of Trade panel contains the usual instruments which are necessary to carry out the various tests required by the Board. They consist of the main ammeter, drop voltmeter, pilot switch, leakage current ammeter, and the shunt for the recording earth return ammeter. The resistance cellar is below the switch-room and contains the shunt-regulating resistances, feeder meters, etc.

The exhaust steam from the engines passes through a

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16in. main under the engine-room floor to the condensers, of which there are three, all of jet type, and each capable of dealing with 10,000lb. of steam per hour. The two original sets are of Blake-Knowles make, and consist of compound engines, driving the air and circulating pumps direct. The third set, which was erected in 1904, was made by Summers and Scott, of Gloucester, and consists of a compound flywheel engine, driving air and circulating pumps of Edwards's type at a speed of 105 revolutions per minute. All three condensers are fitted with an automatic brake vacuum, making it impossible for the injection water to back up into the exhaust main. An automatic atmospheric valve is connected to the exhaust main for relieving the back pressure on the engines in the event of a breakdown to the condensers, or for running non-condensing if required. The condensing water is obtained from the canal basin. The intake pipe is placed at a depth of 3ft. below the lowest summer level of the canal. The water gravitates through 18in. cast-iron pipes to a large screening tank, from whence it is drawn by the circulating pumps. This tank is 14ft. long by 8ft. wide and 15ft. in depth, and is placed outside the engine-room. It is constructed with brick walls 14in. thick, resting on a concrete foundation. The tank is divided by a wrought-iron screen, the intake and suction pipes being on opposite sides of the screen. The screens are in duplicate. The condensed steam and injection water is discharged through 18in. pipes, with a fall of 1 in 76 to the opposite corner of the basin. An overhead tank has been fixed near the screening tank, into which water is pumped by a 1½in. centrifugal pump driven by a 2-h.p. B.T.H. motor. The water so raised is supplied by the works to the Streets Committee for street-watering purposes at a charge of 1d. per van load.

There are 40 miles of cables laid, all on the solid system. The feeders and distributors are of triple-concentric type with the neutral wire outside. They are laid in cast-iron troughs, and are surrounded with insulating compound. The arc cable, of which there is 15½ miles, is composed of a lead-sheathed, armoured, single $^{7}/_{16}$ and $^{7}/_{18}$ conductor laid direct in the ground. All the original cables, connections, junctions, etc., were made by Messrs. Callenders. Since the cables were laid we have improved the network by dividing it into sections, each supplied by one of the existing feeders, and linking these sections together through suitable fuses. The Board of Trade are now asking for this to be done in all low-tension networks. In our case on more than one occasion it has prevented us having a serious breakdown of the system. Owing to the heavy and rapidly increasing load in the centre of the town, it has been found necessary to construct a sub-station at the Cross, into which all three feeders passing that point are run. By this alteration the load on this district is carried by cables equivalent to a 1·2 square inch feeder. The sub-station is built underground, and is 12ft. 6in. long, 9ft. wide, and 7ft. 6in. in height. It is built of brickwork, lined with glazed bricks, with a dampcourse of "Tenax" 1in. thick in the walls and floor. It is well ventilated by means of an upcast shaft and small motor fan, the fresh-air inlet being an ordinary manhole cover at the pavement level. A neat switchboard by J. G. Statter and Co. is fixed in the sub-station, fitted with the necessary instruments. The total cost of the sub-station was £340.

Gloucester is exceptionally well provided with arc lighting, there being a total of 175 lamps installed. Fifty-two of these were included in the original scheme, the remainder were erected in 1904 to provide efficient lighting along the whole of the light railway routes within the city. The lamps are arranged in circuits of nine on 440 volts and of four on 220 volts. Each lamp base is fitted with an automatic cut-out and resistance to maintain the current should any lamp fail. The lamp columns are 20ft. high from the ground level. The lamps are suspended by steel wires, and are lowered for trimming and repairs by means of a winch fitted in the base of the columns. An automatic safety catch prevents the lamps from falling, should the suspending wire break. The lamp circuits are operated by switches placed in the base of the column of each end lamp on a circuit, and automatic time switches are now being experimented with and will be adopted if proved successful. Each alternate lamp is switched out at midnight. There are one or two groups of incandescent lamps installed in side streets, but owing to the keen competition of the local gas company the revenue from each is extremely small, and at the present time it hardly pays us to push their extension. The method of charging consumers is the maximum demand system, and Wright's indicators are used. The charge for lighting is 6d. per unit for any number of units up to the equivalent of 100 hours' use per quarter of the maximum demand recorded by the indicator, and 2d. per unit for all consumption during the quarter beyond the above. The charge for motive power is 3d. and 1½d. per unit respectively.

The capacity of the station plant is 1,150 kw., of which 400 are for traction purposes, and allowing one spare set of 300 kw. the net available capacity for lighting stands at 450 kw., which is equivalent to 15,000 8-c.p. lamps. Some idea of the increase in the demand for energy may be obtained from the fact that in December, 1900, the total equivalent number of 8-c.p. lamps connected to the mains was only 12,000, whilst there are now about 40,000, or about 2⅔ times the available capacity of the plant. The number of consumers has, in like manner, increased from 100 to 460. The load factor is 16·6, with a maximum load of 720 kw. The cost of production for the year ending March 31, 1905, is given below. It will be found to compare favourably with other stations of similar size :

| | |
|---|---|
| Coal | ·35 |
| Oil, waste, water, and stores | ·02 |
| Wages | ·21 |
| Repairs and maintenance | ·15 |
| Works cost | ·73 |
| Rents, rates, and taxes | ·08 |
| Management, office, and legal expenses | ·19 |
| Total cost per unit sold | 1·00 |

Owing to the rapidly increasing demand for energy, it was decided at the close of the past year to lay down large extensions to the plant, and these are now under construction. They consist of three Lancashire boilers, each 30ft. long by 8ft. 6in. in diameter, fitted with downtake superheaters; a 600-kw. steam generator; an electrically-driven surface condensing plant to deal with 30,000lb. of steam per hour; an electrically-driven feed pump; and the necessary extensions to the pipework, including a new economiser section; also the necessary additions to the boiler-house to accommodate the new boilers; and extensions and alterations to the refuse-destructor buildings, giving a greatly increased storage capacity.

### Refuse Destructor.

The construction of the refuse destructor has been dealt with by Mr. Read, the city surveyor, in his paper, but it may be briefly stated here that the destructor consists of two twin cells of Heenan type, each with a grate area of 66 square feet, or 33 square feet per cell. The Babcock boilers are placed above the cells, the combustion chambers intervening. Each twin cell was designed to deal with 25 tons of refuse per day, but the quantity dealt with often exceeds 30 tons per day. The large hoppers as originally installed were not found satisfactory, and we have replaced them by small hoppers holding about 5cwt., with an iron door between the bottom of the hopper and the cell. This door is counterweighted, and is operated by a lever worked by the charger on the tipping platform. When burning the normal quantity of refuse, charging is performed about every quarter of an hour. A fireman stationed on the clinkering floor drags the refuse on to the grates, and distributes it by means of a long rake. Two men are employed per shift of eight hours, but when the amount burned exceeds 25cwt. or 26cwt. an extra hand is required to assist the fireman. The wages of these men are 5½d. and 6d. per hour respectively. The Howden system of forced draught as fitted is a very successful feature of the plant. The temperature of the air in the hot-air chamber is about 220deg. to 230deg. F., with a draught equal to 2in. on the water-gauge. The motors and fans supplying the air work exceedingly well in spite of the trying conditions under which they are operated, and have cost very little for repairs. From tests which

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have been carried out on the plant the temperature in the combustion chamber has been proved to exceed 2,000deg. F., and an evaporation of 1·5lb. to 2lb. of water per pound of refuse burnt was obtained with feed water at a temperature of 212deg. F. The steam pressure is maintained constantly at 160lb. The clinker is of very fair quality, and amounts to about 25 per cent. of the weight of refuse consumed.

MR. R. READ, A.M.I.C.E., CITY SURVEYOR, GLOUCESTER.

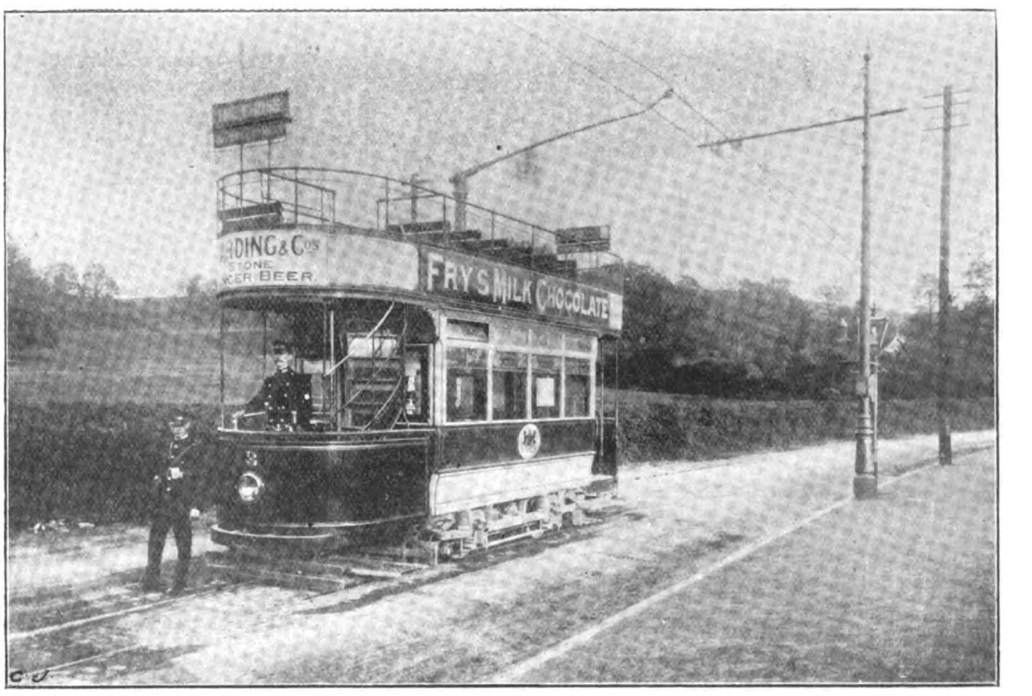
Troubles, such as are bound to exist in a brickwork furnace working at such high temperatures, have been encountered from time to time. The repairs usually consist of renewals of the firebrick work. It may be interesting to note here one of the most serious defects which has occurred—viz, the fusing and consequent failure of the steel joists carrying the brickwork above the entrance to the cells at the bottom of the refuse shoots. These were removed and brick arches substituted. The author is of the opinion that metal should not be built into brickwork exposed to great heat, as the brickwork tends to radiate the heat into the metal, which in the case of steel greatly weakens its strength, even if fusion does not occur.

## GLOUCESTER ELECTRIC TRAMWAYS.

The following details of the electric tramways system at Gloucester appeared in a paper read before the Incorporated Association of Municipal and County Engineers on June 3, by Mr. R. Read, A.M.I.C.E., the city surveyor.

The horse tramway was laid down in the city in 1879 on the Kincaid system, and this was worked by a company until 1902, when it was purchased by the Corporation for £26,000, and in its place the Corporation have laid down a system of electric light railways, covering seven miles of route inside the city and two miles outside the city, the latter being under the order granted to the Gloucestershire County Council, but laid down under the same contract by the Corporation, who work the line. The electric light railway is equivalent to 12½ miles of single track inside the city and 2½ outside, or a total of 15 miles of single track. Messrs. Alfred Dickinson and Co., of Birmingham, in conjunction with Mr. Robert Hammond, of London, were the consulting engineers for the tramways,

MR. E. W. A. CARTER, ASSISTANT CITY SURVEYOR, GLOUCESTER.




Gloucester Corporation Tramcar.

Mr. Hammond looking after the generating plant, while Messrs. Dickinson and Co. looked after the track, feeders, and overhead equipment, in conjunction with the author. The rails are 90lb. to the yard, 50ft. in length, 6in. deep, head 3¾in. wide, tread 2⅛in. wide, groove 1in. wide, guard ⅝in. wide, flange 6in. wide, 3ft. 6in. gauge, double copper bonded with 6/0 S.W.G. and 4/0 S.W.G., paved with 5ins by 4in. setts laid upon 6in. of cement concrete. The rails

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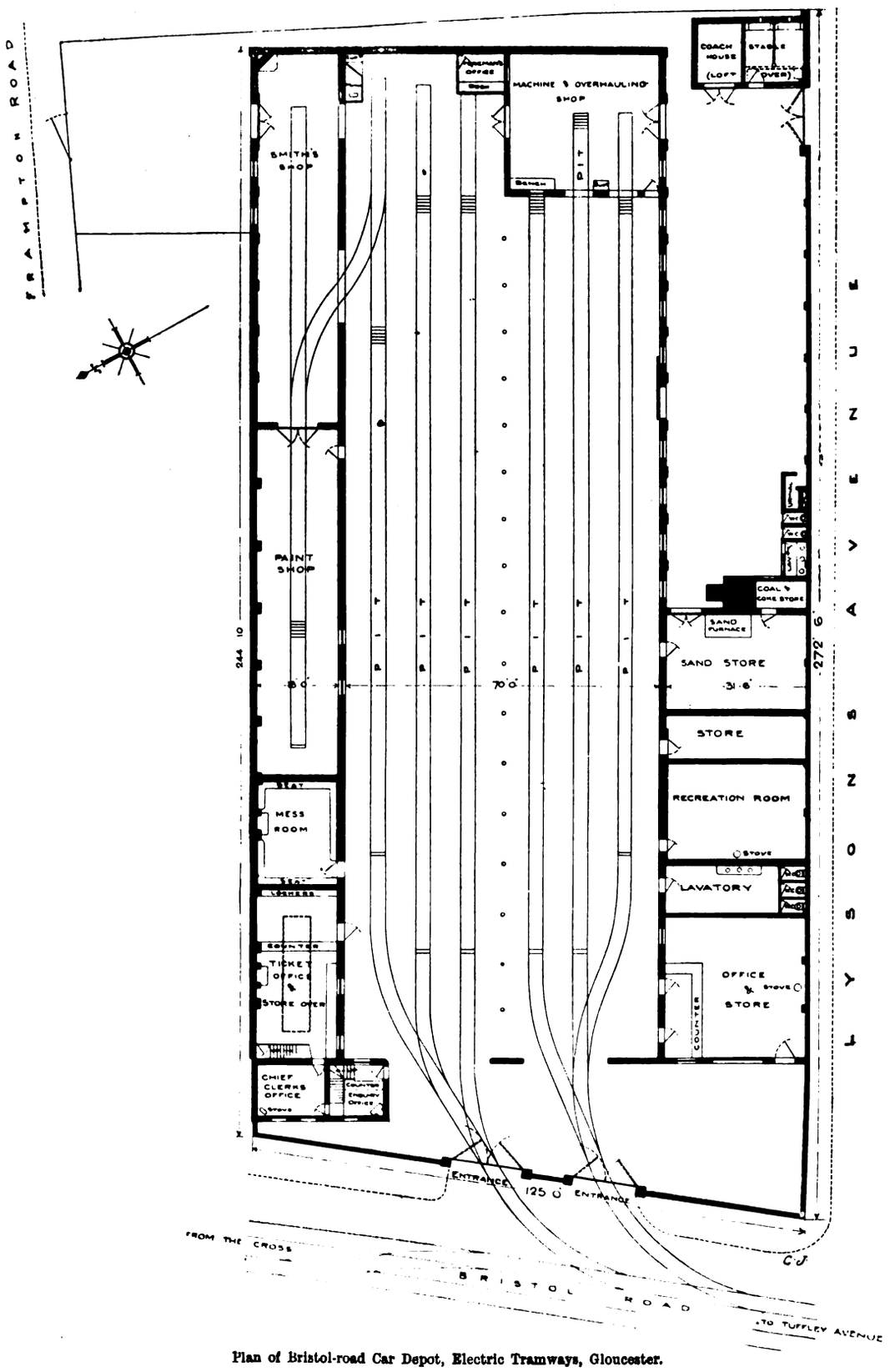
are fished with ordinary fishplates, 60lb. per pair, six bolt. to each joint, tie-bars 8ft. apart, but the joints are not anchored to the concrete in any way. The rails were supplied by the Barrow Steel Company and the points and crossings by Messrs. Askham Bros., of Sheffield, the contract for the poles was let to Messrs. J. G. White and Co., and the overhead equipment to the British




Plan of Bristol-road Car Depot, Electric Tramways, Gloucester.

Electrical Equipment Company. The line is worked by 30 cars constructed by the Brush Electrical Engineering Company. The cars hold 18 inside and 23 outside—total 41 passengers. The cars' electrical equipment is by Messrs. Dick, Kerr, and Co. The work was commenced by Mr. George Law on Nov. 9, 1903, the first section was opened on May 3, 1904, and the last section in July, 1904. The overhead equipment is fed at every half-mile from underground cables laid in cast-iron troughs filled up solid with bitumen, each feeder pillar being fitted with switches for isolating the length and with telephone communicating with the car depôt. The overhead trolley wire is of copper "0" B.W.G., insulated at every pole, which are 40 yards apart. The car-shed was originally an old sawmill, and was purchased as one of the assets of the old horse tramway company. There being plenty of land in connection therewith, the author nearly trebled the size of the buildings, and provided six lines of car sidings, with pits, repairing shop for the electric motors, car-repairing and paint shop, smiths' shop, stores, offices, and messroom for the men, the cost of the additions and alterations being £5,030. 14s. 7d. The total cost of the electric light railway work inside the city was £128,436. 13s. 7d.

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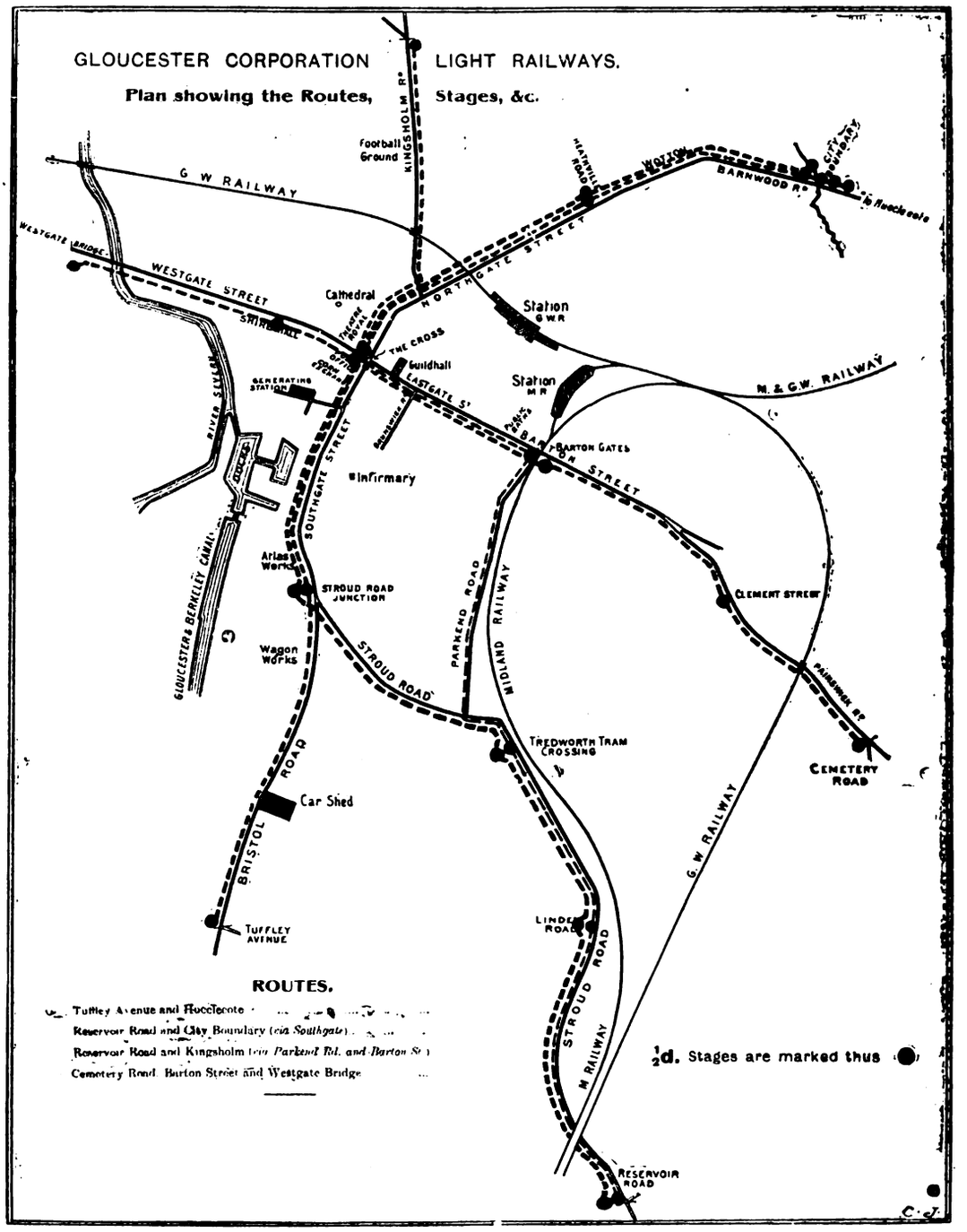
## THE PROTECTION OF ELECTRICAL INSTALLATIONS AGAINST EXCESS PRESSURE RISES.

BY ZODIAC.

With the gradual increase of the use of high-tension transmission schemes the efficient protection of the plant, cables, machine winding, etc., against the effects of excess pressure becomes of vital importance. Cases in which the line is directly struck by lightning are happily of comparatively rare occurrence, as in such instances it is very difficult, indeed, for any device to ensure freedom from insulation breakdown. On the other hand, disturbances in the pressure due to atmospheric inductive effects are quite frequent; indeed, such disturbances often occur during the summer months at times when the sky is perfectly clear. Such comparatively small voltage disturbances *are unable to jump the spark gaps of the normal lightning arresters*, and hence some provision has to be made for dealing with such excess pressures in order to avoid disturbances of the normal working voltage. In the case of installations using cables exclusively for the purpose of distributing the energy, these atmospheric disturbances do not occur; but here, again, rises in the pressure frequently result when transformers or additional feeders are switched in or out, resonance playing an important part in the phenomena.

A marked example of the disturbing influence on the pressure when switching in or out a transformer was recently observed when testing a 50 kw. 5,000-volt transformer which was fused with fuses blowing at about half an ampere, an electrostatic voltmeter reading to some 8,000 volts being used, and the connections being as shown in Fig. 1. The secondary circuit of the transformer being connected to the network, the high-tension switch, F, was closed, when the fuses immediately blew, the arc being quite a normal one; at this instant, however, the electrostatic voltmeter flashed over, thus showing that the voltage must have risen considerably above 8,000 volts, as the distance between the vanes was over ½in. The strength of the primary current at the moment of opening the circuit is not dependent on the load of the transformer alone, but is also dependent on the value of the E.M.F. wave at the instant the switch is opened. The switch used in the experiment was a quick-acting air-break switch, with an oil switch which breaks the arc at the instant when the E.M.F. wave is passing through its zero value; the current at the instant that the circuit is broken would be more or less reduced to zero, hence we have here a very clear argument for using oil-break high-tension switches in preference to air-break switches.

It is owing to the same reason that an alternating

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current can be more easily broken than a continuous current of the same value and voltage. In cases where 500-volt motors have broken down, it has frequently been observed that the voltage at the time of the accident jumped across an air-gap which should have been amply sufficient to withstand a much higher voltage. It will probably be found in such cases that the voltage has originally punctured a weak spot in the armature insulation, when, owing to the strong magnetic field, the resulting arc would be suddenly extinguished, thus giving rise to an oscillating current in the windings (having a very high periodicity); hence the machine field windings would tend to act as a transformer, thus producing a voltage which

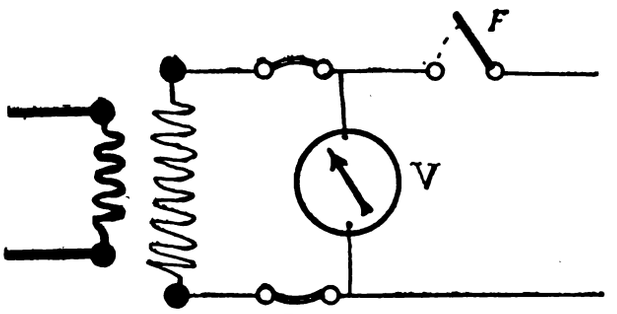

FIG. 1.

may be anything in the neighbourhood of 6,000 to 10,000 volts. Innumerable cases of breakdowns occurring to cables and machines, the cause of which could not have been either lightning discharges or defective material, are doubtless due to the above-mentioned phenomena. It would, therefore, seem essential that all installations, whether high-tension or low-tension, should be provided with suitable excess pressure arresters quite independent of the ordinary lightning arrester. The difficulty, however, in this case arises from the fact that the spark-gap in the case of low-voltage installations has to be made very small indeed; for instance, a 2,000-volt installation would have to have spark-gaps set at a distance of 1·4mm. in order to afford protection against pressure rises exceeding 4,000 volts, as shown on the curve given in Fig. 2. Such small gaps are readily bridged by dirt or insects; in fact, in

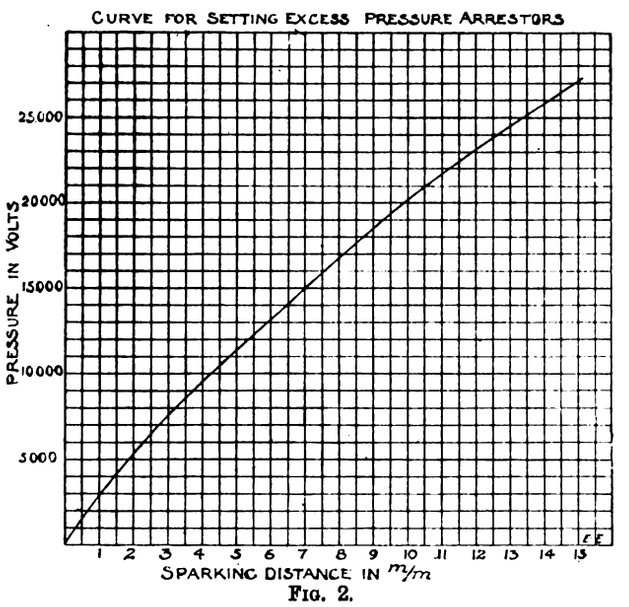

FIG. 2.

actual practice blow-flies frequently cause these excess-pressure arresters to operate, hence high resistances are placed in series with the excess-pressure arresters, so that the current to earth is of so small a value that it does not in any way affect the normal voltage of the circuit, a small energy loss being quite sufficient to relieve the excess pressure.

This is the main difference between the arrangement of the excess-pressure arrester as compared with the ordinary lightning arrester. In the case of a lightning arrester it is not permissible to place a large resistance in series with the arrester, since with the lightning discharge the amount of energy flowing through the arrester is very considerable. Fig. 3 shows diagrammatically a horn-type arrester in which an electromagnetic blow-out arrangement is provided for extinguishing the arc. Such an arrangement would not be permissible in the case of a lightning arrester, as, owing to the high frequency of the lightning discharge, the inductance offered by the electromagnet would seriously affect the operation of the arrester. In the author's opinion these electromagnetic blow-outs are quite unnecessary, and it is questionable whether the ordinary excess-pressure discharge is not of such a high frequency as to be affected, to some extent, by the impedance of these

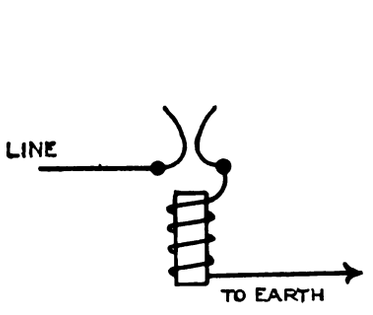

FIG. 3.

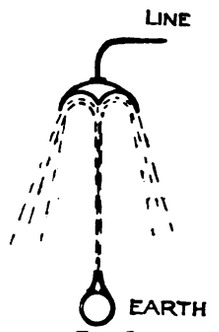

FIG. 5.

blow-out coils. Various forms of non-inductive resistances have been used by different firms. One of the most frequently used resistance consists of an earthenware pot about 10in. in diameter and some 2ft. high. From the top of this pot is suspended a metal plate connected to the line, the bottom of the pot consisting of a metal plate, which is effectually earthed. The whole is filled with water so that the upper plate is thoroughly immersed, thus forming a non-inductive resistance (see Fig. 4). In the case of a three-phase circuit three such resistances are used, one in circuit with each arrester.

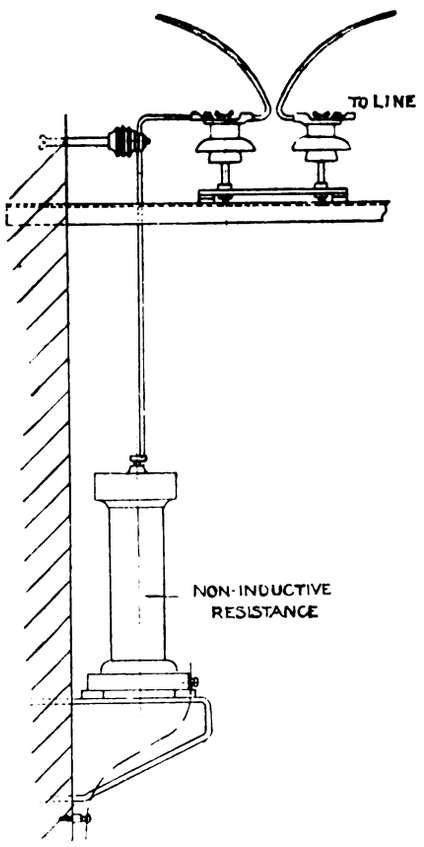

FIG. 4.

For hydraulic installations where a continuous supply of water is always available, the non-inductive resistance illustrated in Fig. 5 can be conveniently used. In this case it will be noted that a jet of water is used, which, by striking a special-shaped bell-mouthed casting, forms an effective high resistance to earth. The value of these water resistances should be such that with the normal

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working voltage the current to earth does not exceed 500 watts. This amount of energy, although it is quite negligible as far as its effect on the working of any ordinary circuit is concerned, is ample to dissipate any excess pressure. The resistance, of course, can be easily varied by altering the length of the water column or of the water jet as the case may be. In practical use care must be taken that the water supply is kept constant, any evaporation in the case of a pot resistance being made good, otherwise if the water supply were to fail the connection between the arrester and earth would be broken, the results of which might obviously be serious.

## INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

The full programme of the tenth annual convention of this association is now issued. The headquarters will be Edinburgh, as Mr. F. A. Newington is president, but meetings are also to be held at Glasgow and Aberdeen. The following extracts from the programme will show the exceptional attractions of this year's convention:

TUESDAY, JUNE 27.

Meeting at Edinburgh, at 10 a.m., at the North British Station Hotel. The Lord Provost, Sir Robert Cranston, has kindly consented to be present and welcome the association. Presidential address by Mr. Frank A. Newington, chief electrical engineer, Edinburgh. The following papers will then be read and discussed: (1) "Load Factor: its Effect upon an Electricity Station," by Councillor Sinclair, chairman of the Electricity Committee, Swansea; (2) "Street Lighting," by Mr. E. E. Hoadley, chief electrical engineer, Maidstone. At 2.45 p.m, brakes starting from the hotel will convey the members and visitors to Dewar-place and McDonald-road generating stations. At 8.30 p.m. there will be a reception at the City Chambers by the Lord Provost, Magistrates, and Council.

WEDNESDAY, JUNE 28.

Meeting at Glasgow, at 10.30 a.m., at the hall of the Institute of Engineers and Shipbuilders in Scotland, 207, Bath-street, Glasgow. The Lord Provost of Glasgow, Sir John Ure Primrose, Bart., has kindly consented to be present to meet and welcome the association. The following papers will then be read and discussed: (1) "Notes on Costs and Tariffs for Electrical Supply," by Mr. Hamilton Kilgour, chief electrical engineer, Cheltenham; (2) "The Supply of Electricity in Industrial Areas, from a Municipal Point of View," by Councillor Hodgson, deputy-chairman, Electricity Committee, Salford. A private luncheon will be given by the Glasgow Corporation, to which members, associate members, and associates have been invited. At 3 p.m. the members and their friends attending the convention will be conveyed in vehicles provided for the purpose on a visit of inspection to the following works: Pinkston power station, belonging to the tramways department; Port Dundas electricity works, belonging to the electricity department; and St. Andrew's Cross electricity works, belonging to the electricity department. Arrangements have also been made for members and their friends to inspect the following sub-stations: Waterloo-street sub-station, belonging to the electricity department; Dalhousie-street sub-station, belonging to the tramways department; and the Yoker generating station of the Clyde Valley Electrical Power Company.

THURSDAY, JUNE 29.

Meeting at Edinburgh, at 10.15 a.m., at the North British Station Hotel. The following papers will be read and discussed: (1) "Extensions to Outlying Areas," by Mr. A. B. Mountain, chief electrical engineer, Huddersfield; (2) "Free Wiring and Supply on the Prepayment System," by Mr. A. R. Sillar, chief electrical engineer, Colchester. For the afternoon it is suggested that members should visit one of the following places: the Forth Bridge, the Falls of Clyde, Hawthornden and Roslin.

The association dinner will be held at the North British Station Hotel, Princes-street, Edinburgh, at 7.30 for 7.45 p.m. Evening dress. Tickets, 7s. 6d. each (exclusive of wine), may be obtained of the secretary before June 20, after which date the price will be 10s.

FRIDAY, JUNE 30.

The annual general business meeting of the association will be held at 10.30 a.m. at the North British Station Hotel, Edinburgh. Agenda: (1) Election of president for 1906; (2) place of meeting for convention, 1906; (3) election of officers and council for 1906; (4) annual report of the council; (5) balance-sheet for year ending Dec. 31, 1904. For the afternoon trips are aranged to Callander, Aberfoyle, and the loch for those who do not go to Aberdeen.

SATURDAY, JULY 1.

For the Aberdeen meeting visits have been arranged to the Aberdeen electricity works and car repair depôt, etc., during the morning under the guidance of Mr. J. A. Bell, the city electrical engineer. At 1.30 p.m. a private luncheon will be given at the town hall by the Aberdeen Corporation, to which only members, associate members, and associates will be invited. For the afternoon an excursion has been arranged to Ballater and Braemar, which will extend over Sunday. Other excursions from Edinburgh have also been organised for those who do not go to Aberdeen.

The secretary of the association, Mr. C. McArthur Butler, has arranged with the railway companies for those attending the convention to obtain return tickets from any station at a single fare and a quarter on production at the booking office of a certificate issued and signed by him. Applications for these certificates and for accommodation in any of the arranged excursions should be made to him promptly at Staple-inn-buildings, Holborn, W.C.

## THE ELECTRIMONGER.

BY B. C. H. J.

It's a wonderful thing, is the 'lectric!
I've studied it a month or two;
And to make my pile in a very little while
Is the project I have in view.
Though the hardware line is a good one,
It has this defective bar:
In Science it's a muff, but the 'lectric is the stuff
With its E = G over R.

It's a marv'lous thing, is the 'lectric!
But I've found how to make it go:
You get coloured wires and you tie 'em up with pliers
And nail 'em all around the show,
One end is hitched to the cut-out,
The other end goes to the lamps;
And if you are wise, you'll calculate the size
By a-multiplying volts by amps.

It's a terrible thing, is the 'lectric!
Oh! many a good man it's killed!
Which has made me swear to take every care
To keep my soul unspilled.
With rubber gloves to the elbows,
And an insulating mat below,
I fills the cells, what rings the bells,
With soda and $H^2O$.

It's a genteel line, is the 'lectric
(Which the hardware line it aint);
It is nice to wear a professional air,
To be free from the tradesman taint (haw).
And soon my cup of glory
Full to the brim shall be
When I sign all correspondence thus:

John Jones A.I.E.E.

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### TO CORRESPONDENTS.

*All Rights Reserved.* *Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

*All communications intended for the Editor should be addressed* C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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## WESTMINSTER STREET-LIGHTING.

The zeal of the councillors of the city of Westminster when street-lighting is concerned is amazing, and it is accompanied by a thirst for figures which must try the patience of the officials. Facts are apparently useless to satisfy that thirst unless they happen to agree with the preconceived notions of the councillors. Thus the full report of the city engineer, Mr. J. W. Bradley, which we reprint in this issue, is not considered satisfactory, and further figures from the town clerk and city treasurer are now asked for. The matter really under discussion is a much smaller one than would be supposed. A certain contract for the supply of sixty-six arc lamps has expired, and tenders were asked for lighting the streets in which these lamps were. The electric supply company's offer was recommended by the Works Committee for acceptance for a period of five years. The gas company also tendered, but their offer included a capital charge which, if spread over the five years, made the cost per lamp slightly higher. Instead of settling the question on its merits, the Council asked for a report on the lighting of the whole of the streets of the city by the two rival illuminants, in spite of the fact that present contracts prevent any extensive scheme being put through. This report clearly shows that there is practically nothing to choose between gas and electricity as far as cost is concerned. Mr. Bradley's conclusions in this respect are for the systems of lighting as actually used, and he has more reliable figures as to what results have been obtained than any other engineer we know of. For some years he had regular photometric trials made, which enable him to distinguish between the promises given on behalf of a particular system and the performance under service conditions. We are, therefore, content with his conclusions as far as they cover existing conditions. They show how close the rival illuminants are when the ordinary arc lamp is compared with the high-pressure incandescent gas lamp. When, therefore, the flame arc lamps are used with their increased candle-power from a given consumption of electrical energy, the pre-eminence of electric street-lighting will be assured. In Westminster the competition between gas and electricity for street-lighting is on equal terms, as the local authority is not the supplier of either commodity. Hence the usual plea of the gas advocates, that electricity succeeds by favour rather than by merit, does not apply. This may account for the strenuous effort of the gas company to secure the present contract.

## METERS.

The accuracy of measurement is absolutely necessary in all commercial transactions. The suppliers of electrical energy assure their customers that nothing in commerce can be measured with greater accuracy than the commodity they supply. The consumer has to take what is told him on faith, for few are conversant enough with applied science to determine for themselves the exact value of this assertion. Men of science with reputations at stake, as well as the sellers of the commodity, vouch for the truth and exactitude of the measurements, and the commonalty believe what it is told, purchases, and pays accordingly. The tale is quite true. The assertion cannot well be denied, yet measuring instruments, like the schemes of mice and men, "oft gang agley." So far as theoretical assumption is concerned, electrical measuring instruments approach perfection among measuring instruments, but, after all, they are more or less mechanical constructions, and, like all such constructions, are liable to troubles and failures. Absolute perfection in mechanical constructions borders on the impossible. They

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are subject to a variety of deteriorating influences, hence the necessity of constant supervision. Then there is another source of error which may be likened to the personal error involved in all investigations. Errors from this source are due to misreadings, mis-entries into books, and such like things. The broad question which the public needs to consider is whether the percentage of error from all sources is large enough to cause distrust. We are of opinion that, on the whole, electrical measurements are more accurate than any other class of measurements whatsoever. A committee of the London County Council reports upon the results of testing carried out by their officials in some disputed cases. Out of eight cases mentioned, seven errors are directly traceable to human failings. Thus in two cases where meters marked two hundred volts were used on one hundred-volt circuits, the division by two was forgotten, and the consumer overcharged. Other cases were due to the meters being incorrectly marked by the makers. The cases given are typical, and serve to show, as we have said before, the necessity of supervision of the meter-reading staff. Every effort may be made to avoid clerical errors or mistakes in reading, but such will occur. On the whole, we think the report confirms all that scientific men and suppliers say about the efficiency of electricity meters.

## CORRESPONDENCE.

### TERMS AS BETWEEN ELECTRICAL MANUFACTURERS AND ELECTRICAL CONTRACTORS.

SIR,—As it is evident from information received that a misunderstanding exists as to the terms upon which electrical manufacturers should supply their goods to members of the Contractors' Association, my committee are desirous that it should be generally known that the preferential discount of 2½ per cent., as provided under the original agreement between the Electrical Manufacturers' and the Electrical Contractors' Associations, ceased with the termination of the agreement, and should in no way be taken into account as from Jan. 1 last.—Yours, etc.,

W. DAVENPORT, Secretary.

## OBITUARY.

### John Munro.

We regret to record the death of a gentleman—little known, perhaps, except as a name to this generation of electrical men—who was greatly revered by those who knew him well. The work "Munro and Jamieson," appreciated by hundreds of users, conveys little to those users of one at least of the *collaborateurs*. Of late years Munro led the life of a recluse, mixing little with his fellows, his extremely sensitive and retiring nature having received rebuff, which caused such retirement. Educated at Glasgow University under Lord Kelvin (then Sir W. Thomson), Munro devoted his attention to cable work, and was at least in one cable-laying expedition, during which period he became friendly with E. Almack, another man of talent and energy who left the profession for other fields of work. Coming back from cable-laying, Munro turned his attention to literature, and, though painstaking and correct in his work, had not that scintillating knack of writing which leads to pronounced success. He wrote many books, and frequently contributed to magazines and technical papers. Living all alone in a small house at Croydon, communicating little or nothing to his friends, few knew of his circumstances, but his old-time friends will ever remember him as they knew him in early days—a man of merit, with legitimate ambitions, a lovable disposition; a man, in fact, who was altogether too much of a gentleman to retaliate when rebuffed, and hence failed to achieve that success he so well merited.

## A STUDY OF SHORT-DISTANCE TELEPHONY.

BY VALENTINE RYAN.

*(Continued from page 733.)*

A few more stations can be added to an intercommunication system when required by running a cable to a junction box, and making the connections uniform with the other stations; all the contact studs on these stations are allotted, so that it cannot be rung up; the home contact should be left "blind," and the switch returned to it after each conversation. A better plan is to break the bell circuit, then the switch can be left anywhere. This method is found convenient when a desk telephone is required for the use of a manager in a large office, there being a wall set at the other end of the room. In the first place, the manager can use the telephone for his own convenience; when someone wants to speak to him, they can ring up on the wall set, and be answered by a clerk, who will notify to the manager, thus saving the latter some annoyance, the same being done when the manager requires to ring up someone.

Writing with reference to overhearing on intercommunication systems, it is stated in text-books (one also meets it in patent specifications) that this is due to induction and condensation. This is not entirely correct. The diagram below (Fig. 6) shows the connection for three stations, A, B, and C, arranged on a 10-way intercommunication system. Suppose A and B to be engaged in conversation, and C to place the line selector on the "line wire" A and B happen to be using, then, as shown

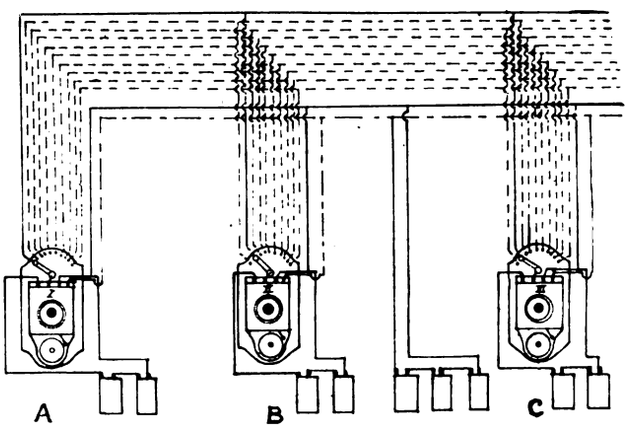


FIG. 6.—Connections of Overhearing Station on Intercommunication Systems.

in the diagram, when C is speaking A and B are in parallel with C in series. When B is speaking, A and C are in parallel with B in series; under these circumstances the third station is in the speaking circuit, so the overhearing is quite independent of induction and condensation—this point has been apparently overlooked. If a spare wire was left in the multiple cable and earthed at a few points, it would assist materially in reducing the overhearing; in similar cases, where direct working telephones are used and a common speaking battery employed, much the same happens. The station that is rung up will be found in parallel with the overhearing station; the third station remains in series with the battery.

From time to time so-called automatic intercommunication telephones have been placed upon the market. These are intended to save the trouble of moving the ordinary lever switch round a semicircle of contacts, and moving it back again to the home contact when the conversation is finished. In these instruments this disadvantage is avoided by the introduction of a multitude of evils; the lines are provided with individual switches which make contact with a common speaking bar, and this bar is tilted when the receiver or micro-telephone is replaced in the normal position. Each of the switches, the speaking bar, and the lever that tilts it, are all controlled by delicate spiral springs. The single spiral spring of the ordinary telephone is the weak point of its construction, yet in the instruments referred to more delicate springs are used in large numbers. The micro-telephone must be taken off the hook before one can ring, or the particular line selector one has moved will spring back again, when this is done. This is anything but an

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advantage. Of course, the working of the apparatus should be the reverse, but this would necessitate the introduction of a rather elaborate gear.

The adjoining Figs. 7 and 8 show a telephone* of very graceful design, which is being marketed by Stanley and Patterson, of New York. To the development of the principles embodied in this instrument one expectantly looks for the final solution of this vexed problem—viz., switchless intercommunication telephones.† The simple act of pressing a particular push-button rings

FIG. 7.

up the desired station and also completes the speaking circuit. This is the first telephone which enables one to do this, and it must remain an axiom in the construction of all such telephones that have any claims to being called automatic. Fig. 7 shows the front view, and Fig. 8 is the back view, with the cover removed, of an intercommunication set. In this country a micro-telephone may be considered more up to date than the arrangement shown, but they are not used to the same extent in America as they are here. Each line is provided with a push-button and label. Towards the lower end of this instrument are shown

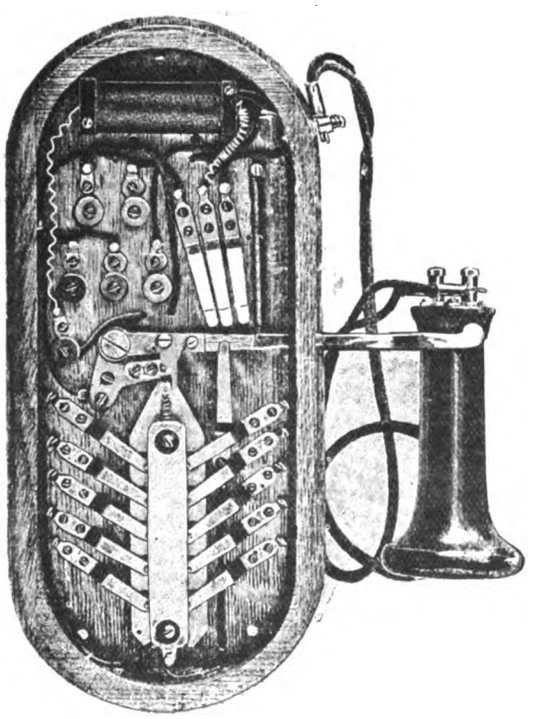

FIG. 8.

two plates, mounted one in front of the other; the outer one is the battery plate, the inner one is the common return plate, and moves in a vertical plane; normally it is held in the upper position by a spring. In it holes are drilled corresponding in number to and concentric with the push-buttons. On pressing one of these buttons, its tapered head is forced through a hole in the common return plate, the tapered edge impinges against the edge of this hole and forces the plate downward, until the head passes through; then the plate is pulled up by its spring and keeps the rivet-shaped head of the push-button from springing back. The tapered head of the push-button shank makes contact with the line spring opposite to it, and when the push-button is forced to its extreme limit it presses this spring against the battery plate, thus ringing up the station to which this particular push-button is allotted. The line springs mentioned are the two rows of diagonal springs shown, the ends of which form the terminals for the various lines. When the push-button is released it springs back, and is stopped half-way by the movable common return plate, and so connects the line

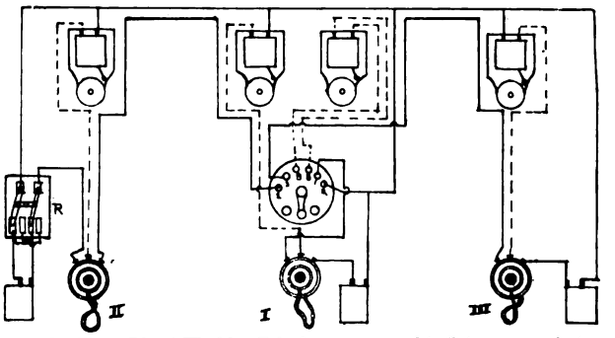


FIG. 9.—Three Direct-Working Telephones arranged to Intercommunicate.

springs to this plate. When the conversation is finished and the receiver replaced upon the hook, a pawl mounted on the hook engages a lug in the common return plate, and pushes the plate downwards far enough to release the push-button; the button is then free to spring outward into its initial position. Continuing its downward movement, the pawl or the receiver hook is thrown out of engagement with the lug on the common return plate, and this plate returns to its normal position.

Three telephone stations are often required to be connected up so that all can communicate. A favourite way of arranging for this is to place a six-point switch and extension bell at the intermediate station. Many persons are familiar with such installations working with induction-coil instruments. When direct working ones are used, the batteries at the outer stations are connected in series with that at the intermediate station; each then can communicate with the latter but not with each other—hence a reversing switch, R (Fig. 9), is placed at either of the outer stations. This is used to reverse the battery connections, connecting it in series with the ones at the other stations as may be required.

*(To be continued.)*

## LARGE DYNAMOS FOR JOHANNESBURG.

It will be remembered that Messrs. Siemens Bros. and Co. secured the contract for the supply of the generators for the new electric power station of the Johannesburg Corporation, which is being erected to the design of Messrs. Mordey and Dawbarn. The order included three direct-current machines, each of 1,350 kw. capacity; two smaller machines of 665 kw. capacity; two two-phase alternators of 1,350 kw. and one of 675 kw. The feature of the station is that power gas is to be used to supply the necessary energy, and this will be utilised in gas-engines which are being supplied by Messrs. Duncan Stewart and Co., of Glasgow. The first of these large direct-current machines have recently been tried at the Stafford works of Messrs. Siemens Bros. The test was made on the Hopkinson method, and gave results which were most satisfactory. The full-load efficiency was well above the guarantee, and the temperature rise on any part of the conductors of the machine was low. The commutation was also good, the machines running sparklessly with a fixed lead in spite of the fact that the field of one had to be weakened to secure the conditions of test. The two illustrations given herewith show these machines as erected for the Hopkinson trials, and give a good idea of the construction of the same. They are to be used for the direct supply of lighting and tramway load, and are com-

* *American Electrician.*

† Specification of patent in U.S.A., No. 710,065, of 1902, describes another arrangement designed for the same purpose.

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pound-wound. The type of the machine is the Siemens 124, 2 H, which signifies that the armature diameter is 124in. The machines have 14 poles, and are arranged to be directly coupled on to the flywheels of the 2,000-h.p. Stewart gas-engine. The dynamo will thus be placed between the two cylinders of the engine. The range of output of each of these machines was specified to be as follows: as shunt machines, 2,815-2,410 amperes, 480-460 volts, at 100 revolutions per minute; as compound machines, 0-2,250 amperes, 500-600 volts at 103-100 revolutions per minute.

In one of our illustrations the upper half of the field-magnet system is removed, which enables the armature winding to be seen. The armature coils in this type of machine are inserted in the open slots in the core. They are carefully insulated with material for securing a high insulation which shall not be affected by moisture. This insulation is tested under high voltage before it is passed. The photographs give a good idea of the large size of these two machines, which can be judged by the workmen standing round them. This is due to the fact that they run at the low speed of

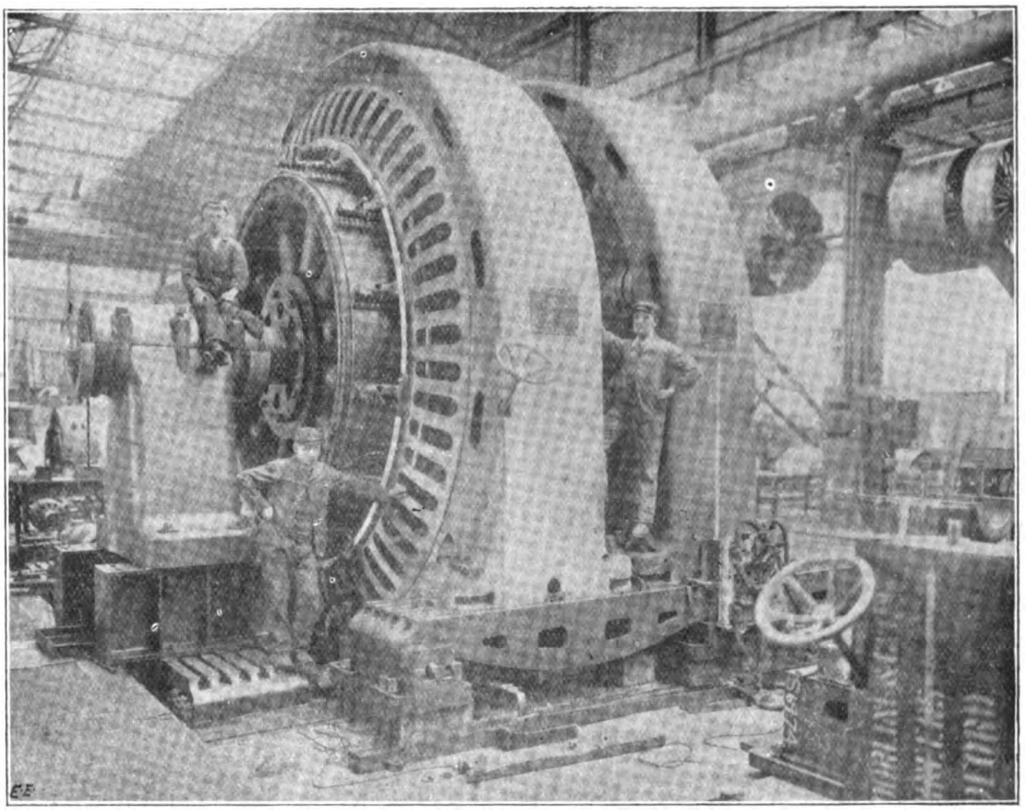

FIG. 1.—View of two Siemens 1,350-kw. Generators for Johannesburg, connected for Hopkinson test.

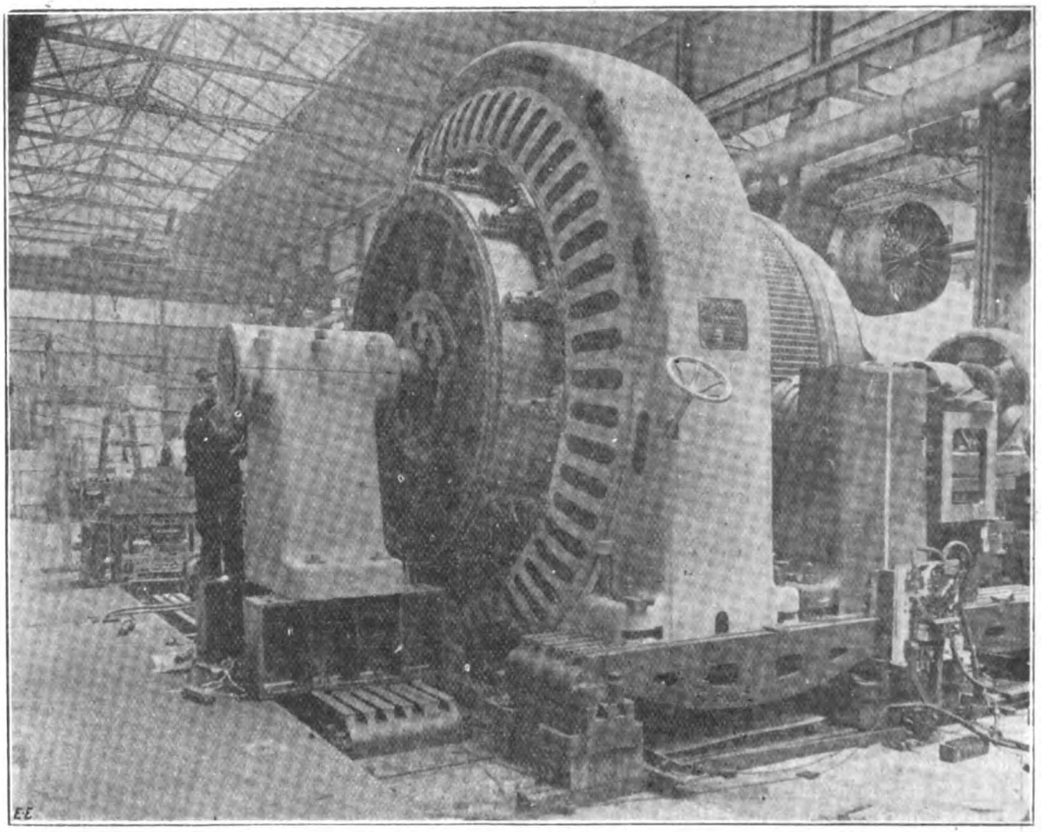

FIG. 2.—Johannesburg Dynamos with top half of one field magnet removed.

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100 revolutions per minute. There will be some interesting information to be obtained from the Johannesburg station when these dynamos are at work, and we trust they will result in more orders for English manufacturers.

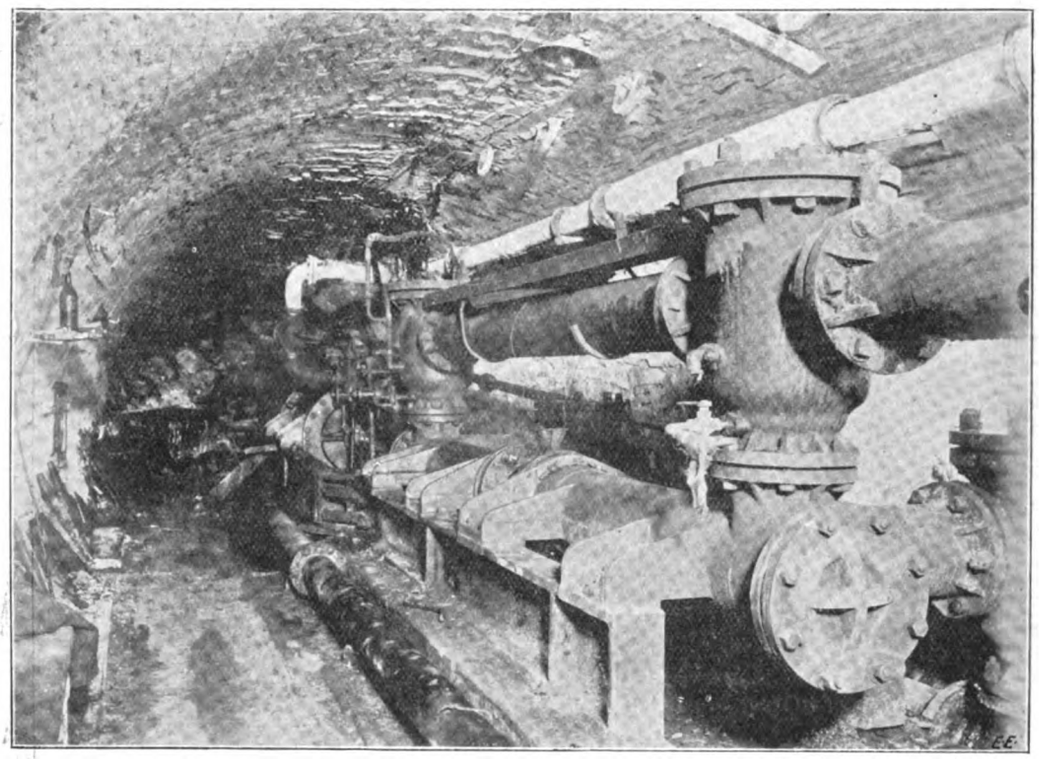

FIG. 1.—The High-Pressure Steam Pump at the Lewis Merthyr Colliery which has been displaced by Electric Pumps.

## ELECTRICALLY-DRIVEN HIGH-PRESSURE TURBINE PUMPS.

The Lewis-Merthyr Consolidated Collieries in South Wales were one of the first to adopt electrical working. Recently, when the question of high-lift pumping came to the fore, they decided to keep in line with the latest practice, and to instal an electrically-driven turbine and auxiliary centrifugal pump at their Coedcae pit, Hafod, near Pontypridd, these taking the place of an already existing steam-driven pump. The order for the work was given to the British Westinghouse Company, who, it may be mentioned, have carried it out to the entire satisfaction of the owners.

The following comparison of the old system with the new is of considerable interest. The steam-pump, which by the way is kept as a stand-by, is of a high-class type with differential valve gear and a condenser, and with steam and water cylinders 28in. and 9½in. diameter respectively, the latter having a 4ft. stroke. The full-speed duty is

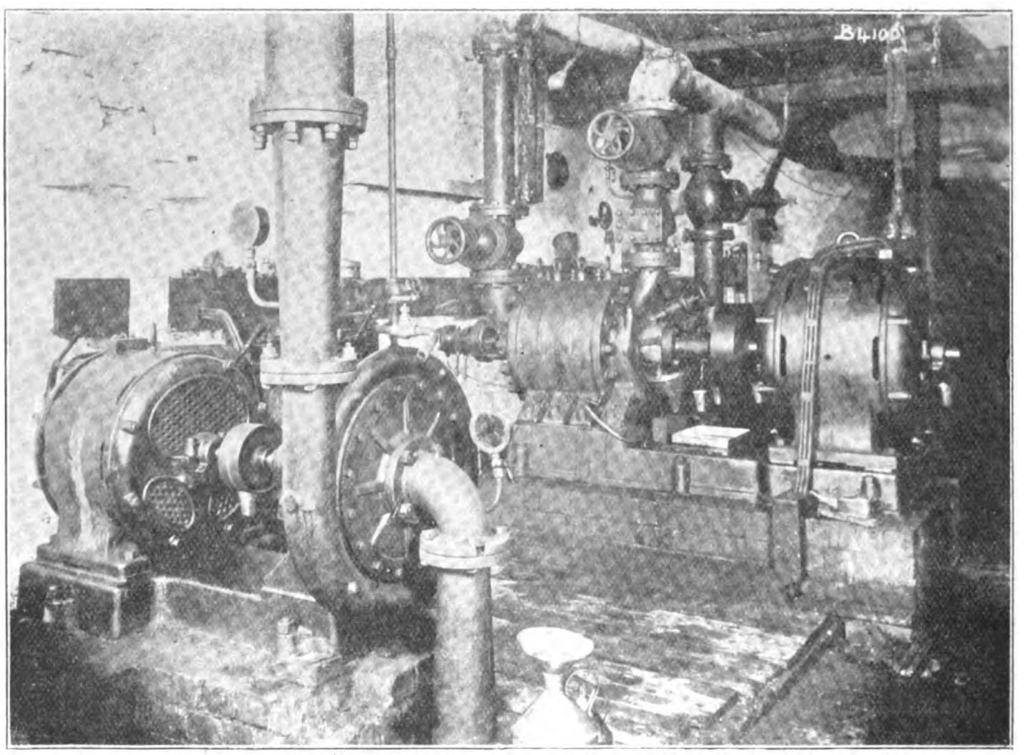

FIG. 2.—View of the New High-Lift Centrifugal Pump driven by Westinghouse Induction Motor.

25,000 gallons per hour against a head of 350ft. Steam is brought down the shaft from the boilers on the surface, this entailing the usual wasteful condensation in the pipes,

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and occasioning the greatest inconvenience should a joint break. Fig. 1 gives a view of this steam-pump, and it may be mentioned that it occupies an area of 253 square feet (39ft. by 6ft. 6in.). Fig. 2 shows the new turbine pump, and also a small centrifugal pump, these being fixed in a heading close to the steam-pump. These are driven by three-phase current taken from the mains of the South Wales Electrical Power Distribution Power Company, the current being transformed from 11,000 to 450 volts at a sub-station on the colliery premises. A three-core armoured cable leads the low-pressure current down the shaft to a dividing box and switchboard fitted with an oil-break circuit breaker, fuses, and indicating instruments. From this board the current passes to the oil-immersed auto-starters of the motors. The larger pump is of the Worthington four-stage turbine pattern, while the smaller is a 4in. centrifugal pump of the same make, and both are direct driven by Westinghouse type "C.B." three-phase induction motors, the larger of these being of 60 h.p. The function of the smaller pump is to supply an overhead tank for feeding the suction of the larger pump, the supply being drawn from the various mine pumps.

It has already been mentioned that the old steam-pump occupies a ground area of 253 square feet, and it is important to note that this area is 10½ times that required by the turbine pump (8ft. by 3ft.), and 7½ times that required by both electric pumps, the area covered by the centrifugal pump being 5ft. 6in. by 4ft. 3in. The electrically-driven pumps possess a combined efficiency of nearly 70 per cent. when delivering 350 gallons per minute against a head of 342ft., this being a very good figure. The type of motor illustrated has a short-circuited rotor winding, and is eminently suitable for driving both turbine and centrifugal pumps in collieries, as well as elsewhere, there being no brushes or other rubbing contacts. The starting switches are wholly immersed in oil and are fitted with gastight covers, so that they are perfectly safe for mine use. The attention required is practically nil, as the bearings both of the motor and pump are self-oiling, and after they have been started the machines may be left entirely to themselves.

## TRADE NOTICES AND NOVELTIES.

### Sectionalising Trolley-Wire Insulator.

Mr. C. A. Schierwater, of Liverpool, has recently patented a trolley-wire insulator, which we illustrate herewith, which has for its object the sectionalising of the trolley wire should a fracture occur. It is also intended to ensure that the ends of the broken wire shall be disconnected from the circuit. The inventor's idea is that these insulators should be employed at every point of support, whether the trolley wire is suspended from poles or by span wires. From the illustration in Fig. 1 the general construction of the insulator can be readily followed. The trolley wires, 1, are attached to the metallic brackets, 2, which are connected together mechanically by the bolts, 6, and by the insulating bush, 8. The middle metallic support, 3, is attached to the span wire or carried from a pole. The bolts, 6, are insulated by means of sleeves from the support, 3, and there is no connection between the two portions of the trolley wire supported by the insulator except through the subsidiary connection, 9. On this contacts shown in the illustration by 10 are carried, and these make the connection between the trolley wire entering and leaving the insulator. It follows, then, that if a trolley wire is broken it falls down, and the circuit is broken at the contact in question. The inventor also provides extensions to the metallic brackets, 2, to which the trolley wire is attached for the purpose of making a through metallic path for the trolley wheel. The way this is done is shown in Fig. 2, which is a plan of the underside of the insulator. The material indicated by 14 is an insulator, and serves to maintain true alignment between the metallic pieces, marked 16. There is, however, no connection between these metallic extensions, except when the trolley wheel is passing over them. Alternative methods of securing this through metallic path for the trolley wheel are described. One of these involves the use of a hinged tongue piece, which is not shown in the illustration. A certain amount of flexibility is provided in connection, 9, in order that contact, 10, may always rest on the upper side of the trolley wire, independently of vibration caused by the passage of the trolley wheel. It will be seen that with this method of support the trolley wire is cut up into short sections, which are automatically cut out of circuit should a fracture occur.

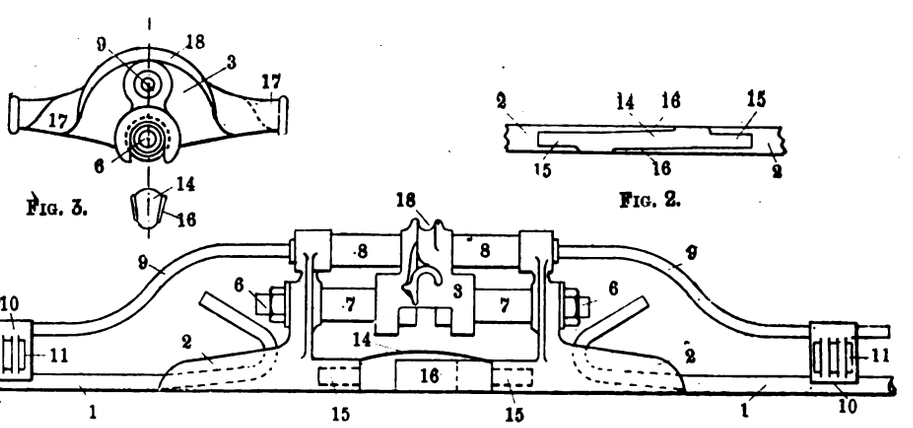


FIG. 3.

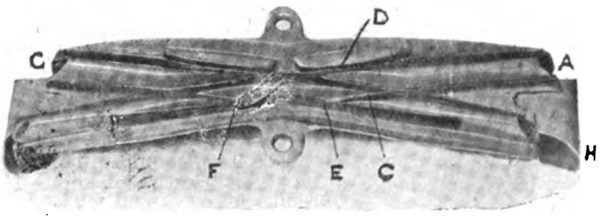


FIG. 2.

FIG. 1.—The Schierwater Trolley Wire Insulator.

### Improved Overhead Crossing.

Crossings and frogs are necessary evils on overhead tramway work, and the erratic behaviour of the trolley at these points is often the principal cause of trouble. The smaller the angle of the crossing, the greater is the liability of the trolley to take the wrong wire. If combined with a narrow-angle crossing the trolley wire is a side-running one, and there is a certain amount of overhang on the trolley wire, this trouble is still further intensified. When a trolley is advancing through a trailing frog, there is considerably more liability of damage to the overhead gear than when it is travelling in the reverse direction. Should the trolley take the wrong wire under these conditions, the mechanical frog that it would meet on this wire presents a most effective trap, and serious damage to the trolley head and overhead gear frequently ensues. On the Burton-on-Trent Corporation tramways narrow-angle crossings about 16deg. are used with a certain amount of overhang on the trolley, due to the cars not running centrally with the trolley wire round the junctions. Damage to trolleys and overhead gear has been of frequent occurrence, and, after numerous experiments, an improved design of crossing was brought out by the general manager, Mr. P. J. Pringle, and it has been the means of reducing the troubles to a negligible amount. The crossing is shown in the print herewith, and in




designing this an attempt has been made to get in practice a continuous through rail without any complicated gear or mechanism to effect it. If we presume a trolley wheel passing from A to B, there is always a possibility of it fouling the point C of the centre diamond and being thrown off the crossing. That part of the crossing marked D acts as a guard rail and prevents this occurrence, and practically gives the equivalent of a continuous rail to the passage of the trolley wheel at this point. On the trolley wheel still further advancing, the hard phosphor-bronze spring piece, E, is quite lightly sprung to one side, and then the flange of the trolley wheel meets the phosphor-bronze spring piece, F, guarding it from any possibility of taking the wrong wire. On the trolley

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advancing from G to H, the same cycle of actions takes place. If a trolley head is taken in one's hand and applied to this crossing, no amount of side pressure or speed in passing across will permit of the trolley taking the wrong rail or being thrown off. All the crossings on the Burton-on-Trent Corporation tramways have been equipped with this pattern for the last six to eight months, and have proved most effective. The spring pieces are made a good length, about 7in., and are therefore quite flexible, so that the amount of wear on these due to the trolley wheel springing them open is exceedingly small, and they will have a considerable life. The replacement of them when necessary is arranged to be quite a simple matter. We understand that the British Insulated and Helsby Cables Company have taken up the manufacture of this crossing.

## Catalogues, etc, Received.

SIEMENS'S PUBLICATIONS.—From Messrs. Siemens Bros. and Co., Limited, York-mansion, York-street, Westminster, S.W., we have three new publications—viz., Price-list 6B, Price-list 3G, and Circular Y.M. 110. In the first-mentioned, carbons suitable for open-type arcs are listed in four classes—namely, marks "A," "R," "T," and "U," mark "A" being the best quality. A special class, mark "E" (which is the finest quality of carbon produced), is made for all enclosed arc lamps, and gives results which it is claimed cannot be excelled. Finally, mark "SA" is used for searchlights. Meter-testing boards are listed in the second. These should meet the demand for a standard apparatus for the rapid and methodical testing of consumers' meters. The boards are fitted with all the necessary attachments, switches, etc., for this purpose, and by which three meters can be tested at a time. They are standardised for continuous currents up to 150, 300 and single-phase meters up to 150 and 300 volts on non-inductive circuits, and for single-phase and three-phase meters up to 150 and 500 volts on inductive circuits. Testing boards for other conditions are quoted for specially. The list further contains spare instruments, compensation resistances, and various accessories, also portable apparatus for testing meters on consumers' premises. The third and last-mentioned publication briefly describes the firm's marine-type ammeter. This instrument can be used for any values of current up to 100 amperes by merely substituting a different shunt. The various sizes of shunt are supplied to give the same fall of potential for each maximum current, whilst the moving coils are all made to have the same resistance. The instrument can be fixed in any position.

BRITISH PROMETHEUS SPECIALITIES.—The latest pamphlet (No. 111) issued by the British Prometheus Company, Limited, Kingston-on-Thames, deals with electrically-heated cooking utensils and convectors of the firm's manufacture. The list includes the majority of their most popular and best selling patterns of domestic apparatus, and is intended for private circulation per the electrical trade. Several new patterns are shown, notably milk sterilizer No. 70, on p. 6, and copper shaving pot No. 780, on p. 4. We note that the company have recently opened a showroom at 27, Ely-place, Holborn-circus, E.C., where a large and representative selection of samples is on view.

COUNTRY HOUSE LIGHTING. — The "Electrical Bulletin No. 1," issued by Messrs. R. J. Nicholson and Co., 26, Cannon-street, Manchester, describes the firm's "Ideal" outfit for country house lighting. This comprises a 2-b.h.p. petrol engine direct coupled to dynamo; a storage battery capable of sustaining 13 8-c.p. lamps for five hours, or six 8-c.p. lamps for 10 hours; and a switchboard mounted with switches for charging and discharging the battery, running the lights direct off the dynamo or off the battery, together with necessary indicating instruments. Price complete, £75.

VENTILATING, WARMING, AND DRYING FANS.—James Keith and Blackman Company, Limited, 27, Farringdon-avenue, E.C., London.

## SHIPLEY ELECTRICITY ACCOUNTS.

The accounts of the Shipley electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £56,250. Abstracts of the general balance-sheet and revenue account, together with the statement of electricity generated, sold, etc., are appended.

GENERAL BALANCE SHEET.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount received | 60,500 | 0 | 0 |
| Sundry creditors | 110 | 1 | 8 |
| Sinking fund account | 786 | 12 | 6 |
| Amount set aside for loan redemption | 2,000 | 0 | 0 |
| Amount credited to electricity revenue account | 2,683 | 10 | 9 |
| | £66,080 | 4 | 11 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended for works | 56,250 | 9 | 9 |
| Sundry debtors for current supplied | 2,793 | 12 | 5 |
| Loans repaid by means of sinking fund | 2,000 | 0 | 0 |
| Cash with treasurer and in hand | 5,036 | 2 | 9 |
| | £66,080 | 4 | 11 |

| Dr. REVENUE ACCOUNT. | £ | s. | d. |
|---|---|---|---|
| To generation of electricity | 2,613 | 12 | 9 |
| Distribution of electricity | 1,051 | 10 | 11 |
| Rents, rates, taxes, and insurance | 109 | 5 | 2 |
| Management expenses, salaries, etc. | 535 | 2 | 4 |
| | 4,309 | 11 | 2 |
| Amount carried to net revenue account | 3,054 | 5 | 9 |
| Balance to provide for bad debts | 562 | 1 | 7 |
| | £7,925 | 18 | 6 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| By sale of current by meter | 7,011 | 8 | 4 |
| Rental of meters and other apparatus | 326 | 7 | 11 |
| Public lighting | 600 | 0 | 0 |
| Sale and repairs of lamps, etc. | 264 | 18 | 2 |
| | 8,202 | 14 | 5 |
| Less discounts and allowances | 276 | 15 | 11 |
| | £7,925 | 18 | 6 |

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

| | | | |
|---|---|---|---|
| Quantity generated in B.T.U. | | | 1,258,371 |
| Quantity sold | Public lamps | 58,733 | |
| | Traction | 511,774 | 997,100 |
| | Private consumers by meter | 426,593 | |
| Quantity used on works | | | 148,986 |
| Total quantity accounted for | | | 1,146,086 |
| Quantity not accounted for | | | 112,285 |
| Number of public lamps (arc) | | | 40 |
| Total maximum supply demanded (kilowatts) | | | 622 |

## BURNLEY TRAMWAYS.

The following is an abstract of the revenue account for the year ended March 31, 1905, just issued by the Burnley tramways department. The capital expenditure to date amounts to £185,787.

| Dr. *Expenditure.* | £ | s. | d. |
|---|---|---|---|
| Traffic expenses—wages, cleaning, etc. | 14,449 | 11 | 4 |
| General expenses—salaries, rents, rates, etc. | 4,374 | 12 | 7 |
| General repairs and maintenance | 6,229 | 13 | 1 |
| Power expenses—cost of current, etc. | 15,449 | 0 | 9 |
| Total amount of working expenses | 40,502 | 17 | 9 |
| Munns depôt suspense account | 178 | 11 | 1 |
| | 40,681 | 8 | 10 |
| Balance carried to net revenue account | 13,345 | 4 | 9 |
| | £54,026 | 13 | 7 |

| Cr. *Income.* | £ | s. | d. |
|---|---|---|---|
| Passenger receipts | 53,497 | 17 | 6 |
| Parcel receipts | 482 | 13 | 7 |
| Advertising on time-tables | 46 | 2 | 6 |
| | £54,026 | 13 | 7 |

## FORTHCOMING EVENTS.

WEDNESDAY, JUNE 14.

**Chemical Society.**—At 5.30 p.m., general meeting.

THURSDAY, JUNE 15.

**Civil and Mechanical Engineers' Society.**—At 2.30 p.m., visit to the South-Western Railway Company's Works, Nine Elms.

FRIDAY, JUNE 16.

**Physical Society.**—"The Ratio between the Mean Spherical and Mean Horizontal Candle-power of Incandescent Lamps," by Dr. J. A. Fleming; "The Electrical Conductivity of Flames," by Dr. H. A. Wilson; "Contact with Dielectrics," by Mr. R. Appleyard; "The Pendulum Accelerometer, an Instrument for the Direct Measurement and Recording of Acceleration," by Mr. F. Lanchester; "A New Form of Pyrometer," by Mr. N. V. Stanford; and an exhibition of a refractometer by Mr. R. Appleyard.

**Dynamicables.**—Dinner at the Trocadero, June 27.

**Electrical Contractors' Association.**—Dinner at the Holborn Restaurant, June 27.

**Incorporated Municipal Electrical Association.**—June 27-30, annual convention.

**Municipal and County Club.**—House dinner (W. H. Grenfell, Esq., M.P., principal guest), June 29.

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## CITY OF WESTMINSTER.

### Electricity v. Gas for Street-Lighting.

The following report by the city engineer of Westminster, Mr. J. W. Bradley, M.I.C.E., to the Works Committee gives useful figures as to the cost of street-lighting within the city. The report is dated May 27, 1905, and reads:

I beg to submit the following particulars, according to your instruction of April 13, with reference to the lighting of St. James's, as reported to you on May 23, including the further extended details as directed at your last meeting. As this instruction practically takes the form of eight questions, I propose to deal with the matter in a categorical manner.

*No.* 1. *Whole Cost at Present of Electric Lighting in the City.*—The cost of electric lighting in the city of Westminster for last year was £27,024. 10s. 1d, made up as follows:

| | £ | s. | d. |
|---|---|---|---|
| Charing Cross and Strand, etc., Company | £3,444 | 0 | 6 |
| St. James's and Pall Mall Company | 1,993 | 9 | 0 |
| Westminster Electric Supply Company | 21,587 | 0 | 7 |
| | £27,024 | 10 | 1 |

The details as to the number and rate per lamp are as follows:

*St. George's Lighting.*

| | | £ | s. | d. |
|---|---|---|---|---|
| Westminster Electric Supply Company— | | | | |
| 954 arc lamps at £22 | £20,988 0 0 | | | |
| 2 incandescent lamps at £6 | 12 0 0 | | | |
| 26 incandescent lamps at £4. 10s. | 117 0 0 | | | |
| 147 incandescent lamps at £4 | 588 0 0 | | | |
| | | 21,705 | 0 | 0 |

*St. Martin's and Strand.*

| | | | | |
|---|---|---|---|---|
| Charing Cross and Strand Electricity Supply Company— | | | | |
| 101 arc lamps at £28 | 2,828 0 0 | | | |
| 22 arc lamps at £27. 10s. | 605 0 0 | | | |
| | | 3,433 | 0 | 0 |

*St. James's Lighting.*

| | | | | |
|---|---|---|---|---|
| St. James's and Pall Mall Electric Light Company— | | | | |
| 65 arc lamps at £30 | 1,950 0 0 | | | |
| 1 arc lamp at £27. 10s. | 27 10 0 | | | |
| | | 1,977 | 10 | 0 |
| | | £27,115 | 10 | 0 |

NOTE.—The Westminster Electric Supply Company have to allow a cumulative rebate of ½ per cent. per annum, which now stands at 1½ per cent.

*No.* 2. *What would be the Cost of Lighting of equal volume by Gas?*—This question is rather a difficult one to answer with any exactitude, as it depends on the prices which may be quoted from time to time by the gas company, who have the monopoly of the supply of gas illuminant within the city area; but on the basis of tenders recently submitted by them and accepted by your Council for lighting small areas in the city, the cost would be, say, about 1,300–700-c.p. gas lamps at about £17 per annum, or about £23,000 to £25,000.

[The present number of gas lamps in the city are given in a schedule, there being some 3,038 lamps, costing £13,089. 15s. 1d. per annum]

Your reference further asks for the cost of 66 lamps in St. James's if gas, and the cost of 66 lamps if electricity, showing the difference between the two for five years and indefinite period. I presume in this question that the costs are to be based on the present tenders of the St. James's and Pall Mall Electric Lighting Company and the Gaslight and Coke Company; that being so, the comparative statement is as follows:

| | £ | s. | d. |
|---|---|---|---|
| Electricity—66 lamps at £17 | £1,122 | 0 | 0 |
| Gas—66 lamps at £15. 1s. | 993 | 6 | 0 |
| Gas—cost of alteration of existing columns for gas lighting purposes—66 lamps at £10 per lamp. Spread over five years—£2 per lamp per annum | 132 | 0 | 0 |
| Total cost per annum (first five years) | £1,125 | 6 | 0 |

NOTE.—The gas company's quotation is subject to an increase or decrease of 9s. 6d. per lamp for every 1d. per 1,000 cubic feet increase or decrease in price of gas, which is now charged at 2s. 2d. per 1,000 cubic feet. The variation of each 1d. will mean an increase or decrease of £31. 7s. per annum on the above figures.

At the end of five years, should the Gaslight and Coke Company be open to continue the annual charge for maintenance at the rates now quoted, the cost per annum for these 66 lamps would amount to £993. 6s.

As I have also been instructed to include in this report a comparative statement of the annual cost which would be incurred if all the streets in the city were illuminated with electricity or gas, I have to report that on an average of 30 lamps per mile the cost of lighting would be as follows:

| | Per annum. £ | s. | d. |
|---|---|---|---|
| St. James's and Pall Mall Company's basis at £17 per lamp | £51,000 | 0 | 0 |
| Scott Snell Self-Intensifying Gas Company's basis at £17 per lamp, as erected in Whitehall | 51,000 | 0 | 0 |
| Gaslight and Coke Company's present basis of £15. 0s. 11d. per lamp, as erected in Aldwych (a reduction on the original tender, consequent upon the reduced price of gas) | 45,137 | 10 | 0 |
| Gaslight and Coke Company's basis including cost of erection of standard spread over five years | 57,137 | 10 | 0 |
| Gaslight and Coke Company's present tender for 66 lamps in St. James's, including cost of conversion, spread over next five years | 51,150 | 0 | 0 |
| Gaslight and Coke Company at the end of five years, if the gas company undertook the lighting for a further period at the present figure quoted by them for 66 lamps in St. James's—viz., £15. 1s. | 45,150 | 0 | 0 |
| The present annual cost of street-lighting (gas and electric) in the city of Westminster | 41,000 | 0 | 0 |

*No.* 3. *Advantages of Lighting by Gas and by Electricity from the City Engineer's Point of View*—Originally, when gas was used through the medium of flat-flame burners for the purposes of lighting shop thoroughfares, electricity was held to have certain advantages owing to the fact that the light as produced by the burning of coal gas through flat-flame burners was very yellow in character, and it was difficult to ascertain the colour of materials and goods in such light. Owing, however, to the introduction of incandescent mantles, the light as now given by gas illumination is, from a colour point of view, practically the same as that of an ordinary electric arc, there being very little difference.

*No* 4. *Relative Penetrability of Gas Lighting and Electric Lighting in Case of Fog*—There is no doubt that the yellow light of the flat-flame burner has a better penetrative effect in times of fog than the whitish-blue of the electric arc, but as between the ordinary electric arc and incandescent gas there is very little difference in their fog penetrative qualities. It is now possible to obtain carbons which give a yellow light, and by using these electric arc lamps would have a much better penetrative effect in times of fog than the ordinary incandescent gas lamp.

*No.* 5. *Whether in "Big Shop" Thoroughfares like Regent-street, Piccadilly, etc., Gas Lighting would be as advantageous as Electric Lighting, and whether the use of Electric Light in certain streets would benefit trade?*—As may be gathered from the replies to queries 3 and 4, there is little difference between incandescent gas lighting and electric in this point. One point in favour of electric light is that it can be turned on and off so quickly as compared with gas lighting.

*No.* 6. *Cost of Lighting such Streets by Gas and Cost by Electricity.*—The cost of lighting streets by gas and by electricity for *equal volumes of light* may on the basis of recent competitive quotations be taken roughly as about 8 is to 9, as referred to in my reply to query 2. While, however, there is competition between electricity supply companies, the gas company have the monopoly of gas supply.

*No* 7. *The Practicability of a System for Lighting "Big Shop" Thoroughfares with Electricity and Remaining Streets with Gas.*—There would be no difficulty in lighting one class of thoroughfare, or shop thoroughfares, with electricity and the remaining streets with gas.

*No.* 8. *Regard to be had to Existing Contracts for Lighting*—The existing contracts for lighting are as follows: Westminster Electric Supply Corporation for lighting St. George's district, terminating Aug. 26, 1930; Charing Cross, City, and West End Electricity Supply Corporation for lighting St. Martin's district, terminating Sept. 17, 1920, but determinable at end of seven or 14 years from the year 1899; St. James's and Pall Mall Electric Lighting Company's contract for lighting St. James's district has expired; the Gaslight and Coke Company for the lamps in the Strand and St. James's areas, St. Martin, and St.

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**Margaret and St. John areas, terminating Dec. 31, 1909; Gaslight and Coke Company for lamps in Aldwych and Kingsway for a period of five years; Scott Snell Self-Intensifying Company for lamps in Whitehall terminable at three months' notice.**

## PHYSICAL SOCIETY.

At the meeting of this society on May 12, Dr. C. Chree, F.R.S., vice-president, in the chair,

Prof. H. L. CALLENDAR read a paper on "*A Bolometer for the Absolute Measurement of Radiation.*" It is now generally agreed that the electric compensation method, in which the heat received by radiation on a metallic strip is determined by measuring the electric current required to produce the same rise of temperature in the strip, is the most satisfactory and accurate method for absolute measurement. Two methods have been used for this purpose: (1) the thermo-electric method of Angström, in which the equality of temperature between the strip exposed to radiation and that heated by the current is determined by means of a copper-constantan couple, the two junctions of which are attached to the backs of the two strips with silk paper and shellac; (2) the bolometric method of Kurlbaum, in which the rise of temperature produced by the radiation or by the electric current is measured by the increase of resistance of the metallic strip itself. In applying the first method it is necessary to use a sensitive galvanometer for the thermo-couple, and an accurate milliammeter for the current. It is also necessary to make measurements with the strips interchanged, as it is impossible to secure exact equality of resistance of strips and exact quality of thermal contact for the junctions which are insulated from the strips by paper and shellac. The advantages of the second method, which has not hitherto been applied to the extent which it merits, are (1) that the strip is also the thermometer, and can, therefore, be made much thinner and quicker in action, as no paper insulation is required; that the power available is much greater, so that the same portable milliammeter which serves for measuring the current may also be used for the resistance balance in place of a sensitive galvanometer; (3) that the actual resistance of the strip may readily be verified at the time without special additional apparatus; (4) that uniformity of resistance of the strip is less important than in the thermo-electric method, in which the mean resistance of the strip is not necessarily the same as the resistance at the central point where the temperature is taken by the couples; (5) that the area exposed to radiation may be more accurately measured. In the practical application of the bolometric method for the absolute measurements of solar radiation, the author has introduced certain modifications suggested by experience in platinum thermometry, with the object of securing (1) temperature compensation, so that the zero remains constant in spite of changes in the surrounding temperature; (2) conduction compensation, so that loss of heat by conduction at the ends of the strips may not affect the readings; (3) accurate measurement of the area of radiation absorbed. (1) In order to secure accurate temperature compensation during the observations of radiation, when changes of temperature of the instrument are sometimes unavoidable, especially with powerful sources of radiation, in spite of the water-jacket in which the instrument is enclosed, the bolometer is balanced against a balancing resistance constructed of the same platinum, enclosed in the water-jacket, but protected from the radiation. (2) To secure conduction compensation, this balancing resistance is made in two parts—one (*a*) precisely similar to the bolometer itself, but with strips 1cm. long instead of 3cm., so that the ends of the strips are subject to the same conduction losses as those of the bolometer when heated by the electric current, the change of resistance measured being that of the central 2cm. only of the strips, which length is uniformly heated. The other part, *b*, of the balancing resistance is replaced by a resistance of manganin when the actual temperature of the bolometer or the heating effect of the current is measured. (3) To secure accurate measurement of the area of radiation absorbed, this area is determined by an aperture in the cover of the water-jacket having a width of 2cm. coinciding with the central portions of the bolometer strips. The strips are arranged with a small overlap, so that all the radiation entering this area falls on the strips. The necessity of accurate measurement of either the length or the width of the strips themselves is thereby avoided. With these modifications the bolometric method appears equal in convenience, and probably superior in accuracy to the thermo-electric. Owing also to the great increase in power available, the absolute measuring bolometer can be directly used with one of the author's self-recording instruments for solar radiation. Comparisons have been made between the bolometer, in which the platinum strips are directly exposed to radiation, and one of the author's ordinary sunshine receivers enclosed in a glass bulb in order to determine the effect, if any, of the glass bulb in selective absorption. The values of the reduction constant obtained for the glass receiver showed no certain variation over a wide range of quality of radiation, from sunshine or arc light down to a dull red heat. This result is probably to be attributed to a self-compensating action of the glass bulb, which radiates to the enclosed coils precisely those ray which it absorbs.

Mr. CAMPBELL pointed out that with regard to the comparison made by Prof. Callendar between the open and the glass-covered bolometers, it should be noticed that the radiation used in the experiment had already passed through the glass of the globe surrounding the glowing filament. This would filter out some part of the radiation, possibly in such a way as to make the two instruments agree more closely than they otherwise would.

Mr. PRETTY suggested that bolometers such as the author described might be used for testing the watts given out by incandescent lamps.

Prof. AYRTON wished to draw special attention to the effect to which Mr. Campbell had alluded—namely, the fact that the radiation used by the author had already been filtered by passing through glass before it reached the glass-enclosed bolometer.

Dr. CHREE enquired whether the Angström instrument was affected by lag, and to what extent?

Prof. CALLENDAR said that in his experience the Angström instrument took nearly one minute to reach within ½ per cent. of its steady reading. He had made comparisons with the naked arc as well as with the enclosed incandescent source, and found the results did not differ materially. The glass-enclosed receiver also gave consistent values of the reduction constant when compared with the Angström instrument or the bolometer, which were not screened by glass.

Mr. W. H. PRICE read a paper on the results of experiments carried out at Crompton's works at Chelmsford, by Mr. C. H. Wright, on the possibility of using the resistance of a conductor heated by an alternating electric current as a measure of the current. An alternating current was passed through a thin conductor in series with a standard resistance, and a small direct current from a storage battery superposed on the system. The mean differences of potential at the terminals enabled him to compare the resistances on a potentiometer. The presence of any considerable body of air near the heated conductor was found to affect the results through the irregular currents of air produced, while the neighbourhood of solid matter caused the permanent condition to be reached only slowly in consequence of its heat capacity. To obtain uniform results so that the resistance of the conductor corresponded consistently and promptly to the current passing, it was found necessary to enclose the conductor in a relatively large vessel exhausted of air. Nearly consistent results were then obtained, affected, however, to some extent by the changes in the vacuum by the liberation of gas occluded in the conductor. At moderately good degrees of exhaustion the resistance of the conductor for a given current varies rapidly with the quantity of gas that remains, and it was suggested that this might form the basis of a vacuum gauge. The results of experiments on carbon incandescent lamps and on platinum-foil ligaments in exhausted bulbs were shown in diagrams, giving the effects of different air temperatures and of the degrees of exhaustion. The author supposed that such conductors enclosed in large glass bulbs, highly exhausted when the conductors are incandescent, would form useful gauges for electric currents. They would be perfectly portable, not easily liable to damage, capable of highly accurate and permanent calibration, and, of course, very inexpensive. They could be made of exceedingly small inductance and capacity, and their values would be independent of periodicity and wave-form. Their employment would correspond in precision and sensitiveness to other measurements of electrical resistance. The useful range of currents measured by one such conductor might be of the order of 1 to 4.

Prof. AYRTON pointed out that at any rate for small alternating currents a suitably wound instrument of the Kelvin-balance type was quite sufficiently accurate.

Mr. CAMPBELL asked was any compensation introduced for the temperature of the walls of the enclosure, or was the temperature merely read and a correction made for it?

The AUTHOR, in his reply, said that in all cases corrections were applied for the external temperature.

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The meeting on May 26 was held at the National Physical Laboratory by invitation of the director, Dr. Glazebrook. The laboratory was open to the inspection of Fellows, and the following special demonstrations were shown:

"*The Specific Heat of Iron at High Temperatures,*" by Dr. J. A. HARKER. A knowledge of the specific heat of iron is important in the determination of high temperatures by calorimetric methods. Dr. Harker has determined the total heat of iron up to temperatures of 900deg. C. by heating the specimen in an electric furnace, the temperature of which was determined by a resistance thermometer, and dropping the iron into a water calorimeter. A difficulty arises at high temperatures owing to the oxidation of the iron when it comes in contact with the water in the calorimeter, and it is necessary in these circumstances to enclose the specimen by a suitable shield. Quartz tubes were tried, but it was invariably found that they splintered when immersed in the calorimeter. The difficulty was overcome by having in the calorimeter a vertical cylindrical brass tube, filled with magnesia, terminating at its upper end in a hemispherical cup. The iron, in the form of a cylinder the diameter of which was slightly less than that of the tube, was dropped into the magnesia. The extreme flocculence of the powder allows the iron to go straight to the bottom of the tube, and it is thus protected from oxidation. Dr. Harker illustrated by curves some of the peculiarities of the specific heat of iron at high temperatures.

Dr. HARKER also exhibited some new types of electric furnace for the attainment in absence of noxious gases of temperatures between 800deg. C. and 2,200deg. C. The conductor conveying the electric current is a tube of solid electrolyte similar in composition to the filament of a Nernst lamp. An essential feature is that for many purposes the usefulness and life of a furnace constructed in this way may be much increased by adopting a "cascade" system of heating—that is, the energy supplied may be divided so that only sufficient is put through the tubular conductor to raise its temperature, say, 1,000deg. C. above its surrounding, the surrounding itself being maintained at 1,000deg. C., thus enabling a temperature of 2,000deg. C. to be attained in the tube without straining it unduly. The regulation of temperature in small furnaces of this type is so perfectly under control that very well defined melting points may be taken with very small quantities of substance. The thermo-electric method has been used in these furnaces for determining the melting point of platinum, the mean result of the experiments giving 1,710deg. C. ± 5deg. C.

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Mr. A. CAMPBELL exhibited apparatus for the measurement of small inductances. The method of measurement is that adopted by Max Wien, and described by him in a paper on "Magnetisation by Alternating Currents" (*Wied. Ann.* (13) August, 1898). It is a modification of Maxwell's method of comparing two self-inductances, the source of voltage being alternating, and the indicating instrument a tuned optical telephone or vibration galvanometer.

In the Optical Department two new optical benches constructed for the laboratory by Messrs. R. and T. Beck were shown by Mr. SELBY. One of these is specially designed for the rapid testing of spherical and cylindrical lenses, such as are found in oculists' trial cases. The bench consists of two parallel steel bars of circular section, 14ft. long, supported on four cast-iron standards. The carriage carrying the lens-holder is moved along the bench by an endless steel tape which passes over pulleys at the ends of the bench, the movement being produced by rotation of the pulley at the eye end: the focal length of the lens is read on the tape at this end of the bench. The most novel feature in the design is the arrangement provided for rotating the lens holder from the eye end, for the determination of errors of centering of spherical lenses, and errors in the position of the axis in the case of cylindrical lenses. A triangular tube, which extends along the whole length of the bench, passes through a rotating fitting which projects from the lens-holder carriage. By means of gut belting and a spring pulley, rotation of the triangular tube is transmitted to the lens-holder.

The second bench is designed for the determination of the loss of light by absorption and reflection in telescopes and binoculars. The carriages with the various parts of the apparatus move on rollers along the bench. A parallel beam of light from a collimator passes through the telescope adjusted for infinity, and a lens interposed forms an image of definite size of the aperture of the telescope objective on the screen of a photometer, where the illumination can be compared with that from a standard source. Comparative measurements can in this way be made: for an absolute measurement the magnifying lens is omitted, and two similar telescopes, or the two halves of a binocular, are set back to back. The light then transmitted is compared with that which passes through an aperture of the same size as the object glasses of the telescopes when the telescopes are removed.

# LEGAL INTELLIGENCE.

## OVERCROWDING.

At Wood Green Police Court, Wm. Vickery, electric tram conductor, was summoned for carrying 20 passengers more than the authorised number.

Mr. Muskett prosecuted on behalf of the Commissioner of Police and Mr. Godfrey defended on behalf of the electric tramway company.

Defendant pleaded not guilty.

A police-constable deposed that on Easter Monday the defendant's car was overcrowded, in consequence of which he stopped it. Witness said, "You have a tidy few over your number," and defendant shouted out, "All who have not got tickets leave the car." Twenty passengers got out. When told that he would be reported, defendant said, "We'll see about that."

Cross-examined: Defendant could easily have stopped the bank holiday crowd from getting on the car. Plenty of cars passed him which were not carrying excess passengers.

The CLERK: If the conductor had difficulty in getting them off he could have kept his car stationary, and, moreover, could have prosecuted them?

WITNESS added that defendant could have put a guard across the entrance to keep people out.

Mr. GODFREY said that the Act under which the summons was taken was passed when stage coaches ran, and it was not thought at that time that bank holidays and electric traction would be invented—two things which absolutely made that law impossible to comply with. It was impossible to cope with the bank holiday crowd except by the reasonable method adopted by the police—viz., by allowing the trams to carry away people as quickly as possible. Another thing of late years was football, and there, again, the police could do nothing beyond getting people away as fast as they possibly could after the matches were over. In order to get over the difficulty, numerous corporations over the country which were running their trams had passed by-laws—Croydon had also done so—whereby on such occasions the number of passengers was not limited.

Mr. MUSKETT: Then they are bad, because they are repugnant to the law of the land.

Mr. GODFREY: We are doing what we can to study the interests of the public. Under the new Metropolitan Electric Act of this year, which was unopposed, and which would go through in about a month's time, there was a clause which would enable them to make a by-law. He asked the Bench to take into consideration the very different state of traffic in London to-day compared with 1842, when the Bill was passed.

The magistrates, after brief consideration, came to the conclusion that there must be a conviction. Having regard, however, to the extenuating circumstances, the nominal fine of 20s. and costs would be imposed.

## GUARANTEE OF AN ELECTRIC MOTOR.

In the City of London Court, before his Honour Judge Lumley Smith, K.C., an action was brought by Mr. Arno Edler, 17, Appold-street, Finsbury, to recover the sum of £94. 11s. from Messrs. Adams Bros., 59, Moor-lane, for an electric motor supplied to their order.

Mr. R. J. COLAM, plaintiff's counsel, said the defendants had until July last year driven their machinery by a large gas-engine. They had had an electric motor for auxiliary purposes, but just prior to July 15 they had an interview with the plaintiff, who was asked to supply a small motor of 2½ h.p., which the defendants said they wanted to enable them to work their machinery overtime. The plaintiff suggested that the defendants should have a separate motor for each separate machine, to obviate transmission losses. As this did not suit the defendants, the plaintiff suggested that the defendants should have two motors, one for each floor. Ultimately a motor was supplied, and the question for the Court to decide was whether there was an implied condition that it was fit for some specific purpose which the defendants mentioned to the plaintiff. Their case was that the motor would do all they had promised.

Mr. GOVER, for the defendants, said they told the plaintiff the purpose for which the motor was required, and it was absolutely useless.

Mr. COLAM said the whole question turned upon whether the motor was strong enough to drive the defendants' machines.

According to the plaintiff, the defendants stated that they wanted a 15-h.p. motor, but when the motor was fixed up it was worked up to 25 h.p., and blew the fuses. The defendants had expert advice as to whether the machines would be suitable or not for their purpose. It was not true that the plaintiff had ever said that a 15-h.p. motor would be sufficient to drive the whole of the defendants' machinery. It was supposed that they would use it for one or two machines at a time, and not for the whole eight.

For the defence Mr. ADAMS said the motor for which the plaintiff was suing was quite useless for the purpose for which it was required. He expected a motor to drive the machines in the basement, and if he did not want to run the basement, then he expected the motor to be able to drive the next floor or the second floor. As a matter of fact, the motor would not turn the shafting round.

Judge LUMLEY SMITH, in giving judgment, said it was true the motor had been fixed on the first floor, because the defendants requested it. The defendants set up the plea that there was a guarantee that the motor would drive all their machinery, or that it would do certain work. The defendants further relied upon Section 14 of the Sale of Goods Act. It was not made out to his satisfaction that the buyers had relied upon the seller's skill or judgment. He did not think there was any guarantee by the plaintiff that the motor would do any particular work. Consequently judgment must be given for the plaintiff on the claim for £94. 11s., as well as on the counterclaim, with costs.

## PRODUCTION OF TRAMWAY TICKETS.

John Wilkinson again appeared at the Bradford City Police Court last week to answer a summons for failing to show his ticket on an electric car when required to do so. The case was reported in our last week's issue. The Stipendary Magistrate said the case was an extremely clear one so far as he could read the law. There was a great distinction between the Sheffield case and the present one. In the case heard by the Lord Chief Justice and his colleagues the facts were different from this one. In that case the ticket never got into the hands of the person charged; it fell on the floor, not having come into the person's hands. The Lord Chief Justice said the man was not bound to touch the ticket. In the present case the defendant took a ticket and threw it on to the floor. He might just as well have thrown it into the street. In throwing it upon the floor he refused to produce it when requested to do so, and the inspector was not obliged to go on to the floor to get it any more than he would have been obliged to go out into the street for it. Defendant would be fined 5s. and 13s. costs.

# COMPANIES' MEETINGS AND REPORTS.

## UNITED ELECTRIC TRAMWAYS OF MONTE VIDEO.

The general meeting of this Company was held at Winchester House on Monday, Mr. William Trotter presiding. In moving the adoption of the report he stated that the result of the working of the tramway systems showed a decrease of 12,560dol. This decrease was due to the revolution which broke out early in 1904, and continued until September. The first six months of the current year had, however, shown increased receipts of £4,481, the total being an amount which exceeded the previous best six months by over £1,000. He also explained the concession obtained by the Company, which was for 75 years certain, but might be extended under certain conditions to 90 years. The municipality for the concession received £9,000, and would take 3 per cent. of the gross earnings of the Company for the first 25 years and 3½ per cent. afterwards. The report and interim dividend on the preference shares at the rate of 6 per cent. per annum were approved.

## ORIENTAL TELEPHONE AND ELECTRIC.

An extraordinary general meeting was held last week at the Great Eastern Hotel.

Sir AUCKLAND COLVIN presided, and moved a resolution for empowering the directors to create debenture stock to the extent of £200,000 and to issue the same from time to time as they might deem expedient. He reminded the shareholders that at the last annual meeting he stated that additional capital would be required in the near future in order to meet expenditure on underground cables and for other similar purposes. It was found that a considerable sum would be wanted within the next few months, and the Board had been advised that it would be better to make the issue before the autumn holidays commenced. They had considered it desirable, in the interests of the shareholders, to create the proposed debenture stock rather than issue the remaining £50,000 of 6 per cent. preferential shares,

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which they had power to do. It would be a much smaller charge upon the revenue, and would carry with it its own sinking fund. The amount which they took powers to create might seem unnecessarily large, but it was thought advisable to fix the sum at £200,000 in view of the possibilities of the Company in the future, for they must remember, supposing it became necessary hereafter to create second debenture stock, that such stock would not be so valuable as one having a first charge on the total assets, and it would naturally be issued under less favourable conditions.

The resolution was unanimously carried.

## WEST AFRICAN TELEGRAPH.

The annual meeting of this Company was held last week at Electra House, London, the Marquis of Tweeddale presiding. Particulars of the report appeared in our issue of the 26th ult.

The CHAIRMAN, after reviewing the financial position, stated that the liability of the Company to maintain certain cables on the West Coast of Africa, in accordance with the arrangement entered into with the French Government in February, 1902, expired in September last, and in regard to these cables no expenses in respect of maintenance would have to be provided by the Company in future. All things considered, he thought the report would be regarded as satisfactory.

The report was adopted unanimously.

## PULFORD BROS., LIMITED.

The seventh annual meeting of shareholders of Pulford Bros., Limited, was held at Liverpool on the 31st ult.

Mr. E. G. PULFORD, who was elected chairman, reported that the year's trading had been most successful. They had completed some large contracts, and had commenced the new year with a considerable amount of work, and the prospects of the Company were of the brightest.

It was proposed by Mr. J. CARGILL, and carried unanimously, that a dividend of 20 per cent., free of income tax, be paid for the year ended March 31 last, and that the balance of profit be carried to reserve fund, raising this fund to 20 per cent. of the capital.

Mr. Theo. S. Sheard was unanimously re-elected auditor for the ensuing year.

A vote of thanks to the chairman concluded the meeting.

## BABCOCK AND WILCOX.

The directors have issued circulars calling an extraordinary general meeting for the 15th inst. to consider suggested modifications in the reserve fund and capital account. It is proposed to make a distribution out of the reserve fund of £265,000, at the rate of 10s. per share to the holders of ordinary shares whose names appear upon the register of members on June 22, while at the same time 265,000 ordinary shares of £1 each will be offered to the shareholders at par in the proportion of one new share for every two ordinary shares held. In order to carry through this scheme it is intended to create 270,000 new £1 ordinary shares.

## SUNDERLAND DISTRICT ELECTRIC TRAMWAYS.

The report for the year ended March 31 last states that during the year the work of construction of this Company's tramways has been proceeded with, and it is now anticipated that the first section will commence operating about the date of the meeting. The construction of the line has been unavoidably delayed by protracted negotiations in connection with road widenings, but nearly all the difficulties in connection with these have been practically overcome. The power station is in course of erection, and is nearly completed. It is expected that the second section of the tramways from Houghton-le-Spring to South Hetton will shortly be constructed, the Company having made financial arrangements to meet the outlay upon the construction of this section, and a large amount of the calls in arrear at the date of the balance-sheet having been since collected. The directors have entered into a contract with the Durham Collieries Electric Power Company, Limited, whereby that company operates under rent and royalty the right to supply electric light and power in the district covered by this Company's orders, and, at the same time, they have further arranged with the Durham Collieries Electric Power Company, Limited, to supply the Sunderland District Tramways, Limited, with the power necessary for driving their electric plant for the operation of the tramways.

The ordinary general meeting was held last week, when Sir RILEY LORD, who presided, reviewed the position in detail and predicted a bright future.

The report was unanimously adopted.

## NEW COMPANIES REGISTERED.

**Everett, Edgcumbe, and Co., Limited.**—Capital, £20,000 (4,000 preference, 15,997 ordinary, and three "A"). Object: to acquire and carry on the business of mechanical and electrical engineers carried on at Hendon, and at 87, Victoria-street, Westminster, as Everett, Edgcumbe, and Co.

### Liens Registered.

**Potteries Electric Traction Company, Limited.**—Particulars of a series of debentures, securing half the amount of the subscribed capital, authorised by resolutions of March 28, 1900, and May 11, 1905, have been filed, pursuant to Section 14 (4) of the Companies Act, 1900. The subscribed capital at date of last return was £489,990. Property charged: the company's undertaking and general assets, present and future. There are no trustees for the debenture holders, but the debentures are issued to trustees for holders of debenture stock acting under a trust deed, dated July 26, 1900. Some of the debentures of this series have already been registered.

**North Wales Power and Traction Company, Limited, London, E.C.**—Trust deed registered May 23, for £135,000 debenture stock. Trustees: London and New York Investment Corporation, Limited; charged on the undertaking, and all the property, assets, and rights, present and future, except the uncalled or unpaid capital.

## PERSONAL.

Mr. Charles Lill has resigned his position as manager of the electrical department of Messrs. Penrose and Co., and accepted the appointment of technical manager in the power department of the Armorduct Manufacturing Company, Limited, Farringdon-avenue, London, E.C.

The Southport Tramways Committee have decided to recommend the Council to advance the salary of Mr. J. T. Kendrew, the tramways manager, from £200 to £225, dating from April 1 last, afterwards advancing by two annual increments of £12. 10s. to £250.

The Sheffield Corporation have presented James Mitchell, until recently motorman in the Corporation's tramway service, with a handsome dressing case on the occasion of his leaving the Corporation after 14 years' service; and Mr. William H. Martin, for over four years a ticket inspector in the municipal service, with a beautiful marble clock as a mark of their esteem on his retirement from the staff.

The Rochdale Town Council have increased the salary of Mr. C. C. Atchison, the borough electrical engineer, by £50, making his remuneration £350 per annum.

Mr. J. Willoughby Meares, who was for some time an electrical engineer at Llanelly, has been appointed electrical adviser to the Government of India, a post only now established, and which he will be the first to fill.

The West Hartlepool Town Council have increased the salary of Mr. H. F. Friederichs by £25 per annum.

## APPOINTMENTS VACANT.

**Assistant Borough Electrical Engineer,** Poplar. Salary, £200 per annum, rising by annual increments of £10 to a maximum of £300 per annum. Applications by June 14.

**Junior Engineer,** Dundee Electricity Department. Applications to H. Richardson, A.M.I.E.E., general manager and engineer.

**Draughtsman,** Trowbridge. Salary, £100 per annum. Applications to Mr. R. W. Merriman, County Offices, Trowbridge, by June 10.

**Various.**—Northampton Institute, St. John-street-road, London, E.C. Mechanical engineering department: drawing office and lecture assistant, full time, £120; pattern maker and instructor in pattern making, full time, £120; junior drawing office instructor, full time, £100; laboratory demonstrator for the engineering laboratories, full time; junior technical assistant, full time; evening instructor in automobile work, two evenings per week. Electrical engineering department: junior technical assistant, full time; junior lecture assistant, full time. Applications by June 29. See advertisement.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Ghent.**—The Harbour Authorities require tenders for three electrical lifts. Tenders by July 17.

**Panama.**—The Municipality will shortly require tenders for construction of an electric tramway.

**Hornsey.**—The Town Council invite tenders for switchboards and brackets for arc lamps. Tenders by June 19.

**Darlington.**—The Corporation invite tenders for switchboard extension and booster. Tenders by June 19.

**Aston Manor.**—The Corporation invite tenders for the electrical equipment of their overhead tramways. Tenders by June 23.

**Grays Thurrock.**—The Urban District Council invite tenders for switchboard extension, storage battery, etc. Tenders by June 17.

**Leigh (Lancs.).**—Tenders are invited for the supply of one water-tube boiler for the electricity department. Tenders by July 1. See advertisement.

**Rosario de Santa Fe Argentine.**—The Municipality require tenders for the construction and working of electric tramways in the town. Tenders by July 30.

**Cardiff.**—The Asylum Visiting Committee invite tenders for the electric lighting of their new asylum at Whitchurch. Tenders by June 14. See advertisement.

**Madrid.**—The Public Works Department invite competitive schemes for making a tramway for passenger and goods traffic from Brezo to Santuario de la Yedra by June 22.

**Kingston-upon-Hull.**—The Electric Lighting Committee invite tenders for the supply, delivery, and erection of various plant. Tenders by June 22. See advertisement.

**Liria.**—The Municipality require tenders for installation of electric lighting; 2,000 c.p. are required for street-lighting, for which it is proposed to pay 6,000 pesetas per annum.

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**Manchester.**—The Electricity Committee invite tenders for the supply of low-tension cables, ampere-hour and watt hour meters, and box compound. Tenders by 10 a.m. on 14th inst.

**Brussels.**—The Belgian Government Railways require tenders for a number of lamps and accessories. Specification No. 97 may be obtained from their office at Brussels. Tenders by June 14.

**Laventhem (Belgium).**—The Municipality require tenders for erection of central station, laying of mains, etc. Particulars (3s. 4d.) may be obtained from the Secretary of the Mayor of that place.

**Bristol.**—Tenders are invited for single-phase alternating-current transformers and three-phase to direct-current motor-generators. Full particulars from the City Electrical Engineer, Temple Backs, Bristol.

**Stalybridge.**—The Stalybridge, Hyde, Mossley, and Dukinfield Tramway and Electricity Board require tenders for the supply, delivery, and erection at the Stalybridge sub-station of a 400-kw. motor-generator, together with the necessary switchgear for same.

**Lugano (Switzerland).**—Tenders are invited for the erection of an electric power station at Zordola, to be worked by water power. Particulars may be obtained from the town clerk. Tenders by June 9.

**Ossett (Yorks).**—The Town Council invite tenders for the following plant: (Section No. 1) quick-speed engines for direct coupling to dynamos; (2) dynamos, boosters, and balancers; (3) storage battery; 4) switchboard; (5) travelling crane; (6) cables. Tenders by June 14.

**Switzerland.**—M. R. Vontobel, of Winterthour, and M. Charles Probst, of Lucerne, have obtained a concession for the construction of a narrow-gauge electric railway from Meiringen to Gletsch. The total cost of the enterprise is estimated at £241,600; £19,600 is to be expended on rolling-stock.

**Esh (Durham).**—Tenders are invited for erection of electric lighting plant on the road leading from Cornsay Lodge by Commercial-street, Cornsay Colliery, and then by the low road to Hausteels crossing, being a distance of about 1,600 yards. Tenders to the Esh Parish Council by June 13.

**Glasgow.**—The Corporation invite tenders for the construction of tramway in Dalmarnock-street and Springfield-road from Great Eastern-road to Dalmarnock-road. Specification, etc., can be had on application to Mr. James Dalrymple, general manager, 46, Bath-street, Glasgow. Tenders by 10 a.m. on June 13.

**London, W.**—The Great Western Railway Company invite tenders for the supply, delivery, and erection of the following plant in connection with their electricity generating station at Park Royal: (Specification 18) pipework, feed and other pumps, tanks, feed heaters, water-softening and oil-separating plant, etc. Tenders by 10 a.m. on 26th inst.

## RESULTS OF TENDERS.

**London County Council.**—The following tenders have been recommended for acceptance: Dick, Kerr, and Co., induction motor-generators (5), £8,850; H. Lovatt, Limited, erection of boundary wall, Greenwich electricity station, £2,800.

**Birmingham.**—The Corporation have accepted the tender of Bolckow, Vaughan, and Co., Limited, Cleveland Steelworks, Middlesbrough, for the supply of 1,650 tons of steel rails and fishplates for the electric tramways, the contract price of the rails being £5. 10s. per ton.

**Brighton.**—The Town Council have accepted the offer of the British Westinghouse Electric and Manufacturing Company to supply and fix additional switchgear required at the North-road station for £690, and their offer to supply isolating switches to all existing feeders and accessories at the generating station at Southwick for £1,450.

**Heywood (Lancs.).**—The Corporation have accepted the following tenders for the supply, erection, and completion of electrical plant and tramway work: T. Hill and Sons, Victoria Ironworks, Heywood (Section A) boiler; Dick, Kerr, and Co., Abchurch-yard, Cannon-street, London, E.C. (B), engines, etc.; Ferranti, Hollinwood (C), switchboards; British Insulated and Helsby Cables, Prescot (D), cables; R. W. Blackwell, 59, City-road, London, E.C., permanent way (Sections A and B). Total, £29,393.

**Sutton (Surrey).**—The following tenders have been received for the proposed telephone exchange at Sutton, for H.M. Office of Works, etc.:

| | |
|---|---|
| A. N. Coles | £1,155 |
| Gathercole Bros. | 1,200 |
| H. M. Patrick | 1,207 |
| Martin, Wells, and Co., Limited | 1,220 |
| Smith and Sons | 1,238 |
| W. H. Lorden | 1,259 |
| R. Dean and Co. | 1,260 |
| E. M. Bulled and Co. | 1,273 |
| Higgs and Outhwaite | 1,275 |
| J. B. Potter | 1,276 |
| F. J. Shopland | 1,277 |
| F. G. Lawrence | 1,288 |
| Enness Bros. | 1,292 |
| J. Smith and Sons, Limited | 1,298 |
| Banyard and Son | 1,300 |
| E. Streather | 1,354 |
| C. Ansell | 1,387 |

**Fulham.**—The following tenders are recommended for acceptance: Redpath, Brown, and Co., for construction of steel roof and coal bunkers at the electricity works, £2,442. 13s. 2d.; General Electric Company, for 100 3-ampere meters £187. 10s., 50 10-ampere ditto £98. 15s.; British Thomson-Houston Company, for 100 5-ampere meters £187. 10s., 25 30-ampere ditto £50, 10 50-ampere ditto £24. 6s. 8d., 10 75-ampere ditto £28. 6s. 8d., and 5 100-ampere ditto £15. 16s. 8d.; E. Green and Son, for removing the existing economisers and constructing two new economisers, £624. Messrs. Windsor and Co. have been approved as sub-contractors for the construction of foundations, and other work in connection with the contracts of the Stirling Boiler Company for boilers, and of E. Green and Sons for economisers.

# BUSINESS NOTES.

## TRACTION.

**Warsington.**—The trams show a profit on the past year of £450.

**Dover.**—The extension to River is proceeding apace, and may be completed within a couple of months.

**Derby.**—The work in connection with the construction of the electric tramways on the Kedleston-road has been commenced.

**Leith.**—The Corporation have asked the Board of Trade to inspect the new lines from Pilrig to Newhaven, so that a temporary service of tramcars may be run.

**South Shields.**—A commencement has been made with the work of constructing the tramways, which are expected to be completed before the end of October.

**Epping Forest.**—On Saturday the first electric tramway to Epping Forest was inaugurated. By means of the line the forest is brought into close touch with suburban Essex.

**Queensferry.**—At a special meeting of the Town Council the draft provisional order to incorporate a company to construct an electric tramway from Edinburgh to Queensferry was approved.

**Light Railways.**—A Board of Trade return issued on Tuesday shows that between 1896 and 1904 234 orders were confirmed under the Light Railways Act, representing a mileage of 1,552, and an estimated expenditure of £11,279,780.

**Rotherham.**—At the meeting of the Borough Council on Tuesday the chairman of the Tramways Committee intimated that they were still open to negotiate for through running with Sheffield if the latter would meet them in a reasonable spirit.

**Dewsbury.**—Major Druitt, on behalf of the Board of Trade, has held an enquiry relative to the proposal to pave certain roads with granite setts, as desired by the British Electric Traction Company. The Corporation want the tramway track paved with Yorkshire stone.

**Lancaster.**—The tramway returns for the past year show a deficit of £3,180, against £2,833 for the previous year. The revenue totalled £4,908 against £4,687, and the expenditure was £8,088 against £7,520, of which the cost of energy amounted to £1,855 against £1,663 last year.

**York.**—An informal discussion took place at Tuesday's meeting of the Corporation upon the question of motor 'buses *versus* electric trams. Some disposition to favour the former has been manifested, but on this occasion there was a tendency to veer round in favour of the electric tram.

**Perth.**—Some misunderstanding appears to have arisen in regard to the height of the cars. According to the specifications these should have been 6ft. 3in., but apparently those ordered reach only 6ft. 1in. Mr. Dawson, the engineer, has been invited to attend Perth to examine the portion of the work so far completed.

**North-Eastern Railway Co.**—The new railway which has been constructed by the North-Eastern Railway Company between Newcastle-on-Tyne and Ponteland, seven miles in length, and which opens out a considerable agricultural district, was inaugurated last week. The passenger service is to be developed by means of auto-cars.

**Glasgow.**—The annual report of the Tramways Department shows traffic revenue £756,480, against £717,893 for the previous year—average revenue per car mile 10·12d., against 10·58d.; passengers 195,767,519, against 188,962,610; and mileage 17,943,595, against 16,291,082. The length of track was 144¾ miles (single), against 136 miles.

**Swansea.**—At a meeting of the Tramways Committee it was resolved that the leases between the company and the Corporation in regard to the new tramway be finally approved, the company agreeing to allow £1,000 to form part of the capital expenditure on the lines in respect to the mains from the Strand generating station to Villiers-street.

**Private Bills.**—In the House of Commons the Shropshire, Worcestershire, and Staffordshire Electric Power Bill and the Metropolitan Railway Bill have been ordered for third reading. The following Bills were read a second time: Gosport and Fareham Tramways, Hastings Tramways, Metropolitan and Great Central Railway Companies, and South Lancashire Tramways.

**Municipal Motor 'Buses.**—It was reported at the meeting of the Eastbourne Town Council on Tuesday night that the motor 'bus accounts for the past year showed a loss, allowing for depreciation, of about £1,000. As a remedy it was decided to strike off the non-paying routes and decrease the winter service. The loss was mainly attributed to the single-decked 'buses.

**Wednesbury.**—The work of reconstructing the tramway between Wednesbury and Darlaston, which has been closed for about 18 months, has been commenced. A new service of cars will, it is anticipated, be inaugurated in about three months, and it is stated that other portions of the tramways of the South Staffordshire (Lessee) Company in the same district will subsequently be reconstructed.

**Montreal.**—It is reported that arrangements are being made for the amalgamation of the companies operating the Montreal street railways and light supply. Both companies at present are making electricity for running and lighting purposes, and the projected amalgamation is for the purpose of economy in plant. No obstacle thus far has been presented to the merger, and it is believed that it will take place shortly.

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**Liverpool.**—At the fortnightly meeting of the Tramways Committee last week it was decided to experiment with 1½d. fares on the Smithdown-road and Wavertree routes. The returns showed a decrease for the preceding fortnight as compared with the corresponding period of 1904 of £512. 7s. 5d., the figures being last year £21,728. 5s.; this year £21,215. 17s. 7d. There had also been decreases of 74,784 in passengers, 8,851 in mileage, and 82 in the number of cars running.

**Bradford-road Tramways.**—The latest news with regard to the electrical equipment of the Bradford-road tramways is that the British Electric Traction Company has fixed an appointment for the formal transfer of the Bradford-road tramways to the local authorities of Batley, Dewsbury, Soothill Upper, Birstall, and Gomersal, and for the signing of the leases under which the company will take over the line. When these formalities have been completed, the Batley Corporation will be in a position to seal the contract with Messrs. Dick, Kerr, and Co. for the re-equipment of the Batley portion of the track.

**Birmingham.**—At Tuesday's meeting of the City Council, the Lord Mayor (Alderman Beale) referred to the excellent progress which was being made with the development of the city's tramways. Satisfactory arrangements had been made with the City of Birmingham Tramway Company in reference to the running of the cars at the city end of the Bristol-road route. The accounts for the past year the Lord Mayor characterised as eminently satisfactory, and he gave it as his opinion that when the Corporation came into possession of the whole of the receipts of the tramway system other than the 1911 route, it would be able to start with no debt upon it.

**Seaham Harbour.**—In reference to our note last week, we hear that a syndicate, understood to be the same as that which is providing the populous Houghton-le-Spring district of Durham county with electric traction, has given notice to the local bodies concerned of its intention to apply for a provisional order to construct further lines in the East Durham district in order to embrace Seaham Harbour, New Seaham, and Burton Colliery, a very populous neighbourhood. The new routes comprise about eight miles of track, beginning at Ryhope, to which place lines are already laid, and running thence to Seaham Harbour, and on to New Seaham, Murton, and South Hetton, so as to join the system already authorised in connection with the Houghton-le-Spring scheme.

**Kimberley-Alexandersfontein.**—The opening of the newly constructed overhead electric tramway from Kimberley to De Beers marks another era in the diamond fields of Griqualand West. The line extends from Victoria-crescent, in the centre of the town, to the Alexandersfontein Hotel, 6¾ miles. The hotel was rebuilt some time since, and fitted with all the latest requirements, also by De Beers. Thanks to the tramway, the local public will be able to make much more general use of Alexandersfontein as a pleasure resort than hitherto. The current is generated by De Beers central power station at Blankenbergs Vlei. There are four cars of the latest design, and every provision is made for the comfort of passengers. For the present the trains will run every hour.—*South African World.*

**Proposed Electric Railway.**—A meeting was held at the Midland Hotel, Manchester, on Tuesday, when the scheme for an electric railway between South Manchester and some of the Cheshire suburbs (described in our last week's issue) was explained. It is estimated that the necessary capital would approximate to between £400,000 and half a million. A good deal is likely to depend upon whether the County Council insist upon bridges or allow level crossings. In the former case the expense might be prohibitory An informal resolution was carried expressing the opinion that it was desirable to construct the line. The scheme was outlined by Mr. J. M. Newton, one of the engineers, who has prepared the plans, and who was a promoter of the Manchester Southern Tramways, which the Corporation acquired.

**Paris Metropolitan Electric Railway.**—The balance-sheet of the Compagnie du Chemin de fer Métropolitain de Paris shows the following general results for 1904. The length of line worked from Jan. 1 to Oct. 18 was 24·818 km. (15·37 miles), and from Oct. 19 to Dec. 31 30·851 km. (19·1 miles), making an average of 26 037 km., or 16·1 miles, for the year. The opening of line No. 3 in its total length on Jan. 25, 1905, brought the total line up to 31·818 km. (19·4 miles). The total proceeds were £824,490. The expenses were £351,185, giving a ratio of 42·49 per cent. against 42·9 in 1903, 41·52 in 1902, and 47·17 in 1901. The gross profits were about £473,000. After paying the royalties due to the municipality, which amounted to about £265,000, there remains a net profit of about £208,000. The average profit per kilometre was therefore £8,004, or about £5,000 per mile.

**Rochdale.**—After some delay the Local Government Board have replied to the Corporation's application for sanction to a loan to extend the electricity works, part of the extension being for the purpose of supplying energy to the trams. To the surprise of the Tramways Committee, the Board now suggest that the Corporation should make arrangements for a supply with the Lancashire Electric Power Company, who, it is understood, are willing to provide same on some such terms as the following: for any quantity up to 100,000 units per annum for tramway purposes, 1·3d.; for any quantity in excess of 100,000 and not exceeding 200,000 units, 1·2d.; for any quantity in excess of 200,000 and not exceeding 300,000 units, 1·1d.; for any quantity in excess of this amount, 1d. Therefore, for 200,000 units the cost would be 1·25d., as against 1·43d. The Corporation, like their neighbours at Heywood, have decided not to entertain the offer.

**Heywood.**—At a special meeting of the Tramways Committee last week, the tenders for the tramway track, overhead equipment, and extensions to the electricity works necessitated by the decision to adopt electric traction were considered. Some details of these appear in our "Results of Tenders" column. The work will involve an expenditure of some £29,400, which is more than £2,000 less than the engineer's estimate. A general resolution was adopted to extend the electricity works as required, and to proceed with the electrification of the system. The heads of the agreement for working the trams in Heywood, which had been agreed upon by the sub-committees of the Bury, Heywood, and Rochdale Tramways Committees, were submitted and approved subject to one or two minor alterations. The Hopwood section is not included in the scheme for which tenders have been accepted. It is expected that the work will be completed in about five months. The offer of the Lancashire Electric Power Company to supply energy has been refused.

**Belfast.**—At the meeting of the Tramways Committee on Monday, the town clerk read Mr. Balfour Browne's opinion *re* overhead telephone wires, which was to the effect that the Corporation had full power to order the removal of any such wires which would interfere with the wires for the tramways, and he was requested to inform the company of this decision, which the Corporation would carry out. Mr. Nance explained that during the time that the Belfast Street Tramways Company had a lease from the Corporation the watering of the track was attended to by themselves, and he now asked that the Works Committee should make such arrangements as would ensure its being watered as well as the other portions of the streets. He pointed out that a watered track was much more comfortable for passengers when there was dust flying about than one which had not been so treated. It was decided that this should be done. On the consideration of the Tramway Committee's minutes, an amendment that the question of the fair wages clause should be referred back was negatived by the casting vote of the chairman, it being held that the sub-contractors, Messrs. Combe, Barbour, and Co., have substantially complied with the clause.

**Aston.**—The suggestion made by the Town Council on behalf of the City of Birmingham Tramway Company, that the Corporation of Birmingham should replace it as workers of the tramways in Aston, apparently remains at the suggestion stage. A proposal to this effect was made in the first week in April, when it was announced at a meeting of the Town Council that the town clerk had replied to the communication from the company stating that in the event of the Birmingham authorities being willing to take the place of tramway companies under the agreement of June, 1903, the Public Works Committee would be prepared to recommend the Council to enter into such agreement as might be necessary to give effect to the suggestion that the Birmingham Corporation should take the place of the company in the matter of working the trams in the Manor. Apparently each of the three parties is waiting for one of the others to make a move. The tram company is under a covenant to pay Aston a minimum amount of £1,200 a year. Birmingham would be willing to work the trams in Aston as in other surrounding districts, and pay to those districts the net profits earned in those respective areas. The company says it is prepared to stand on one side altogether and let Birmingham go and work the trams in the Manor, as it is in a better position to do so than the company under the existing conditions. Aston, however, is not inclined to release the company from its bond except for something in the nature of a *quid pro quo*.

**London County Council.**—The scheme for reconstructing several tramways, extending over 17 miles, to which we referred in our last week's issue, was again before the Council on Tuesday, when, after some discussion, the proposal was adopted. The accounts for the year ending March 31 show that the total receipts were £682,095 (to which the electric trams contributed £548,295, and the gross surplus £182,269, this being entirely derived from the electric lines, as the horse trams showed a slight deficiency. The total receipts are £145,856 more than in the previous year. The passengers numbered 164,818,560, being 31,679,475 more than the previous year, and the car miles 14,081,397, an increase of 2,544,853. The operating expenses work out at 7·49d. per car mile. The length of the system operated was about 47 miles, exclusive of the London, Deptford, and Greenwich Company's line, acquired in July. The top covers are considered to have materially contributed to the revenue. The net capital expenditure amounted in all to £2,623,692. In regard to the northern system, leased to the North Metropolitan Tramways Company, but about to be taken over and reconstructed by the Council, the receipts amounted to £59,846. The construction of the tramway subway from Kingsway to the Strand is approaching completion, and the Highways Committee recommended that £5,000 be voted for concreting up certain portions of the walls. The South-East London Tramway Company's undertaking has been transferred to the Council. The City Corporation last week discussed the Embankment scheme in the light of the decision of the House of Commons Committee, and eventually the matter was referred to the Streets and Bridges Committee. The proposal to run the trams along Stamford-street instead of the Embankment is being revived.

**Aberdeen.**—Judgment was delivered last week in the action brought against the Corporation by the Great North of Scotland Railway Company. The plaintiffs are the owners of the Palace Buildings. The site was acquired from the Town Council of Aberdeen under two dispositions dated 1851 and 1864. The plaintiffs maintained that they were entitled to a foot pavement of their property in Union-street of the width of 10ft. beyond the 8ft. 6in. of foot pavement which is their own property, and in Bridge-street of the width of 8ft., and they stated that the width of pavement to which they had a right had been seriously curtailed by a junction which the defendants had made between their tramways in Union-street and Bridge-street. They sought a declaration in those terms, and additional or alternative remedies. The judge found (1) that the plaintiffs having objected to the construction by the defendants of the junction between the tramways in Bridge-street and in Union-street, the defendants were not entitled in view of the provisions of Section 10 (2) of the Tramways Order, 1903, to construct the junctions so that any rail should be nearer than 9ft. 6in. to the outside of the footpath *ex adverso* of the plaintiffs' property in those streets, as they existed when notice was given by the defendants to the plaintiffs of their intention to construct

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the junction; and (3) that the defendants were not entitled, for the purpose of enabling them to construct the junction on the lines proposed, notwithstanding the objection taken by the plaintiffs, to diminish the width of the footpath to such an extent as was required to leave a space of 9ft. 6in. between the outside of the footpath, as so diminished in width, and the nearest rail of the junction. He therefore granted an injunction prohibiting the defendants from using the junction, and made an order for the restoration of the footpaths of the plaintiffs' property to the condition which they were in before. The costs to be paid by defendants. The receipts for the year ended the 27th ult. show a total of £68 084 as compared with £62,794 for the previous year, an increase of £5,289. The expenditure on power and wages amounted to £30,056 as compared with £26,530 for the previous year.

**Bradford.**—The results of the year's working of the trams were outlined at last week's meeting of the Corporation. The traffic income was £223.541, but to this amount must be added sundry other receipts. The parcels department brought in £1,840, mails £138, advertising on cars £3,222, the Bowling Shale Hill £1,020, and bank interest £284, making, with one or two minor sums, a total income of £230,369. The previous year the amount was £197,437, so that there is an increase of £32,932. Against this must be put an increase in the expenses of £30,401. The total expenditure, including all charges on capital, amounted to £214,439, against £184,037 in the previous year. The pay of the general officers and staff accounts for £2,983, motormen and conductors £45,388, and other employés £3,471, making a total of £51,842, the previous year's total being £44,751. Amongst other working expenses, £19,134 is credited to maintenance of cars, £7,417 to cleaning and oiling cars, £6,986 to the maintenance of permanent way, £3,515 to the electrical equipment of lines, and £1,162 to fuel, light, and water for depôts. During the year compensation was paid to the extent of £4,600, and the department's contribution to rates and taxes totalled £8,580. The charges for power amounted to £39,196. The previous year's cost was £33,675. Turning to the various capital charges, we find that from the £70,228 gross profit a total of £54,582 has been deducted, leaving £15,646, to which £284 bank interest is added, making a net profit of £15,930. The chief items deducted are £24,491 for sinking fund and £23,661 for interest on capital, the two together totalling to £48,152, as compared with £46,106 for the previous year. Repayment of mortgage loans accounts for £949, rent of leased lines for £4,000, and income tax for £1,000. The surplus of £15,930 goes to the reserve fund. Up to March 31, 1904, the amount standing to the credit of the depreciation and renewals fund was £28,056, but with the addition of the above sum the total will reach £43,986. The question of ½d. fares was again raised in the debate, but there is no indication of a reduction being effected at present. Doubtless the exhibition and the fine weather contributed to the satisfactory results obtained last year, but, judging by general appearances, there should be little, if any, falling off this year if the weather be favourable. For May the receipts were some £2,000 less than for the corresponding period of last year, when, it must be remembered, there was the substantial benefit of the Whitsuntide holidays. With this advantage in hand the difference may be cleared off during the present month.

## LIGHTING AND GENERAL.

**Aberdeen.**—The output at the electricity works during April amounted to 350,726 Board of Trade units.

**Harrogate.**—All-round reductions are being made in the price of current for private lighting and power purposes.

**Barrow.**—The Corporation electrical works made a profit last year equal to a 1d. rate, or 7½ per cent. interest on the capital.

**Dudley.**—The Town Council have agreed to the re-engagement for a further six months of Mr. R. Wilson, their electrical expert.

**Hanwell.**—The amended agreement with the Uxbridge and District Electric Light Company has been approved by the District Council.

**Brynmawr.**—An electric lighting installation, which could be laid down for the whole district at a total cost of about £8,000, is under consideration.

**Ripon.**—Circulars are being issued with a view of finding out whether the leading citizens are in favour of the introduction of electric light.

**Bridgetown (Somerset).**—It is said that this hamlet is the smallest centre in England to have an electric installation. It is thought that all the cottagers will take the light.

**London Electric Power Supply Bill.**—The Administrative County of London and District Electric Power Bill was read a third time, and passed, in the House of Lords on Tuesday.

**Calcutta Electric Supply Co.**—The number of units delivered to consumers during the four weeks ending April 28 is reported as 301,369, compared with 289,653 in the corresponding four weeks of the preceding year.

**Bradford.**—The Town Council intend to apply for sanction to borrow £60,000 for the purpose of carrying out certain extensions to mains in order to enable the department to meet the constantly increasing demand for current.

**New Issues.**—The Sir Hiram Maxim Electrical Company, Limited, are issuing 15 000 6 per cent. preference shares, and the Newcastle and District Electric Lighting Company £150,000 of 4½ per cent. mortgage debenture stock.

**Brighton.**—On Tuesday the mayor received the delegates of the Postal and Telegraph Benevolent Society at the Royal Pavilion. They were entertained by the Duke of Norfolk, formerly postmaster-general, at Arundel on Wednesday.

**Middlesbrough.**—Mr. Taylor's last report shows that the estimated profit for last month, exclusive of interest and redemption, was £461, and the number of lights at present connected was 77,000, whilst there were new applications for 420.

**Metropolitan Electric Tramways Bill.**—This Bill, conferring powers on the company compulsorily to acquire land in the county of Middlesex and to widen and alter roads for the purpose of the undertaking, has been reported for third reading.

**London County Council.**—On Tuesday it was agreed to lend the Poplar Borough Council £3,660 for electric light installation and meters. A large number of notices under Electric Lighting Acts and orders of intention to lay mains were agreed to.

**Cheltenham.**—The last monthly report of the electrical engineer shows that there were 817 customers, with the equivalent of about 54 640 8-c.p. lamps, connected to the private supply mains, the corresponding figures for 1904 being 763 and 48,890 respectively.

**Ashton.**—The Guardians at their last meeting discussed a recommendation to apply for power to borrow £5 000 for electrical purposes at the new hospitals and the wiring of the old workhouse. The voting was against the proposal, but notice to rescind has been given.

**Agency.**—Messrs. R. J. Nicholson and Co., 26, Cannon-street, Manchester, have been appointed sole agents in Manchester and district for Messrs. Joseph Richmond and Co.'s lifts and cranes. Messrs. Nicholson and Co. will furnish full prices and particulars on receipt of enquiries.

**Rand Central Electric Works.**—The result for May is reported as follows: "Kilowatt-hours generated 972,000, yielding a gross revenue of £9,000." For the corresponding period of last year the result was kilowatt-hours generated 968,000, yielding a gross revenue of £8,500.

**Wrexham.**—The borough electrical engineer's last report shows that 14,466 units were used for tramways in April, 1905, and 29 052 units for lighting, etc. The total consumption amounted to 43 518 units, compared with 34,138 in April, 1904. Two new consumers were connected. The total number of consumers is at present 179.

**Burton-upon-Trent.**—Sanction has been received for loans amounting to £5,611 to defray excess expenditure on works for which loans have previously sanctioned, £4,000 for the extension of mains, etc., and £500 for the provision of a 100-kw. continuous-current tramway generator, regarding which an enquiry was recently held by the Board of Trade inspector.

**Electricity Supply Company for Spain.**—The second drawing for repayment of 77 6 per cent. first mortgage debentures and 43 7 per cent. "B" mortgage debentures has just been made. These bonds will be paid off at £100, with interest to date added, at the office of the company, College-hill-chambers, College-hill, London, E.C., on June 30, 1905, from which date interest will cease.

**Catalogue.**—We have received from Messrs. Matthews and Yates, Limited, Cyclone Works, Swinton, Manchester (London, 84, Gray's-inn-road, W.C.), a reduced price-list of their well-known cyclone air-propellers for ventilating, cooling, and drying purposes. We are informed that the reduction is due to up-to-date plant installed owing to the increasing demand for their appliances.

**Portsmouth.**—On Tuesday Portsmouth was practically cut off from telegraphic communication with the outside world for some hours, owing to the heavy rainfall of Monday, which flooded various parts of the town, including the underground channel in which the telegraph wires are carried from the railway to the post office. The telephone trunk lines were used for telegraphic purposes.

**Lincoln.**—At Tuesday's meeting of the City Council Mr. C. Pratt said the electricity works reflected credit on the management. The profits had steadily increased from £3,493 last year to £3,928 in this, an increase of £403. The deficiency, which stood at £907 last year, was practically wiped out. The contractors were pushing forward as quickly as possible, and they hoped to start the tramway soon after Whitsuntide.

**Ossett.**—The Town Council last week discussed a proposal that the standing orders be suspended to enable the Council to reconsider their decision in regard to the electricity undertaking, and that the resolution passed at the meeting of the General Purposes Committee on April 4, relating to the proposed electric lighting station, and confirmed at the Council meeting on April 10, be rescinded. The attempt to reopen the question failed by one vote.

**Bath.**—An enquiry has been held into the Corporation's application for sanction to a loan of £19,000 for electric lighting purposes. The application of the National Telephone Company for permission to extend the system of underground mains in the city has been referred to the Sub-Surveying Committee jointly with the Electric Lighting Works Sub-Committee, the town clerk and surveyor being asked meanwhile to confer and draw up a draft agreement with the company.

**Eastbourne.**—A recent report shows that in the 5¼ years of its existence the electric works have produced a profit of £14,000, of which £4,000 has been paid to the depreciation fund and £750 to the relief of the rates. The accumulated surplus was £9 412 and the profits for the year £2 725, of which £2,000 is to be devoted to depreciation fund and £725 to the relief of the rates. The committee have decided to reduce the charge from 6d. to 5½d. per unit. That will mean a reduction of income of £1,450 per annum.

**Stock Exchange.**—The Stock Exchange Committee have ordered the British Westinghouse Electric Manufacturing Company's further issue of £400,000 4 per cent. mortgage debenture stock to be quoted in the official list. Applications have been made to the committee to allow the following securities to be quoted in the official list: the Adelaide Electric Supply Company's 10,000 6 per cent. cumulative preference shares of £5 each, £3 paid; and the Eastern Extension, Australasia, and China Telegraph Company's further issue of £150,000 4 per cent. mortgage debenture stock (perpetual).

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**Whitby.**—The report of the Lighting Sub-Committee on the working of the electricity department for the year ending March 31, 1905, shows a profit of £307, against which had to be paid £1,702 for principal and interest, leaving £1 395 to be met from the rates. This sum a year ago was £1 673. The number of lamps connected in equivalents of 8 c.p. was 9,124, as against 6,175 last year—an increase of 2 949. Of the 9,124 lamps, 7,768 were private and 1,356 public. During the year the price to private consumers was reduced from 6d. to 4½d. (net) per unit. The number of units sold had increased in the 12 months from 85,961 to 125,779.

**Stockton-on-Tees.**—Gas continues to maintain itself as an illuminant against electricity at Stockton-on-Tees, and the Gas Committee of the Corporation has just completed the installation of new mechanical charging and discharging apparatus, which, with a range of new workshops, has cost the town £9 000. All the new machinery is actuated by electricity, and supersedes hand charging etc. The capacity of the Stockton gasworks is now equal to 500 million cubic feet per annum, and the Corporation expects to make still larger profits than the £7,000 per year, which on last year's trading was available for reducing the rates, although consumers are charged only 2s. per 1,000 feet.

**Bo'ness.**—A special meeting of the Town Council was held last week for the purpose of meeting Mr. W. B. Cownie, general manager and secretary of the electric company, and Mr. Monkhouse, consulting engineer, to discuss various matters connected with the electric lighting scheme. The burgh surveyor submitted a report on the proposed lighting scheme for the burgh. Mr. Monkhouse said he approved of the scheme as proposed by Mr. Lawrie. After discussion it was agreed that before the scheme be adopted and extensions laid, the Council extend their borrowing powers, or, alternatively, that only as much of the work as could be done with the money in hand be carried out, so as to save further borrowing for the scheme.

**Lancaster.**—It has been arranged that in consideration of a credit of £500 the Electricity Committee waive all claims for penalties and damages against the Westinghouse Company in connection with their contract for the supply of generating station equipment and switchboard, and to accept an equivalent amount of electrical apparatus manufactured by the company in lieu of the £500 in cash. Further, that the final balances due to the Westinghouse Company under their contracts with the Corporation be paid, excluding a sum of £500 to be retained by the Corporation pending the supply of the electrical apparatus above referred to. In connection with the new town hall scheme, certain cables are to be removed, etc., at a cost of £517.

**Darlington.**—The electricity department of the Corporation has been successful since the commencement, and the statement of accounts for the year ending March 31 last shows a profit, after payment of interest and depreciation, of £1,449, equal to about one-half the loss on the year's working of the municipal light railways. The consumption of electricity in the borough is increasing satisfactorily, and it is being adopted for motive power purposes. From the end of the present month the Corporation of Darlington has decided that the charge for electricity shall be 4d. per unit up to 20,000 units, and 3½d. per unit for all above 20,000 units. For power purposes the charge will be reduced to 1½d. for the first 500 units supplied per quarter, and 1½d. for all over that amount supplied during the same period.

**London Gazette.**—A receiving order has been made out on debtor's petition in the estate of F. Shaw, electrical contractor, 258, Hessle-road, Kingston-upon-Hull. The partnership between Arthur Ronald Holmes and Charles Walter Scott Nicholson, carrying on business as accumulator manufacturers and electrical engineers at 231, Liverpool-road, Islington, N., under the style of G. R. Holmes and Co., has been dissolved by mutual consent. The partnership between Robert Gray Linscott and Guy Clement Hurrell, carrying on business as electrical engineers at 148, Aston-street, Birmingham, under the style of the Cable Accessories Company, has been dissolved by mutual consent. A receiving order has been made out on creditors' petition in the estate of Alex. Gavan Inrig, electrical engineer, 16, Bruce-grove, Tottenham, Middlesex. A winding-up order has been made out in the estate of the Garcin Renault Electric Cars and Accumulators, Limited, Denman-street, London.

**Hammersmith.**—At the last meeting of the Guardians the Building Committee reported that they had had an interview with Mr. J. Enright (of Messrs. J. and J. S. Enright, electrical engineers), who had informed their committee that the firms whose tenders for the transforming apparatus and electric wiring were provisionally accepted at the last meeting desired to withdraw such tenders, and therefore under the circumstances the committee recommended the acceptance of the tender received from Messrs W. J. Fryer and Co., of the Bravington Works, Bravington-road, Paddington, W., in the following sums—namely: Section 1, electric wiring, £4,580; Section 2, transforming apparatus, £1,061—total, £5,641. The committee further recommended that Messrs. Watson, Sons, and Room, solicitors, be instructed to prepare the contract to be entered into with Messrs. Fryer providing for the carrying out of the work. After discussion it was agreed that instructions be given to the engineer to report in writing in the matter in which these people had not complied with the specifications.

**Bath.**—An enquiry was held on Tuesday into the application of the Council for power to borrow £19,000 for electric light purposes. Of this, £9,000 is for excesses of expenditure over estimates in respect of works carried out, which were discussed in the Council some months ago, the principal items being £1,368 excess on the building of engine and boiler house and river-wall; £2,166 on boiler, chimney, and steel flue; £830 for main switchboard extension; £1,979 on sub-station switchgear; £1,815 on high and low-tension feeders and roadwork, etc.; £802 on extensions to low-tension distributors; and £700 on engineer's fees and contingencies; £7,000 is for the provision of more plant and the execution of additional works at the station, including £150 for boiler-house plant; £540 for water-softening plant; £230 for transfer of distributors; £4,195 for a storage battery scheme; £2,945 for generating plant; £3,000 for extensions to mains and new services; £480 for increase of size in motor-alternator; £175 for new connection at the Gravel-walk sub-station; £325 for Manvers-street power main; and £3 000 for extension of mains.

**Warrington.**—The report of Mr. F. V. Mathias, borough electrical and tramways engineer, on the working of the electric supply undertaking during the year ending March 31 shows that a reduction in charges for current to the extent of £625 has been made to the tramways as compared with last year. There is also a decrease equivalent to 20·93 per cent. in public lighting, and the contribution to interest and sinking fund charges has been increased by £540 in excess of last year. The gross revenue amounts to £12,560, working expenses take £6 075 leaving a balance of £6,505. Out of this has been paid: interest on capital, £2,461; sinking fund, £3,276; rates income tax, etc., £224; leaving net profit on year's working of £1,543, as against £128 for the previous year. During the year the equivalent of 8,345 8 c.p. lamps has been added to the mains. The total revenue from private lighting and power is £12,070 representing 1,482,456 units—288 261 units for lighting and 1,194,195 for power—being an increase of £1,081 and 283,455 units over last year, the average yield being 1·954d. per unit, which is a low figure, and compares very favourably with other towns. The cost of production shows a material reduction per unit as compared with last year.

**Capo Telephones.**—The introduction of the telephone system into the Cape Colony has, according to the *British South African Export Gazette*, proved, as elsewhere, no inadvisable step from the point of view of a profit-earning concern, and hence Sir Lewis Michell was able to affirm its flourishing condition on a recent occasion in the Cape Parliament. In a year of reputed depression it has shown a net profit of £765 on its working, and thus justifies those pressing extensions and improvements which Sir Somerset French, the Cape Postmaster-General, deems necessary. His programme contemplates a total expenditure of £187,876 on new lines and exchanges, of which £53,452 stands for unexpended capital already sanctioned, and indents for new machinery and material have, as a matter of fact, long since been framed. In view of the certain returns which this outlay must give, the Cape Parliament should have no hesitation in granting the funds, and, at the worst, the postponement of a grant cannot be deferred immediately. It is worthy of note that the dearth of workmen skilled in laying pipes and cables in the Cape Colony is such that extension works of the department have been greatly retarded. Moreover, the invocation of the assistance of the Agent-General in London had proved unavailing to find a remedy.

**Chatham.**—Early on Saturday last the electric lighting works of the Kent Electric Power Company at Chatham were destroyed by fire. From the information received we gather that the whole of the dynamos and engines have been completely destroyed, and that only one or two of the boilers are likely to be of further service. The inconvenience caused by the fire is considerable, owing to a large number of business hours being dependent upon electric lighting. We understand, however, that arrangements have been made to continue the supply from the Corporation of Gillingham. It seems that the origin of the fire was not electrical, but it is thought to have been due to the carelessness of a workman who was making some structural alterations to the building. Immediate steps were taken for the purpose of restoring the supply, and after various methods had been discussed the plan of taking a supply of current from the Gillingham Corporation, which was offered to the company, seemed to be the most feasible. The chief difficulty apparently in the way of doing this was the provision and laying of a high-tension main over 1,000 yards long across the ground known as the "Chatham lines." To do this it was necessary to obtain the consent of the War Office, and, of course, also at the same time to complete a bargain with the Gillingham Corporation as to the terms upon which the current would be provided. We are glad to be able to say that both these negotiations have been carried through successfully, and that in all probability the current will be again available for the public immediately after the holidays, and we think that the officials of the War Office, the Gillingham Corporation, and the Kent Power Company are to be congratulated upon the rapidity with which these negotiations have been completed. In regard to the permanent supply, we are asked to state that the Kent Electric Power Company anticipate that their new power station at Frindsbury will be in a position to supply energy before the end of the present year.

**Blackburn.**—Mr. P. P. Wheelwright, borough electrical engineer, in his report (shortly noted last week) says that the effect of the reduction in the charges was clearly demonstrated by the fact that, although nearly a quarter of a million more units had been sold during the year the net revenue was £300 less than that of the previous year. The expenditure had been reduced £200 notwithstanding this increased output, whilst the capital charges exceeded those of last year by £1,270. The number of units sold during the year for all purposes had increased from 2,895 181 to 3,129,215, the works cost of which had been reduced to ·65d. per unit sold, a figure comparing most favourably with the results obtained by other towns having similar undertakings. The total number of consumers taking supply from the mains was 1,110 being an increase on last year of 120, aggregating in 8 c.p. lamps 17,184, and the total number up to date connected to the mains to 106 358, exclusive of tramways demand. During the year 80 motors, totalling 380 b.h.p., had been connected to the supply mains—of these 57 motors, or 275 b.h.p., having been supplied and fixed by the department, the remainder being the property of the consumers. At the present time there were 140 motors on loan, and maintained by the works staff, of an aggregate horse-power of about 500. The total number of motors in use up to March 25 was 260, of a total capacity of 1,150 b.h.p., which provides a day load for the station plant and tends to economical production of current. Mr.

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Wheelwright considers that during the present year the motor business will be rapidly increased, owing to the better trade conditions, coupled with the very low charges which came into operation last July.

**Islington.**—The Lighting Committee of the Borough Council presented the following report at the meeting on Friday: "Referring to the report which was presented to, and which was adopted by, the Council on April 14 last, recommending, *inter alia*, the purchase of six mechanical stokers, satisfactory tests have been made at the electric lighting station with the mechanical stoker of the chain-grate type manufactured by Messrs. Babcock and Wilcox, and we are of opinion that in view of the economy that will be effected by their use, it is desirable that at least three sets of these stokers should be put into operation as soon as possible. We therefore recommend that three sets of chain-grate mechanical stokers, costing £900, be at once ordered from Messrs. Babcock and Wilcox, subject to their agreeing that the Council shall not be liable for any payment therefor until the sanction to the loan has been received from the London County Council." In the course of the discussion Alderman Mills said that the use of these stokers would mean a reduction of the coal bill by one-half. The report was agreed to. At the same meeting the Lighting Committee stated as follows: "We have received a report from the electrical engineer to the effect that Messrs W. R. Rershaw and Co., with whom the Council on Aug. 5, 1904, upon our recommendation, entered into a contract for the hire of 40 12-ton coal wagons, at £7. 12s. 6d. per wagon per annum, for a period of five years, have gone into liquidation, and that the agent for the trustees of the debenture holders has suggested that the contract should be transferred to the British Wagon Company, of Rotherham. We understand that the latter firm are willing to undertake the contract, but that they object to the Council retaining the option to determine the agreement at the end of one year upon payment of an additional £1. 12s. 6d. per wagon. We recommend: (*a*) that the Council do approve of the transfer from Messrs. W. R. Rershaw and Co. to the British Wagon Company of the contract for the hire of coal wagons as above mentioned; (*b*) that the Council's option to determine the agreement at the end of one year be eliminated from the contract." The recommendations were agreed to.

**Finchley.**—An enquiry is to be held into the proposed loan of £23,500 for electricity works. The electrical engineer has been authorised to proceed with such preliminary works as is necessary for supporting the new feed tank, removal of pumps to original pump-house, and the preparation of foundations for No. 5 boiler, together with the requisite pipe alterations, all of which will be carried out by his own staff as before. The electrical engineer's annual report gives the following particulars: "On April 1, 1904, the plant included in the original loan (£35,600) was practically all installed, with the exception of a few minor details, and with the exception of a certain balance of cable included in the contract which had not been laid. At that time there was a considerable falling off in the applications for current, and the progress of the undertaking appeared somewhat doubtful. In view of this I instituted a system of canvassing, whereby all builders and others were called upon at short intervals, and every inducement within my authority was offered them to wire their houses. I am pleased to say that the effect of this was immediately felt, and applications have been coming in during the whole of the 12 months at a nearly uniform rate of 235 8-c.p. lamps per week, with the result that at the end of May it was apparent further plant would be required for the following winter's load and I presented you my estimate for first extensions of £15,000. This amount was subsequently increased by the Council to £17,000. The Local Government Board disallowed £400 for spare armature, leaving an amount of £16,600. These extensions were put in hand forthwith, and some considerable trouble was caused owing to the short date for delivery; but plant which was absolutely essential was erected in October, and although many of the details are not yet finally completed, the whole of the machinery was erected and used during the last winter. Applications still continued to come in at a uniform rate, and in February last it became evident that further extensions would be required to meet next winter's load. I therefore reported to you and submitted a further estimate for extensions No. 2 of £23,500. At the end of the year (March, 1905) I made a thorough inspection of various plant, and have pleasure in reporting that all was in a satisfactory condition on that date. During the 12 months there have been no serious breakdowns. On two occasions the supply was interrupted for a few minutes—in one case owing to a fault on a consumer's premises, and in the other case owing to a cart having been driven over a soft footpath and caused derangement to a joint box on the cable. During the year several consumers discontinued receiving supply owing either to bankruptcy or to their leaving the neighbourhood; in most instances the premises have been re-let, and the consumers regained. For comparison with figures of other undertakings published from time to time, I have pleasure in placing the following statistics before you: units generated, 296,400; units sold—consumers, 152,179; sold—public lighting, 105,000; used on works and battery, 26,300; mains loss and unaccounted for, 12,921."

**Rochdale.**—The annual report of the Corporation Electricity Committee shows that during the year ended March 31 there was an additional number of consumers approximately the same as during the previous years, though the number of equivalent 8-c.p. lamps connected did not show so large an increase, the new consumers during the last year being mostly shops and private houses. We quote from the report as follows: "The increase in the maximum load has been in almost direct proportion to the number of consumers, but the units sold have very considerably increased per equivalent 8-c.p. connected, thus giving a better load factor on the generating plant. The increase in the consumers with fewer numbers of lamps or small motors is having a beneficial effect, and has a tendency to minimise the trouble caused by the consumers with a large number of lights who only rarely use the whole of them for any length of time. The year has seen an increase also in the number of units supplied to the tramways department, but the increase in the maximum load has been very considerable and has counterbalanced the gain, the load factor for the year showing no material increase. This, of course, is due to the new sections having only run for a portion of the year, and should be somewhat rectified during 1905-6, but as Littleborough will not be fully working the whole year much the same will occur then, though it is hoped in a lesser degree. The suggestion having often been made that this committee was short of power for the tramways, it is interesting to note that the estimate of 27 cars, which it was stated the existing plant could supply, has been fulfilled. The prices charged for the supply of electricity have remained as before, but the increased number of units sold for tramway purposes have reduced the average price obtained for all units sold from 2·096d. last year to 1·98d. for 1904-5. The interest and sinking fund charges have increased this year, and there will be a considerable addition to them for the year 1905-6, owing to the extensions of plant carried out during the financial year, for which the first payments have not yet become due. As mentioned in the report for 1903-4, the Council, at its meeting on May 5, 1904, passed a resolution to extend the present plant at Dane-street. Estimates were then obtained, and application was made to the Local Government Board on June 3, 1904, for powers to borrow £42,405 for electricity supply purposes. On Jan. 18 of this year an enquiry was held by Mr. H. Ross-Hooper, one of the Local Government Board inspectors, and the Corporation awaits the sanction of the application. As, however, it was essential to make use of the light days for getting on with the works, the following portions have been commenced and are either completed or nearing completion. The accumulators have been moved and re-erected, the room thus set at liberty being converted into a switch-room and the lighting and traction switchboards removed thereto. A three-phase switchboard is also in course of erection. The main engine-room building has been practically doubled in length, and already three out of five steam sets it is capable of holding have been installed, as also has one motor-alternator. The steam, exhaust, and condensing-water pipes are almost completed, and the condensers for the new sets have been erected. Considerable alterations and extensions of the cable work in the generating station have been necessitated, and the major portion is complete."

**Sheffield.**—The Corporation Electric Light Committee on Tuesday approved the statement of accounts of the electric supply department for the year ended March 25 presented by Mr. S. E. Fedden, the general manager and engineer. The engineer draws attention to the report dated Oct. 22, 1901, which was presented to the Finance Consultative Committee, in which he estimated that a deficiency of £2,850 would be shown on the year's working when the gross revenue amounted to £60,000. Mr. Fedden says: "Our progress, however, has not been so rapid as I anticipated, owing chiefly to trade depression, which has retarded the growth of our business, particularly in the supply of electricity for power purposes, and also owing to the much higher average of bright weather during the past two or three years, as shown on the 'Progress Chart' which I am submitting to you. For the year ending March 25 last, with a turnover, from all sources, of £59,395. 3s. 5d., the accounts show a loss of only £650. 9s. 7d., after meeting all charges, a result considerably more than £2,000 better than was anticipated. This is due chiefly to the great reduction in the works costs consequent upon the use of our new plant at Neepsend, which, although only in regular service during five months of the last year, has enabled us to produce and sell 4,546,141 units with an expenditure of £16,270 for fuel, wages, material, management, etc., against 3,980,049 units, with an expenditure of £17,234 in 1904, a reduction of 17·30 per cent. in the cost of each unit sold. Although I am unable to look forward to making any considerable surplus in the current year, I have no hesitation in predicting that in a comparatively short time a satisfactory and continuously increasing profit will be earned, and I would respectfully suggest that in order to hasten the financial success of this department it is important that we should be entrusted with the lighting of every municipally-controlled building, and also the principal thoroughfares of the city. It will be seen from the accounts that the capital expenditure to March 25, 1904, amounts to £740,943. 3s. 8d., and that the expenditure for the year has been £63,584. 2s. 3d., a total expenditure to March 25, 1905, of £804,527. 5s. 11d. The interest and sinking fund to be provided for out of revenue for the 12 months amounts to £43,056. 1s. 2d., the total income received from all sources amounts to £59,396. 3s. 5d., and the total cost of generation, distribution, rates, taxes, and management amounts to £16,990. 11s. 10d., leaving a gross revenue of £42,405. 11s. 7d. The interest on mortgages, stock, and bank charges amounts to £26,317. 12s. 3d., and the sixth instalment set aside out of revenue for the extinction of loan indebtedness to £16,738. 8s. 11d.—total, £43,056. 1s. 2d.; from which must be deducted the gross revenue, £42,405. 11s. 7d.; leaving a deficit, after covering all charges, of £650. 9s. 7d. The accumulated surplus to March 25, 1904, was £21,002. 6s. 9d., from which must be deducted the deficit at March 25, 1905, £650. 9s. 7d., leaving a total available surplus of £20,351. 17s. 2d. A detailed revenue account is appended, also detailed capital account, sinking fund account, and balance sheet. A diagram shows that the number of 8-c.p. lamps installed, or their equivalent, has increased from 215,000 in April, 1903, to 340,000 in March, 1905, and the December maximum number alight at one time has increased from 115,000 in December, 1903, to over 130,000 in December, 1904. The total revenue of the undertaking in the successive years of Corporation management has been as follows: 1898, £19,039; 1899 (15 months), £23,242; 1900-1 (12 months), £41,390; 1902, £39,831; 1903, £47,201; 1904, £57,100; 1905, £59,396. The number of units sold in the corresponding years respectively has been 978,088, 1,293,900, 2,381,708, 2,487,584, 2,919,722, 3,980,049, and 4,546,141. As pointed out in Mr. Fedden's report, the working expenses for the past year

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show for the first time a reduction coinciding with an actual increase of units sold—viz, from £17,234 for 3,980,049 units sold in 1904 to £16,270 for 4,546,141 units sold in 1905.

## PROVISIONAL PATENTS, 1905.

MAY 27.

**11119. Accumulative mercurial gravitation safety valves for hot-water installation boilers, and engine, boiler, steam, or other pressure indicators.** Charles Mackintosh, 36, Gower-place, Gower-street, London. (Complete specification.)

MAY 29.

**11169. Improvements in carbon-holders for arc lamps.** Siemens Bros. and Co., Limited, Queen Anne's chambers, Broadway, Westminster, London. (Siemens-Schuckertwerke, G. m. b. H., Germany.) (Complete specification.)

**11233. Improvements in or relating to dynamo-electric machines.** Frederick Edmund Berry, 46, Lincoln's-inn-fields, London.

MAY 30.

**11243. Improvements in electric arc lamps.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**11260. Improvements in electric cables.** Alfred Whalley and Ernest Arthur Bayles, Ashville, Helsby, near Warrington, Chester.

**11290. Telephone exchange systems.** Francis William Dunbar, 65, Chancery-lane, London. (Complete specification.)

**11300. Improved manufacture of copper sulphide for thermo-electric couples.** Compagnie Thermo-Electrique (Système Hermite) Soc. Anon., Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, April 27, 1905, being date of application in France. (Complete specification.)

**11301. Improvements in sulphide of copper thermo-electric generators.** Compagnie Thermo-Electrique (Système Hermite) Soc. Anon., Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, May 3, 1905, being date of application in France.) (Complete specification.)

**11329. Improvements in trolley wheels for electric traction.** James Alexander Kidd, 23, Southampton-buildings, Chancery-lane, London.

**11330. Improved means applicable for use in testing lightning conductors.** Arthur Annesley Voysey, Oun House, Surrey-street, London.

**11336. Improvements in telephones.** John Edward Kingsbury, 24, Southampton-buildings, Chancery-lane, London. (The Western Electric Company, United States.) (Complete specification.)

**11337. Improvements in telephones.** John Edward Kingsbury, 24, Southampton-buildings, Chancery-lane, London. (The Western Electric Company, United States.) (Complete specification.)

**11344. Improvements in and relating to insulators for electric conductors.** Robert Norman Redmayne, 70, Chancery-lane, London.

**11353. A process for regenerating electric accumulators.** Carl Luckow, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MAY 31.

**11407. Improvements in electric heating apparatus.** Gustav Teuter, 23, Mittelstr., Berlin, Germany. (Complete specification.)

**11415. Improvements in apparatus for measuring electrical resistances.** Evershed and Vignoles, Limited, and Sydney Evershed, 1, Queen Victoria-street, London.

**11440. Improvements in connection with single-phase alternate-current electrical motors provided with commutators.** The Elektrizäts Akt.-Ges vormals W. Lahmeyer und Co., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, July 11, 1904, being date of application in Germany.) (Complete specification.)

**11441. A device for limiting the speed of compensated single-phase alternate-current motors.** The Elektrizäts Akt.-Ges. vormals W. Lahmeyer und Co., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, July 30, 1904, being date of application in Germany.) (Complete specification.)

**11442. Improvements in the manufacture and production of coils of wire, more especially intended for use in electrical measuring instruments.** Hartmann und Braun Akt.-Ges., 47, Lincoln's-inn-field, London. (Date applied for under Patents Act, 1901, June 16, 1904, being date of application in Germany.) (Complete specification.)

**11454. Improvements in means for automatically regulating the load on engines or motors used for driving electric current generators.** Helios Elektricitäts-Aktiengesellschaft (in liquidation), 18, Buckingham-street, Strand, London. (Date applied for under Patents Act, 1901, June 1, 1904, being date of application in Germany.) (Complete specification.)

**11424. Improvements in apparatus for controlling electric currents.** Augustus Nelson Frisby, 10, Church-road, Watford.

**11460. Improvements in and relating to fusible electric cut-outs.** British Thomson-Houston Company, Limited, and Edmund Basil Wedmore, 83, Cannon-street, London.

**11463. Improvements in electrical connections.** William Ernest Burnand, 124, Oak Brook-road, Sheffield.

JUNE 1.

**11470. Improved electric cables.** William Bacon, 15, Water-street, Liverpool.

**11484. Improvements in electrical automatic cut-outs.** Edward Woodrowe Cowan, West Bank, Disley, Cheshire.

**11491. A self-contained electric bicycle bell.** John William Perry and John William Perry, jun., Rawreth Schools, Battles Bridge, Essex.

**11494. Improvements in and relating to sealing devices for electricity meters.** William Hamilton and Ferranti Limited, 18, Southampton-buildings, Chancery-lane, London.

**11502. Improvements in dynamo-electric machines.** Gilbert (known as Alfred) Berry, 53, Chancery-lane, London. (Date applied for under Patents Act, 1901, June 2, 1904, being date of application in France.) (Complete specification.)

**12525. Improvements in the manufacture of wire and the like by electro-deposition.** Richard David Sanders, 4, South-street, Finsbury, London.

JUNE 2.

**11534. Improvements in and relating to electrical conductors adapted to be used for commutators of dynamo-electric machines and other purposes.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**11535. Improvements in regulators for dynamo-electric machines and the like.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.) (Complete specification.)

**13536. Improvements in and relating to electric motor control systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**11537. Improvements in and relating to electric motor control systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**11538. Improvements in systems of overhead electric railways.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**11600. Improvements in dynamo-electric machines.** Gilbert (known as Alfred) Berry, 53, Chancery-lane, London.

**11605. Improvements relating to retransmitting and reinforcing telephone currents on lines also used for telegraphic purposes or otherwise liable to have currents of relatively low frequency passing over them.** John Edward Kingsbury, 24, Southampton-buildings, Chancery-lane, London. (The Western Electric Company, United States.) (Complete specification.)

**11606. Improvements in telephone current retransmitting and reinforcing apparatus.** John Edward Kingsbury, 24, Southampton-buildings, Chancery-lane, London. (The Western Electric Company, United States.) (Complete specification.)

**11614. Improvements in electric traction.** John Smith Raworth, Norfolk House, Norfolk-street, Strand, London.

**11626. Improvements in protective device for alternating-current systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**11627. Improvements in syatems of electric distribution by means of rectified alternating electric current and in apparatus therefor.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

JUNE 3.

**11635. Improvements in the trembler blades of contact makers for electrically-fired internal-combustion engines.** Andrew Arthur Donald, 24, Temple-row, Birmingham.

**11654. Improvements in accumulator plates.** Alexander Scharshieff, 55, Market-street, Manchester.

**11673. Portable electrical measuring instruments.** Henri Bourgeois, 65, Chancery-lane, London. (Complete specification.)

**11685. Improvements in multiplex telegraph systems.** Tullio Giara, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**11702. Improvements in dynamo-electric machines.** (The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

**11703. Improvements in and relating to dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

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**11765. Improvements in and relating to electric arc lamps.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published June 22.*

1904.

**12365. Telphers.** Siemens Bros. and Co., Limited. (Clift.)

**12372. Apparatus for transmitting and receiving telegraphic signals and the like.** Armstrong and Orling.

**12375. Electric clocks or time indicators and like mechanism.** Bowell.

**12623. Electric controllers.** British Thomson-Houston Company, Limited. (General Electric Company.)

**12801. Dynamo-electric machines.** Sayers.

**12861. Electric contact devices or collectors for electric traction.** British Thomson-Houston Company, Limited. (General Electric Company.)

**13360. Electrical measuring apparatus.** British Thomson-Houston Company, Limited. (General Electric Company.)

**13902. Electric insulators.** Aiken.

**14058. Solutions for the electro-deposition of metals.** Potthoff.

**14276. Single-phase electric motors.** Punga.

**15632. System of protection for parallel electric feeders.** British Thomson-Houston Company, Limited. (General Electric Company.)

**15646. Electrical fuse distribution and like boxes.** Veritys, Limited, and Gott.

**16108. Alternating-current electric motors.** British Thomson Houston Company, Limited. (General Electric Company.)

**16426. Contact breakers for induction coils.** Butt and Cox.

**16586. Point mechanism for electric tramways and the like.** Lawrence.

**16595. Supporting devices for electric fans.** Leach and Bergtheil.

**16601. Telephone central-station systems.** Lambert.

**16663. Electric meters.** British Thomson-Houston Company, Limited. (General Electric Company.)

**16729. Contact shoes for electrically-propelled vehicles.** British Thomson-Houston Company, Limited. (General Electric Company.)

**16837. Electric conductors more especially intended for use with "earthed" pipes, or pipes for protecting electrical conductors.** Johnson. (Hartmann und Braun Akt.-Ges.)

**18020. Electrical driving mechanism for machinery in general.** Hill.

**26791. Transformers and the like for use with compounded dynamo-electric machines.** Heyland. (Date applied for under International Convention, Dec. 8, 1903.)

**28166. System of connections for the generation of electric oscillations.** Eichhorn. (Date applied for under International Convention, Dec. 20, 1903.)

**28434. Electric insulating material and the process of manufacturing the same.** Billwiller and Karrer.

1905.

**956. Vapour electric apparatus.** Wood. (Date applied for under International Convention, Jan. 18, 1904.)

**1384. Electric apparatus for felling trees or sawing wood.** Wilson. (Date applied for under International Convention, Jan. 30, 1904.)

**1518. Binding screws and terminals for electric conductors.** Maunsell, Butt, and Harry W. Cox, Limited.

**2934. Temperature compensating devices for thermo-electric temperature measuring instruments.** Bristol.

**4859. Field-magnet arrangements of alternate-current electrical machines.** Elektrizitäts Act.-Ges. vorm. W. Lahmeyer und Co. (Date applied for under International Convention, April 30, 1904.)

**5834. Windings of field magnets of dynamo-electric machines.** Siemens Bros. and Co., Limited. (Siemens-Schuckertwerke G. m. b. H.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. £ | | Last price £ |
|---|---|---|---|
| **Commercial and Industrial.—** | | | |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ⅝-¾ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 7/16-17/32 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | – | 5¼-6 |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | – | 5⅞-6¼ |
| —— 4½ per cent. Mortgage Debentures | 100 | – | 102-105 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 100-102 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | – | 2 11/16-2 13/16 |
| —— 4 per cent. Mortgage Debenture Stock | 100 | – | 89-91 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 | 2 | – | ½-⅝ |
| —— Non. Cum., 6 per cent. Pref. | 2 | – | 1¼-1⅜ |
| —— 4½ per cent. 1st Debenture Stock | 100 | – | 92-95 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | – | 79-82 |
| Callender's Cable, Debentures | 100 | – | 107½-109½ |
| —— Ordinary | 5 | – | 10-11 |
| —— 5 per cent. Pref. | 5 | – | 5¼-5⅜ |
| Crompton and Co. | 5 | – | 1¼-2¼ |
| —— 5 per cent. Debentures | 100 | – | 95-100 p.c |
| Edison and Swan United, "A" Shares, 1-99,251 | 5 | – | 1¼-1½ |
| —— "A" Shares, 01-017,139 | 5 | – | 2-2¼ |
| —— 5 per cent. Debentures | 100 | – | 88 93 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 83 88 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | – | ½-1¼ |
| —— 7 per cent. Cumulative Pref. | 2 | – | 2¼-2½ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | – | 96 99 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | – | 9⅞-10¼ |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | – | 97-101 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | – | 11¼-12½ |
| —— 4½ per cent. Preference | 5 | – | 5¼-5⅜ |
| —— 4½ per cent. Debentures | 100 | – | 109-111 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | – | 15½-16½ |
| —— 4 per cent. Debentures | 100 | – | 100 103 |
| Parker, Thos., Limited, Ordinary | 10 | – | 10-10½ |
| Telegraph Construction and Maintenance | 12 | – | 33-35 |
| —— 5 per cent. Bonds | 100 | – | 103-105 |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary | 10 | – | 11½-12½ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | – | 10-10¼ |
| —— 5 per cent. Cum. Second Pref., 15,001-22,500 | 10 | – | 11-12 |
| —— 4½ per cent. Debenture Stock. Red. | 100 | – | 107-109 |
| Bromley (Kent) Electric Light and Power Co. | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. 1st Debenture Stock, Red. | 100 | – | 102-105 |
| Brompton and Kensington, Ordinary | 5 | – | 9⅜-10¼ |
| —— 7 per cent. Preference | 5 | – | 9¼-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 | 5 | – | 8¼ 9¼ |
| —— Nos. 60,001-80,000 | 5 | – | 7⅞ 8¼ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | – | 12½-13½ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 103-106 xd |
| Charing Cross and Strand, 70,001-80,000 | 5 | – | 7¼-8¼ |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5⅜-5⅝ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 5 5¼ |
| —— 40,001-80,000 | 5 | .. | 5-5¼ |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | – | 106 108 |
| Chelsea Electricity Supply | 5 | – | 6¼ 6⅝ |
| —— 4½ per cent. Debentures | 100 | – | 109-111 |
| City of London, Ordinary | 10 | – | 10,-11¼ |
| —— 6 per cent. Cumulative Pref. | 10 | – | 13½-14½ |
| —— 5 per cent. Debenture Stock | 100 | – | 124-128 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | – | 104-106 |
| County of London Electric Supply, Ordinary | 10 | – | 8¼ 9 |
| —— 6 per cent. Cum. Pref. | 10 | – | 12-12¼ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 103 105 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. | 100 | .. | 113-116 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | – | 5⅜-6¼ |
| —— 6 per cent. Cum. Pref. | 5 | – | 6-6¼ |
| —— 4½ per cent. First Mort. Deb. | 100 | – | 107-109 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 2¼-3 |
| —— 5 per cent. Debenture Stock, Red. | 100 | – | 86-91 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | – | 5¼-5⅜ |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | – | 101-104 |
| Havana Electricity, Limited, 1-15,000 | 10 | – | 9¼-10¼ |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | – | 7⅞-9¼ |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 100-103 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 | 1 | – | ⅜-½ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | – | 12-13 |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red | 100 | – | 101-103 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9½-10¼ |
| London Electric, Ordinary | 5 | – | 2-2¼ |
| —— 6 per cent. Pref. | 5 | – | 5-5¼ |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | – | 99-101 |
| Metropolitan Ordinary, 100,001-300,000 | 5 | – | 9¼-9¾ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | – | 109-114 |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5¼-5⅜ |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | – | 98-100 |
| Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb. | 100 | – | 99-101 p.c. |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | – | 98-101 |
| —— Preference | 4 | – | 100-102 |
| Notting Hill Electric Lighting | 10 | – | 14½-15½ |
| —— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.) | 100 | – | 100-102 |
| Oxford Electric, Ordinary, 1-96 and 3[illegible]-14,510 | 5 | – | 6¼-6⅝ |
| —— 4 per cent. Debenture Stock | 100 | – | 98-100 |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures | 100 | – | 101-104 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 | – | 2⅜-3¼ |
| —— 4 per cent. Debenture Stock | 100 | – | 79-83 |
| South London, Ordinary | – | – | 3⅜-4¼ |
| South Metropolitan Electric Light and Power Co., Ord. | 1 | .. | 13/16-15/16 |
| —— 7 per cent. Cum. Pref. | 1 | .. | 1 11/32-1 13/32 |
| —— 4½ per cent. 1st Mort. Deb. | 100 | .. | 105-108 |
| —— Ditto, June, 1904 | – | – | |
| St. James's and Pall Mall, Ordinary, 101-30,080 | 5 | – | 14-15 |
| —— 7 per cent. Pref. | 5 | – | 8¼-8⅜ |
| —— 3½ per cent. Deb. | 100 | – | 98-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | – | 4 13/16-5 1/16 |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5¼-5⅜ |
| Westminster, Ordinary | 5 | – | 12-13 |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | – | 6-6¼ |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 | 5 | – | 6-6¼ |
| —— Ord. | 5 | – | 8⅜-8⅝ |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | – | 141-144 |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 106-108 |
| Barcelona Tramways, Limited, Ord., 1-20,000 | 10 | .. | 12½-13½ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 | 10 | .. | 9¼-10¼ |
| —— 5 per cent. Deb., Red., 1-600 | 100 | .. | 99-102 |
| —— 4½ per cent. Red. Deb. Stock | 100 | .. | 96-100 |
| Bath Elec. Tramways, Ld, Pref. Ord. Shs., 75,001-150,606 | 1 | .. | ⅜-½ |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 | 1 | .. | 15/16-1 1/16 |
| Belfast Street Tramways, Ord., 1-26,600 | 10 | .. | 10½-11¼ |
| Blackpool and Fleetwood Tramroad | 10 | – | 13⅜-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | – | 1-1¼ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | – | 3¾-4¼ xd |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 91-98 |
| British Columbia Electric Railway Co., Ord. Def. | 100 | – | 105-108 |
| —— Ord Pref. | 100 | – | 98-101 xd |
| —— 5 per cent. Cum. Perpetual Pref. Stock | 100 | – | 104-107 |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each | 40 | – | 103-105 p c |
| —— 4½ per cent. Vancouver Power Deb. | 100 | – | 100-103 |
| British Electric Traction Ord. 1-300,000 & 60,001-80,000 | 10 | – | 9½-9¾ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | – | 11-11¼ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | – | 122-124 |
| —— 4½ per cent. 2nd Deb. Stock | 100 | – | 97-99 |

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| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| | £ | | |
| Buenos Ayres and Belgrano Tr m. | 5 | – | 3½-3¾ |
| —— "A" 6 per cent. Cm. Pf., 1-40,000 | 5 | | 5¼-5½ |
| —— "B" 6 per cent. Cm. Pf., 1-27,500 | 5 | – | 5½-5¾ |
| —— 5 per cent. Deb. Stock, Red. | 100 | – | 107-109 |
| —— Prov. Cert., all paid | 100 | – | 105-106 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | – | 97-99 |
| Calcutta Tramways, Limited, 1-102,268 | 5 | .. | 8¼-8½ |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | .. | 107-109 |
| Cape Electric Tramways Nos. 1-480,000 | 1 | – | 1¼-1½ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | – | 4¾-5¼ |
| —— ½ per cent. 1st Mortgage Deb., 1-3,000 (1917) | 10 | 0 | 99-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | | 101-103 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | – | 9½-10 |
| —— 5 per cent. Cum. Pref. | 10 | – | 11-12 |
| —— 4 per cent. Debentures | 100 | – | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | – | 13½-14½ |
| —— ½ per cent. Pref., Nos. within 1-60,000 | 10 | – | 15¼-16¼ |
| —— 5½ per cent. Mort. Debs., 1-5,000, Red. | 100 | – | 94-97 |
| Imperial Tramways Ordinary | all | – | 18-19 |
| —— ½ per cent. Cum. Pref. | all | – | 14-14¼ |
| —— 4½ per cent. Deb Stock | 100 | – | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cm. Pref., Nos. 30,001-60,000 | 5 | | 3-3¼ |
| —— – 4 per cent. Debenture Stock | 100 | – | 85-90 |
| Kilmarnock and District Lighting and Traction, Pref. | 5 | – | 8-8¼ |
| London United Tys. (1901), 5 per cent. Cum. Pref. | 10 | – | 9¾-10¼ |
| —— ½ per cent. 1st Mt. Db. Stock, Red. | 100 | – | 99-102 |
| Madras Elec. Trams. (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 | .. | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016 | 1 | .. | 9/32-11/32 |
| —— – 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | .. | 1-1 1/16 |
| —— – 4½ per cent. Deb. Stock, Red. | 100 | .. | 105-107 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000 | $1,000 | .. | 106-110 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 | .. | 101-104 |
| —— – Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 | .. | 103-105 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000 | 5 | – | ¼-1½ |

| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| | £ | | £ |
| Oldham, Ashton, and Hyde, Tramway, Ordinary | 10 | | 12 |
| —— 6 per cent Cum. Pref. | 10 | – | 9½-9¾ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Sk. | 100 | – | 105-108 |
| Potteries Electric Traction, Ordinary 20,001-40,00 | 10 | – | 8½ 9¼ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | – | 9¼ 9½ |
| —— 4½ per cent. Debenture Stock | 100 | – | 101-104 |
| South Lancashire Electric Traction and Power Company | | | |
| —— £250,000 Ordinary | 1 | – | 1 |
| —— £101,158 5 per cent. Preference | 1 | – | 1 |
| —— £597,170 4½ per cent. Debenture Stock | 100 | p.c. – | 100 p.c. |

## Electric Railways.—

| | | | |
|---|---|---|---|
| Central London, Ordinary | 100 | – | 91-93 |
| —— 4 per cent. Pref. | 100 | – | 101-103 |
| —— ,, ,, deferred | 100 | – | 80-83 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | – | 111-113 |
| City and South London, Consolidated Ordinary | 100 | – | 40-42 |
| —— 4 per cent. Debenture Stock | 100 | – | 107-110 |
| —— 5 per cent. Pref. Stock '91 | 100 | – | 120-123 |
| —— ,, ,, ,, '96 | 100 | – | 118-121 |
| —— ,, ,, ,, '01 | 100 | – | 115-118 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | – | 10-10¼ |
| —— Ordinary, 1-50,000 | 10 | – | 3¾-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | – | – | 99-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | – | – | 88¼-89¼ xd |
| Waterloo and City, Ordinary | 100 | – | 90-92 |

## Telephones.—

| | | | |
|---|---|---|---|
| National Telephone, Preferred | 100 | – | 111-112 |
| —— Deferred Stock | 100 | – | 103-105 |
| —— 6 per cent. Cum. First Pref. | 10 | – | 12¼-13¼ |
| —— 6 per cent. Cum. Second Pref. | 10 | – | 11¼-12¼ |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | – | 5½-5¾ |
| —— 5½ per cent. Deb. Stock, Red. | 100 | – | 100-102 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 103-105 |
| —— 4 per cent. Prov. Cert. | – | .. | 103¼-105¼ |
| Oriental Telephone and Electric Company | 1 | – | 1¼-1¾ |
| —— – 6 per cent. Cum. Pref. | 1 | .. | 1¼-1¾ |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905. | 1904. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pas-s'nger | Car mile. | Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | May 27 | 1,249 | 1,376 | – 126 | – h | 19½ | 19½ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·14 |
| Ayr Corporation | ,, 27 | 329 | 304 | + 25 | + 44 | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 336,049 | 1·03 | 10·11 | 1,770 | 5 0 |
| Barking Corporation | — | — | — | — | — | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | June 4 | 1,031 | 1,118 | – 27 | – 271 | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,349,701 | 1·158 | 9·98 | 2,383b | 6·1 |
| Birmingham Corporation | ,, 3 | 316 | 249 | + 97 | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | — | — | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | May 31 | 1,014 | 987 | + 26 | + 216 | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10·94 | — | 4·59 |
| Blackpool Corporation | June 1 | 781 | 1,667 | – 886 | – 1,331 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 3 | 382 | 775 | – 393 | – 1,408 | 16½ | 16½ | Dec. 31 | 32,021 | 2,258,984 | 600,757 | 3·34 | 12·75 | 2,001 | 7·05 |
| Bolton Corporation | ,, 4 | 2,005 | 2,223 | – 218 | — | 38 | 38 | March 31 | 94,151 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·89 |
| Bournemouth Corporation | May 31 | 1,033 | 1,025 | + 7 | — | 10·15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | June 3 | 4,507 | 4,596 | – 88 | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 4 | 181 | 8 0 | + 91 | — h | 9 | 7½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 2 | 5,113 | 5,172 | – 59 | — | 51½ | 51½ | Dec. 31g | 253,150 | 44,391,439 | 6,035,528 | — | — | — | — |
| Burnley Corporation | ,, 3 | 1,116 | 1,093 | + 23 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 4 | 325 | 343 | – 17 | – 278 | 8½ | — | March 31j | 11,574 | 2,556,134 | 282,378 | 1·08 | 9·84 | 1,570 | 7·57 |
| Cardiff Corporation | ,, 3 | 1,995 | 2,166 | – 170 | – 784 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 3 | 202 | 235 | – 33 | – 409 | — | — | Dec. 31g | 9,987 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 3 | 6,615 | 6,726 | – 111 | + 1,901h | 6 | 6 | ,, 31 | 362,471 | 44,953,938 | 1,292,674a | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 4 | 2,521 | 2,859 | – 338 | – 3,685h | 6½ | 6½ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Colchester Corporation | May 31 | 198 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. T. and L. Company | June 1 | 496 | 539 | – 43 | + 434 | — | — | ,, 31g | 26,657 | 6,353,323 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | ,, 2 | 248 | 239 | + 9 | + 41 | 7·23 | 7·23 | March 31g | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | May 13 | 198 | 195 | + 3 | — | 4½ | 4½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0 94 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | June 2 | 131 | 161 | – 30 | – 554 | 7 | 6½ | Dec. 31g | 6,234 | 388,905 | 107,164 | 3·88 | 14·09 | 952 | 7·39 |
| Dublin U. T., electric cars | ,, 2 | 4,199 | 4,349 | – 150 | } — | 47 | 46 | ,, 31g | 134,648 | — | 3,429,356 | — | — | — | — h |
| Dublin S. District, Electric | ,, 2 | 1,017 | 1,302 | – 285 | | | | | | | | | | | |
| Dundee City Tramways | May 31 | 880 | 831 | + 29 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | June 3 | 898 | 739 | – 159 | + 285 | 10·77 | 10·75 | March 31 | 34,312 | 12,950,269 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 3 | 15,766 | 16,010 | – 274 | — h | 145 | 123 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Gloucester Corporation | ,, 1 | 308 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | May 17 | 3,042 | 2,624 | + 418 | + 627 | 33 | 30½ | March 31 | 68,289 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,069 | 8·77 |
| Huddersfield Corporation | June 3 | 1,401 | 1,288 | + 113 | + 139 | 35 | 35 | ,, 31 | 65,545 | 11,899,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | ,, 3 | 2,202 | 2,165 | + 37 | — | 26 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | April29 | 546 | 446 | + 100 | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | May 31 | 136 | 134 | + 2 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 31 | 219 | 221 | – 2 | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | June 3 | 6,268 | 5,850 | + 418 | + 1,220 | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | April22 | 1,961 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | May 27 | 10,528 | 11,374 | – 846 | — | 103 | 103 | Dec. 31g | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | June 4 | 1,546 | 1,547 | – 57 | – 1,829h | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — a |
| London County Council | May 27 | 13,673 | 13,260 | + 413 | +18,281 | 46½ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | June 1 | 113 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 3 | 12,990 | 12,847 | + 143 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 3 | 139 | 134 | + 5 | + 92 | 2¾ | — | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newcastle-on-Tyne Corptn. | ,, 3 | 3,731 | 3,708 | + 73 | — | 45 | 38½ | ,, 25 | 185,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111b | — |
| Newport (Mon.) Corporation | — | — | — | — | — | 15 | — | — | — | — | — | — | — | — | — |
| Oldham Corporation | ,, 4 | 1 662 | 1 204 | + 458 | + 4,142 | 34¾ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 3 | 1,920 | 1,904 | + 16 | — | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·16 | 12·39 | — | — |
| Reading Corporation | ,, 1 | 624 | 639 | – 13 | — | — | — | — | — | — | — | — | — | — | — |
| Rochdale Corporation | April29 | 582 | 120 | + 462 | + 1,811 | 4½ | 4½ | 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | June 1 | 443 | 423 | + 20 | — | — | — | ,, 31 | 20,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·68 |
| Salford Corporation | ,, 5 | 4,444 | 4,118 | + 325 | + 210 | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 3 | 116 | — | — | — | 7¾ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 4 | 4,963 | 4,652 | + 301 | + 318 | 34¼ | — | ,, 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | May 31 | 988 | 1,007 | – 18 | – 541 | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 31 | 354 | 309 | + 45 | + 94 | 6½ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | June 2 | 648 | 817 | – 169 | — | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | May 21 | 1,157 | 1,260 | – 103 | — | 19·54 | 18·48 | ,, 31 | 62,506 | 14,848,958 | 1,433,463 | 1·01 | 10·46 | — | 6·02 |
| Swindon Corporation | ,, 31 | 202 | — | — | — | 3¾ | — | — | — | — | — | — | — | — | — |
| Wallasey U.D.C. | June 3 | 777 | 783 | – 6 | + 180 | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·50 |
| Warrington Corporation | ,, 1 | 326 | 321 | + 5 | + 90 | 7½ | — | — | — | — | — | — | — | — | — |
| West Ham Corporation | ,, 1 | 1,727 | 1,055 | + 671 | + 6,152 | 8·62 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | May 31 | 771 | 588 | + 183 | — | 7½ | — | ,, 31g | 20,878 | 4,263,066 | 417,335 | — | 12·006 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile. Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse-traction. g 1903. h Half-year's figures. Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**City and Guilds of London Institute.**—An exhibition of practical work executed by students of technical classes in the United Kingdom and the Colonies and by students at the institute's 1905 examinations will be inaugurated at the Imperial Institute (North Gallery) on Wednesday, the 28th inst., at 3.30, and will remain open until July 8. Earl Spencer will perform the opening ceremony.

**Personal.**—The council of the Society of Arts have, with the approval of the president, awarded the Albert Medal of the society for the present year to Lord Rayleigh "in recognition of the influence which his researches, directed to the increase of scientific knowledge, have had upon industrial progress, by facilitating, amongst other scientific applications, the provision of accurate electrical standards, the production of improved lenses, and the development of apparatus for sound signalling at sea."

**The American Institute.**—According to the *Electrical Review* of New York, the annual convention of the American Institute of Electrical Engineers is to be held at Asheville from the 19th to the 23rd of this month. A long list of papers is announced for discussion, some of which are, as usual, of only local interest, though others will be considered by a larger number of readers. It is said that "Coming events cast their shadows before," and when we find down for discussion such a paper as that by C. de Muralt on "Heavy Electric Freight Traction" we must begin to recognise that traction electrical is passing from the mere propulsion of light vehicles to general adaptation upon railways.

**Society of Arts.**—The annual conversazione will be held in the gardens of the Royal Botanic Society, Regent's Park, on Tuesday evening, the 4th prox., from 9 to 12 p m The gardens will be illuminated with coloured lamps and also by the Kitson incandescent oil light. The conservatory and the clubhouse will be open. The reception by Sir William Abney, chairman, and other members of the council, will be held at the entrance to the conservatory from 9 to 10 o'clock. The tropical house will be open to visitors. A selection of music will be performed by the string band of the Royal Artillery in the conservatory, and by the band of H.M. Grenadier Guards in the gardens. A concert and entertainment will be given from 10 to 10.45. Each member is entitled to a card for himself and a card for a lady. Additional tickets will be supplied to members or persons introduced by members at the price of 5s, which will be increased to 7s. 6d. on the day.

**Institution of Mechanical Engineers.** — The summer meeting of this institution, to be held at Liége, will commence on Monday next. A reception committee has been formed by the Liége Association of Engineers. The following papers have been offered for reading and discussion: "A Superheater applied to a Locomotive on the Belgian State Railways," by M. J. B. Flamme, of the Belgian State Railways, Brussels; "The Growth of Large Gas-Engines on the Continent," by M. Rodolphe Mathot (member), of Brussels; "Ferro-Concrete, and some of its most characteristic applications in Belgium," by M. Ed. Noaillon, of Chênée, Liége; "Colliery Electric Winding Engines," by M. Paul Habets, of Liége; "Strength of Columns," by Prof. W. E. Lilley (member), of Dublin; and "An Investigation to Determine the Effects of Steam-Jacketing upon the Efficiency of a Horizontal Compound Steam-Engine," by Mr. A. L. Mellanby, of Manchester. The tour will last until the 23rd inst., and a number of visits and other entertaining items have been arranged.

**The Tantalum Lamp.**—Dr. Bell and Prof. Puffer have been testing these lamps in the laboratory of the Massachusetts Institute of Technology. It is unnecessary to go into details, but six were in clear globes and four in frosted globes, and in the photometer tests six clear lamps gave an average of 22·20 c.p. at an average of 1·85 watts per candle. The four frosted lamps gave an average of 19·08 c.p. at a mean of 2 1 watts per candle. Corroborating this test, it is stated that Prof. Kennelly found a mean candle-power of 19 20 at 2·1 watts per candle-power. As regards life, the tantalum lamps stood for 800 hours with a mean candle-power of 20 at about 2·05 watts per candle, thus showing an effective life of about 16,000 candle hours. The observers say it is sufficiently obvious that if these lamps are anywhere nearly typical examples of the tantalum lamp, its life efficiency is so great as to entitle it to an immediate and important place in the art. Our reference is from an article on these tests in the *Electrical World and Engineer* of New York by the authors of the tests.

**Radiation from Ordinary Materials.**—An abstract of an article by Mr. Norman R. Campbell on his investigations into radiation from ordinary materials appears in the *Journal* of the Chemical Society. The author has measured the spontaneous saturation current (or "leak") through vessels of various forms and materials. It appears that the influence which the walls of a containing vessel exert on the spontaneous ionisation of the enclosed air is due to a radiation proceeding from the walls. Part of this radiation from certain materials, such as tin, zinc, graphite, and platinum, is analogous to the secondary radiation excited by Röntgen and other rays. The absorption coefficient of air for the radiation is comparable with that of air for the $\alpha$-radium rays, and is different for different materials. Hence the radiation is not likely to be due to radioactive impurities, but is probably an inherent property of the material. There is no evidence of rays from ordinary materials of a penetrating power considerably greater than that of the $\alpha$-rays from radioactive elements.

**Telegraphic Communication with the Continent.** The Association of Chambers of Commerce recently addressed the Postmaster-General, with a view to the establishment of additional cables between the United Kingdom and the Continent, and also more direct wires between the chief commercial centres for the distribution of telegrams. Lord Stanley has replied that additional facilities have been provided in recent years for telegraphic communication with the Continent not only by means of new cables, but also by the use of improved apparatus, rendering it possible to transmit two or more telegrams over one wire at the same time. Direct communication has also been arranged with many Continental towns which before could only be reached indirectly. As a result of these improvements he considered that the service was, on the whole, satisfactory. Such delays as took place were chiefly due to interruptions on the long Continental land lines used in connection with the service, which were unavoidable. Lord Stanley concluded by stating that the Post Office had under consideration the question of still further increasing by means of improved apparatus the number of channels available for communication, and he would not fail to take such other steps as might be practicable for maintaining the efficiency of the service.

**Ionisation by Radium.**—A paper is contributed to the *Comptes Rendus* by Mr. William Duane on the ionisation produced between parallel plates by radium emanation, of which an abstract appears in the *Journal* of the Chemical Society. Air containing radium emanation was introduced into a chamber containing two parallel plates, and the

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ionisation current between the plates for a considerable difference of potential was determined: (1) immediately after the introduction of the emanation, (2) three hours later, and (3) half an hour after the emanation had been removed by a current of air. In the first case the observed current is due to the emanation, in the second to the sum of the effects of the emanation and of the imparted activity, and in the third case to the third substance, C, of the imparted activity. Formulæ are given showing the dependence of the current on the distance between the electrode plates in each of the three cases. Assuming that the charge on an ion is $3 \times 10^{-10}$ electrostatic units, the maximum number of ions of each sign produced by unit quantity of the emanation per second is $2{\cdot}1 \times 10^{9}$. It is also calculated that the energy involved in the production of the emanation from radium bromide corresponds with about one-twentieth of the total heat disengaged by the radium salt, and, further, that 14,500 ions of each sign are produced in the destruction of a molecule of emanation.

**Junior Institution of Engineers.**—The summer meeting of this association is this year to be of a special character in celebration of the society's coming of age. It is to be held earlier than usual, so as to include Foundation Day (June 30), and will open on Monday morning, the 26th inst., when the Lord Mayor and the sheriffs will receive the members in the Council-chamber of the Guildhall. The proceedings will include the reception of representatives of kindred associations; the presentation of a historical note by Mr. W. J. Tennant, past-chairman; a short address by the president, Mr. W. H. Lindley, of Frankfort-on-Maine; and votes of thanks, after which an adjournment will be made for luncheon. In the afternoon there will be a special visit of inspection of St. Paul's Cathedral, under the guidance of the Archdeacon of London and the consulting architect, Mr. Somers Clarke, followed by a choral service. The members are afterwards to be received by the Lord Mayor and Lady Mayoress at the Mansion House. On Tuesday both the morning and afternoon will be devoted to visiting Woolwich Arsenal, under arrangements specially made by Mr. H. F. Donaldson, chief superintendent of ordnance factories. In the evening a reception will be given by the institution at the Royal United Service Institution, Whitehall. For Wednesday, visits have been arranged to the Royal Mint; Messrs. Yarrow's works, Poplar; the North London Railway works, Bow; and the Greenwich generating station of the London County Council tramways (where the engines are in course of erection) and to the New Cross depôt. On the following day an excursion to Chatham will take place, for which the "Clacton Belle" has been chartered to leave London Bridge at 10 o'clock. On arrival at Chatham the dockyard will be visited, and the return to London will be *via* the Nore. Friday morning will be occupied with visits to Messrs. Doulton's potteries and to the Neasden power-house of the Metropolitan Railway. In the afternoon and evening the members and their friends will foregather at Earl's Court for an inspection of the Naval, Shipping, and Fisheries Exhibition, concluding with the inevitable dinner.

**Railway Electrification in South Africa.**—In our issue of Dec. 16 and Jan. 27 we alluded to the scheme which the Central South African Railways Administration, in conjunction with Messrs. Mordey and Dawbarn, had evolved for the electrification of the Springs-Randfontein section of their system. Messrs. Mordey and Dawbarn estimated that this would result in an economy of at least £40,000 per annum, without making any allowance for increased revenue due to improved service. It was stated that the administrators had only been deterred from adopting the scheme earlier by the question of raising the requisite capital, but it appeared that this difficulty had been overcome, as a large contracting firm agreed to undertake the work and accept payment out of profits by instalments. Notwithstanding this, the project has been shelved, though only, it is understood, pending an improvement in commercial conditions, which have latterly shown some indications in that direction. The possibility of the eventual introduction of electricity for operating a number of sections of the South African railways, and especially those where steep gradients occur, is, we hear, a constant subject of study on the part of the authorities, and the engineers of Cape Colony and Natal have made repeated efforts to devise powerful types of locomotives to cope with the geographical conditions obtaining on some of the routes. It is reported that the electrification of the short line from the Victoria Falls to Livingstone is on the eve of realisation; and with the immense quantity of power which the Falls may eventually provide for generating energy, it may be hoped that this will prove but the prelude to the electrification of Rhodesian railways on an extensive scale. In any case the electrification of South African railways is a possibility which electrical engineers will do well to keep in mind We observe, by the way, that at its meeting the other day the South African Intercolonial Council sanctioned a substantial vote for railway construction, which confirms the impression that commercial conditions in that quarter of the globe are on the up-grade, though the fact that the scheme was somewhat modified will act as a caution against forming premature anticipations.

**Trifles.**—The success of a factory or an installation or of an individual depends absolutely upon the appreciation of trifles. There are trifles which are important and there are trifles which are foolish, and the man who spends his time considering the latter is not of much account. It constitutes a difference between a success and a failure whether it is easily determined that the trifle is valueless or valuable. Perhaps in most industries it will be found that an industry has commenced by paying attention to points which were visible to everybody, but in the end the business has succeeded which has taken into account not only that which was originally seen, but that which was originally unseen. In gasworks the utilisation of by-products has proved in many cases salvation. In many factories a similar result has happened. In electrical works during the past 25 years a vast mass of what might be termed experimental work has been carried out; also a great deal of temporary work and large quantities of plant of one kind and another have been brought into play, but which have not fulfilled what may be termed their life's labour. What becomes of the old material, and how can it be best adapted for further use? These are questions which are oftentimes forgotten, but which when fully considered and successfully answered have given a small fortune to the person making the utilisation. The Americans are fairly keen in this direction, and have devised machinery for the getting out and the working up anew of old conductors. It has been suggested that there are many tons, probably, of old telephone and other wires used for electrical purposes at the present time existing as wasters, it being nobody's interest to do anything with this material. Perhaps with a little foresight circuits might be adapted so that if no longer required, the material used in them could be very cheaply turned to another purpose with corresponding advantage. At the end of the World's Fair at St. Louis, the United Railways Company of that city obtained a machine for putting braided cover on faded wire. The machine has been used for putting braided cover on a lot of underground cables, the insulation of which had been

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removed. This is a sample, as we say, of making the best of a bad job, and might be successfully emulated.

**Testing of Electricity Meters.**—We alluded in our editorial columns last week to the subject of meters and to eight cases in which tests by London County Council inspectors had shown errors to have arisen in the charges made against the consumer. As the majority of these cases illustrate a particular point, it is worth while to give particulars of them: (1) The meter at the end of three months was over-read to the extent of 1,000 units, and at the end of the subsequent quarter, although the consumer had discontinued the use of the current, he was, as an outcome of the first misreading, charged for 9,000 units, making a total overcharge of 10,000 units, valued at about £85. (2) The meter was marked for 200 volts, but was used on a 100-volt circuit. During two quarters the supply company omitted to divide the readings by two, and the consumer was, therefore, charged double the correct amount. At the end of one quarter the meter was over-read by 100 units. The total overcharge resulting was £9. 0s. 4d. (3) Upon one consumer leaving a house and the supply being cut off, the meter was under-read by 100 units. This misreading was taken as the basis of the new tenant's consumption, and he was, therefore, overcharged by 100 units in his first quarter. (4) A 200-volt meter was used on a 100-volt circuit. The readings were not divided by two, and the total overcharge resulting was 100 per cent. of the correct amount for nine months. (5) The consumer had not been given the benefit of the maximum demand system. An overcharge of 80 units was the result. (6) The meter was incorrectly marked by the makers. The error was not discovered by the supply company. The consumer was consequently charged double the correct amount during the whole time the meter was installed, less the under registration owing to the meter running slow, which at the time of the test was found to be 21 per cent. (7) A similar case to the above. The meter was found to over-register the consumption 72 per cent. (8) The meter had been over-read by 100 units. The error was subsequently acknowledged by the supply company. It will be seen that in every instance except one the fault was not with the meter, but in the reading thereof. Thus, the chief difficulty lies, not in the fallibility of the instrument, but of that still more complex factor known to our Transatlantic friends as "the human equation." Even electricity meters do not quite attain to perfection, but, as we remarked last week, they are, in general, probably more accurate than any other class of measurements whatsoever.

**Commercial Conditions in South America.**—The lives of South American administrations have usually been of a brief order, and the authorities, realising the fact, have apparently acted on the principle that while their tenure lasts it shall at any rate be merry. One consequence of this has been that Europeans have had concessions repudiated with a levity that would be highly diverting were there not important interests at stake. Latterly there have been indications of the dawn of a more stable era for the revolution-ridden continent, and the example of Mexico lent encouragement to the hope that the Spanish republics have attained to a saner state of mind both in regard to self-government and the rights of those who invest money for the development of the natural resources of the country. It rather looks, however, as if one of the largest of these countries—Argentine—is lapsing into its old ways. In 1887 the City of Buenos Ayres Tramways Company acquired a concession, duly ratified by the National Congress, for a line of tramways along the front of the port. As far as the conditions permitted the company complied with the terms of the concession, but the condition of the roads prevented the whole of the system from being completed within the specified two years. A year or so ago the Anglo-Argentine Tramway Company, on taking over the property of the former company, applied to and obtained permission from the Municipality of Buenos Ayres to convert the lines to electric traction. Meanwhile, the Argentine Government granted to certain speculators a concession embracing the whole of this route, and issued a decree revoking the original concession, for which the City of Buenos Ayres Tramways Company paid £80,000, on the ground that the system had not been completed within the stipulated period. Three fácts are specially to be noted in this connection. The City of Buenos Ayres Company had performed their part of the covenant, so far as the conditions permitted; the Act of federalisation of the city of Buenos Ayres confers exclusive rights in such matters upon the Municipality, subject only to the National Congress; and neither the Municipality nor the National Congress have given their approval to the revocation of the original concession or the granting of a new one. The Anglo-Argentine Company, it may be remarked, have instituted proceedings for the protection of their rights; and by sticking to their guns they have a good chance of maintaining them, for experience has shown that if the arrogance of the South American republics be opposed by firmness it generally results in an ultimate climb-down on the part of the authorities. At the same time it is to be hoped that the latter will take a more rational view of the position, so that by judicious methods the ephemeral governments of the past may be replaced by a stable administration, enabling the great natural resources of the country to be developed.

**Telephony in Canada.**—In our issue of the 26th ult. we referred to the Government enquiry that was being held at Ottawa into the subject of telephonic control in the Dominion. We have received a further batch of the official reports, bringing the proceedings down to the 19th ult. The evidence, both documentary and oral, that has been considered by the Commission is of a voluminous character, and we can but indicate a few of the more notable features. Apparently, the Commissioners are taking pains to obtain complete information, as, in addition to extensive enquiries into the Canadian systems, those of Great Britain, the Continent, and the United States have come under review. A number of witnesses were examined in regard to rural lines. One of them stated that the farmers were so anxious for a telephone system that they supplied the timber for the poles and did the bulk of the transport work themselves; indeed, many of these rural lines, founded on the co-operative system, had somewhat primitive beginnings. In one instance a parish priest was the moving spirit in the formation of a rural line, to which he acted as electrical engineer. He thus described its history: "A telephone was needed to go from the presbytery up to the station on the Quebec and Lake St. John Railway, about two miles, and I interested the merchants. On the Lake St. John Railway the trains are sometimes very late, and there is no need to go to the station so much ahead of time. So we began building that small line with the help of the persons interested. Some of the merchants gave help in the shape of hauling the poles and also erecting them. They sent their serving men. It was not a long work; it only took four or five days to build the line." The cost of construction naturally varied in different cases, but one witness put the cost for a fairly typical line, with two instruments to the mile, at £45 per mile. It appears, however, from the testimony of Mr. J. H. Winfield, manager of the Nova Scotia Telephone

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Company, that, while many of the farmers are willing to use the lines, they are not always prepared to pay for the accommodation. The company offered to construct a certain rural line for the benefit of the farmers if a stipulated number of them subscribed. After some time the necessary number came along, when it was discovered that half a dozen farmers, by putting together a small sum, were having the benefit of each instrument. Notwithstanding this, the company is one of the most prosperous telephone concerns in the Dominion. It ousted the Bell Company, and now has one subscriber in 74 per head of population, which is the best average in Canada, while its subscribers are increasing at the rate of 300 per annum. Subsequently, Mr. C. F. Sise, president of the Bell Company, was examined in detail as to the financial and general position of that company. The Canadian section of this concern was founded in 1880, and during the first year the receipts amounted to £6,000 against an expenditure of £3,800. These figures were more than trebled during the following year, the receipts and expenditure advancing in substantially the same ratio. For the year ending Dec. 31 last the receipts totalled some £600,000, the expenses being £420,000. The increase has been progressive from year to year. An Act passed in 1902 confers power on the Governor in Council to vary the company's rates on the application of any interested municipality. No application under this Act appears to have been made. Evidence was given by some of the witnesses as to the obstructive tactics of the Bell Company, but this state of affairs has not been universal, the Bell Company having in some instances co operated with other concerns, apparently when the latter were well established. The Railway Act of 1903 vetoes exclusive privileges to any telephone company in regard to installations at railway stations, but the Bell Company appear to still have a substantial monopoly of the stations on the Grand Trunk and the Canadian Pacific lines, though a few local telephone companies have latterly been admitted. An interesting witness was afterwards examined in Mr. H. Laws Webb, of London, details of whose evidence are not yet to hand.

**Insulation Resistance of High-Tension Cable Coverings.**—The results of some tests carried out in Messrs. Felten and Guilleaume's laboratories on various qualities of impregnated paper-insulated cables are described by P. Humann in a recent number of the *Elektrotechnische Zeitschrift*, and serve to emphasise the fact once more that high insulation resistance by itself forms no guide to the practical utility of a cable. Cable specifications requiring guarantees of excessive insulation resistances are still constantly met with, and these requirements can be readily complied with by the cablemakers by the employment of solid impregnating substances amongst other methods, but generally at the expense of flexibility in the insulating covering. The cracking of a single layer of insulation in a cable insulated with a large number of layers of impregnated paper will greatly facilitate the breakdown of the whole insulation, just as in the case of a sheet of glass a fine scratch with a diamond is found greatly to reduce the breakdown voltage. For this reason soft and flexible coverings are essential, and this is only possible, in the case of paper-covered cables, if the impregnating materials consist largely of oils. This involves a lower insulation resistance, but gives a reliable and easily laid cable. It is often supposed that a high insulation resistance means a reduction in the dielectric losses at high tensions. That this is not the case is clearly shown by the following measurement of dielectric losses in two three-phase cables differing greatly in their insulation resistances. The cables were 5,000-volt lead-covered ones, and each contained three 25 square millimetre conductors. In each case the losses between the three phases and the lead covering were measured by means of a mirror wattmeter.

| No. 1 Cable.—1 280 megohms per kilometre; ·284 microfarads per kilometre. | | No. 2 Cable.—10,850 megohms per kilometre; ·282 microfarads per kilometre. | |
|---|---|---|---|
| Voltage. | Loss in watts per kilometre. | Voltage. | Loss in watts per kilometre. |
| 2,745 | 13·38 | 3,200 | 16·4 |
| 4,160 | 30·7 | 4,000 | 25·4 |
| 5,220 | 48·35 | 4,800 | 36·3 |
| 6,260 | 69·3 | 5,600 | 49·5 |
| 7,470 | 99·8 | 6,400 | 64·8 |
| 8,540 | 129·4 | 7,200 | 84·1 |
| 10,270 | 195·7 | 8,000 | 100·4 |
| 11,470 | 243·8 | | |

The tests were made at 53 ~. The alternator employed did not give a sinusoidal E.M.F. curve, so that the figures can only be considered as relatively correct. It will be seen that the difference between the two cables amounts to only about 10 per cent., and allowing for errors of observation, the two cables can well be assumed to have equal losses, and yet the insulation resistance of cable No. 2 was about 8½ times as great as that of No. 1. These results only apply to properly dried cables. If the drying process is only partially completed, reduced insulation resistance can be experimentally shown to lead to increased dielectric losses. In general, therefore, it may be taken that with properly dried cables the dielectric losses are not influenced appreciably by the insulation resistance, but that in cables having low insulation resistances due to incomplete drying out the losses increase decidedly as the resistance falls. In order to permit proper mechanical strength and flexibility to be obtained, the specification of excessive insulation resistances of several thousand megohms should be avoided, for a 300-megohm cable may have quite as good all-round qualities as one of 1,500 megohms, and better qualities than one of still higher resistance. The measurement of insulation resistance should, in fact, only be employed to indicate whether the cable has some actual fault of construction.

**The Telephone Transfer.**—Chief interest in the enquiry which the House of Commons Committee is conducting into the purchase agreement between the Postmaster-General and the National Telephone Company centered last week in the evidence of Mr. W. S. Gaine, the manager of the company. He stated that the company was now working in 280 telephone areas. At the end of March last they had 1,139 exchanges, 320,017 subscribers telephones, and 5,365 public call offices. In 1890 the capital of the company was £2,589,000, and it had grown to £10,840,000 in 1904. The net revenue had increased from £191,000 to £759,000. The total wire mileage was 728,000 miles, and the messages sent over the wires per annum numbered 995,000,000. The average age of the plant at the end of last year was only about four years. He claimed that the company had shown enterprise in the conduct of their business. The greatest development of telephone service had taken place in New York, although the charges there were approximately three times higher than in this country. He considered that the agreement was of great value to the public, because it encouraged the company to push and develop the service up to the last day of the license. The view of the directors was that the Postmaster-General had driven a very hard bargain, because it gave no consideration in respect of the goodwill of the great business which the company had built up. The company had had to pay for all the experiments and mistakes which were associated with the development of a new industry, and a sum of £1,848,000 had already been paid in royalties to the Post

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Office. Yet the Post Office was going to step into this business in 1911 on paying only for the plant employed in it. The company had never obtained assistance from the Post Office, so far as he knew, without having to pay for it; on the contrary, every impediment had been put in the way of the company. In spite of every impediment, however, the company had developed a most useful public service to a high point both in extent and efficiency. Mr. Gaine charged the London County Council in particular with having retarded the telephone service of the Metropolis. He stated that if the provincial municipalities had not taken a much more enlightened view than the London County Council, the telephone service would not have developed generally throughout the provinces to the extent it had done; but, fortunately, he had been able to make arrangements with the local authorities of the great towns in England, and most of those in Scotland, with the result that the plant in those towns had been practically reconstructed and placed underground. He regarded as unreasonable the provision in the agreement to the effect that the Postmaster-General should have the right to pick and choose plant at the end of the license. Replying to a question by Sir William Holland, Mr. Gaine stated that the rate which gave unlimited service had every disadvantage that could be thought of, and ought not to be maintained, or, at any rate, lowered. In reply to another question as to whether there was a lower rate in places where there was a municipal exchange, he replied in the negative. The unlimited service rate had never been altered in any of such places, but additional rates and tariffs had been brought into being very largely to meet the exigencies of competition. Mr. Gaine thus expressed this part of the situation: "We cannot engage in a fight with gloves on, and I may add that I have met the competition in an extremely successful way." He did not think he was exaggerating in stating that municipal telephony had proved a failure. There was only one case of important competition — Glasgow. His own view was that the Glasgow Corporation before long would be very sorry that they had embarked upon it. The splitting up of the administration of this service did not lead to greater economy. He did not know whether the Post Office would conduct the business more economically than the company was now doing, but he was sceptical on the point. At the conclusion of his evidence Mr. Gaine requested that he should have an opportunity of replying to the statements of witnesses representing local authorities, to which the chairman replied that the request must be made later. The committee then adjourned until after the Whitsuntide recess.

**Cable Rates to the East.**—The Chancellor of the Exchequer last week received a deputation of representatives of chambers of commerce on the question of a further reduction in the cable rates to India, China, and West Africa. The deputation, which was introduced by Sir Edward Sassoon, included Sir William Houldsworth (chairman of the Commerce Committee of the House of Commons), Sir W H. Holland (president of the Association of Chambers of Commerce), Mr. Henniker Heaton, Sir Alfred Jones, and representatives from London, Liverpool, Belfast, Blackburn, Bury, Dundee, Newcastle, Newport, Wolverhampton, Glasgow, Leith, Sheffield, and Bradford. The Government, it may be mentioned, has an opportunity of considering and readjusting the cable rates charged by the various companies when the landing rights of these companies are renewed by Government grant. Sir Edward Sassoon urged the reduction of cable rates to India from 2s. 6d. to 1s. 6d. per word, a reduction of 25 per cent. on the charges to West Africa, and an amelioration of the rates to China. The deputation was present in no hostile spirit to the private cable companies, but it was desired that the State should enter more into the provision for adequate cable facilities. He quoted the Viceroy of India to the effect that the reduction made in the Indian rates some three years ago had resulted in a large increase of cable traffic. In reply to a question from the Chancellor of the Exchequer as to how any losses were to be met, Sir Edward replied that, if the Government did the business properly, there would be no loss. Sir Alfred Jones stated that cablegrams could be sent from France to Africa at about a quarter of the English rates. Mr. Henniker Heaton expressed a hope that the Chancellor of the Exchequer would appoint a committee to report on the whole question. Mr. Chamberlain, in reply, said that cable companies had shown enterprise, skill, and public spirit, and he was glad to see that this fact was recognised. At the same time the Government might, under special conditions, itself aid in the construction of cables, though he would never choose Government enterprise in these matters where private enterprise showed itself able and willing to undertake the work. He thought it would be doing ill service to the cause of cable telegraphic expansion if the Government lessened the inducement to private enterprise, or harassed or frightened such enterprise by Government competition. It did not follow that increase in traffic brought an increase in profit to the owners of the cables, because it might happen in that case that other cables would have to be laid down at considerable expense. In regard to charges, it was not fair to take mileage simply as a basis, because it was in some areas more expensive to construct the cable and more costly to work it than in others. Dealing with the rates charged by France to its West African possessions, Mr. Chamberlain stated that he did not think that, on the average, British rates compared unfavourably with our neighbours. In reference to the rates to and from India, the Chancellor remarked that the rates were reduced from 4s to 2s. 6d. from March 1, 1902. He did not think the great increase of traffic to India had been altogether caused by the reduction in rates. At the same time, he was very glad to be in a position to inform the deputation that in pursuance of the arrangement of 1902, by which in the first place the rate was reduced from 4s. to 2s. 6d., that a further reduction would be made by Oct. 1 next from 2s. 6d. to 2s. Although that would involve further favours on the part of the Indian Government in pursuance of their guarantee, he hoped and believed that the response of the traffic to the reduction might be sufficient in a short time to relieve them of any additional burden. Regarding the Pacific cable, he thought it would be inopportune for him to discuss the question at the present juncture, the matter being virtually *sub judice*, as the much-deferred conference would be opened in a few days. He did not think it desirable to appoint a further committee at the present time. Such a committee could not usefully go again over the ground covered with so much care and ability by Lord Balfour of Burleigh's Committee. From time to time, as opportunity occurred, the Government would do its best to secure improved communication between the different portions of the British Empire, but he did not think the necessity was proved at the present time for the Government itself to embark upon further great cable enterprise. In his opinion, any capital expenditure by the Government in that direction would be received with great dislike by many. It would adversely affect the Government's credit, and it would tend to check the return of commercial and financial prosperity. In conclusion, Mr. Chamberlain stated that it was hoped that the rate to Egypt would very shortly be reduced to 1s. a word.

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## WIDNES AND RUNCORN TRANSPORTER BRIDGE.

This transporter bridge across the Mersey was recently opened by Sir John Brunner, M.P., and forms a most useful connection between the towns of Widnes and Runcorn. The bridge is of the "transporter" type, and is in design precisely similar to an ordinary stiffened suspension bridge, with the exception that the approaches to the bridge are at a low level—thus dispensing with the very costly high-level approaches—and the traffic, both foot and wheel, is carried over in a car suspended to the underside of the bridge. This principle was designed by Mr. Charles Smith, of Hartlepool, who planned a bridge of this type about 30 years ago for crossing the River Tees at Middlesbrough, but it was never constructed. Several bridges of this type have been since built on the Continent, but the general construction of these bridges is entirely different from the Widnes and Runcorn Bridge, the principle only being the same.

FIG. 1.—View of the Widnes Tower and Bridge, End on, showing the Engine Room and Car.

By a coincidence, and not from design, the Widnes and Runcorn Bridge is on exactly the same site as the one proposed by Telford, and is of exactly the same span—viz, 1,000ft. between the centres of the towers. The bridge is approached on the Runcorn side from Waterloo-road, and on the Widnes side from Mersey-road, the approaches consisting of new roadways at an improved level, nearly flat, built between stone and concrete retaining walls as far as the water's edge. The two main towers carrying the cables and the stiffening girders are built, one on the south side of the Ship Canal and the other on the foreshore on the north bank of the river, and are approached from the above earthwork approaches by steel elliptical girders resting on cast-iron columns carrying a corrugated steel flooring, upon which are laid the timber blocks on concrete, forming a roadway 35ft. wide between the parapets, the footpaths being 6ft. wide each. The roadway in front of the towers is widened out to 70ft. for marshalling the traffic, and for providing space for waiting-rooms, etc.

The transporter car (Fig. 1) consists of a platform 55ft. long by 24ft. wide, and is suspended from the trolley by steel-wire ropes, so hung that they prevent either side or end oscillation of the car. The car is capable of holding at one time four two-horse farmers' wagons, loaded, and 300 passengers, the latter being protected from the weather by a glazed shelter, with folding doors at the ends and side. On the top of the car is fixed the operator's cabin, in which is placed the switchboard, so that the operator has a full view of the course, and has the car quite at his command; he can thus reverse, go ahead, or put on the brakes at a moment's notice. The time occupied by the car in crossing is about 2¼ minutes; so allowing the time for loading and unloading, it is capable of making about nine or ten trips per hour. The bridge, approaches, and car are electrically lighted, and fog signals and bells are sounded when necessary. The bottom of the car is about 12ft. above high-water level, and clears the Ship Canal wall by about 4ft. 6in.

With the construction of the towers, the steel-wire girders, the anchorages, and the stiffening girders we do not propose to deal at the present time, as we are chiefly concerned with the moving portion of the bridge—*i e*, the transporter. This is carried from the lower flanges of the stiffening girders (Figs. 2 and 3), on which are fixed the rails, upon which runs the trolley, from which is suspended the car. The trolley is about 77ft. long, and is carried by 16 wheels on each rail. It is propelled by two electric motors of about 35 b h.p. each, a large excess of propelling power being provided, partly for economy of working and principally to be ready for any emergency of strong head winds with heavy load. The motors are fixed to a kind of bogie arrangement in the trolley, so that in the case of large curvature of the bottom boom of the stiffening girders, due to either temperature or load, the driving wheels would be certain to be hard on the rails. Efficient automatic and hand brakes are fixed, so that it will be possible to pull up the car within its own length when going full speed. This transporter is worked electrically, and the whole of the plant required was supplied by Messrs. Mather and Platt, Limited, of Salford Ironworks, Manchester. This firm

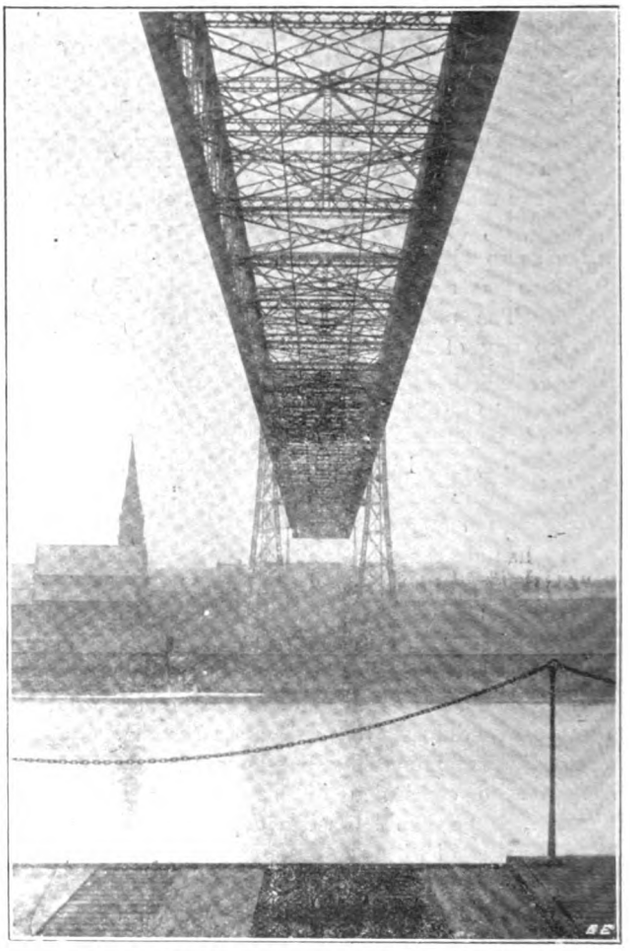

FIG. 2.—View of the Underside of the Main Boom, showing the Conductor Rails below the Cross Girders.

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have made a special study of the electrical working of bridges, two swingbridges over the River Weaver, as well as the rolling bascule bridge at Barking, having been equipped with electrical plant by them; and the experience

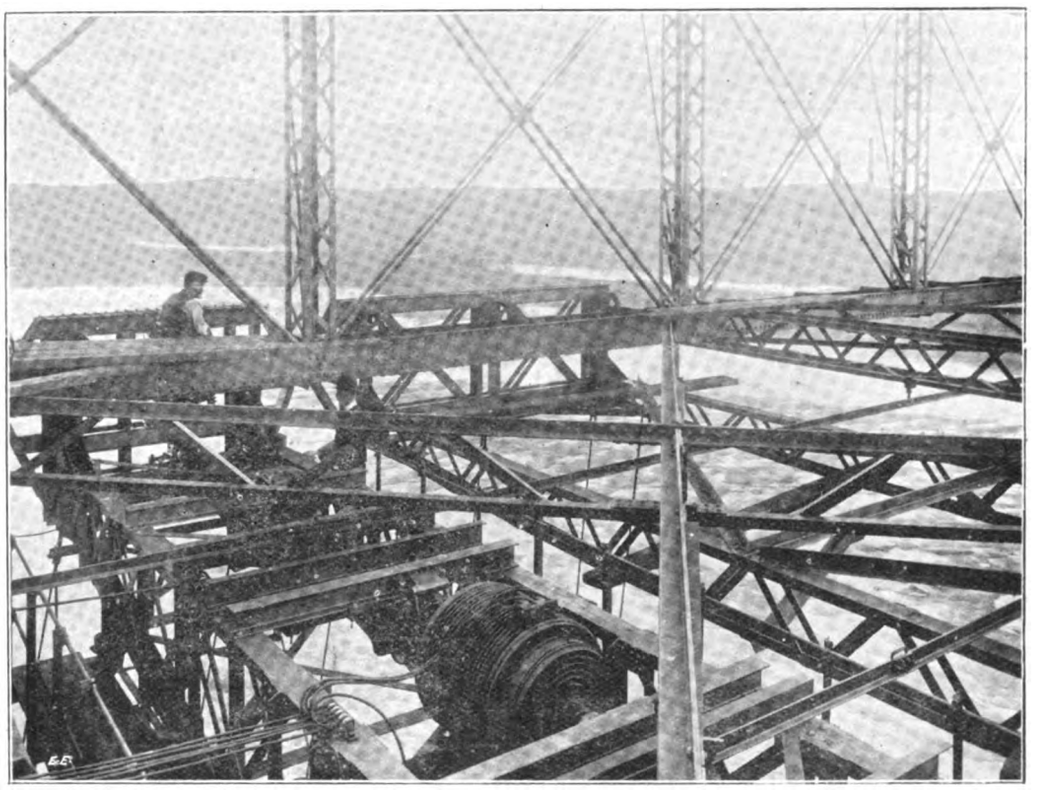

FIG. 3.—View of one of the Trolleys, showing the Entirely Enclosed Motor and Gear.

gained has enabled them to introduce improvements on the methods previously used in the case of transporter bridges such as that at Rouen.

The engine-house (Fig. 4) is erected within the left-hand tower on the Widnes side of the river, and contains the

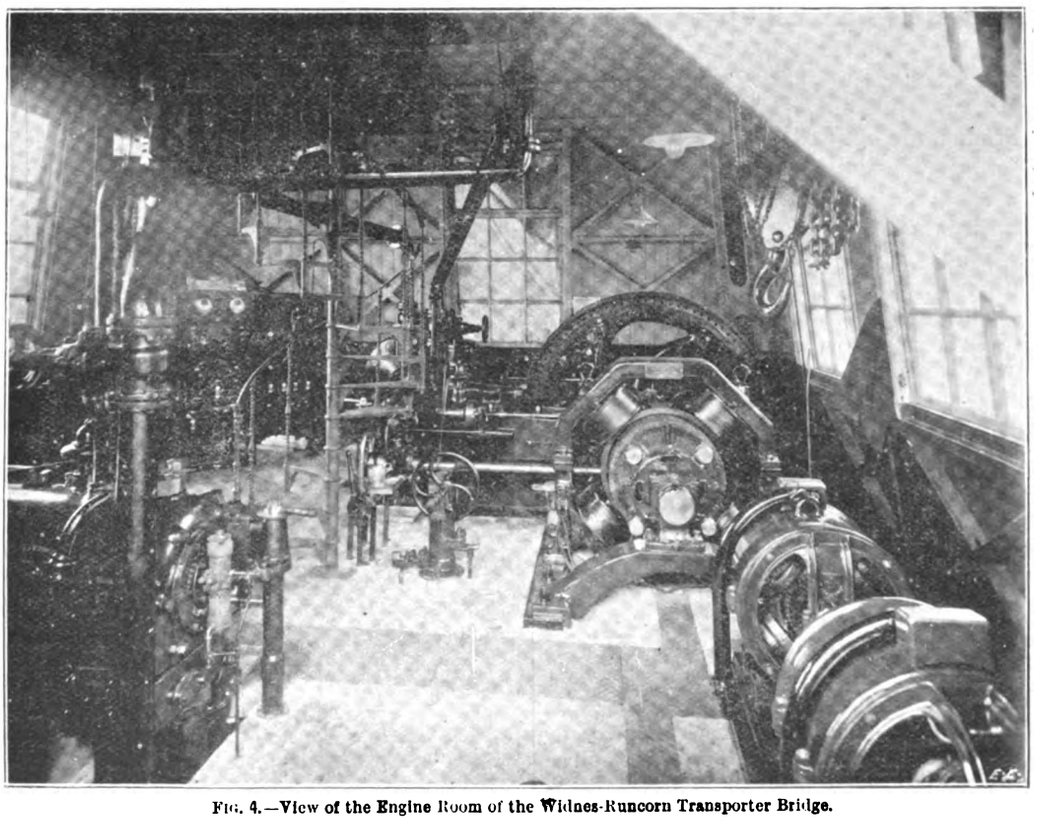

FIG. 4.—View of the Engine Room of the Widnes-Runcorn Transporter Bridge.

whole generating plant, which comprises two gas-engines, made by Messrs. Crossley Bros., Limited, for Messrs. Mather and Platt, Limited, each capable of developing 75 b.h.p. when running at a speed of 210 revolutions per minute, the gas being supplied from the Widnes town gas-mains. These engines have cylinders 16in. in diameter with a stroke of 21in., and are fitted with the usual silencers and water-cooling pipes, the water supply being obtained from a large tank fixed at the top of the engine-house. To each engine is directly coupled a Mather and Platt multipolar dynamo of 45 kw. capacity, capable of giving a continuous output of 90 amperes at a pressure of 525 volts when running at 210 revolutions per minute. The engine-room also contains a booster, consisting of motor and generator directly coupled, and used for boosting the pressure when charging the accumulators, and also for maintaining the voltage on the line, and equalising the load

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on the generating dynamos. The accumulator (Fig. 5) referred to is placed in a room above the engine-room, and consists of 245 cells supplied by the Chloride Electric Storage Company, having a capacity of 90 amperes for one hour. The cells are mounted on insulators carried on suitable stands. In the corner of the engine-room is the switchboard, arranged with three panels—one for the dynamos, with the necessary main and regulating switches and measuring instruments; the second for the accumulator cells and booster similarly fitted up; and the third panel for the feeding and lighting circuits.

From the switchboard the two main supply cables are led up by the tower and across on to the main girders of the bridge, where they are attached to two overhead T-shaped conductors, which are carried by insulators below the cross girders of the bridge, and from which the current is collected by trolley arms, and thence passes down to the controlling apparatus in the driver's cabin, placed on the top of the transporter car. The regulating apparatus consists of a circular type controller, by means of which the starting, regulating, and stopping of the motors on the travelling trolleys is effected. From the controller cabin to Messrs. W. Thornton and Sons, Liverpool; the contract for the steel superstructure being let to Arrol's Bridge and Roof Company, Glasgow, who sublet the sinking of the cylinders, greenheart fenders and scaffolding to Messrs. Holme and King, Liverpool. The construction of the towers, approach girders, and cylinder foundation was sublet to the Widnes Foundry Company. The construction of the steel cables was let to the St. Helens Cable Company. The whole of the electric installation and equipment, including the lighting of the structure, is being carried out by Messrs. Mather and Platt, of Salford Iron-works, Manchester.

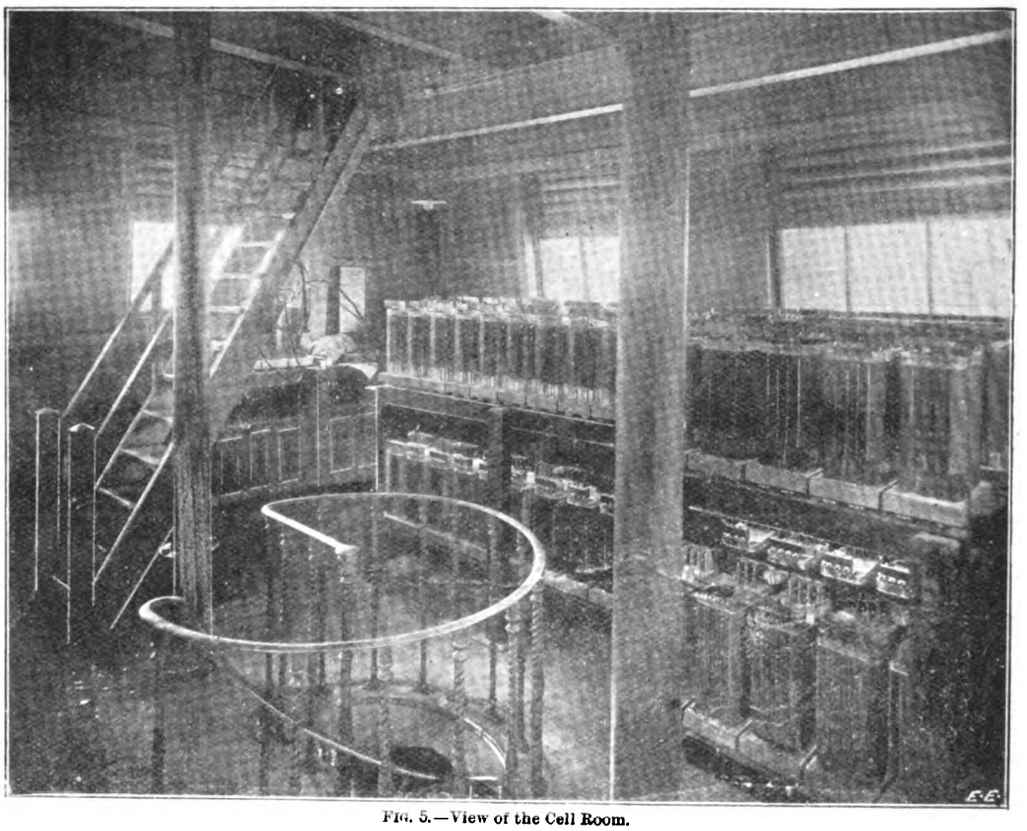

FIG. 5.—View of the Cell Room.

the wires are led straight up to the motors fixed on cross girders connecting the pairs of trolleys, which run on each of the continuous main girders of the bridge. The motors are of Messrs. Mather and Platt's steel-clad entirely-enclosed type, and are each capable of developing 36 b.h.p. when supplied with current at a pressure of 500 volts. They drive by means of gearing and shafts the two driving wheels of the trolleys, and are arranged also to act as brakes for stopping the car. The control cabin also contains a small switchboard with the requisite switches and instruments for the information of the driver.

In addition to supplying the plant for the power, Messrs. Mather and Platt, Limited, have also supplied and erected the whole of the electric lighting of the bridge. This consists of five arc lamps in each of the four lanterns at the summits of the towers, incandescent lamps in standards on the approach roads on either side of the river, as well as the necessary lights on the car itself, and in the waiting-rooms and offices on the landing stages.

The consulting engineers for the whole of the work have been Mr. John J. Webster, M.I.C.E., of Westminster, and Mr. John T. Wood, M.I.C.E, of Liverpool; the resident engineer being Mr. L. H. Chase, M.I.C.E. The contract for the masonry in the approaches and anchorages was let

## A STUDY OF SHORT-DISTANCE TELEPHONY.

BY VALENTINE RYAN.

(*Concluded from page 812.*)

The connections for a rather improved design of intermediate switch are shown in Fig. 10. A cylindrical piece of ebonite is mounted on the switch spindle, around which is fastened a brass sleeve divided into four equal parts, the switch terminals being connected to six brass strips which make contact with the split ring. When the position of the switch lever is changed, the split ring moves with it, thus altering the connections as desired. In Fig. 10 the switch

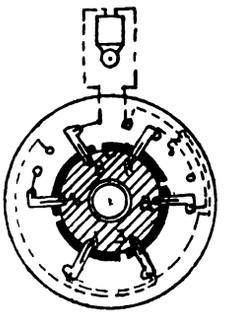

FIG. 10.—Back of Intermediate Switch in Centre Position. 1, 2, 3, contact pieces connected to line terminals; B, B, ditto to bell terminals; R, ditto to return wire; dotted lines show internal wiring of switch.

is shown in the centre or "through" position, the intermediate station is disconnected, and the outer ones are engaged in conversation with the extension bell in circuit. This switch can be arranged to reverse the battery con-

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nections, thus enabling those at the outer stations to be connected in series, and so avoiding the trouble caused by the reversing switch mentioned above. To do this the switch should be made somewhat bigger, and a smaller split ring mounted in a similar manner and concentric with the one described, this split ring having two parts, with four brass strips making connection with it—one each for the telephone and return wire, and a pair for the battery, it being arranged to reverse the battery connections as the switch lever is placed in the right or left hand positions. Otherwise the switch would be the same as before, these latter connections being independent of the former ones. Usually the arrangement of the instruments at the intermediate station does not combine to form an imposing station, and the local wiring does not add to its appearance. It would be a decided improvement, and there are no objections in the way, if all the apparatus was made combined in a single casing with a micro-telephone. The cost would be slightly reduced, and the local wiring would be dispensed with, which is an advantage in many ways.

A system that is frequently required for hotels and other large buildings consists of a number of stations arranged to communicate with a central station only. This system is often erected in commercial establishments for the use of the employés generally, as was previously mentioned. The accompanying diagram (Fig. 11) illustrates five direct working telephones, arranged to communicate with a central station. When one of the outer stations rings up the central station, the numbers on the bell indicator move;

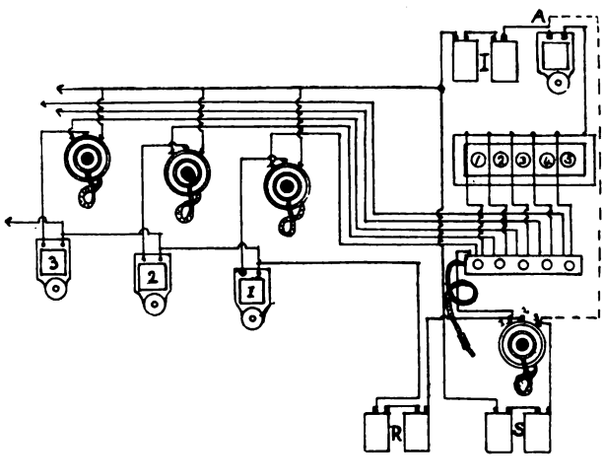


FIG. 11.—Five Stations arranged to Communicate with a Central Station.

the plug is then placed in the corresponding hole of the line selector. This plug separates the lugs of a V-shaped spring, which breaks this particular bell circuit and also completes the connection with the home telephone. The rest of the bell circuits remain complete, so that a call can be received at any time without interrupting the conversation. Many persons would prefer a number of two-point switches for line selectors instead of a plug-board; they may also be more familiar with the "reply and call" system, which is used for much the same purpose. In the latter a battery and a switch must be provided at each station, and in using direct working telephones these may be confined to the central station. With the latter any bell installation can be readily and cheaply converted into a telephone one, all that is necessary being to replace the bell pushes with the telephone and add a telephone and line selector at the indicator. When bells are required at the outer stations, a third wire, common to all bells, must be erected.

In the diagram (Fig. 11) three batteries are shown. The battery S is used exclusively for speaking; R may be called the ringing battery, and is employed for signalling to the sub-stations; I, the indicator battery, is used by the sub-stations to ring up the central station. Except in some installations where the change has been initiated by the writer, this battery, I, is not used. The second terminal, A, of the bell is connected to the terminal marked 3 on the telephone, as shown by the dotted line, and then a person at a third station can overhear, and, if they choose, join in, the conversation. When strangers are using the system, as in hotels, for which the arrangement is particularly adapted, this would lead to confusion. It is interesting to observe how this happens. If the connections are traced out, they may be reduced to those shown in Fig. 12. Suppose A and B to be engaged in conversation, and C a third station, X and Y are the bell and indicator coils respectively. Then across the battery terminals there are two circuits in parallel. In practice the resistance of these circuits often happens to be equal, the resistance of X and Y in the overhearing circuit helping to make up the resistance of the second telephone in the speaking circuit, direct working receivers having a resistance of, say, six ohms.

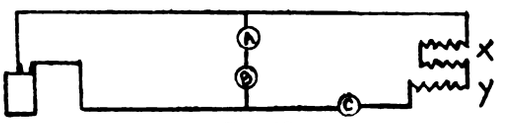


FIG. 12.

Now, as the current fluctuates in one circuit, a corresponding variation is produced in the other. To overcome this disadvantage, the third battery, I (Fig. 11), was introduced; when the connections are traced out, they will reduce to those shown in Fig. 13. The overhearing station, C, can complete a circuit as before, but it has the indicator battery, I, in it, not the speaking battery, S; the latter is completely under the control of the central station. At first sight three sets of cells may appear clumsy, but they can be used to work a large installation, even when the number of stations approach 30; anyhow, a far larger number would be required if induction-coil instruments were employed. If a fault occurs on the installation, each battery being used for a separate purpose, they are an advantage in helping to locate it.

With the receivers in position as shown, the terminals marked 1 and 2 are connected; press the push-button and 1 and 3 are connected; when speaking, the receiver and transmitter are connected in series across 1 and 3. At the central station it will be noticed that one pole of the ringing battery, R, is connected to the centre terminal of the telephone. The internal wiring of this instrument is different from the rest, and when the button is pressed, terminals 1 and 2 are connected, and not 1 and 3, as in all other instruments.

The stations arranged on this system have a common return wire, and induction may lead to overhearing in much the same way as with an intercommunication one; it lends itself to overcoming this disadvantage in an original manner. Suppose, for the moment, A and B (Fig. 13) to be engaged in conversation, and C, at a third station, to place the receiver to his ear, then there are two complete circuits as shown. A and B complete a circuit through S, and C through the battery, I; in each there will be a primary current—that in C will be weaker and more constant in strength than the other. The batteries are shown connected up in the opposite ways. Hence, if along any portion of the common return wire both currents pass, they will be flowing in the same direction, and the current in C will not interfere with the speaking. The induced

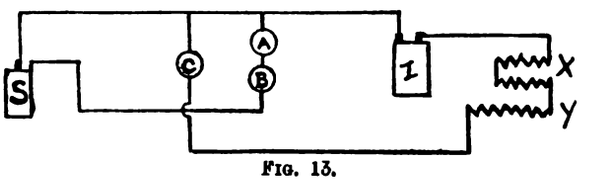


FIG. 13.

current in the circuit C is due to the fluctuation of the current caused by the speaking in A and B, and will be in the opposite direction to the primary current in the same circuit. This induced current will be neutralised by the primary current—it follows there will be no overhearing. The connections on the central-station system (Fig. 11) are arranged on this plan. The writer has not had an opportunity of testing this in practice, while experience in such matters tempts him to hesitate before pronouncing this system as private; anyhow, it certainly is a sound practical approach to being so. If a little discretion was used in erecting such a system, it could be arranged to be a secret one. The development of the principles embodied in the above system offers a promising scope for ingenuity.

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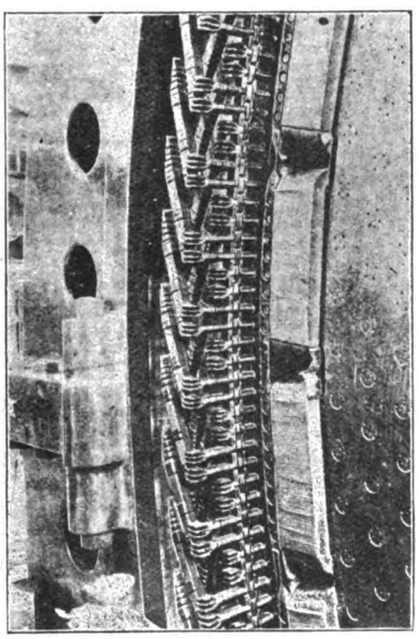
Owing to the situation of telephone stations varying so much, and hence the relative position of the wires in which the induction takes place, diagrams of systems of connections under any circumstances are hardly qualified to be called private.

## TEST OF A 5,000-KW. ALTERNATOR.*

BY L. L. GAILLARD.

The following paper is intended to give a general description of the series of tests made on each of the alternators installed in the Seventy-fourth-street, Manhattan, power station of the Interborough Rapid Transit Company, of New York City. The object of the tests was to obtain characteristic curves of the machines and to determine how nearly they conformed to the contract requirements and the manufacturer's guarantee. Each machine is a 5,000-kw., 11,000-volt, 25-cycle, 75-revolutions-per-minute Westinghouse alternator, direct connected to a double horizontal-vertical Allis compound engine. It may be well to preface the account of the tests with the following extracts from the contract specifications, giving certain data obtained from the calculations of the manufacturer, and certain guarantees upon



Armature End Connections, showing the Wooden Block Bracing between the Coils.

which was based the acceptance or rejection of the machine by the purchaser:

A guaranteed full-load efficiency of 96·5 per cent., to meet which guarantee the total permissible losses in the alternator are therefore 181,300 watts.

| | | |
|---|---|---|
| The full-load field current equals | 202 | amps. |
| The full-load armature current equals | 263 | amps. |
| The armature copper loss equals: $263^2 \times 0{\cdot}4 =$ | 27,667 | watts. |
| The field resistance equals | 0·85 | ohms. |
| The resistance of the armature equals | 0·4 | ohms. |
| The field copper loss equals: $202^2 \times 0{\cdot}85 =$ | 34,683 | watts. |
| Total copper losses = | 62,350 | watts. |
| Total allowable iron losses, based on 96·5 per cent. full load efficiency = | 118,950 | watts. |

The efficiency on non-inductive load will be:

| | |
|---|---|
| At one-quarter load = not less than | 90·00 per cent. |
| At one-half load = not less than | 94·50 ,, |
| At three-quarters load = not less than | 95·50 ,, |
| At full load = not less than | 96·50 ,, |
| At 25 per cent. overload = not less than | 97·00 ,, |

The efficiencies are based on $I^2R$ loss in the armature and field coils and on the armature iron loss. Friction is not included.

The current in the armature when short-circuited with normal no-load field current, will equal three times full-load current.

The regulation at 100 per cent. power factor will equal 6 per cent.

After running for 24 hours at full load at 100 per cent. power factor, the rise in temperature in no part will exceed 35deg. C.; and at 25 per cent. greater load, with the same power factor, for 24 hours, the rise in temperature will not exceed 45deg. C.

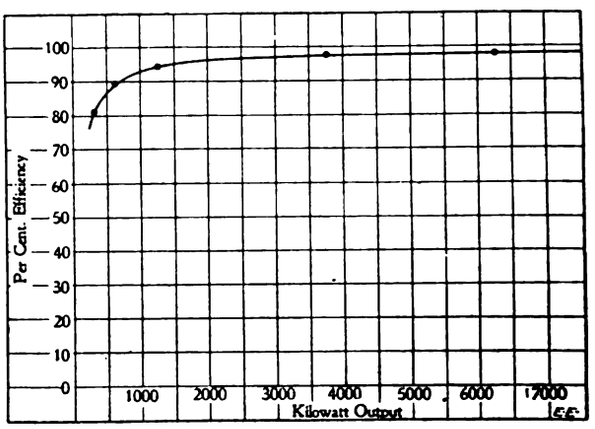
* Reproduced from the *Electric Club Journal*.

The following measurements and tests were made on the alternator: measurement of armature iron loss; resistance of armature winding; resistance of field winding; $I^2R$ loss in armature; $I^2R$ loss in field; efficiency at various loads; no-load saturation curve; short-circuit characteristic; regulation (calculated); insulation puncture test; temperature rise under load.

Laminated Ring and Clamping Device for determining the Quality of the Iron used in the Manhattan Alternators, and thus the Total Iron Loss.

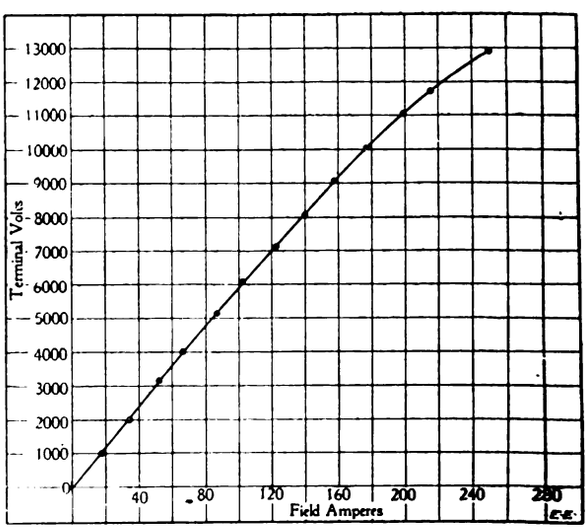
*Armature Iron Loss.*—It being entirely impracticable to measure this loss in the usual manner, the following interesting method was adopted. The alternator armature is built up of the following amounts of sheet steel worked at magnetic inductions given below:

| | | | | | |
|---|---|---|---|---|---|
| 234 000 cu. in., | 90 per cent. | solid, | at 65,500 | C.G.S. lines per | sq. in. |
| 16,500 ,, | ,, | | at 91,100 | ,, | ,, |
| 20,300 ,, | ,, | | at 76,500 | ,, | ,, |




Efficiency Curve of a 5,000-kw. 11,000-volt Manhattan Alternator.

The iron losses were determined from a measurement of the losses in sample rings made from the material of which the armature was built up. These samples were annealed in the ovens with the armature laminations, were




Running Saturation of a 5,000-kw. 11,000-volt Manhattan Alternator.

painted the same as these laminations, and then built up into test rings and compressed until their volume contained 90 per cent. solid metal. The rings were then wound for test purposes, and the losses at the different inductions mentioned above were measured with a sensitive wattmeter.

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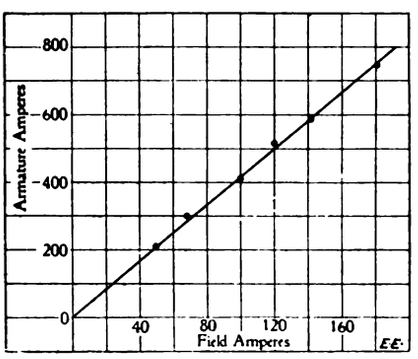
The dimensions of the test samples were: outside diameter, 12in.; inside diameter, 8in.; thickness (compressed to 90 per cent. solid), 2in.; cross-section, 2in. by 2in., four square inches; mean circumference, 31·416in.; volume, 125 66 cubic inches. The calculation of 90 per cent. solid material in samples were based upon specific gravity tests made on samples cut from the steel bars from which the sheets were rolled. The average specific gravity of several samples was 7·847, which gives 3·91 cubic inches per pound for 90 per cent. solid material. The weight of the sample, on the basis of these calculations, should therefore be 32·13lb. About 20 sample rings were built up and each sample was wound with 72 turns of No. 18 B. & S. annunciator wire, wound in 12 groups of one layer, and six turns each, with the groups symmetrically disposed around the circumference of the ring. The iron loss in each sample was measured at each of the three inductions mentioned above—viz.:

| | C.G.S lines per sq. inch. | | C.G.S. lines per sq. cm. |
|---|---|---|---|
| (*a*) | 65,500 | = | 10,155 |
| (*b*) | 91,100 | = | 14,124 |
| (*c*) | 76,500 | = | 11,860 |

The voltages required for each of the three inductions at 3,000 alternations were obtained from the following calculations:

B = maximum induction per square centimetre;
E = effective volts;
$n$ = periods per second;
$t$ = number of turns;
$a$ = sectional area in square centimetre;

$$E = \pi \sqrt{2}\, a\, n\, t\, B\, 10^{-8}.$$




Short-Circuit Characteristic of a 5,000-kw. 11,000-volt Manhattan Alternator.

Reducing this formula to area in square inches and alternations per minute, we have

$$E = \cdot 2388\, a'\, n'\, t\, B\, 10^{-8},$$

where $a'$ = sectional area in square inches = 4;
$n'$ = alternations per minute = 3,000.

The voltage at the various inductions is then as follows:

(*a*) $E = \cdot 2388 \times 4 \times 3{,}000 \times 72 \times 10{,}155 \times 10^{-8} = 20\ 96.$
(*b*) $E = \cdot 2388 \times 4 \times 3{,}000 \times 72 \times 14{,}124 \times 10^{-8} = 29\ 15.$
(*c*) $E = \cdot 2388 \times 4 \times 3{,}000 \times 72 \times 11{,}860 \times 10^{-8} = 24\cdot 48.$

The losses in the samples were measured by carefully calibrated instruments, and the alternator used for supplying current for the purposes of the test gave a wave of almost exactly sine form. The average results of measurements on the 20 samples were as follows:

(*a*) 0·1340 watts loss per cubic inch.
(*b*) 0 2320 watts loss per cubic inch.
(*c*) 0·1724 watts loss per cubic inch.

The total watt loss in the armature was, therefore, as follows:

(*a*) 234,000 × 0·1340 = 31,830 watts.
(*b*) 16,500 × 0·2320 = 3,821 ,,
(*c*) 20,300 × 0·1724 = 3,492 ,,

Total ..... 38,693 watts.

The impracticability of making an accurate determination of the iron losses after the machine had been assembled is to be regretted, as the method adopted and just described contains probabilities of error which cannot be predetermined or eliminated. The armature casting is made in six sections, and the sheet-steel laminations are each no greater than 6ft. in length, thus making in the magnetic circuit six butt and numerous lap joints. The losses due to these breaks in the magnetic circuit are, of course, neglected when the determination of the iron losses is made in the manner just described, but it is probable that they are of so small a value when compared with the total losses as to be negligible.

*Resistance Measurements of Armature and Field.*—These measurements were made by the usual drop-of-potential method, the temperature of the winding and of the room being observed. The resistances as measured were then calculated for a room temperature of 25deg. C., and the $I^2R$ losses calculated on this basis. Resistance of armature:

Phase 1—2 R = 0·2325 ohms at 25deg. C.
,, 2—3 R = 0·2332 ,, ,,
,, 1—3 R = 0·2329 ,, ,,

Two times combined resistance of three phases

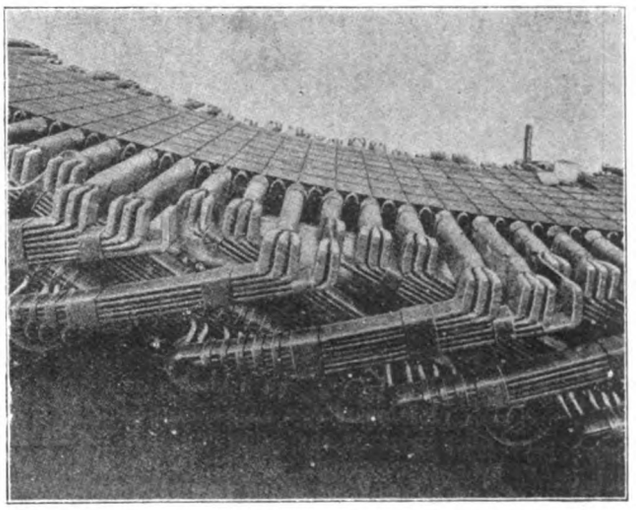
$$= 0{\cdot}2325 + 0{\cdot}2332 + 0{\cdot}2329 = 0{\cdot}6986.$$

Total armature resistance, therefore, equals

$$\frac{0\ 6986}{2} = 0{\cdot}3493 \text{ ohms.}$$

Resistance of field at 25deg. C. = 0·8206 ohms.

*Efficiency.*—As noted above, the efficiency is based on the armature iron losses and the field and armature $I^2R$ losses. The iron losses were determined as described above, and from the resistance values as obtained by measurement the



End Connections of the Armature Winding.

$I^2R$ losses in field and armature have been calculated for various loads from 25 per cent. to 125 per cent. of full rated load. These appear in tabulated form below, and following is a curve plotted from the calculated efficiencies. In calculating the field $I^2R$ loss, 208 1 amperes were used as full-load field current, this value being obtained in the following manner:

| | | |
|---|---|---|
| Field current corresponding to terminal voltage on open circuit plus armature resistance drop = ..... | 198·5 amps. | |
| Field current necessary to give full-load armature current or short-circuit = ..... | 62·6 | ,, |
| Full-load field current is the vector sum of above, or ... | 208·1 | ,, |

| — | ¼ load. | ½ load. | ¾ load. | Full load. | 1¼ load. |
|---|---|---|---|---|---|
| Iron loss.....KW. | 39·69 | 38 69 | 38·69 | 38·69 | 38·69 |
| Armature $I^2R$ loss ,, | 1·51 | 6 04 | 13 59 | 24·16 | 37·75 |
| Field $I^2R$ loss ... ,, | 35·54 | 35·54 | 35·54 | 35·54 | 35·54 |
| Total losses ..... ,, | 76·74 | 80·27 | 87 82 | 98·39 | 111·98 |
| Output ..... ,, | 1,250· | 2,500· | 3.750· | 5,000· | 6,250· |
| Input ..... ,, | 1 325·74 | 2,580 27 | 3,837·82 | 5,098·39 | 6,361·98 |
| Efficiency.....per cent. | 94·29 | 96·50 | 97·71 | 98·06 | 98·24 |

*No-Load Saturation.*—The no-load saturation curve was obtained in the following manner: The alternator field was excited from a 250-volt steam-driven generator running at constant speed. The alternator, with its armature circuit open, was brought to full speed with the engine on the throttle, and held at this speed while the

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measurements were made. Simultaneous readings of volts field, amperes field, volts armature, and speed were taken. The instantaneous readings of speed were made by means of a frequency indicator which had been previously carefully calibrated. Below is given in tabulated form the instrument readings from which the saturation curve has been plotted. As some of the readings were taken at a frequency higher than 25 cycles (due to the engine speeding up), the armature volts at these points were corrected for this difference in speed by decreasing them in proportion to the increase in speed.

| Frequency. | Amperes field. | Volts field. | Volts armature— Observed. | Volts armature— Corrected. |
|---|---|---|---|---|
| 25·0 | 17·5 | 15·3 | 1,000 | 1,000 |
| 25·0 | 33·5 | 29·4 | 1,963 | 1,963 |
| 25·0 | 51·4 | 44·8 | 3,140 | 3 140 |
| 25·0 | 66·0 | 57·3 | 4,010 | 4,010 |
| 25·0 | 86·0 | 74·5 | 5,150 | 5,150 |
| 25 0 | 101·8 | 87·3 | 6,100 | 6,100 |
| 25·2 | 121·8 | 103·5 | 7,190 | 7,133 |
| 25·2 | 139·0 | 117·8 | 8,120 | 8 055 |
| 25·2 | 157·2 | 134 8 | 9,150 | 9,077 |
| 25·2 | 176·2 | 150·0 | 10,100 | 10,019 |
| 25·2 | 198·0 | 168·5 | 11,160 | 11,070 |
| 25·5 | 214·0 | 183·0 | 11,970 | 11,640 |
| 25·2 | 249·2 | 218·0 | 13,020 | 12,916 |

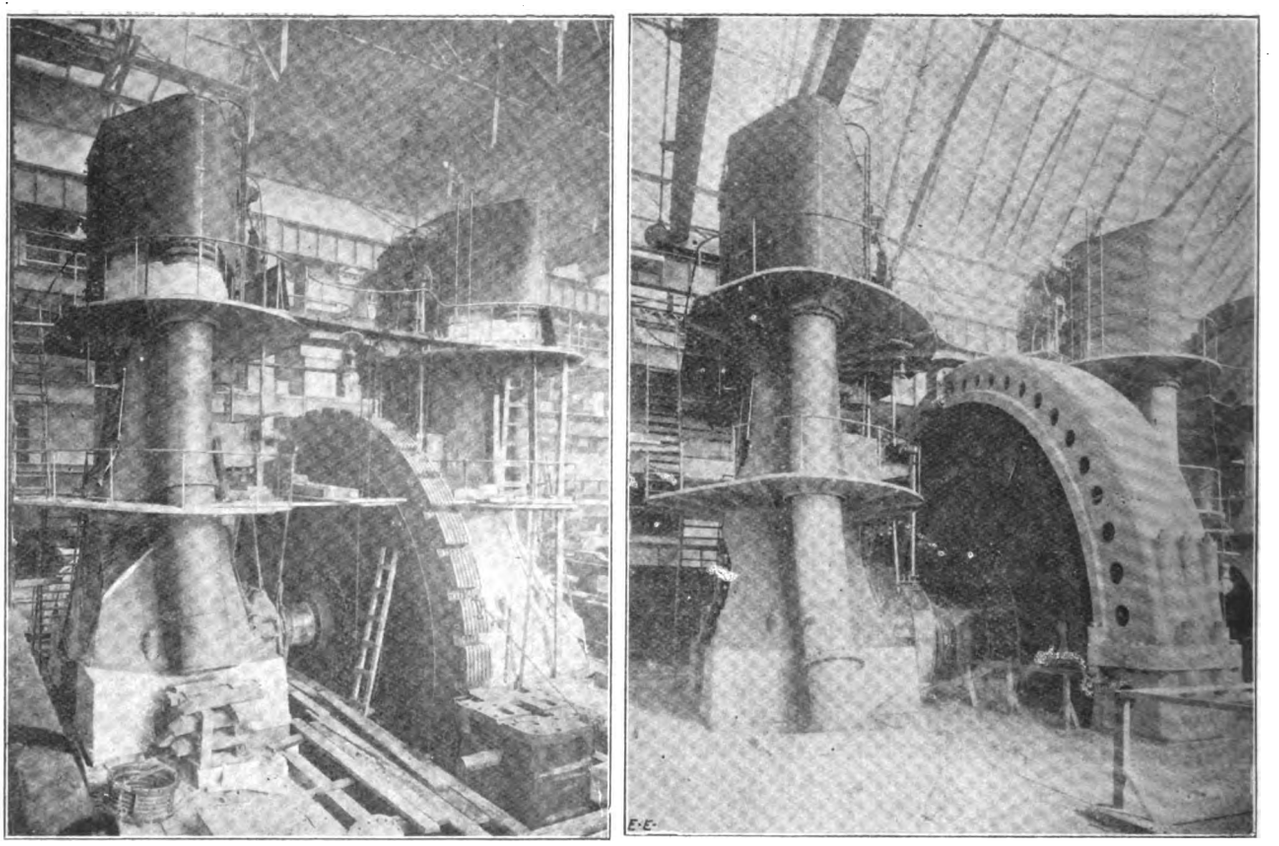
*Short-Circuit Characteristic.*—For this test the armature terminals were short-circuited, the alternator run at full speed and the armature current measured at different values of field current. The tabulated readings and the curve plotted from them are given below:

| Speed R.P.M. | Field amperes. | Field volts. | Armature amperes. |
|---|---|---|---|
| 75 | 50·0 | 36·0 | 210·0 |
| 75 | 68 0 | 50·0 | 300 0 |
| 75 | 100 0 | 74·5 | 411·6 |
| 75 | 120·2 | 89·5 | 516·0 |
| 75 | 141·2 | 105·5 | 588·0 |
| 75 | 181·0 | 140·5 | 744·0 |
| 75 | 193·3 | 158·0 | 798·0 |

*Insulation Test.*—The contract specifications required that after the machine had been assembled, the insulation of the field winding from the frame should be subjected to a puncture test of 2,500 volts alternating E.M.F. for a period of one minute, and that the insulation of the armature winding from the frame should be tested at a potential of 25,000 volts for 30 minutes. As the armature coils had been exposed to moisture for some time before being assembled, it was thought advisable to give them a drying out before subjecting them to the puncture test. For this purpose the armature was short-circuited and the machine run at about two-thirds full speed, with sufficient field current to give about 500 amperes in the armature. This heat run was kept on for about 60 hours, then the machine was shut down and the windings carefully wiped off and allowed to cool to the temperature of the room before the insulation test was made. The insulation tests were made by using a 250-kw., 40,000 : 360-volt 25-cycle oil-cooled transformer, the low-tension winding of which was connected in series with a water rheostat, to the 400-volt 25-cycle station 'bus bars. The potential on the high-tension side of the transformer was measured with a 50,000-volt electrostatic voltmeter which had been previously calibrated. It may be of interest to note that when the test potential was first raised to 25,000 volts, and for some minutes thereafter, a considerable static discharge was noticed taking place over the surface of the windings. As the test was prolonged, this static gradually decreased in intensity until after the lapse of about 20 minutes it almost entirely disappeared.

*Regulation.*—The specifications for this machine provide that "a load of 263 amperes per terminal at 11,000 volts E.M.F. and at 100 per cent. power factor may be thrown off, and the E.M.F. will rise 6 per cent. with constant speed and constant excitation." It has not been found convenient to make an actual measurement of the regulation of the machine, but from the data and characteristic curves it has been calculated. This calculation was made by the usual magnetomotive-force method and the regulation was found to be 4 5 per cent. This figure is undoubtedly too small, as this method of calculation invariably gives results more favourable to the machine than those obtained from actual test.

*Temperature Measurements.*—A number of determinations of the temperature rise in field and armature conductors and in armature laminations were made after the machine had been running under load for a sufficient length of time to have reached a constant temperature. The following



A 5,000-kw. Unit of the Interborough Rapid Transit Company, New York, during construction and as it now appears.

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results represent the average rise in temperature above the surrounding air of the various parts of the machine after a run of 17 hours at an average load of 5,000 kw.:

| Temperature rise above air: | |
|---|---|
| Field winding | 22·5deg. C. |
| Armature winding | 22·6deg. C. |
| Armature laminations | 25·5deg. C. |

The performance of the eight alternators, of which this one is representative, has been so excellent and the temperature so greatly below the guarantee, that their rating has been increased from 5,000 kw. to 6,000 kw.

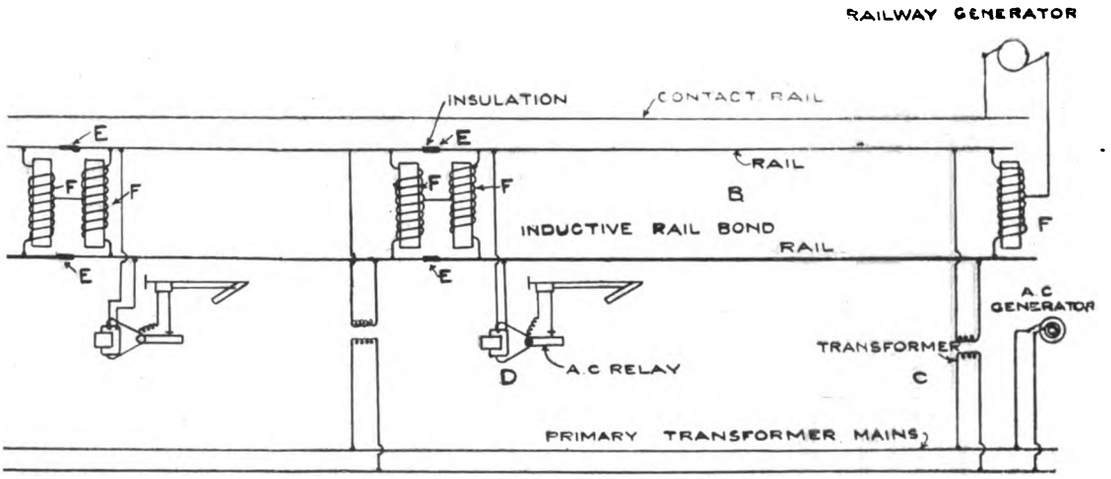


FIG. 1.—Diagram of Connections of the Thullen Alternate-Current Signalling System.

*Testing Synchronising Connections* —After the first machine had been installed it became necessary to make sure of the correctness of the synchronising connections of each of the others as it became ready for operation. For synchronising, dark lamps and a dial synchroniser are used. To make an absolutely certain test of the synchronising connections, the following interesting method was adopted: When the second machine was ready for service, the main switches of both Nos. 1 and 2 were closed, tying the machines to the 'bus. Full-load field current was put on each alternator, and both engines were started simultaneously and slowly brought to full speed together. If the lamps remained dark, and the synchroniser indicated exact synchronism, no better check could be had on all connections. Had there been any wrong connections in the armature circuit of one machine, making a short-circuit when the two machines were tied together, this would have been indicated on the ammeter in the armature circuit immediately after the machines started. The relay would also have operated immediately to open the armature switch. After the two machines had been brought to full speed (tied together), they were then cut apart and synchronised in the usual manner. This method was used with great success on all the machines, a separate 'bus bar being used for the purpose.

## THE THULLEN ELECTRIC SIGNALLING SYSTEM.

In certain electric signalling systems on steam roads it is customary to make one rail continuous, and divide the remaining one by means of insulated joints into sections suitable for signalling. This manner of signalling has been modified to suit electric roads by using a polarised relay, so constructed that the difference of potential at the end of the block, due to the propulsion current, will not operate the relay. In the case mentioned but one rail can be utilised for the return of the propulsion current, the other being used for signalling purposes only. The loss of this rail for a return conductor is supplied by a copper cable, which costs, approximately, £600 to £1,000 per mile, according to the mode of construction. This copper cable adds greatly to the cost of signalling, and the expensiveness of this scheme led Mr. L. H. Thullen to invent a system whereby both rails can be used for the return current, and at the same time the track be divided into sections for signalling purposes. This latter system involves the use of an alternating current for the signalling system, and a relay that is operative by alternating current only.

The idea is shown in diagrammatical form in Fig. 1, in which A and B are block sections of an electrical road; C is a transformer supplying alternating current for the track signalling circuit; D is a relay, operative by alternating current only; E, E are insulating joints dividing the track into sections; F, F are inductive rail bonds that allow the free passage of the propulsion current, and at the same time restrict the alternating current to each individual block section.

The inductive rail bonds, as shown by Figs. 6 and 7, are composed of laminated iron cores wound with a few turns of copper conductor; this conductor is made in sections equal per foot to the carrying capacity of the rail. The length of the winding on these cores is but a few feet, and therefore imposes practically no resistance in the return circuit. In actual practice the resistance imposed in a block

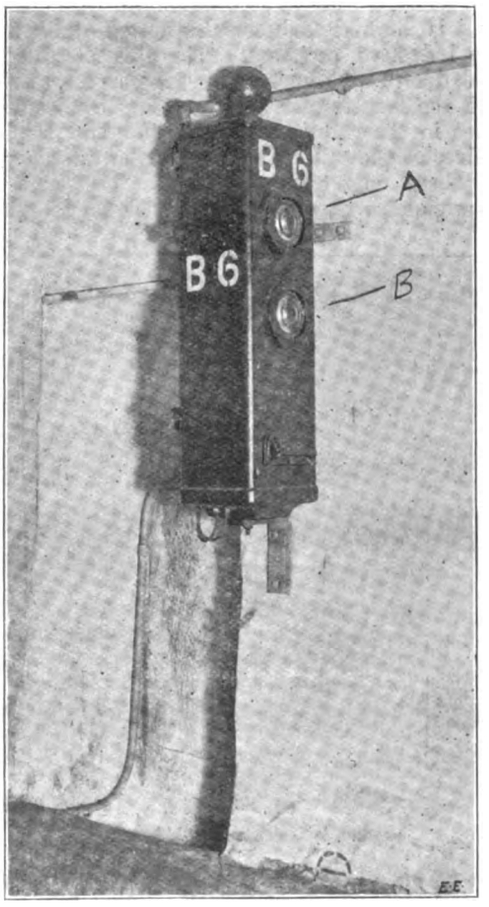


FIG. 2.—A Signal showing the Two Lights.

section 3,000ft. long is less than 1 per cent. As can be seen, the propulsion current traverses one-half of the winding of the bond in one direction and the other half in the other direction, thus neutralising the magnetic action on the core; while at the same time the alternating track current

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traverses the winding in one direction only, thus making the bond inductive to the alternating track current.

Poor bonding sometimes causes a difference in the amount of current traversing the two rails, and to prevent this the iron core is made with an air-gap in the magnetic circuit. This increases the reluctance of the magnetic circuit, and keeps the core from becoming saturated by the direct

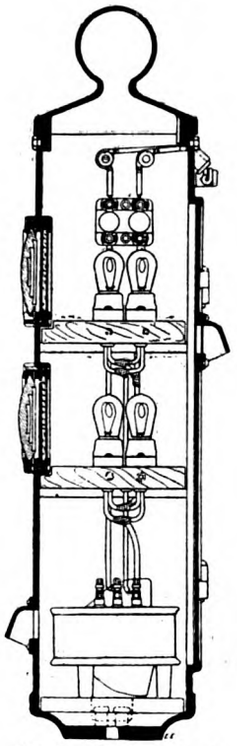


FIG. 3.—Section of Signal.

current. If allowed to become saturated, the bond would lose its inductive property. There is no difference of potential, due to the direct propulsion current, at the point at which the transformer and relay are connected, as the resistance in the coil is extremely low and the same in both halves of the coil. This has the advantage over any system where only one continuous rail is used for the return propulsion current, and the other rail subdivided,

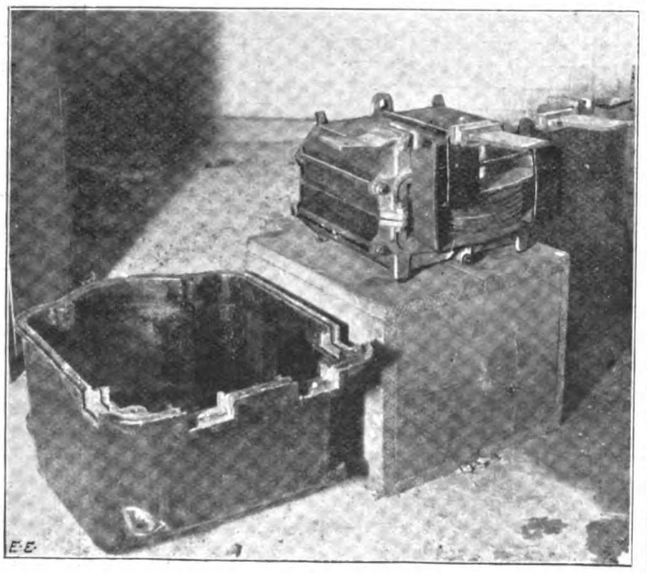
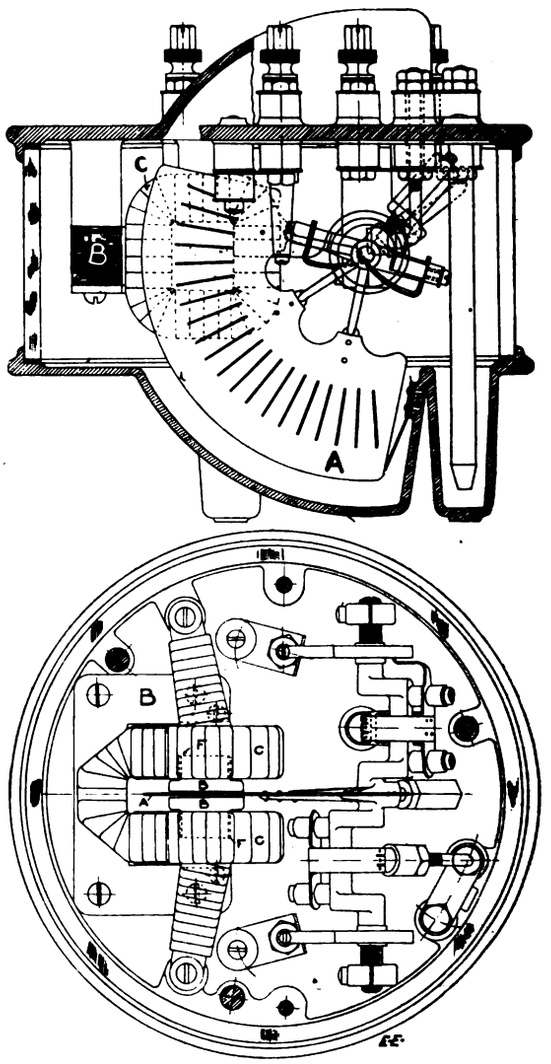


FIG. 6.—An Inductive Rail Bond.

as in the latter case the difference of potential at the ends of the block might be as high as 20 or 30 volts.

This system has been in successful operation in the East Boston Tunnel since Feb. 2, 1905. In that installation alternating current is supplied by primary wires extending the length of the tunnel. Current is furnished to the primaries of the transformers at a frequency of 60 cycles, and a potential of 500 volts. The transformers are wound with two secondary windings; one winding furnishes current at 50 volts to light the signals, the other furnishes current to the track at three volts. The energy taken for one block section, exclusive of the lamps in the signals, is about 75 watts. The signals are lighted with four 4 c.p. lamps, two lamps being connected in multiple back of each lens. Clear glass is used for the lamps, but the lenses are red and green, red being the danger signal and green the clear signal.

The signals used are shown in Figs. 2 and 3. A is a red lens, B a green one. The lamps are lighted and extinguished back of the different lenses by means of the track relay. The relay is shown in Figs. 4 and 5. A is an aluminium vane, B a laminated iron core, and C, C are two coils connected by wires to the rails. A copper furrel, F, embraces one half of the poles B, B. The relay operates on the well-known principle of the generation of eddy currents in the aluminium vane. The eddy current induced in the aluminium vane between that part of the poles




FIGS. 4 AND 5.—Alternate-Current Relay.

embraced by the copper furrel is not in phase with that induced in the other part of the field. We then virtually have a two-phase motor of which the aluminium vane is the armature. Two lamps are connected in multiple, so that if one should burn out the other would still be in service. As low-voltage and low efficient lamps are used one lamp is seldom out, and the possibility of two being out at one time is quite remote. However, no danger would result from both lights being out, as no light is always considered a danger signal. A local relay would be used whereby only one lamp would be in service at a time, the other going into service on the burning out of the first lamp; but the present method has been found to answer nicely, and is void of all complications. The two lamps are placed as close together as possible, one back of the other, and the focussing point of the lens is midway between them. Good results are shown by this method, as

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there is little difference between the light shown with lamps placed in this position and that shown when the lamps are in the focus of the lens. This method of lighting signals has proved very satisfactory in the New York Subway.

Electrically lighted signals are coming more and more into vogue in the United States. They are now in use on the East Boston Tunnel, the New York Subway, the North Shore Railroad in California, and will be used on the electrified portion of the Long Island Railroad. The part of the Long Island Railroad which will be equipped with these signals is 16 miles in length, and is partly subway, partly elevated, and partly surface road. The installation for this road is well under way, and will be completed some time the coming summer. The overlap system will be used. The blocks will be an average length of 2,000ft., and there will be a home and distant signal for each block. Signals in the subway portion will be similar to those used in the East Boston Tunnel, with the addition of a distant signal, which will be operated by the current of the home signal in the block in advance. The signals for the elevated and surface portions will be of the two-arm semaphore type, operated by electric motors. Current at a potential

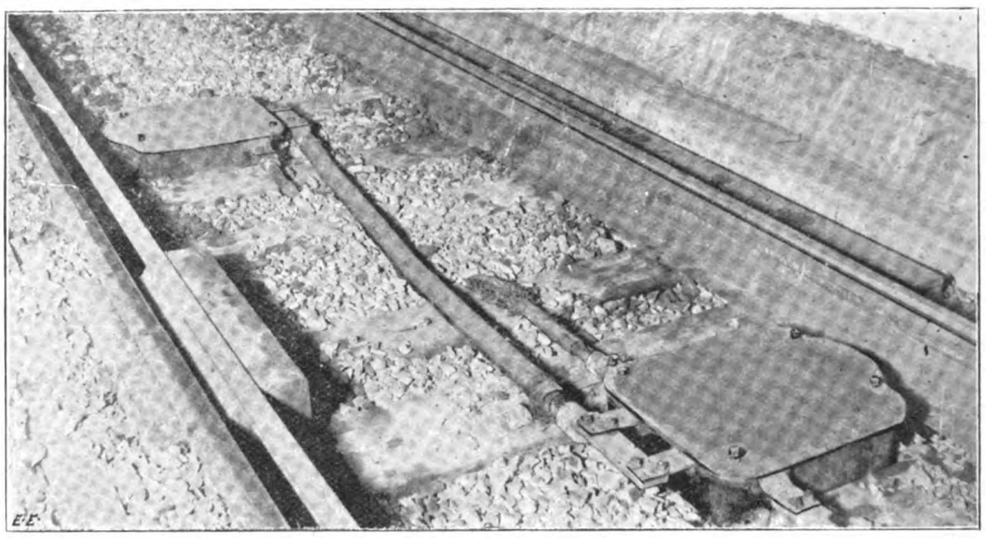

FIG. 7.—View of Track, showing two Inductive Rail Bonds in position.

of 2,000 volts will be furnished the primary of the track transformer by mains extending the entire length of the track.

## THE ALTERNATING-CURRENT SERIES MOTOR.*

BY F. CREEDY, STUDENT.

(*Continued from page 675.*)

### APPENDIX I.

*Symbolic Theory of the Series Motor.*

The theory of the series motor is so simple that it can be treated by a geometrical method, as has been done above, without undue complication. In order, however, to bring out the analogy between the series motor and other motors whose theory is more complicated, and in order to deduce some results which do not come out easily by the geometrical method, I give in this appendix a discussion of the theory of the series motor by Mr. Steinmetz's symbolic method, the only method that can profitably be used when the theory of a motor presents any degree of complexity.

Mr. Steinmetz's methods are now very well known, so that I need not describe them. The idea of the "scalar part" of the product of two vectors, or their "scalar product," is also, I think, perfectly familiar. Thus all that is necessary is to show how this idea may conveniently be introduced into Mr. Steinmetz's method. In the following discussion vectors will be denoted by thick black type, such as $\mathbf{i}$; quantities such as impedances by small capitals, such as $z$; and numbers by italics, such as $n$.

Every vector $\mathbf{a}$ may be written $\mathbf{a} = a(\cos\alpha + j\sin\alpha)$, which may be abbreviated to $a \operatorname{cis}\alpha$. Here $\alpha$ is the angle between $\mathbf{a}$ and the real axis. By a well-known trigonometrical theorem, $\cos\alpha + j\sin\alpha = \epsilon^{j\alpha}$. Therefore, $\operatorname{cis}\alpha = \epsilon^{j\alpha}$.

Consequently, by the laws of exponentials, $\operatorname{cis}\alpha \operatorname{cis}\beta = \operatorname{cis}(\alpha+\beta)$; $\operatorname{cis}\alpha/\operatorname{cis}\beta = \operatorname{cis}\alpha \operatorname{cis}(-\beta) = \operatorname{cis}(\alpha-\beta)$.

Thus the operator $\operatorname{cis}\theta$ simply turns a vector through the angle $\theta$, counter-clockwise or clockwise, according as $\theta$ is positive or negative.

Now the scalar product, or the scalar part of the product, of two vectors $\mathbf{a}$ and $\mathbf{b}$, is the product of the length of either vector into the projection of the other upon it—*i.e.*, it is $a\,b\cos\theta$, where $\theta$ is the angle between $\mathbf{a}$ and $\mathbf{b}$. Thus what we require is a simple and convenient expression for $a\,b\cos\theta$ in terms of $\mathbf{a}$ and $\mathbf{b}$.

If the vector $\mathbf{b}$ lies along the real axis—*i.e.*, if $\mathbf{b} = b$—we have $\mathbf{a}\,\mathbf{b} = a\,b\,(\cos\alpha + j\sin\alpha)$.

Now in this case $\alpha$ is the angle between the two vectors—*i.e.*, $\alpha = \theta$, so that $[\mathbf{a}\,\mathbf{b}]_1 = a\,b\cos\theta$, the expression we require if, following Steinmetz, we denote the real part of a vector, or product of vectors, by square brackets with the suffix $_1$. This is not true unless either $\mathbf{b}$ or $\mathbf{a}$ lie along the real axis.

Now the expression we require only depends on the length of the two vectors, and the angle between them, and not at all on their position with respect to the real axis.

Let $\mathbf{a} = a \operatorname{cis}\alpha$ and $\mathbf{b} = b \operatorname{cis}\beta$. Let us multiply both these vectors by $\operatorname{cis}-\beta$, thus turning them till $\mathbf{b}$ lies along the real axis. If we call the vectors so turned $\mathbf{a}'$ and $\mathbf{b}'$, then $\mathbf{a}' = a \operatorname{cis}\alpha \operatorname{cis}-\beta$ and $\mathbf{b}' = b$.

Then $\mathbf{a}'\,\mathbf{b}' = a\,b \operatorname{cis}\alpha \operatorname{cis}-\beta = a \operatorname{cis}\alpha\, b \operatorname{cis}-\beta$, and the real part of this, as shown above, is the expression we want.

Now $b \operatorname{cis}-\beta$ is the conjugate of $\mathbf{b}$.

Thus $\mathbf{a}'\,\mathbf{b}' = \mathbf{a}\,\bar{\mathbf{b}}$, where $\bar{\mathbf{b}}$ denotes the conjugate of $\mathbf{b}$ and $[\mathbf{a}'\,\mathbf{b}']_1 = [\mathbf{a}\,\bar{\mathbf{b}}]_1 = a\,(b\cos(\alpha-\beta)) = b\,(a\cos(\beta-\alpha)) = [\bar{\mathbf{a}}\,\mathbf{b}]_1$

Thus we have arrived at the conclusion that the product of the length of either vector into the projection of the other upon it, is

$$[\mathbf{a}\,\bar{\mathbf{b}}]_1 = [\bar{\mathbf{a}}\,\mathbf{b}]_1$$

Similarly, it might be proved that

$$[\mathbf{a}\,\bar{\mathbf{b}}]_j = -[\bar{\mathbf{a}}\,\mathbf{b}]_j$$

is the "vector part" of the product of $\mathbf{a}$ and $\mathbf{b}$, where the square brackets with the suffix $j$ denote that the imaginary part only of $\mathbf{a}\,\bar{\mathbf{b}}$ is taken. As I shall have no occasion to use this, however, I need not go into it here. By the introduction of this "scalar part," Mr. Steinmetz's method becomes a system of analytical geometry of great power, as will be found by those who use it. Let us apply this method to the series motor.

Let $\mathbf{e}_0$ be the impressed E.M.F.

$\mathbf{i}$ „ current.

$z_0$ „ impedance due to the main flux and iron losses.

* Paper read before the Institution of Electrical Engineers.

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Let $z_1$ be the impedance due to the resistance and leakage.
$z_2$ ,, armature impedance.

In this motor the following E.M.F.'s occur:

(1) $e_0$ the impressed E.M.F.
(2) $e_1$ the counter E.M.F.
(3) $e$ the E.M.F. induced in the field by the main flux.
(4) $-i z_1$ the E.M.F. due to the resistance and leakage of the field.
(5) $-i z_2$ the E.M.F. due to the impedance of the armature.

Now $e$ may be expressed in the form $-i z_0$, and will lag 90deg. behind the flux, and consequently more than 90deg. behind the current. Moreover, $e = 2\pi f i n^2 p\, 10^{-8}$, where these symbols have the same meanings as in the paper.

Now $e_1$ lags 90deg. behind $e$, and has the magnitude $4 s i n n_1 p\, 10^{-8}$.

Thus
$$e_1 = \frac{s}{2\pi f}\,\frac{4 n_1}{n}\, j e.$$

Let us put $\frac{4}{2\pi}\,\frac{n_1}{n} = a$ and $\frac{s}{f} = k$.

Then
$$e_1 = -i a j k z_0.$$

Now, by Kirchhoff's law the sum of the above E.M.F.'s must be zero.

$$\therefore\ e_0 - i(z_0 + z_1 + z_2) - i a j k z_0 = 0 \quad . \quad . \quad (1)$$

the fundamental equation of the series motor. Let us multiply through by $-\bar{i}\,\bar{z}$, and take the real part only of the product. We get

$$[\bar{i}\,\bar{z}_0\,(i(z_0 + z_1 + z_2) - e_0)]_1 = 0$$

(since $i z_0\ \bar{i}\,\bar{z}_0$ is real, the term involving $k$ is purely imaginary), and $k$ is eliminated.

Multiplying out and dividing by $[\bar{z}_0\,(z_0 + z_1 + z_2)]_1$,

$$i^2 - \left[ i e_0 \frac{\bar{z}_0}{[z_0\,(z_0 + z + z_1)]_1} \right]_1 = 0,$$

since $i\,\bar{i} = i^2$ a scalar. Writing

$$2c = e_0 \frac{\bar{z}_0}{[z_0\,(z_0 + z_1 + z_2)]_1},$$

and factorising again

$$[\bar{i}\,(i - 2c)]_1 = 0, \text{ or } i^2 = 2[\bar{i}\,c]_1 \quad . \quad . \quad . \quad (2)$$

The first equation asserts that $i - 2c$ is perpendicular to $i$, and is therefore the equation of a circle passing through the origin.

Dividing equation (1) by $(z_0 + z_1 + z_2)$ and transposing, we get

$$\frac{e_0}{z_0 + z_1 + z_2} - i = i\,\frac{a j k z_0}{z_0 + z_1 + z_2}.$$

Setting $\frac{e_0}{z_0 + z_1 + z_2} = i_s$, changing the sign, and dividing by $i$

$$\frac{i - i_s}{i} = -\frac{a j k z_0}{z_0 + z_1 + z_2} \quad . \quad . \quad . \quad . \quad (3)$$

Now $i_s$, the standstill current, is equal to OS in Fig. 2, and $i$ to OI. Thus equation (3) asserts that $\frac{SI}{OI}$ is proportional to the speed. In fact, the process by which equation (3) was derived from equation (1) suggested the geometrical proof of the circle-diagram, which I gave above. Now torque × speed = output, or

$$\text{Torque} = \frac{\text{output}}{\text{speed}}, \text{ or is proportional to } \frac{I}{k}[\bar{i}\,e_1]_1.$$

Thus since $e_1 = -i a j k z_0$

$$\text{Torque} = i^2 [a j z_0]_1.$$

Now from equation (2)

$$i^2 = [\bar{i} \,.\, 2c]_1 \text{ or } OI^2 = OM \,.\, ON \text{ (Fig. 2)},$$

substituting

$$\text{Torque} = [\bar{i} \,.\, 2c]_1\,[a j z_0]_1 \quad . \quad . \quad . \quad (4)$$

Thus the torque is proportional to the projection of the current vector on 2c—*i.e.*, on that diameter of the circle which passes through the origin.

*The Lines of Constant Output.*

Equation (1) may be written

$$e_0 - i(z_0 + z_1 + z_2) = e_1.$$

Now output $= [\bar{i}\,e_1]_1$. Let us substitute the value of $e_1$. We get

$$[\bar{i}\,(e_0 - i(z_0 + z_1 + z_2))]_1 = [\bar{i}\,e_1]_1 = c$$

if we put output $= c$. This is the equation of a circle, as will be shown below.

Multiplying out, changing the sign, and dividing through by $[z_0 + z_1 + z_2]_1 = r$, the total resistance of the motor, we get

$$i^2 - 2\left[ \bar{i}\,\frac{e_0}{2r} \right]_1 = -\frac{c}{r}.$$

Adding to both sides $\left|\frac{e_0}{2r}\right|^2$ we get

$$i^2 - 2\left[ \bar{i}\,\frac{e_0}{2r} \right]_1 + \left|\frac{e_0}{2r}\right|^2 = \left|\frac{e_0}{2r}\right|^2 - \frac{c}{r}.$$

Factorising again, we get

$$\left| i - \frac{e_0}{2r} \right|^2 = \frac{e_0^2}{4r^2} - \frac{c}{r} \quad . \quad . \quad . \quad . \quad (5)$$

The two vertical lines in the above equations form the usual notation for the modulus or absolute magnitude of a complex quantity. The use of an italic letter, though very convenient to denote the magnitude of a single symbol, is obviously inapplicable to a sum of complex quantities such as occurs above.

So long as $r$, the total resistance of the motor, remains constant, it is obvious that the above equation represents a circle, the vector to the centre being $\frac{e_0}{2r}$, and the radius $\sqrt{\frac{e_0^2}{4r^2} - \frac{c}{r}}$. Thus when the output is zero the circle passes through the origin. Now it is obvious that the output can only be zero when the speed is zero. Thus we see that the *locus* of the standstill current vector, as we vary either the field turns or the armature turns, or both, is a circle passing through the origin, and having its centre on the line along which the impressed E.M.F. is set out. That the lines of constant output, in practice, are circles, is shown fairly well by Fig. 6, above.

A construction for the radius of the circles of constant output is easily found. Let us describe a semicircle on $\frac{e_0}{2r}$. If an output circle cuts this at the point C (Fig. 15), then $R^2 = \frac{e_0^2}{4r^2} - O C^2$.

Hence $O C^2 = \frac{c}{r}$. This gives us the construction we require.

*The Lines of Constant Efficiency.*

We have
$$\text{Efficiency} = \frac{\text{output}}{\text{input}} = \frac{[\bar{i}\,e_1]_1}{[\bar{i}\,e_0]_1} = \eta$$

if we put efficiency $= \eta$, a constant. Substituting for $e_1$ from the equation—

$$e_1 = e_0 - i(z_0 + z_1 + z_2),$$

as was done above, we get

$$[\bar{i}\,(e_0 - i(z_0 + z_1 + z_2))]_1 = \eta\,(\bar{i}\,e_0]_1,$$

or,
$$[\bar{i}\,(e_0(1 - \eta) - i(z_0 + z_1 + z_2))]_1 = 0,$$

the equation of a circle passing through the origin.

Multiplying out, dividing by $[z_0 + z_1 + z_2]_1 = r$, the total resistance of the motor, and changing the sign, we get

$$\left[ \bar{i}\,\left( i - \frac{e_0(1 - \eta)}{r} \right) \right]_1 = 0.$$

Thus the diameter of the circle, $\frac{e_0(1 - \eta)}{r}$, gets smaller as the efficiency gets higher. The circle of zero efficiency is identical with the standstill current circle, as one would expect, while the circle of 100 per cent. efficiency is a mere point (the origin). These circles are shown in Fig. 15. They give us yet another linear construction for the efficiency, though not a very convenient one. Draw a perpendicular from the extremity of any standstill current vector cutting the line of unity power factor at a certain point, P. From the extremity of any other current vector

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draw a line perpendicular to it, cutting the line of unity power factor in Q. Then P Q measures the efficiency corresponding to that current vector.

*Effect of Varying the Number of Field Turns.*

In order to consider the effect of varying the number of turns on the field, it is necessary to express the constants of the motor in terms of the number of field and armature turns.

The total reactance of the field is

$$-j\,2\,\pi\,f\,n^2\,p\,\nu\,10^{-8} = -j\,n^2\,x_0.$$

The total reactance of the armature is

$$-j\,2\,\pi\,f\,n_1^2\left(\frac{2}{\pi}\right)^2 p_1\,10^{-8} = -j\,n_1^2\,x_2.$$

The counter E.M.F. is equal to

$$4\,i\,s\,n\,n_1\,p\,10^{-},$$

and differs in phase from the current by a small angle.

Thus it may be represented by $-\mathrm{i}\,k\,n\,n_1\,\mathrm{Z}$, where

$$\mathrm{Z} = \frac{a\,j\,\mathrm{Z}_0}{n\,n_1}.$$

The resistances of the field and armature are proportional to the number of turns on each if we use the same size wire throughout. The "equivalent resistance" of the field, due to the iron losses, is also proportional to the number of field turns. There will also be a resistance which may be assumed constant, due to the brushes, etc. Thus the resistance of the motor may be expressed in the form $r_0 + n\,r + n_1\,r_1$. However, as the influence of the resistance on the shape of the curves is small, I shall consider the resistance of the motor as a constant, $r$. The fundamental equation of the series motor now takes the form,

$$\mathrm{e}_0 - \mathrm{i}\,(r - j\,(n^2\,x_0 + n_1^2\,x_2) + k\,n\,n_1\,\mathrm{Z}) = 0 \quad . \quad (6)$$

The first thing that we notice about this equation is that it is of exactly the same form both in $n$ and in $n_1$. Consequently any curves which we may arrive at by considering $n_1$ as constant and $n$ as variable will be paralleled by exactly similar curves obtained by considering $n$ as constant and $n_1$ as variable.

*To plot the locus of* i *in equation* (5) *if* $n_1$ *and* $k$ *are constant*

Dividing equation (5) by i, we get

$$\frac{\mathrm{e}_0}{\mathrm{i}} = r - j\,(n^2\,x_0 + n_1^2\,x_2) + k\,n\,n_1\,\mathrm{Z}.$$

Thus $\frac{\mathrm{e}_0}{\mathrm{i}}$ or $\frac{\mathrm{I}}{\mathrm{i}}$ will move on a parabola, as may easily be seen. The simplest way to plot the *locus* of i seems to be to first plot this parabola, the *locus* of $\frac{\mathrm{e}_0}{\mathrm{i}}$. The reciprocals of the vectors to this parabola will to a suitable scale be the vectors to the curve required.

Now, the reciprocal of a compiex number, regarded as a vector, is a vector having a reciprocal length, and making an opposite angle with the real axis to that made by the original vector. We shall evidently obtain the same results if we set out the reciprocals along the line of the original vectors, and then change the direction of rotation of our diagram from clockwise to counter-clookwise, thereby changing an angle $\alpha$ into an angle $-\alpha$, as if we set out the reciprocals, making an opposite angle with the real axis to that made by the original vector. I usually adopt the first procedure as being the most convenient.

Thus with the aid of this parabola it is quite easy to plot the *locus* of i in equation (5) or the curve on which the current vector moves if we keep the speed constant and vary the number of field turns. We obtain a number of points on it corresponding to various values of $n$. To each of these values corresponds a current circle, such as is discussed above. If we neglect the phase difference between current and counter E.M.F. as has been done for convenience in Fig. 15, these circles will all have their centres on the line of zero power factor. Since they all pass through the origin, the point just obtained on each serves to determine it completely.

Having obtained, as above, one line of constant speed, and having also the standstill current circle, it is easy to draw as many other lines of constant speed as may be required by means of the speed construction given in Fig. 2.

In Fig. 15 are shown three of these speed lines. Together with the lines of constant output these lines enable us to determine the torque, output, efficiency, etc., corresponding to any speed and any number of field turns. From the lines of constant speed we see that as we increase the number of field turns the power factor rises to a maximum, and then falls slowly down to zero again. In fact, when $n = \infty$ equation (6) becomes

$$\mathrm{i} = \frac{\mathrm{e}_0}{-\mathrm{j}\,n_2\,x_0},$$

which has a direction perpendicular to $\mathrm{e}_0$. Thus the speed lines are all tangent to the line of zero power factor at the origin. As we saw above in the paper, the power factor attains a maximum for a definite ratio of armature turns to field turns which is independent of the speed. Thus, if the number of armature turns be constant, there will be one current circle in Fig. 15 for which the power factor will be a maximum at every speed.

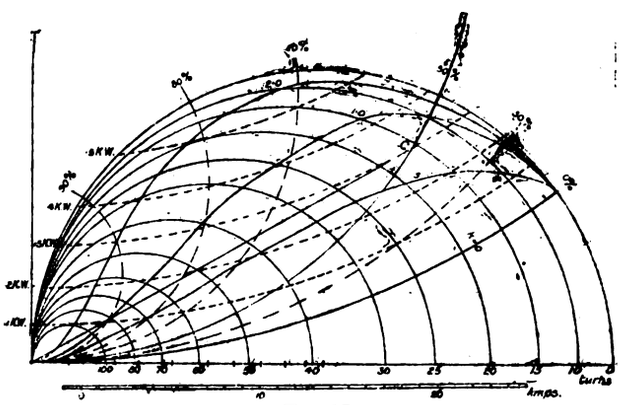

FIG. 15.

In Fig. 11 are given some experimental curves showing the relation between output and number of field turns at constant speed. Although this relation cannot profitably be studied analytically, on account of the complication of the equations involved, Fig. 15 gives us a simple geometrical means of studying it. We see that the point at which the output circle touches a given speed line gives us a smaller value of $n$ the greater the speed, till finally, when

$$k = \infty \quad n = 0,$$

*(To be continued.)*

## PERSONAL.

We understand that the Johannesburg appointment has not yet been officially confirmed, therefore to make a definite statement would be somewhat premature.

Mr. Lackie, the chief electrical engineer of the Glasgow Corporation, in the name of the employés, has presented to Mr. W. A. Chamen a pair of silver candlesticks and a silver inkstand as a memento of his occupancy for seven years of the post of chief engineer to the Corporation electricity department; and Mr. R. B. Mitchell, on behalf of the street labourers, has presented to Mr. C. H. K. Chamen a dressing case and pocket knife.

Mr. L. Paton Greig, borough electrical engineer, Bury St. Edmunds, has been appointed engineer to the Richmond (Surrey) Electric Light and Power Company, Limited, in succession to Mr. M. C. Flemyng, resigned.

The Bournemouth Corporation have appointed Mr. Bulfin (electrical engineer) resident engineer in connection with the construction of the Christchurch tramways. On the completion of this line he will act as electrical engineer for the whole of the system, including the Poole lines, at a salary of £400 per annum, rising by annual increments of £25 to £450. The Council have also increased the salary of Mr. Barber, traffic manager, from £300 to £400 per annum, rising by annual increments of £25 to £450 per annum.

The Luton Town Council have increased the salary of the electrical engineer, Mr. Cooke, from £230 to £260 per annum.

**Handbook.**—The revised edition of the official handbook upon Felixstowe and the locality, edited by Mr. Lemmon Lingwood and published by Jarrold and Sons, Limited, should relieve the visitor from any need of invoking the guidance of the local constabulary. It contains a quantity of information about the chief buildings, postal and travelling services, recreations, and the like, in addition to a historical sketch of the town and a number of illustrations.

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### TO CORRESPONDENTS.

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*All communications intended for the Editor should be addressed* C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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## ELECTRICITY—DEFENSIVE AND OFFENSIVE.

The report of Mr. Fedden to the Electric Light Committee of Sheffield seems to us to indicate a new departure. The army that acts purely on the defensive is usually in the long run worsted, and the country that ceases to be aggressive ceases to be progressive, so the industry that sits down and takes the attack of vigorous opposition without deigning a reply is in danger of extinction. It seems to us that the electric lighting industry is passing through a very real crisis, and if its supporters are not more aggressively combative, it is likely to experience a hard time. In these days of associations, of books, pamphlets, and technical papers it is rather a hazardous thing to dogmatise in the direction that the electric lighting problem has never yet been properly attacked, hence not yet properly solved. It is not so simple as it looks. Interior lighting has to provide for anything between the extremes of a rushlight and a brilliantly lighted ballroom, hence even for interiors, if one system of lighting is to become universal, it must possess great versatility and not lack economy. It is, however, not so much with interior lighting as with exterior that such reports as this of Mr. Fedden's provide pabulum for thought. Has this problem of street-lighting ever been properly considered? Have we not always had that millstone of comparative cost round our necks, to the great detriment of asking what is wanted? At the same time when arc lighting was introduced the gas lighting of our streets was not lighting at all, so far as the requirements of civilised life were concerned—it was merely the survival of a something better than lanterns. The progress of trade, of civilisation, of the necessities of modern life, has left nothing in common with what existed only a century or so ago. Then the world lived and moved and worked practically only between sunrise and sunset. People did not shop after dark; they mostly dined at midday and went to bed early. Now it is fashionable to dine at eight, and go to the theatre later. When the house doors were locked at nine, the question of lighting the streets resolved itself into the getting of mere guiding lights for belated travellers. At the present time the main streets are used almost or quite as much during the four hours ending at midnight as during the four hours ending at midday, and the nearer the lighting of these streets during the absence of the sun approaches that when it gives light the better, and more economically can trade and traffic be carried on. So far as side streets and residential streets are concerned, the problem is a different one and resolves itself into giving enough light to guide the traveller and to prevent crime. It seems to us, then, that the first factor a lighting authority should consider is quantity, or more scientifically, the intensity of light per unit area in the main streets that will enable trade and traffic to be carried on in the best and most economical way under the existing modern conditions. When they have determined that intensity, then, and not till then, should the cost to provide that intensity by various kinds of illuminants be considered. We have no hesitation in saying that nothing at present known is as cheap as electric energy to give the lighting which ought to be provided in our main thoroughfares. We do not forget—and the electrical engineer ought never to forget—the immense strides made by gas engineers since the introduction of electricity as a luminant. The electrical engineer, partly because of his cock-suredness, has not made so great comparative advance. It seems to us that sometimes he forgets that good lighting depends not only on candle-power, but quite as much, if not more so, upon the

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equitable diffusion of light. Lighting is not good where here you get brilliance and there shadow. Much of our lighting is like a corduroy road, equally distributed in ridge and furrow, in the case of the lighting alternately light and dark. What is the use of all the talk and discussion about candle-power if half the area supposed to be lighted is really not so? While the law that intensity varies with the square of the distance holds good, the limit of distance between the point of generation of light is practically determined, and intense centres of light at long distances apart should be avoided. The people who from time to time have suggested huge candle-powers on high masts at long distances apart have failed to prove the practicability of the idea, as might have been expected, for the system is wrong in principle. Mr. Fedden is on firmer ground when he considers the existing conditions and compromises so as to give each condition the maximum it can have when the requirements of the other conditions have been similarly satisfied.

## CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

### FORCED DRAUGHT.

SIR,—The article on "Gloucester Electricity Works," by W. J. Bache, in your issue of the 9th inst., giving the cost of forced draught as compared with the chimney stack, sums up greatly in favour of the former. This result is arrived at by means of charging against the motor-driven fan 54,000 units per annum at ¼d. per unit. The previous description of the plant gave no impression of exceptional economy to account for this low charge, and a few pages over the works' costs are given at 1d. per unit, one item alone—coal—accounting for ·35. To me this difference requires an explanation, which may only be a matter of up-to-date book-keeping at present an unknown quantity to—Yours, etc.,

CLYDE.

## FORTHCOMING EVENTS.

FRIDAY, JUNE 16.

**Physical Society.** — "The Ratio between the Mean Spherical and Mean Horizontal Candle-power of Incandescent Lamps," by Dr. J. A. Fleming; "The Electrical Conductivity of Flames," by Dr. H. A. Wilson; "Contact with Dielectrics," by Mr. R. Appleyard; "The Pendulum Accelerometer, an Instrument for the Direct Measurement and Recording of Acceleration," by Mr. F. Lanchester; "A New Form of Pyrometer," by Mr. N. V. Stanford; and an exhibition of a refractometer by Mr. R. Appleyard.

MONDAY, JUNE 19.

**Institution of Mechanical Engineers.**—Summer meeting at Liége commences. Particulars in another column.

WEDNESDAY, JUNE 21.

**Royal Meteorological Society.**—At 4.30 p.m., "Normal Electrical Phenomena of the Atmosphere," by Mr. George C. Simpson; and "Two New Meteorological Instruments: (1) Automatic Pole Star Light Recorder, and (2) The Ombroscope," by Mr. S. P. Fergusson.

**Dynamicables.**—Dinner at the Trocadero, June 21.

**King's College.**—Annual dinner at the Hotel Cecil, June 26.

**Electrical Contractors' Association.**—Dinner at the Holborn Restaurant, June 27.

**Incorporated Municipal Electrical Association.**—June 27 30, annual convention.

**City and Guilds of London Institute.**—Exhibition at the Imperial Institute, to be opened on June 28, at 3.30 p.m.

**Municipal and County Club.**—House dinner (W. H. Grenfell, Esq., M.P., principal guest), June 29.

**Institution of Electrical Engineers.**—Conversazione, June 29.

**Junior Institution of Engineers.**—Summer meeting commences June 30. For particulars see another column.

**University of Liverpool.**—Opening of new electrotechnics laboratory by Sir J. Swan, July 8.

**Permanent-Way Institution.** — Summer convention begins on July 21, continuing till July 27, in the course of which a visit will be paid to Holland.

## THE VERBAND DEUTSCHER ELEKTROTECHNIKER.

### Thirteenth Annual Meeting—Dortmund and Essen.

[FROM OUR SPECIAL CORRESPONDENT.]

Appropriately enough, the thirteenth annual meeting of the Verband Deutscher Elektrotechniker held last week in Dortmund and Essen was heralded by a thunderstorm. It is usual for the members and their ladies to meet for social intercourse on the evening prior to the first general business meeting, and I fear this storm may have diminished the attendance. However, it was early apparent that the meeting would be a record one in point of numbers. The news soon circulated that it would not fall far short of 600—nor did it as a matter of fact. This proves the readiness of our Teutonic friends to avail themselves of any exceptional opportunity which may come in their way. On this occasion the chief ambition of all was to inspect Messrs. Krupp's celebrated works, apart from which the programme of visits arranged in the district offered very tempting bait. Neither Dortmund nor Essen in itself could be by any stretch of the imagination styled attractive, but by reason of intimate association with the iron and coal industries of Westphalia and the Rhine Provinces each is of first-rate commercial importance. The industrial portions of Westphalia and the Rhine Provinces together constitute what may be termed the Black Country of Germany. In extent this country is some 80 km. long by 30 km. wide, and is the most thickly populated and busy district on the European Continent, resembling with its numerous mines, ironworks, and miscellaneous factories one continuous hive of industry. Corresponding to the rapid development of its mineral resources the increase in the population of this track of country has been quite phenomenal, necessitating the erection by the local authorities of workmen's dwellings and the establishment of colonies near the works on an extensive scale. The coal mines employ no less than 270,000 workpeople, a further 160,000 or thereabouts being engaged in the iron industry—together, 430,000. The progress which has been made during the past 10 years is attributed largely to the formation and activity of the great coal syndicate, which in 1893 put a stop to unwholesome competition and unremunerative prices, while consolidating the industry and preparing it for steady development. The policy pursued by this syndicate, whose headquarters are in Essen, has been freely discussed, the shutting down of certain pits calling forth especially severe criticism. No doubt, however, over-production was at the root of the original trouble, and the forcible method adopted to prevent this has had the desired effect, reacting favourably in the long run also on the iron industry. It is surely an economically sounder policy to regulate the output to the demand by working less pits than by restricting hours of labour. But apart from economics it is interesting to note the growing tendency in Germany for the coal mines to devolve into the hands of a few very large companies. A similar tendency exists in regard to the electrical industry, and one wonders where combination will cease. As for the stimulus given to the German electrical industry by enterprise in the mining country of Westphalia and the Rhine Provinces, the value of same can be scarcely overestimated. It was here that the first large direct-coupled electrically-driven pump, the first high-pressure centrifugal pump, and the first main winding engines driven by three-phase and continuous current motors were erected. It was here also that the possibility of utilising blast-furnace gas for driving gas-engines was first practically demonstrated.

In welcoming the visitors to Dortmund on Sunday evening, the President of the local section of the V.D.E. said that according to recent statistics about 500,000 h.p. of dynamos had been installed during the last five years in the Black Country of Germany. I quote this statement merely to convey an impression of the extensive use to which electricity is put for industrial purposes within the area in question.

Drs. Wilhelm Siemens and Gisbert Kapp were prominent among the first gathering of members. The prospect of a large attendance and its early realisation were no doubt

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gratifying to Dr. Kapp. Indeed, the meeting was a personal triumph for our esteemed friend. He has piloted the V.D.E. through troubled waters, and leaves it flourishing as never before. That the members have felt his able generalship during the past 11 years, and are not ungrateful, was apparent on all sides.

Further, I am pleased to report that his services in the cause of the profession of which he is himself so eminent a representative have also been recognised in wider circles, the honorary title "Doctor of Engineering" having been conferred upon him by the Universities of Dresden and Karlsruhe. This, in view of the important appointment which he is so soon to take up at the Birmingham University, is of peculiar interest. Hearty congratulations, Dr. Kapp.

*(To be continued.)*

## AN APPLICATION TO ELECTROLYTES OF THE HYDRATE THEORY OF SOLUTIONS.*

BY DR. T. MARTIN LOWRY.

The object of the paper is to consider the possibility of extending the hydrate theory to electrolytes in such a way as to take account of the observations which form the experimental basis of the theory of electrolytic dissociation. The hydrate theory postulates that an aqueous salt solution consists of a mixture of hydrates in equilibrium with the solvent and with one another. But it must be supposed that even in solution there is a limit to the possibility of hydrate formation, so that ultimately a stage will be reached at which the molecule as such will be unable to combine with any further quantity of water. The ionisation of an aqueous electrolyte consists essentially in a further process of hydration, whereby the fully hydrated molecule combines with an additional quantity of water to form two or more hydrated ions. The hydration of the ions is thus conceived to be the primary cause of the ionisation of aqueous electrolytes. It is believed that this extension of the hydrate theory to the phenomena of electrolysis may help to remove the fundamental difficulty of Arrhenius's theory—namely, the absence of a *motive* for electrolytic dissociation.

The evidence in support of the hydrate theory of ionisation is summarised as follows:

1. The theory is in accord with the fact that the best "ionising" solvents are those which are themselves most highly associated. Whilst Arrhenius laid special stress on dissociation as the characteristic feature of the process of ionisation, the hydrate theory emphasises an association of solvent and solute which is the primary cause of the separation of the ions. Such an association with the solute may be expected to occur most readily in the case of solvents composed of molecules having a high coefficient of association.

2. Complete ionisation is possible only in presence of a very large excess of water—that is, under exactly those conditions which are most favourable to the formation of complex hydrates.

3. The influence of temperature on ionisation is also in accord with the view that the process is essentially one of association with the solvent.

4. Evidence in favour of the hydrate theory of ionisation is afforded by a consideration of the mobilities of the different ions in aqueous solutions. In the following table of ionic mobilities

| Li | Na | K | Rb | Cs |
|---|---|---|---|---|
| 33·44 | 43·55 | 64·67 | 67·6 | 68·2 |

the larger atoms yield the more mobile ions; the lithium ion (at. wt. 7) moves through the solution only half as rapidly as the rubidium ion (at. wt. 85) or the cæsium ion (at. w. 133). Such a result strongly supports the view that in aqueous solutions the ions are present in the form of complex hydrates.

5. The mobility of the hydroxyl ion is more than double as great as that of any other anion; whilst that of the hydrogen ion is nearly five times as great as that of any other kathion. The peculiar properties of these two ions are most readily explained by supposing that they are either anhydrous or are combined with a smaller proportion of water than any of the other ions. Confirmation of this view is afforded by at least two independent considerations:

(1) The affinity of water molecules for the ions H and OH must be relatively slight, since otherwise liquid water, like fused salt or caustic soda, would be a good electrolyte.

(2) Whereas nearly all sodium and potassium salts are good conductors, the acids from which they are derived are often exceedingly poor conductors.

6 Independent evidence in favour of the hydrate theory of ionisation is to be found in a consideration of the freezing points of dilute aqueous solutions. At extreme dilutions the molecular depression of the freezing point reaches a maximum value corresponding very closely with that required by the theory of electrolytic dissociation. In less dilute solutions, however, values are obtained which cannot be accounted for in terms of this theory as originally propounded, but which are explicable if, as the hydrate theory assumes, part of the solvent is removed as far as freezing-point lowering is concerned.

7 The theory of electrolytic dissociation owes much of its acceptability to the readiness with which it lends itself to exact mathematical treatment. The whole theory can, indeed, be summed up in the well-known equation,

$$K = m\alpha\,(u+v).$$

The essential constants of the hydrate theory are, however, quite as simple as those of Arrhenius's theory. For any given solution the chief constants are: (1) The *total hydration*, H, of the solution, which expresses the total number of molecules of water present per molecule of salt. (2) The *coefficient of combination*, $\beta$, which expresses the fraction of the total quantity of water that is actually combined with the salt to form hydrates. (3) The product of these two quantities will give the average composition of the hydrates in solution; this may be termed the "molecular hydration" of the solution, and may be represented by the symbol $h$. Thus $h = \beta H$ may be regarded as the fundamental equation of the hydrate theory. Jones and Getman and Biltz have attempted to determine the molecular hydration of dissolved salts. Assuming that the abnormally great molecular depressions of the freezing point of salt solutions of moderate concentration were due to a combination of solvent and solute, Jones and Getman were able to compute the amount of solvent water remaining in the solution by comparing the observed molecular depression with that calculated from the coefficient of ionisation of the solution. The author, after correcting the figures—in which two serious flaws were made—calculated by Jones and Getman, shows that the corrected values point to a regular increase of molecular hydration as the dilution increases, and are, therefore, in accord with the view that ionisation involves an increase, and not a decrease, in the hydration of the solute.

8. The theory may easily be extended to non-aqueous electrolytes in which ionisation may again be attributed to the superior combining power of the ions as compared with the molecules of the dissolved salt.

9. In the case of autolytic salts, which became conductors when fused, it is known that polymerisation is an essential characteristic of these, hence it is only necessary to suppose that the complex molecules of these are associated with the ions. Evidence of the formation of complex ions has recently been obtained in the case of fused salts by Lorenz and Fausti, who have shown that, in fused mixtures of lead chloride with sodium and potassium chlorides, the transport values prove that the lead is present in the form of a complex anion which travels in the opposite direction to the current. Their experiments afford direct evidence of the presence in the fused salt of positive and negative ionic complexes. Conduction in mixtures of solid oxides, such as the Nernst filament, is doubtless electrolytic in character. Like glass, this filament has the composition of an electrolyte, but behaves as an insulator until the temperature has been raised sufficiently to permit ionic migration to take place. Temperature-conductivity curves for filaments of very various compositions have been plotted by Reynolds, and are very similar in form to those for glass, or for overcooled, concentrated, aqueous solutions of calcium chloride or sulphuric acid. An

* Paper read before the Faraday Society.

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**even more striking resemblance is to be seen between the family of curves given by Reynolds for the conductivity of mixtures of $ZrO_2$ and $Y_2O_3$ at 900, 1,000, 1,100, 1,200, and 1,300 degrees C., and the isothermal conductivity-concentration curves for mixtures of sodium hydroxide and water at 0, 18, 50, and 100 degrees C. The appearance of the two series of curves is such as to warrant the conclusion that the mechanism of conduction is essentially the same in the two cases.**

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Mr. H. D. LAW pointed out that molecular mobilities were often largely influenced by the undissociated molecules; an ion might wander more quickly through its own molecule than through another. He thought that the experimental evidence on which the hydration was based was as yet somewhat slender.

Dr. C. H. DESCH hoped that Dr. Lowry would develop the theory on the mathematical side. The unsymmetrical pulls, due to electric attractions, on an atom in a solution might be sufficient to cause an interchange of ions, and so explain how conduction occurs in solutions.

Mr. W. R. BOUSFIELD (*communicated*) showed that the experimental investigation of the relation between hydration and ionisation could be approached along three conveying lines: firstly, on the assumption of a rectilinear relationship between freezing-point depression and concentration; secondly, on the assumption that the amount of contraction per gramme of solute, in aqueous solutions, is a measure of the combination between solvent and solute; and thirdly, by a consideration of the variations of ionic sizes with temperature and concentration based on the application of Stokes's theorem on the movement of small sphere in a viscous fluid. The results of these three lines of investigation indicated the generalisation, pointed to by Dr. Lowry, that the amount of combination of solvent with solute increased progressively and continuously with increasing dilution. With regard to the conductivity of water, he inclined to the opinion that the H and OH ions were not entirely anhydrous, but were combined with a smaller proportion of water than any of the other ions, and that the conductivity of water depended upon a volatile organic impurity.

Dr. F. G. DONNAN (*communicated*) drew attention to the work of Werner, who first showed how it was possible to bridge over the gap between the "hydrate" and the "ionisation" theories.

Mr. G. T. BEILBY, referring to the author's views on solid conduction, said that recent observations of his seemed to prove that the impact of electrons—*e.g.*, $\beta$ rays—was able to produce electrolysis—ionisation—in solid crystals, such as calc-spar.

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## TELEPHONE TRAFFIC.*

BY HERBERT LAWS WEBB, MEMBER.

A paper on telephony before this Institution is under a certain disadvantage, because it is difficult to tell the earnest telephone men anything about telephony that they do not already know, and it is difficult to tell the non-telephone men anything about telephony that they care to know. In attempting to describe the improvements that have been made in the conduct of telephone traffic and to indicate the relation between traffic efficiency and engineering economy, I shall hope at the least to provide a topic for discussion which may interest those members who are not directly engaged in telephony as well as those who are.

I have always held that the study of the traffic is the most important part of a telephone man's work. The chain of reasoning which leads to this conclusion is simple. The sole object of a telephone system is to supply telephonic communication, and telephonic communication consists of hundreds or thousands, or hundreds of thousands, of daily telephone connections. Each connection consists of a certain number of operations, each operation involving a definite performance by apparatus and by a manipulator. Therefore the principal aim of the telephone engineer should be to put the apparatus and the manipulators in a position to execute those various operations with maximum accuracy and celerity. The efficiency—efficiency here meaning accuracy combined with celerity—of the individual connection is the object to be attained, and efficiency of the connection requires efficiency in each step.

Even if the result were solely the supply of the most effective service possible to the public, the accurate and rapid production of the individual connection should be the chief solicitude of the telephone engineer. But the matter goes much deeper than that. It affects the whole engineering design of the system, and it affects both the capital charges and the working costs. Any gain, however slight, in the accuracy or the rapidity of manufacturing the individual telephone connection is felt throughout the whole system. It reduces the size of the plant in proportion to output, and so reduces capital charges, and it reduces the amount of work done in proportion to output and so reduce working costs.

I have read somewhere a remark, attributed to a famous member of this Institution, which aptly illustrates the point. Sitting on a mountain side, he said: "I let fall this grain of sand, and the whole earth feels the shock." Telephone men might well use this as a text. If in a telephone system, where hundreds of thousands, sometimes even millions, of operations are performed daily, we make anyone of those oft-repeated operations more accurate or more rapid, the whole system feels the effect. The gain of a second, or of a fraction of a second, on an operation many times repeated each day, has in a large telephone system a cash value running into handsome figures.

The importance of the study of telephone traffic, then, cannot be over-estimated, and it is clear that the efforts of all who are engaged in the design and conduct of telephone systems are ultimately focussed on the production of accurate and rapid telephone connections. There are many different functions to be performed in a modern telephone system, as there are in a modern battleship; but the true function of the battleship is straight and rapid shooting, and the true function of the telephone system is straight and rapid operating. The cook of the battleship does his share in straight and rapid shooting by keeping the gunners' digestions in order, and in the telephone system even the humble wayleave officer or the storekeeper has his indirect share in the production of accurate and rapid operating.

The improvements in telephone exchange apparatus during the past 10 years have been revolutionary. The history of telephone exchange working, covering now about 25 years, may be roughly divided into two periods—one of about 16 years, in which the apparatus was mainly experimental, and many different systems were tried, but none was produced capable of dealing with a large daily traffic with real accuracy and rapidity; and one of about eight years, in which there has been perfected and standardised apparatus, largely automatic in its working, capable of the greatest accuracy and rapidity in operation. In the old apparatus the percentage of error was very great, owing to the distances between the signals and the jacks and plugs they were related to, and owing to lack of definiteness in some of the signals—on many occasions they worked at the wrong time, and on others they failed to work when required to. With regard to rapidity of operating, the old apparatus was relatively slow in working for a variety of reasons. The distance between the signals and the jacks and plugs imposed a certain strain on the operator's attention and memory, the replacement of signals occupied time, and the lack of definiteness of some of the signals and the total absence of some essential signals necessitated a certain amount of supervision of each connection by one or more operators to ensure a reasonably accurate and satisfactory service.

In the standard apparatus of to-day all these conditions have been changed. The use of lamp signals enables many things to be done which were impossible before. The prime advantages of lamp signals are that they are extremely compact, they have no working parts, and therefore may be placed in any position—vertical, horizontal, or at an angle; they are automatic in action or self-effacing, since the signal disappears immediately the current is cut off; and, finally, they give a much more positive and assertive signal than any form of indicator. These various qualities enable several radical improvements to be made. The signals are placed immediately adjacent to the jacks or cords they control, which, in large switchboards, is impossible with electromagnetic indicators; the line lamp is immediately above or below its corresponding answering jack, and the supervisory lamps are in line with the connecting cords and close to them. With this arrangement the operator loses no time and has to exert no brain power in tracing the relation between the signal and its corresponding jack or cord. The difference in effect between the modern arrangement of directly associating the signals with their corresponding jacks and cords and the old arrangement of placing the signals in a separate part of the board from that occupied by the jacks and cords is something akin to the difference between a telegram in plain language and one in code. In the one case the meaning of the signal flashes instantly to the brain of the operator, and in the other case a certain effort and a certain interval of time are required for translating the meaning of the signal. The automatic working of lamp signals is of much wider range than that of electromagnetic signals. We had self-effacing, or automatically restored, indicators before lamp signals were introduced. But the self-restoring indicator had but two positions—only two words in its vocabulary, so to speak. The lamp signal has several; it may be alight or out, corresponding to the down and up positions of the indicator, but it may also flash, and it may be made to flash at different rates of speed, easily recognisable. Therefore, apart altogether from the fact that it is much more easy to apply to lamps distinctive marks indicating different classes of service than it is to apply such marks to indicators, the lamp signal is able to convey a greater number of meanings as a working signal than an indicator. Finally, the more assertive and positive signal given by a lamp as compared with an indicator is due to a simple physical fact—the great sensitiveness of the eye to light. The glowing of a lamp signal instantly attracts attention, no matter at what angle the lamp may be relative to the eye, and in many cases the lamp is seen instantaneously where a fallen drop would be unnoticed for several seconds. The lamp is seen out of the corner of the eye, so to speak, whereas an indicator must be more directly in the range of vision. The diagrams (Figs. 1,

* Paper read before the Institution of Electrical Engineers, May 11.

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2, and 3) illustrate the relative positions of the signals and jacks in the three chief types of multiple switchboard.

Perhaps the most striking improvement in operating resulting from the use of lamp signals and the supply of energy from a central source is automatic supervision. In the older systems of working, as has already been said, the indefiniteness and unreliability of the signals made it necessary, in order to reduce as far as possible the percentage of error, that the operator should give each connection a certain amount of supervision. This supervision was directed to ascertaining that the two subscribers had got together all right, and later, in the many cases where the disconnection signal was not given, of ascertaining whether the subscribers had finished talking and the lines could be disconnected. This supervision demanded a certain amount of the operator's time on each connection in excess of the time actually required for the operation of the connection. In the modern switchboard the exact condition of the two subscribers' lines connected is shown by the state of the two supervisory lamps associated with the connecting cords. By the automatic working of these two signals the operator knows when the called subscriber answers, she knows when one subscriber hangs up and the other does not; she knows if either subscriber wants her to come in on the line; and, finally, she knows when the two have hung up. The operator sees these various conditions of the line by the action of the two lamps, and she requires to do no direct supervision. If either subscriber desires to attract her attention he flashes one of the supervisory lamps by moving his switch-hook up and down, and it is only on this signal that the operator goes into the circuit. The

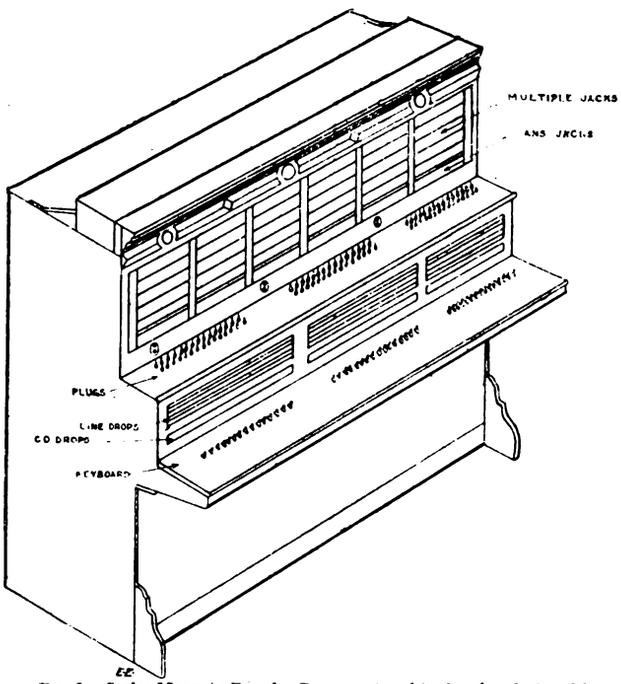


FIG. 1.—Series Magneto Board. Drops restored by hand and placed in separate part of board from jacks and cords.

automatic supervision and the automatic and definite disconnection signal afforded by the double supervisory signals constitute an immense advance in the means of handling telephone traffic.

In the working of junction lines—a branch of the operating which is of the highest importance in large systems, since the greater proportion of the traffic passes over the junctions—great improvements have been effected by modern apparatus and methods. The use of lamp signals affords what was lacking before, a positive disconnection signal at the incoming end of the junction. The absence of such a signal was formerly responsible for many operating errors and for much extra work and waste of time. The existence of the supervisory lamp on the cord at the answering position enables the incoming junction operator to signal back automatically to the answering operator if the line wanted is engaged or out of order.

In the accompanying diagrams the average time occupied in the various steps of a connection between one direct line and another is shown for magneto working and for working with modern standard equipment. The explanation of the diagrams is as follows: Zero being the starting point at which the subscriber rings or takes his telephone off the hook, A is the point at which the operator has plugged in and answered, B the point at which she has taken and repeated the number, C the point at which she has tested the line wanted, plugged in and started to ring, and D the point at which the called subscriber answers. From D to E is the conversation, which is not shown on the diagrams, and F indicates the point at which the lines are disconnected after the end of the conversation at E. It will be seen that the total time spent in operating a local connection with magneto working was 14·77 seconds from the beginning of the call to the moment when the operator began to ring the called subscriber, and 17·1 seconds from the end of the conversation to the moment when the operator disconnected the two cords. In the diagrams relating to junction calls the step, B-C, includes the time occupied by the answering operator in speaking by call-wire to the junction operator and getting from her assignment of a junction and in plugging into the

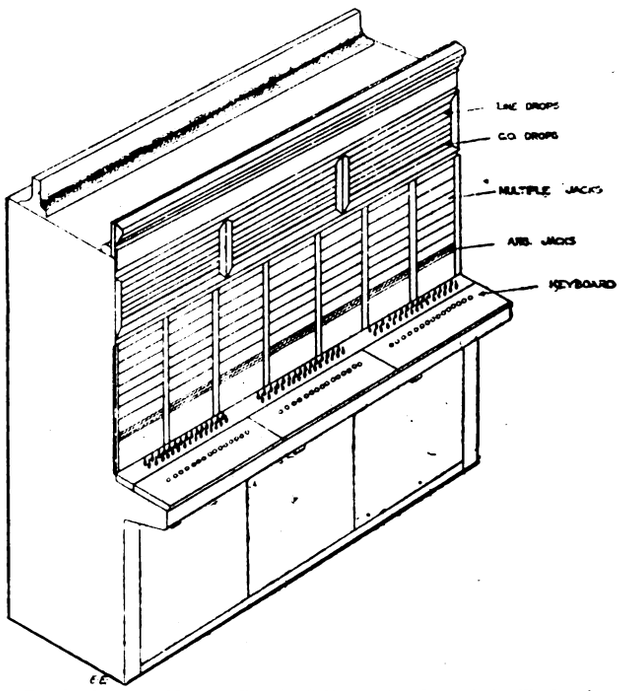


FIG. 2.—Bridging Magneto Board. Self-restoring drops, but still placed apart from jacks and cords which they control.

junction, and the time occupied by the junction operator in testing the line called for, plugging in and starting to ring; during the step B-C on junction connections work is being done simultaneously by the two operators at either end of the junction line.

There are several noticeable points in these diagrams. I should say first of all that the times given are the averages of many thousands of stop-watch observations made by trained

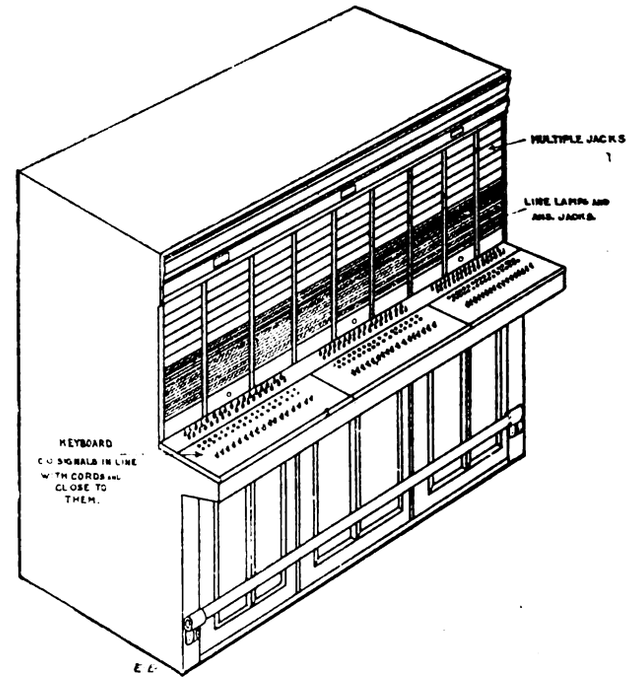


FIG. 3.—Relay Board. Automatic lamp signals placed immediately adjacent to jacks and cords which they control.

observers with special signalling appliances attached to the lines under observation, and the figures indicate with great accuracy the actual average service received by the public. The service observed is that of New York City, where the working was at one time uniformly magneto, though with various types of equipment at different central offices, and is now and has been for the past three years uniformly relay, or common battery, with practically identical equipment at all central offices.

Taking the magneto service, the average time of disconnec-

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tion, 17·1 seconds, seems long. The explanation is that on many occasions no disconnection signal was received by the operator, either because the subscribers failed to "ring off," or because the signal failed to work. In such cases the operator would only learn that conversation had actually finished by supervision—listening-in. Such a measure being necessary on a large proportion of connections, a high average figure for the disconnection necessarily resulted. Similar conditions would be found on any magneto system to-day where the subscribers have not been rigorously trained to "ring off."

the total time of operating and apparent time of subscriber's answer longer on junction connections.

The really striking features of the diagrams, however, are the great improvements in efficiency resulting from uniform relay working. It is seen that the local connection is operated in 8·55 seconds, as against 14·77 seconds, and the junction connection in 10·92 seconds as against 20·15 seconds, while the delay in disconnection is reduced from 17·1 seconds to 3·08 seconds, a substantial and important gain due entirely to the use of double supervisory signals.

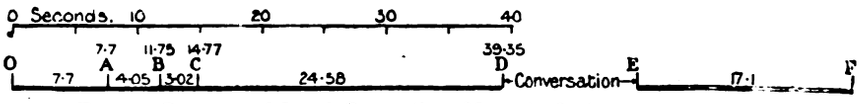


FIG. 4.—Progress of Local Connection, Magneto System.

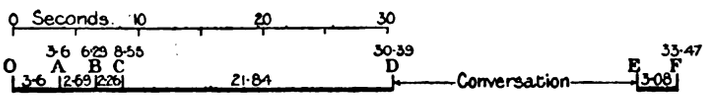


FIG. 5.—Progress of Local Connection, Relay System.

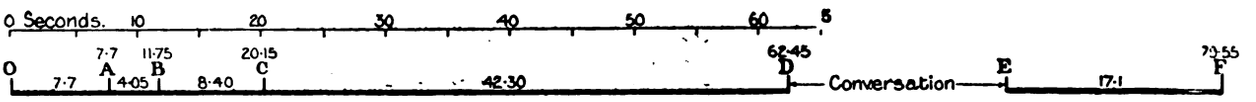


FIG. 6.—Progress of Junction Connection, Magneto System.

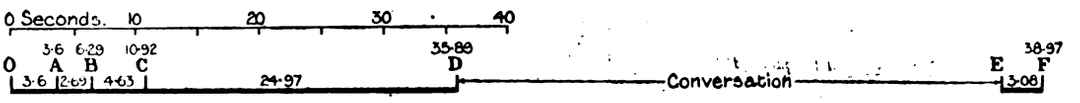


FIG. 7.—Progress of Junction Connection, Relay System

O. Beginning of call. Subscriber rings (Magneto) or takes down Telephone (Relay). A. Operator plugs in and answers. B. Operator takes number and repeats it. C. Operator tests line called for, plugs in and starts ringing. In Junction Connections step B-C includes assignment of Junction by Junction to Operator plugging into Junction by Answering Operator, and testing, plugging in and starting ringing by Junction Operator. D. Called Subscriber answers. E. End of Conversation (duration of conversation is not shown to scale). F. Operator takes connection down.

A curious feature of the service with magneto working is the much longer time taken to complete junction connections, and the diagrams show that the called subscriber's answer was apparently 18 seconds slower on junction than on local connections. As a matter of fact, the diagrams do the called subscriber a slight injustice; he really answers the call somewhat more quickly than the diagrams show. The explanation is that the operations on each connection are not strictly consecutive, as an operator usually deals with several connections at once. This results in breaking the strict continuity of the operations on a given connection; there occur short gaps in the train of operations on each connection, during which intervals operations on other connections are being performed. For the sake of clearness I have not attempted to illustrate this interweaving of operations, but have shown the various steps as if they were performed always consecutively. The natural tendency of operators is to complete local connections first; this slightly increases the gaps in handling trunk connections, and so makes the total time of operating and apparent time of subscriber's answer longer on junction connections.

To show more clearly the gain in efficiency in operating with modern apparatus, I have plotted in Figs. 8 and 9 the total time occupied in operating each class of connection under magneto and relay working, including supervision and allowing five seconds for ringing, but eliminating the called subscriber's delay in answering, and, of course, the conversation. These diagrams show a very striking contrast between the results under old and modern methods. It is seen that the time spent in operating the average connection with standard apparatus is just a third of the time occupied with magneto apparatus; in junction connections the gain is even greater, the time spent in operating the average connection with standard apparatus being less than a quarter the average time with magneto apparatus.

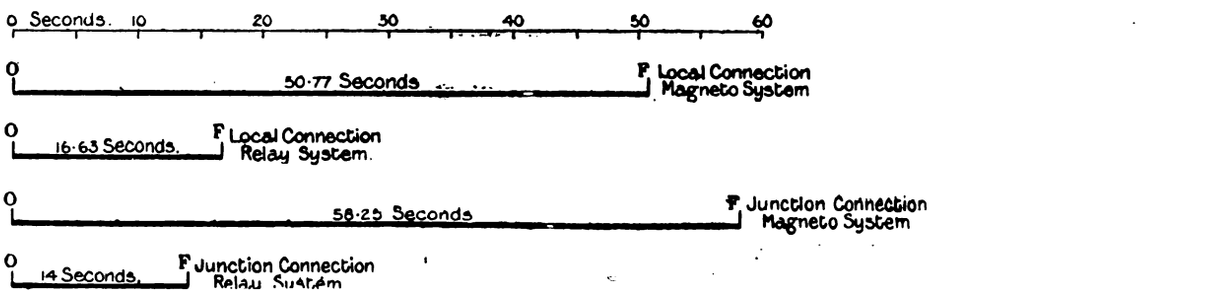


FIG. 8.—Total Operating Time per connection, including supervision and ringing. Junctions in Relay System have Automatic Ringing.

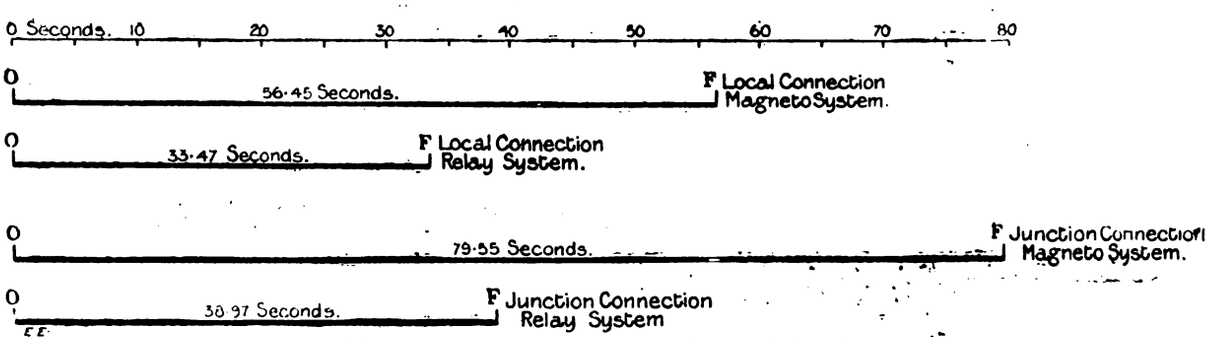


FIG. 9.—Total Time Plant is in use per Connection, exclusive of Conversation.

These figures include that with the apparatus of to-day the operator should be able to do from three to four times the amount of useful work, that is, handle from three to four times the number of calls in a day that she was able to cope with 10 or 12 years ago. It is impossible to give quantitative results of

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any exactitude, for a variety of reasons. The nature of the telephone call itself varies in different places; in some places there is hardly any junction work and the business is nearly all flat rate, making the average connection a very simple operation; while in other places there is much junction work, and a large proportion of the traffic consists of message-rate calls, party-line calls, call-office calls, and suburban and long-distance calls, which all have their quota of complication and extra work. Moreover, with the great increase in the use of the telephone during the past 10 years, there has arisen a corresponding increase in the fluctuation of the traffic—the busy hour is busier, the sudden rushes are more frequent and more accentuated—and it is the busy hour which, to a great extent, regulates the day's work of the operator in large exchanges, and the day's work of the junction lines in large systems.

For all these reasons it is impossible to establish exact comparisons of quantitative results to prove that the whole gain in efficiency and economy indicated by these diagrams has really been utilised. That a large part has is unquestionable. One instance that has come under my notice, illustrating a very substantial gain in economy, may be mentioned; it is an exchange which formerly contained a magneto equipment for 5,200 lines. The present switchboard equipment of standard apparatus is contained in a room of exactly the same size as the former room—indeed, built over it—and has a capacity of 9,600 lines. To show how difficult it is to make exact comparisons, I may mention that in the present switchboard the answering positions occupy about three-quarters of the space formerly occupied by the answering positions of the old board, whereas the incoming junction positions, though they are more economical, occupy more than twice the space formerly required for incoming junctions, so great has been the increase in the amount of junction traffic.

A saving in time in operating the average connection results in a more economical use of the plant in two ways: first, as the operator can handle more traffic in a day more lines can be terminated at a position, which means, as I have just indicated, a shorter switchboard for a given number of lines, with many attendant economies; and, second, as the plant is used for a less amount of time on each average connection, the daily traffic-carrying capacity of the plant is increased. This has a direct effect on the economy of a very important part of any large system—the junction lines and their necessary switchboard equipment. It has also an effect in reducing the "engaged" trouble—that bugbear of all busy telephone systems. In Fig. 9 the diagrams illustrate the total time that the plant is employed in the unproductive part of the connection, the time that the plant is in use from the call to the second subscriber's answer, and from the end of the conversation to the disconnection. It will be seen that on the local connection the operating period on each connection has been reduced from 56·45 seconds to 33·47 seconds, a gain of 22·98 seconds, and from 79·55 to 38·97, a gain of 40·58 seconds on junction connections. Allowing an average of 120 seconds for the conversation, the result of shortening the time during which the plant is tied up on each connection by 40 seconds is an increase of 25 per cent. in the traffic-carrying capacity of the junction plant.

### Importance of Traffic Study.

It must not be imagined that the great increase of efficiency shown by these diagrams is due solely and entirely to improved methods of signalling and improved apparatus generally. It is also due to more efficient operating and a more thorough study of the minutest details involved in the handling of telephone traffic. It remains true, however, that the improved apparatus is the fundamental cause of the increased efficiency, for with the standard apparatus of to-day we not only get signals having definite meanings, and so eliminate a fundamental defect from telephone switchboards, but we get absolute uniformity of working, and so are able to train operators more effectively and more systematically. We give the operators better tools to work with, tools which involve less mental labour and less physical labour, and we are able to better teach the operators how to use those tools most effectively, both because the whole group of apparatus has become more scientific, and because the study of all the features of telephone traffic has become more scientific. The gain in efficiency of the telephone connection would be much less than it is if the introduction of accurate and automatic apparatus had not been accompanied by the adoption of systematic medods of instructing and training operators, of supervising their work, and of continuously observing and testing the service. The preliminary training of operators is a most important point in a large and complicated system. In the old days, with a variety of types of equipment in use in the different exchanges, it was impracticable to establish a really effective training school. To-day, with uniform equipment in all exchanges, a training school where the embryo operator learns her work by the practical manipulation of the same appliances as she will handle in the regular exchange is a most natural institution. At such a training school more progress is made in a month in turning out an efficient operator than was formerly made in three months by the method of letting learners listen-in at a working position and gradually pick up the work by experiment. In any large system a training school is absolutely necessary for teaching operators the general methods of the work, the proper terms to use, the geography of the exchange districts, and so forth, but the course is relatively ineffective unless it includes practice with the actual appliances the operators are to handle, and practice in answering and completing calls; thorough practice of this kind is difficult to give unless the exchanges have a uniform type of equipment.

The general supervision of the service becomes much more effective with standard apparatus, because the lamp signals are much more easily observable by the supervisors than indicators are. Standing behind the operators at a relay switchboard one can practically follow every movement of the subscribers' telephones; a line signal unanswered or a pair of supervisory signals unattended to glare insistently until the operations demanded are performed. The supervisor's attention is instantly called to any unusual rush of cells, to any difficulty or delay.

The constant observation of the traffic is the measure which has contributed most to the effective use of modern apparatus, and to the attainment of a high standard of efficiency and accuracy in the operation of a large daily volume of telephone traffic. It is only by making continuous tests on a certain proportion of the daily traffic, noting not only the time of every step, but the method and manner of conducting every part of the operation, that sufficient information can be gained of operations involving so much detail to enable defective methods of operating to be eliminated or checked, and suggestions to be evolved tending to a general increase of efficiency.

Some idea of the complexity of telephone traffic may be had from the fact that the form for recording these service observations contains 42 columns, each with its appropriate heading. An entry in each of these columns would not be made for a single call, but the test of one connection might require notes in a fair proportion of the columns, and even if but very few entries are made, each test or series of observations contributes its quota of information relative to the speed, the accuracy, and the general efficiency of the service. To set all these observations out on a diagram would hardly be interesting, and I will only say that the observations give the time in seconds and fifths of every step of the connection, the result of every connection, whether effective or ineffective, and if ineffective from what cause—engaged, don't answer, cut off, wrong number, subscriber left instrument, etc.—the mistakes and omissions of the operator or the subscriber, for even telephone subscribers are known sometimes to make mistakes, and, in short, every ordinary vicissitude that the telephone connection is subject to. The information gained by a large number of tests of this kind, in which observation is made of every detail in the brief history of the telephone connection, is of enormous value in bringing to light the weak spots in the service, whether they be due to defects or faults in the plant, to slowness, inattention, lack of co-operation or lack of method, or erroneous methods on the part of the operators. I hardly like to hint that there may be sometimes lack of method or erroneous methods on the part of the users of the service, who may thus contribute to the errors and delays which sometimes occur in the daily stream of telephone traffic; but if there be, continuous service observations will reveal them, and measures may then be taken to suggest such reforms as seem advisable.

To secure speedy and accurate operation of the vast volume of traffic which flows daily through a large telephone system requires, first, that the apparatus used have signals of definite meaning, that the working of the apparatus be largely automatic, and that the apparatus be of uniform type throughout the system; second, that the operators be thoroughly trained in the manipulation of the apparatus and in the methods of dealing with all varieties of calls before being entrusted with the conduct of actual traffic; third, that the operators be continuously trained to active co-operation with each other, so as to produce general efficiency, and to accuracy and method in every detail; fourth, that a constant study be maintained of the actual conduct of the traffic, directed to the improvement of the standards of accuracy and speed.

## APPOINTMENTS VACANT.

**Manager** for accumulator works. Z K 227, Messrs. Deacon's, Leadenhall-street, E.C. See advertisement.

**Various.**—Northampton Institute, St. John-street-road, London, E.C. Mechanical engineering department: drawing office and lecture assistant, full time, £120; pattern maker and instructor in pattern making, full time, £130; junior drawing office instructor, full time, £100; laboratory demonstrator for the engineering laboratories, full time; junior technical assistant, full time; evening instructor in automobile work, two evenings per week. Electrical engineering department: junior technical assistant, full time; junior lecture assistant, full time. Applications by June 29. See advertisement.

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## CITY OF SHEFFIELD—PUBLIC LIGHTING.

**The following is the report of Mr. S. E. Fedden, manager Sheffield Corporation electric supply department, on the public lighting of the city of Sheffield. The report is dated June 6, 1905, and is addressed to the chairman and members of the Electric Light Committee:**

Gentlemen,—I have from time to time considered the possibilities and advantages of electricity for lighting the streets of Sheffield, and have recently acquired a quantity of information on the present condition of electric lighting in the principal cities of the kingdom, a digest of which, together with my observations on the subject, I now have pleasure in submitting to you in the form of a general report.

*General Observations on Street-Lighting.*—The amount of light provided must, of course, be proportioned to the importance of the thoroughfares in question. In some cases it is desirable to exceed the actual requirements of the traffic in order that the effect may be worthy of the surrounding buildings, and increase the attractiveness of the roads by night to the benefit of the tradesmen and the city generally, but in no case should the illumination be less than is necessary for the proper and safe handling of traffic and the convenience of pedestrians, and in this connection stress must be laid upon the importance of uniformity of illumination over the road surface and throughout a strata some 5ft. or 6ft. in height from the ground.

*Modern Conditions.*—Owing to the increase in the height of shop fronts, the width of roads, and the presence of tall tramcars and omnibuses, it is to-day more important for the light to be supplied at a considerable height from the ground, which has the further advantage of keeping the direct rays out of the eye of a person on the road and securing more uniform illumination between the lamps, because the distances between the points of greatest and least illumination and any two lamp globes are more nearly alike than in the case of a short post. Also the rays of light approach more nearly to the vertical, which is a decided advantage, securing better illumination on horizontal surfaces—roadway, sidewalk, tops of vehicles, etc.—where it is needed.

*Comparison of Different Illuminants.*—In order to fairly compare various forms of street-lighting, some precautions must be taken and attention paid to the actual illumination of every square yard of ground in the vicinity of the lamp, avoiding as much as possible directly looking at the source of light and being influenced by its colour and intensity. Many streets at a first glance appear well lit owing to the bright glare of numerous lights on short posts, but a little examination will show that at the surface of the road the effect is very poor and small obstructions are unnoticeable, and when making comparisons of effect and cost between our illuminant and gas several real disadvantages attendant upon the latter should be borne in mind, notably that the bulk of the illumination is not supplied below the horizontal; the necessity for frequent changes of the mantles, the light falling off very rapidly after the first few hours; unless expensive and elaborate lanterns are provided, the gas mantles are very susceptible to the wind, which destroys a large number at certain seasons of the year.

*Electric Lighting.*—The use of electricity for public lighting has greatly increased of recent years, owing largely to the improvement of the lamps and carbons and the cheapening of current supply. I may mention that the particular form of lamp now in use around the town hall—a "long-burning flame lamp"—has only been on the market a few months, although similar lamps burning only a few hours with each trimming, and so unsuited for street work, have been used here and elsewhere for some time now. The modern arc lamp may be relied upon to give a uniform light from the first hour of burning to the last, to be unaffected by wind and weather, and to provide the finest artificial light yet produced by any means. In addition to this the cost per unit of light is lower than with any other illuminant, as subsequent figures will show.

The accompanying list of important towns (Table A) shows the extent to which electric lighting is in use to-day, and a consideration of the populations and general importance of some of these places may well cause one to ask if Sheffield is really one of the best lit cities, as is so often stated.

*Advertisement and Advantage to the Supply Department.*—A satisfactory system of street-lighting is admitted generally to be one of the best possible advertisements for the use of electrical energy, and it removes the reproach sometimes heard that the electricity department exists only for a limited section of the community. The addition of a street-lighting load to our generating plant would be of great advantage to this department, owing to the high load factor of a system of lamps, half of which would burn 4,000 hours and half 2,000 hours out of a possible 8,760. It may be taken approximately that every 100 arc lamps supplied would consume 150,000 units per annum. I append extracts from the recent principal comparisons which have been made between electric and gas lighting in public thoroughfares, and some tabulated details which I have obtained from towns where the system of working is similar to our own. The values given for the light in every case are the results of photo-

TABLE A.—ABSTRACT OF REPLIES RECEIVED FROM VARIOUS TOWNS CONCERNING STREET-LIGHTING, MAY, 1905.

| Town. | Population. | No. of arc lamps. | Hours of burning per annum. | Inclusive charge per annum. | No. of gas lamps. | Charge for gas. | Remarks. |
|---|---|---|---|---|---|---|---|
| Aberdeen | 164,124 | 288 | 3,601 and 1,768 | 6d. and 1½d.; 6d. and 2d. | 3 876 | (*a*) 2s. 6d. | — |
| Blackburn | 130 000 | 219 | — | * £18 and £15. | 2,502 | (*a*) 3s. 3d. | * Arc half-night; two incandescents half-night. |
| Blackpool | 50,000 | 270 | 1,900 | About £15. | 1,980 | (*a*) 2s. 4d. | |
| Bedford | 35 144 | 15 | 2 000 | * £18. | 390 | (*b*) 2s. 7d. | * Includes capital charges. |
| Bristol | 365,000 | 670 | 4,380 | £14. 10s. and £21. | 8,796 | (*b*) 1s. 11d. | — |
| Cardiff | 200 000 | 491 | 3 800 | £14. | 3 200 | (*b*) £2. 3s. 2d. (gas only) | — |
| Cheltenham | 55,000 | 358 | 3,668 | £22 10s. (current only | 1 359 | (*b*) 2s. 4d. | — |
| Derby | 125 000 | 140 | 3 6 0 | * £22. 10s. † £10. | 2 456 | (*b*) 2s. | * All night. † Half-night. |
| Dublin | 360 000 | 487 | 3,750 | £22. | 6 640 | (*b*) 3s. 2d. | — |
| Ealing | 205 000 | 73 | 3 000 | £21. 10s. | 6 074 | (*b*) 2s. 5d. | — |
| Eastbourne | 51,000 | 96 | 4,013 | £22 10s. | 1,252 | (*b*) 2s. 8d. | — |
| Edinburgh | 410,000 | 997 | 3 800 | £10. 15s. | 11,539 | (*a*) 2s. 8d. | Additional arcs, £10. |
| Fulham | — | 270 | 3 780 | * £25 and £20 | — | — | * Includes capital charges. |
| Glasgow | 1,000,000 | 825 | 3,800 | £14 | 25,206 | (*a*) 2s. 4d. | — |
| Halifax | 112,000 | 69 | 4,300 | £27 (current only) | 4,486 | (*a*) 2s. | — |
| Hammersmith | — | 227 | 3 778 | £20 and £7. 10s. | — | (*b*) 2s. 5d. | — |
| Hampstead | — | 122 | 3,900 | * £28 | — | — | * Considering £24. |
| Hanley | 75,000 | 72 | 3 800 | £22 | 1 035 | (*b*) £2. 18s. 5d. | — |
| Harrogate | 30,000 | 61 | 2,100 | £11 (current) | 1,402 | (*b*) £2. 5s. 7d. | — |
| Hastings | 80,000 | 104 | 4,383 and 2,192 | £39 (average) | 1,656 | (*b*) £3. 7s. 8d. | — |
| Islington | — | 488 | Dusk to dawn | £29 (current) | — | — | — |
| Kingston-on-Thames | 50,000 | 77 | Dusk to dawn | * £20 | 1,900 | (*b*) £3. 10s. 6d. | * Including sidelights after midnight. |
| Leeds | 443 569 | 300 | 3,640 and 1,786 | £10 (average) | 15,615 | (*a*) 2s. 3d. | |
| Paisley | 84,000 | 91 | — | £25 | 1,721 | (*a*) 2s. 6d. | — |
| Poplar | — | 320 | 4,117 | £13 | — | — | — |
| Portsmouth | 200,000 | 264 | Dusk to 11.30 | £18 | 2,061 | (*b*) £3. 5s. | — |
| St. Pancras | — | 755 | 3,840 and fogs | £16 (current) | — | — | — |
| Salford | 350,000 | 116 | 3 413 | £14. 10s. | 8 803 | (*a*) 2s. 7d. | — |
| Southampton | 100,000 | 72 | Dusk to dawn | £19 | 2 059 | (*b*) 2s. 1Cd. and *3s. 4d. | * Less 5 per cent. discount. |
| Southport | 68,000 | 69 | Dusk to dawn | £20 | 2,296 | (*a*) 2/4, 2/9, and 2/11 | — |
| South Shields | 165 000 | 91 | Dusk to midnight | £22. 10s. | 3,035 | 1s. per lamp per week | — |
| Sunderland | 150,000 | 165 | Dusk to dawn | £13. 18s. 8d. | 2,802 | (*b*) £2. 9s. | — |
| Taunton | 20,000 | 72 | 2,190 | £20 | 100 | (*b*) £1. 18s. 6d. | — |
| Tunbridge Wells | 35,000 | 80 | 3,120 | * £17 | 604 | (*b*) £3. 14s. | *Includes 60 per cent. interest on loan. |
| Wallasey | 56,000 | 61 | 3,800 | £20 | 1,819 | (*a*) £3. 7s. 6d. | |
| Worcester | 43,000 | 57 | 3,685 and 2,000 | £27. 10s. and £15. 10s. | 915 | (*b*) 2s. 3d. | — |
| Plymouth | 124,000 | 74 | 3,000 | £21 | 2,500 | (*b*) 1s. 9d. | — |

(*a*) Corporation. (*b*) Company.

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metric measurement on the spot, and possibly favour gas more than electricity, as presumably the incandescent mantles were more or less new at the time of the experiments, and the light given by them falls off considerably and continuously after a few days of use.

*Unit of Illumination.*—"The Candle-foot."—This unit of illumination employed in the tests may be defined simply as the lighting effect observed with normal eyesight on a surface illuminated by one standard candle burning at a distance of 12in. from that surface. The exact measurement of light in candle-power requires great care and precision of apparatus, and the results are to some extent subject to the personal peculiarities of the observer, but when the instruments are used by the same person for comparative tests only, the errors are generally negligible and a fairer estimate can be arrived at than by any other means.

*Extracts from Paper by Mr. H. B. Maxwell, of Partick, on the subject of Street-Lighting.*

*Note.*—The technical questions in the following notes are to be decided by local conditions and can only be taken as general statements :

"In certain streets in Partick as many as six 3ft. incandescent gas-burners have been displaced by each 12½-ampere arc lamp, with the arc 25ft. from the road level. With the gas lamps there was undoubtedly plenty of light, but objects on the road between lamps at a distance of 100 or 150 yards were indistinct, and in some cases quite invisible, whereas with the arc lamps similar objects were quite clear when 300 yards distant in straight streets. Surely this is the form of illuminant required for street-lighting, for both police and traffic purposes.

"From information received from about 50 towns, the average cost per lamp per annum of incandescent gas lamps (including gas, repairs and maintenance, wages, uniforms, etc., but providing nothing for capital charges or for buying new lamps out of revenue) is :

| | | | |
|---|---|---|---|
| Single 3½ft. to 4ft. burner | £2 | 10 | 0 |
| Two " " burners | 4 | 10 | 0 |
| Three " " " | 6 | 15 | 0 |

"The candle-power of these on the street after 50 hours' use will be respectively 40 c.p., 70 c.p., and 100 c.p. There is not the slightest doubt that a very large number of towns can light their streets with arc lamps as cheaply as with incandescent gas, and with a large increase in light, provided the arc lamps are judiciously placed, and the whole scheme has been carefully designed."

*Official Test of Flame Arc Lamps around Sheffield Town Hall compared with Lucas Gas Lights.*

May 4, 1905.

Results calculated by Electric Supply Department.

| | Illuminating power. | | Cost per 1,000 c.p. | |
|---|---|---|---|---|
| | Arc c.p. | Gas c.p. | Arc d. | Gas d. |
| Nominal | 5,000 | 2,100 | ·354 | ·467 |
| Mean actual—calculated from all the observations up to 80ft. | 2,694 | 1,202 | ·657 | ·816 |
| Calculated from the observations at 60ft., 70ft., and 80ft. | 2,590 | 1,154 | ·684 | ·850 |

The illumination of the arc lamp at a distance of 120ft. was ·17 of a candle-foot, whilst at a distance of only 100ft. the illumination of the gas lamp was too low to be measured, and was consequently estimated at ·09 of a candle-foot. It also follows from the observations that with arc lamps at 100 yards apart, the illumination at its lowest point midway between any two lamps would be ·2 of a candle-foot.

*Tests at Paddington, London.*—On making certain tests on the lighting of Westbourne-terrace, Paddington, the Gas and Electricity Committee admit that 14 arc lamps give a better result than 56 incandescent gas lamps, and as a result nine main streets and 13 side streets are to be changed over to electric light.

Reference is then made to Mr. Bradley's tests at Westminster, which have been fully dealt with in these columns.—ED. *E. E.*]

*Excerpt from Mr. Pearce's Report on the Recent Electric Lighting of the Streets in Manchester by the Corporation.*

"The six open-type 10-ampere Crompton lamps in front of the infirmary on Piccadilly have been replaced by nine nine-ampere enclosed Gilbert lamps. In addition, 12 six-ampere lamps of the same make have been placed on the centre poles of the tramways running from Portland-street to Mosley-street. The old Brockie-Pell 10-ampere open-type lamps in Albert-square have been replaced by six-ampere Gilbert lamps to the same number. In St. Ann's-square, the old six Brockie-Pell lamps have been replaced by new Gilbert lamps, and two more have been added, one on either side of the centre of the square. These latter took the place of the gas lamps that were taken down. We have, therefore, in all now 45 lamps, and, so far, the new Gilbert type of lamp has given great satisfaction, burning with a clear and very steady light for at least 120 hours without recarboning, trimming, or any attention. The current consumption is, as stated by the makers, 600 watts, or six amperes at 100 volts, equivalent to seven-tenths of a unit per 1,000 candle-power hours.

"Comparing the cost of production for street-lighting as between 'arcs' and the 'intensified gas,' I take the last figure furnished me by the gas department for the latter method, which is at the rate of 1·08d. per 1,000 candle-power hours. I believe this figure also includes 10 per cent. for depreciation.

"*Gas.*—At 4,000 hours of burning. Degree of illumination equivalent to 1,000 c.p. Cost = 4,000 × 1·08d. = £18.

"*Electricity.*—Under the same conditions as above. Number of units used = 4,000 × 7s. 10d. = 2,800. 2,800 × 0·95d., £11. 1s. 6d.; carbon and trimming, 8s.; depreciation 10 per cent., £1. 3s. Cost = £12. 12s. 6d. Equivalent to 0·75d. per 1,000 candle-power hours.

"I have taken the same figure for depreciation for comparison.

"From calculations made I find that the costs of illumination in Albert-square and Sackville-street work out as follows :

*Albert-square Arcs.*

Consumption, 600 watts per hour.
Mean candle-feet (M.C.F.) taken from curves = 2·03.
Board of Trade units per M.C.F. per hour = 600/2·03 × 1,000 = 0·295.
Which at 0·95d. per Board of Trade unit = 0·28d.
Cost per M.C.F. per hour for arcs = 0·28d.

*Sackville-street Intensified Gas.*

Cost of production, 1·08d. per 1,000 candle-power hours.
Equivalent to 0·565d. per 525 candle-power hours.
Mean candle-foot taken from curves = 1·43.
Cost per M.C.F. per hour for gas = 0·565d./1·43d. = 0·395d."

The above calculations, as far as they affect the "arcs," are based on actual measurements taken on the site. These results are based on the results of working of the past few months, and are therefore reliable, and there is only one conclusion to be drawn—viz., "That the electricity department can carry out a system of street-lighting that compares more than favourably with the 'intensified gas system,' both from the point of view of annual cost and illuminating effect."

*(To be continued.)*

## CITY OF LAUNCESTON, TASMANIA.

The following is the report of Mr. Wm. Corin, A.M.I.C.E., A.M.I.E.E., the city electrical engineer, on the working of the electric light and power department for the year 1904 :

1. *Financial Results.*—I am happy to be able to point out that in place of the surplus of £660 which I showed in the forecast in my report for 1903, the year's operations have resulted in a surplus of over £2,000. In making that estimate, I had calculated that a large part of the normal increase in receipts from extended lighting would have been swallowed up by interest on the increased capital requisite for the extensions in hand, which for last year had to be provided in part before any benefit could be derived from the new plant. Fortunately, however, although the interest increased by about £400, the total receipts increased by about £1,500. Again, the previous year had been marked by the renewal of a large number of unsound poles, whilst last year it was not found necessary to renew nearly so many, and the items "wages and material," under the heading "repairs and renewals," were thus reduced by several hundred pounds. The increased surplus is thus accounted for, and as the demand for new connections is not diminishing, there is every reason to believe that this year's receipts will similarly exceed those of 1904. Added to this, as referred to below, many new motors are being connected, so that a still larger surplus may be anticipated for 1905.

2. *Accounts.*—Following on a suggestion published in a recent report of the city treasurer's, I am for the first time this year attaching to this report accounts showing the results of the working of the department during the past year. This suggestion has come at an opportune moment, for from the commencement of last year the accounts have been, as far as possible, kept in the form prescribed by the British Board of Trade for a local authority. I had for long wished to see the accounts in this form, but the high pressure under which the then limited clerical staff was continually working prevented it being attempted before last year. As they now are, the figures can be more easily compared with the published returns of municipal authorities in Great Britain. In addition to the accounts, I have added the usual analysis and tables of technical information, but have abbreviated the latter, omitting some of the less necessary items in order to prevent the appendix becoming too lengthy. I might here with advantage call attention to the fact that the sinking funds and the reserve fund, including last year's surplus, amount to nearly £14,000, the latter alone being about £4,000. The extensions being still in progress, there has not yet been written off capital any amount representing the difference between the original cost of the old plant and its present

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value, but I presume that from time to time the reserve fund will now be applied to this purpose. Meanwhile the sinking funds are year by year increasing, and the total indebtedness of the undertaking may be regarded as being reduced by an equivalent amount.

3. *Progress with Extensions.*—The past year has seen the completion of the first step in the change over from single-phase to three-phase. Early in the year the first single-phase 100-kw. alternator set was taken down, and immediately the erection of the first three-phase 300-kw. set was commenced. Unavoidable delays occurred, and it was not until June that this set could be finally connected with the water-pipes and started. Even then it was necessary to make very sure before trusting any of the city lighting to it, and some months were spent in testing and adjusting it. Finally, in October it was ready to carry load, and some of the new enclosed street arc lamps and a small part of the city lighting were supplied by it. This enabled a second single-phase set to be put out of service, and the erection of the second three-phase set to be proceeded with. Until the latter was erected and in running order, I deemed it inexpedient to trust to the first set to run continuously, and, therefore, with some difficulty, arranged that the load could be changed at the sub-station from single-phase to three-phase, or *vice versâ*, at a moment's notice. Although the consequent switching arrangements were somewhat complicated, subsequent experience showed that this provision was well judged, as but for its aid continuity of supply during the transition period could not have been maintained. It was not until last month that the difficulty in this direction was over, when the contractors placed the services of the two machines at our disposal. Since then one or other of the three-phase machines has been running continuously, and the temporary switching gear has been dismantled. Nearly the whole of the lights and motors of the central area of the city are now supplied from the new machinery, by means of the 360-kw. transformers and the low-tension underground feeders described in my last report. The results are quite satisfactory wherever the work on the overhead distributing mains, rendered necessary by the change, has been finished. This work is now rapidly approaching completion, and at the same time the changing over of the outer residential circuits is being vigorously pushed on, and will probably be complete by June. The third three-phase generator will probably be running within three weeks from now, and the fourth will be commenced immediately afterwards. The work on the pipe for duplicate water supply from the mouth of the tunnel is well under way, but its completion will have to wait until all the load is changed over to three-phase.

4. *Street-Lighting.*—Some of the new arc lamps were supplied from the three-phase plant in October. Of the remainder, some were put into service during November, and the change was completed on Dec. 22. The necessity of pushing on with the alterations to the private lighting circuits has hitherto prevented some of the arc lamps from being properly hung. Several are not yet in position, and a large part of this work is at present only temporary. When complete the majority of the lamps will be suspended over the centre of the streets. Whilst on the subject of street-lighting, I may remark that it was a matter of considerable difficulty last winter to carry the maximum load with only four machines, one of the single-phase machines having been dismantled, and the first new three-phase machine not being ready for running, and I therefore had to devise various expedients for reducing the load. Amongst others, the street lamps, which normally are 25 c.p., 32 c.p., and 50 c.p., were temporarily reduced to 16 c.p. It is noteworthy that in spite of this reduction no complaint was ever received of diminished light in the streets, although the candle-power was in many cases reduced to less than one-third of its former value. This seems to indicate that the public eye gauges an incandescent lamp used for street-lighting by the intrinsic brilliancy of the filament, rather than by the amount of light shed around.

5. *Motors.*—The month of October saw the first three-phase motor started at work. This was of 18 h.p., and was supplied to the Tasmanian Woolgrowers' Agency Company for a hydraulic dumping press, elevator, etc., in connection with their new wool stores and salerooms. The working of this motor, I am informed, is all that could be desired. There are now 46 three-phase motors, totalling 119 h.p., at work, and all are giving the greatest satisfaction. There are yet 41 motors, totalling 126 h.p., waiting to be changed over, and we have additional orders from new consumers for 15 motors, totalling 138 b.h.p., making altogether 102 motors, and a total of 383 b.h.p. at work or on order. I need scarcely remark that a considerable increase of revenue may be expected from this source.

6. *Testing-Room.*—The new testing-room at the sub-station has already justified its existence. As regards incandescent lamps, the addition of an accumulator or secondary battery and other minor improvements have so facilitated the work that it can now be carried out with the maximum of ease and comfort. Five per cent. of every batch of lamps received are tested for candle-power and efficiency, and 1 per cent. for life. Any consignments below a certain standard are rejected, and payments are made according to the result of the average life tests. As illustrating the value of this work, recently our contractor, being unable to supply some 16-c.p. lamps at short notice, a consignment was ordered from another manufacturer. Out of 984 received only 156 were within the limit, and the candle-power of the others averaged about 12, some being less than 8 cp. Had we not been systematically testing these would have been distributed to the public, but I need scarcely say that they were rejected and not paid for.

*Conclusion.*—A glance at the present position of the undertaking shows that the prospects for the immediate future are extremely encouraging. The capacity of the plant has been practically trebled for a comparatively low expenditure. In spite of the consequent augmented capital and increased interest charges, the receipts are increasing in a greater ratio, so that the new plant will be profit-earning from the start. As I showed in a recent memorandum, after providing for the lights and motors now connected, and between 300 h.p. and 400 h.p. for trams, additional motors to the extent of another 1,000 b.h.p. may yet be connected without overloading the plant. I, therefore, venture to express the hope that the suggestion already made to seriously consider the question of trams may be put into effect at an early date. I need scarcely state that the results referred to above have not been accomplished without very considerably increased work, not only to myself, but to all the staff; and, in conclusion, I wish to put on record my appreciation of their services.

ANALYSIS OF ACCOUNTS AND SUPPLY RECORDS FOR YEAR ENDED DEC. 31, 1904.

*Financial Position.*

| | |
|---|---|
| Amount of loans sanctioned | £160,000 |
| Amount borrowed | 127,097 |
| Amount expended | 139,984 |
| Amount of sinking funds | 9,908 |
| Amount of reserve fund | 1,811 |
| Total of items 4 and 5 | 11,719 |

*Financial Results for Year ended Dec. 31.*

| | 1904. | 1903. |
|---|---|---|
| Completed year of working | 8th | 7th |
| Capital expenditure at end of year | £139,984 | £115,580 |
| Revenue from lighting rate | £3,272 | £3,104 |
| Revenue from electricity supply | £8,929 | £7,545 |
| Revenue from rental of meters, motors, and fittings, and from other sources | £1,091 | £1,043 |
| Total revenue | £13,292 | £10,692 |
| Total costs | £4,391 | £5,116 |
| Gross profit before providing for interest and sinking fund | £7,901 | £5,576 |
| Percentage of gross profit to average capital | 6·19 | 4·91 |
| Interest on loans, less interest receivable | £4,191 | £3,781 |
| Sinking fund contribution | £1,531 | £1,143 |
| Percentage of ditto to average capital | 1·20 | 1·00 |
| Financial results after payment of all charges, including interest and sinking fund, surplus | £2,179 | £745 |

*Supply Records.*

| | | |
|---|---|---|
| Number of 8 c.p. lamps connected at end of year (arc, incandescents, and motors equivalent in 8-c.p.) | 44,221 | 38,677 |
| Average for the year | 41,797 | 36,368 |
| Number of units sold— | | |
| Private supply | 493,226 | 442,015 |
| Power and heating, other departments and workshops | 20,240 | 16,752 |
| Street-lighting | 244,958 | 248,550 |
| Total units sold, private and streets | 758,424 | 707,317 |
| Units sold per 8-c.p. lamp (connections during year averaged) | 18·15 | 19·45 |
| Maximum load reached, including arc lamps | 513 kw. | 575 kw. |
| Load factor | 16·83 | 14·0 |
| Capacity of plant at end of year | 600 kw. | 548 kw. |
| Average price obtained per unit— | | |
| Private supply, including other departments, etc. | 4·17d. | 3·95d. |
| Street-lighting | 2·23d. | 2·03d. |
| Total supply | 3·55d. | 3·27d. |
| Population of area supplied (last census) | 19,700 | 19,700 |

Prices charged: Private lighting, maximum demand system, with initial charge of 6d. per unit for daily average of two hours, and 1½d. per unit after. Private lamps in streets, half rates. Power and heating, 2d. per unit for first 200 units per quarter, per brake horse-power, or kilowatt, 1d. per unit after. Motors and heating apparatus for other departments, ½d. per unit. Street-lighting paid for by lighting rate.

*Analysis of Costs.*

| | 1904. £ | 1904. Per unit. d. | 1903. £ | 1903. Per unit. d. |
|---|---|---|---|---|
| Generation and distribution costs— | | | | |
| Oil, waste, and station stores | 89 | ·028 | 79 | ·027 |
| Wages of workmen | 1,756 | ·556 | 2,001 | ·679 |
| Repairs and maintenance of buildings, plant, instruments, tools, mains, transformers, meters, etc. (materials only) | 877 | ·277 | 1,264 | ·429 |
| Works costs | £2,722 | ·861 | £3,344 | 1·135 |

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| | | | | |
|---|---|---|---|---|
| General costs— | | | | |
| Rent, management expenses, election expenses, assessment roll, mayor's allowance, salaries town hall staff, hallkeeper, and messenger, salaries engineer's department and clerical staff, printing, advertising, and general establishment charges ..... | 1 669 | ·528 | 1,772 | ·601 |
| Total costs..... | £4 391 | 1·389 | £5,116 | 1·736 |

*Further Supply Records—General.*

| | 1904. | 1903. |
|---|---|---|
| Maximum loads— | | |
| Private alternating..... | 421 kw. | 457 kw. |
| Private and streets, alternating ..... | 475 kw. | 533 kw. |
| Total arc lighting, private and streets..... | 513 kw. | 575 kw. |
| Units supplied— | | |
| Streets arc, direct-current..... | 83,292 | 87,998 |
| Streets arcs, enclosed, alternating-current..... | 32,928 | 7,454 |
| Street incandescents, alternating-current ..... | 128 738 | 153,093 |
| Streets, total units..... | 244,958 | 248,550 |
| To consumers, lighting, power, and heating ... | 513,466 | 482,999 |
| Total units sold (sum of 7 and 8)..... | 758 424 | 731,549 |
| Loss in transformers, mains, meters, etc. ..... | 285,051 | 225,602 |
| Grand total, units from station ..... | 1,043,475 | 957,151 |
| Private lighting— | | |
| Number of consumers connected Dec. 31 ..... | 2,143 | 1,915 |
| Increase of ditto during year ..... | 228 | 285 |
| Number of 8-c.p. lamps connected Dec. 31 ... | 30,489 | 27 461 |
| Increase of ditto during year ..... | 3,028 | 3,871 |
| Power— | | |
| Number of motors in use on Dec. 31 ..... | 80 | 65 |
| Total aggregate horse-power..... | 218 | 161 |
| Heating— | | |
| Number of consumers on Dec. 31 ..... | 257 | 185 |
| Total kilowatts in use ..... | 116 | 90 |

# LEGAL INTELLIGENCE.

## PRODUCTION OF TRAMWAY TICKETS.

At the Nottingham Guildhall last week Mr. W. W. Simpson, secretary of the Derby and Nottingham Electric Power Company, was summoned for refusing to produce his ticket when travelling on one of the Corporation trams

Mr. STEVENSON, on behalf of the Corporation, stated that the defendant seemed to have the idea firmly fixed in his mind that he need not deliver up his ticket when travelling on the tramways. When an inspector got on to the car and asked him for his ticket, Mr. Simpson refused to produce it, saying, "I have thrown it over the side." Defendant also refused to pay the fare when requested. After quoting the by-law under which the proceedings were taken, Mr. Stevenson pointed out that the case was of very great importance, because if people acted in the way that the defendant had done the business of the Corporation would be completely disorganised.

Evidence having been given by the inspector, the DEFENDANT deposed that when he paid his fare he was offered a ticket, but he refused to take it, as he had done on several previous occasions. When asked by the inspector for his ticket he said that he had been so insulted of late by inspectors that he had ceased to take tickets, and had not taken one on that occasion.

Cross examined by Mr. Stevenson, defendant stated that when offered a ticket, he told the conductor that he "would not touch the accursed thing."

Mr. GREEN, for the defendant, said there was no by-law which compelled a passenger to take a ticket when he paid his fare, and if a man refused to take a ticket he could not be summoned for not producing one.

The CHAIRMAN: We are perfectly clear that he took a ticket on this occasion.

Mr. GREEN said that it was no business of Mr. Simpson's to act as a servant of the Corporation in checking the honesty of their employés by taking tickets, and Mr. Simpson had now adopted the attitude of paying his fare just before getting off.

The CHAIRMAN said it was quite clear that the offence was committed, and imposed a fine of 20s.

A summons for a similar offence on May 22 was then heard.

According to the prosecution, the defendant, in this case, was asked for his ticket as he was about to leave the car, and he replied that it was "on the top."

The Bench held that this was not "producing" the ticket, and, in fining the defendant 10s., said they were prepared to state a case if necessary.

# COMPANIES' MEETINGS AND REPORTS

## ELECTRIC AND GENERAL INVESTMENT.

The directors recommend the payment of the following dividends, etc., for the year ended May 31: ordinary shares, a dividend of 4s. per share, of which 1s. per share was paid on account in January last, leaving 3s. per share to be distributed; the trustees for the ordinary shares reserve fund propose to distribute out of the dividends received 1s. per share, making a total present distribution of 4s. per share, or 20 per cent., or a total distribution of 5s. per share, or 25 per cent., for the year; founders' shares, a dividend for the year ended May 31 of £20 per share; the trustees for the founders' shares reserve fund propose to distribute out of the dividends received £10 per share, making a total present distribution for the year of £30 per share. The above-mentioned payments will be subject to the deduction of income tax.

## CHADBURN'S (SHIP) TELEGRAPH.

The report for the year ended March 31 shows the balance to the credit of the profit and loss account to be £18,095, less managing director's remuneration, directors' fees and expenses, depreciation on properties and plant, £8,234—£9,860. From this amount £6,000 must be deducted, being dividends which have been paid at the rate of 6 per cent. per annum on the preference shares and an interim dividend of 8 per cent. per annum on the ordinary stock, leaving the sum of £3,860. This sum, together with the balance carried forward from last year, makes a total of £11,187. 3s. 8d. to be dealt with. The directors propose to pay a dividend on the ordinary shares of 12 per cent. per annum, less income tax, for the half-year ended March 31, making, with the interim dividend already paid, a dividend of 10 per cent. per annum for the 12 months, carrying forward a total balance of £7,587. The year's working has, state the directors, been extremely satisfactory, and a large amount of very profitable work has been carried out, independent of the ordinary telegraph business. They consider this a favourable opportunity to write off a larger sum than usual under the head of depreciation in reduction of the amount appearing in the balance-sheet for goodwill, patents, etc. New works have been purchased in Cyprus-road, Bootle, and they have now been in full operation for over 12 months. The results have shown an economy in working.

# LIENS REGISTERED.

**Barbados Light Railway, Limited, Westminster.**—Lien registered, June 1, for £6,000 5 per cent. debentures. Holder: C. J. P. Cave, Petersfield, Hants. Charged on the railways, plant, and rights, etc., in the island of Barbadoes, the undertaking, and all other property, present and future.

**Woking Electric Supply Company, Limited.**—Issue on May 6 of £150 debentures, part of a series created Nov. 2, 1899, to secure £25,000. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £24,850.

**Diesel Engine Company, Limited.**—Issue on May 27 of £15,000 debentures, being the whole of a series created May 26, 1905. Property charged: the company's undertaking and property, present and future, including uncalled capital. No trustees.

# CONTRACTS FOR ELECTRICAL SUPPLIES.

**Panama.**—The Municipality will shortly require tenders for construction of an electric tramway.

**Hornsey.**—The Town Council invite tenders for switchboards and brackets for arc lamps. Tenders by June 19.

**Darlington.**—The Corporation invite tenders for switchboard extension and booster. Tenders by June 19.

**Aston Manor.**—The Corporation invite tenders for the electrical equipment of their overhead tramways. Tenders by June 23.

**Grays Thurrock.**—The Urban District Council invite tenders for switchboard extension, storage battery, etc. Tenders by June 17.

**Paddington.**—The Guardians invite tenders for rewiring the whole of the electric bells at their infirmary in the Harrow-road. Tenders by 5 p.m. on 20th inst.

**Leigh (Lancs.).**—Tenders are invited for the supply of one water-tube boiler for the electricity department. Tenders by July 1. See advertisement in last issue.

**Rosario de Santa Fe Argentine.**—The Municipality require tenders for the construction and working of electric tramways in the town. Tenders by July 30.

**Kingston-upon-Hull.**—The Electric Lighting Committee invite tenders for the supply, delivery, and erection of various plant. Tenders by June 22. See advertisement in last issue.

**Bristol.**—Tenders are invited for single-phase alternating-current transformers and three-phase to direct-current motor-generators. Full particulars from the City Electrical Engineer, Temple Backs, Bristol.

**Stepney.**—The Electricity Committee invite tenders for the supply during the year ending June 30, 1906, of ampere-hour meters, demand indicators, and arc lamp carbons. Tenders by noon on 28th inst. See advertisement.

**Rotherham.**—The Corporation invite tenders for the supply and delivery of cable and meters according to their requirements between July 1, 1905, and June 30, 1906. Tenders by 26th inst. Full particulars in advertisement columns.

**Stalybridge.**—The Stalybridge, Hyde, Mossley, and Dukinfield Tramway and Electricity Board require tenders for the supply, delivery, and erection at the Stalybridge sub-station of a 400-kw. motor-generator, together with the necessary switchgear for same.

**London, W.**—The Great Western Railway Company invite tenders for the supply, delivery, and erection of the following plant in connection with their electricity generating station at Park Royal: (Specification 18) pipework, feed and other pumps, tanks, feed heaters, water-softening and oil-separating plant, etc. Tenders by 10 a.m. on 26th inst.

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## RESULTS OF TENDERS.

**Exeter.**—The Corporation have accepted the tender of Dick, Kerr, and Co. for two cars and equipments.

**Burnley.**—The Corporation have accepted the tender of Dick, Kerr, and Co. for one 500-kw. direct-current generator.

**Metropolitan Electric Supply Co.**—The tender of Dick, Kerr, and Co. has been accepted for two 500-kw. motor-generators.

**Batley.**—The Corporation have accepted the tender of Dick, Kerr, and Co. for 5¼ miles permanent way and overhead equipment.

**Partick.**—The Municipality has placed with Messrs. Bruce Peebles and Co. an order for a 600-kw. direct-coupled set for their lighting station.

**Hammersmith.**—The Electricity Department have accepted the tender of E. Bennis and Co., at £747, for a complete coal and ash elevator conveyor plant.

**Johannesburg.**—The Municipality have accepted the tender of Dick, Kerr, and Co. for 100 single-truck top-covered cars and equipments and two watering cars.

**Portsmouth Dockyard.**—The tender of Bennis and Co. has been accepted for 20 Bennis stokers and furnaces, shafting, gear, etc., through E. Danks and Co. (Oldbury), Limited.

**Ashton-under-Lyne.**—The Corporation have accepted the tender of Dick, Kerr, and Co., Limited, Abchurch-yard, Cannon street, London, E.C., for six tramcars and equipments.

**Burton-on-Trent.**—The Corporation have accepted the tender of Messrs. Edward Bennis and Co. for four Bennis patent machine stokers and new patent self-cleansing compressed-air furnaces.

**Northampton.**—The Northampton Electric Light and Power Company have accepted the tender of Messrs. Edward Bennis and Co. for complete coal and ash elevating and conveying plant, coal-bunkers, etc., at £862.

**Blackpool.**—The Corporation have accepted the tender of Messrs. Bennis and Co. for two Bennis patent stokers and self-cleansing compressed-air furnaces for Lancashire boiler, and automatic steam regulator.

**Heywood.**—The Town Council have accepted the tender of R. W. Blackwell, 59, City-road, London, E.C., for the construction of the permanent way and paving and overhead electrical equipment of about four miles of tramways.

**Trefriw (Denbighshire).**—The Hart Accumulator Company, Limited, Marshgate-lane, Stratford, London, E., have secured the order for the supply of a battery of 120 of their standard lighting type cells required at the electricity works.

**Scottish Central Power Co.**—Messrs. Bruce Peebles and Co. have secured a contract for the extension of the above company's generating plant. The contract includes 3,000 h.p. in steam alternators, condensers, switchboard, etc. The price is £17,000.

**Kettering.**—The Urban District Council have received the following tenders for Nernst lamps:

Total of tender with type "A" brackets.

| | | | |
|---|---|---|---|
| Johnson and Phillips, Old Charlton | £566 | 2 | 2 |
| T. L. Scott and Co., London | 623 | 16 | 5 |
| National Electric Construction Company, Limited, Wolverhampton | 636 | 2 | 0 |
| Drake and Gorham, Limited, London | 638 | 5 | 6 |
| Improved Electric Glow Lamp Company, London | 641 | 9 | 8 |
| W. Lucy and Co., Limited, Oxford | 666 | 8 | 2 |
| W. T. Allen and Co., London | 668 | 19 | 0 |
| Keighley Electrical Engineering Company, Limited, Keighley | 674 | 6 | 6 |
| D. Firth and Son, Manchester | 687 | 18 | 9 |
| W. T. Skelding and Co., Limited, Dudley | 679 | 13 | 0 |
| Reason Manufacturing Company, Limited, Brighton | 690 | 15 | 6 |
| General Electric Company, Limited, London | 696 | 10 | 0 |
| Electrical Company, Limited, London | 739 | 9 | 4 |
| Moorwood, Sons, and Co., Limited, London | 747 | 0 | 0 |
| Hattersley and Davidson, Sheffield | 740 | 4 | 10 |
| H. P. Hodge, Kettering | 773 | 4 | 6 |
| Tibbington Foundry Company, Tipton, Staffs. | 843 | 0 | 0 |
| Oliver and Co., Woolwich | 921 | 17 | 4 |
| H. A. Jackson and Co., Burnley | 989 | 7 | 6 |
| A. C. Dickens, Northampton | 1,004 | 0 | 0 |
| J. Milne and Son, Limited, London | 4,005 | 9 | 8 |

Total of tender with type "B" brackets.

| | | | |
|---|---|---|---|
| Johnson and Phillips (accepted) | 535 | 1 | 0 |
| T. L. Scott and Co. | 570 | 13 | 8 |
| National Electric Construction Company | 599 | 9 | 0 |
| Drake and Gorham, Limited | 630 | 16 | 0 |
| Improved Electric Glow Lamp Company | 651 | 3 | 6 |
| W. Lucy and Co., Limited | 690 | 9 | 8 |
| W. T. Allen and Co. | 669 | 17 | 6 |
| Keighley Electrical Engineering Company, Limited | 666 | 9 | 6 |
| D. Firth and Son | 653 | 19 | 9 |
| W. T. Skelding and Co., Limited | 725 | 7 | 0 |
| Reason Manufacturing Company, Limited | 650 | 15 | 0 |
| General Electric Company, Limited | 694 | 5 | 6 |
| Electrical Company, Limited | 743 | 14 | 6 |
| Moorwood, Sons, and Co., Limited | 720 | 10 | 0 |
| Hattersley and Davidson | 723 | 6 | 8 |
| H. P. Hodge | 777 | 6 | 0 |
| Tibbington Foundry Company | 813 | 0 | 0 |
| Oliver and Co. | 915 | 16 | 6 |
| H. A. Jackson and Co. | 1,050 | 17 | 6 |
| A. C. Dickens | 997 | 0 | 0 |
| J. Milne and Son, Limited | 3,824 | 5 | 3 |
| Pontifex and Co. (posts and brackets only) | 189 | 3 | 0 |

**Durham Collieries Electric Power Supply Co.**—Messrs. Bruce Peebles and Co. have secured an order for a 9,000-h.p. generating station complete, at £92,000, from the above company.

**Stoke Newington.**—Ferranti Limited have received, through Bruce Peebles and Co., Limited, the order for the transformers required for stepping down 10,000-volt three-phase current to supply motor-generators. The ratio of the transformers is 10,000/500, they are oil cooled, and the total capacity is about 350 kw.

**Thirsk.**—The Parish Council have accepted the tender of the Northern Counties Electric Supply Company for the lighting of Thirsk for 1905-1906. The contract price is 29s. 6d. per 40-c.p. lamp per year as against 31s. paid to the electric light company previously. The Northern Counties Electric Company has also secured the contract for lighting Thirsk Junction railway station.

**Moxley (near Bilston).**—The South Staffordshire Joint Small-pox Hospital Board have received the following tenders for the electric wiring and lighting (including main cables, fittings, etc.) at the small-pox hospital:—

| | | | |
|---|---|---|---|
| Whittaker Bros., 204, Wolverhampton-street, Dudley (accepted) | £193 | 0 | 0 |
| Cross and Cross, Walsall | 211 | 9 | 0 |
| D. Firth and Son, Manchester | 218 | 0 | 0 |
| National Electric Construction Company, Wolverhampton | 230 | 13 | 6 |
| W. T. Skelding and Co., Dudley | 255 | 15 | 6 |
| G. Cave and Son, Raby-street, Wolverhampton | 262 | 8 | 6 |
| District Electric Company, Berry-street, Wolverhampton | 268 | 0 | 0 |
| Egginton and Co., Tempest-street, Wolverhampton | 276 | 0 | 0 |
| Dudley Electrical Company, 53, High-street, Dudley | 300 | 0 | 0 |
| H. A. Jackson and Co., Burnley | 350 | 0 | 0 |

# BUSINESS NOTES.

## TRACTION.

**Grimsby.**—The Corporation and the company have come to terms by which the latter will extend their system.

**Leeds-Wakefield.**—Electric trams are now run from the centre of Leeds to the centre of Wakefield, a distance of 10 miles.

**Bolton.**—The Tramways Committee have decided to grant their motormen, conductors, and night-shed men four days' holiday per annum with pay.

**Eccles.**—The electrical engineer has been instructed to obtain from the Salford tramways manager definite information as to the quantity of electrical energy required for working the tramways within the borough of Eccles.

**Russia.**—It is reported that in view of the great lack of efficient electricians on the Russian railways the Minister of Ways of Communication has decided to establish special electricity schools on all the Government railways.

**Anglo-Argentine Tramways Co.**—The directors have declared an interim dividend on the preference shares of 2s. 9d. per share, less income tax, for the half-year ending June 30, on which date the dividend warrants will be posted.

**Bournemouth.**—Some little delay appears to have arisen in the completion of the transfer of the company's business to the Corporation, at which the latter are manifesting symptoms of impatience, as they are anxious to link up the systems. A complete scheme of fares has been prepared.

**Bristol.**—At a meeting of the inhabitants of Warmley, the following resolution was carried unanimously: "That the chairman be asked to present the resolution to Mr. Samuel White personally to consider it with the greatest possible care, and give them the greatest facilities to get the extension carried out at once."

**Signalling by Wireless Telegraphy.**—The Chicago and Alton Railway has prepared a section of its system and rolling-stock to conduct tests with a wireless telegraphic device. It is proposed to equip engines with instruments by means of which wireless signals may be exchanged between trains so as to avoid disasters.

**Halifax.**—A special meeting of the Town Council has been convened for to-night, when a proposal to construct a line of tramways from the terminus at Salterhebble to the Calder and Hebble Inn, at an estimated cost of £6,400, will be considered. A loop line is to be constructed on the Triangle section at a cost of £250. A proposal to introduce an eight-hour day was negatived as impracticable. The employés work nine hours per day.

**Railway Electrification in America.**—It is reported that electric traction is to replace steam power on the Chicago and Evanston line of the Chicago, Milwaukee, and St. Paul Railway, and that the line will be operated by the North-Western Elevated Railway, which will connect with the surface line by an extension from its present terminus at Wilson-avenue. All passengers and freight traffic will be handled by electricity north of this point, and within a few years the railway will be elevated from Wilson-avenue to the city limits.

**Croydon.**—The Corporation have decided to give the British Electric Traction Company notice of determination of the latter's lease on May 31 next. An independent engineer is to be engaged to report to the Corporation upon the condition of the system. The town clerk has been instructed to take such steps against the company as may be necessary for the restoration of certain feeder cables, regarding which the Corporation have been in communication with the company for some time. The borough electrical engineer reports that, in general, the rails and equipment are in a satisfactory condition.

**Darlington.**—At last week's meeting of the Tramways Committee a report of a somewhat unsatisfactory nature regarding the ½d. fares was given. During May the revenue per car mile was only 6·35d. as

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against 6·63d. in April. The receipts for the four weeks ending May 27 were £779. 0s. 3d., £112 less than in April. The number of passengers carried was an increase, being 241,655 against 225,419, so that onus of the decrease apparently rests on the new ½d. fare system. The car mileage for May was 29,434·4, comparing with 28,625·5 for the previous month. A much larger increase in passengers than has obtained was expected by the committee.

**Yarmouth.**—The accounts for the past year show that the total income amounted to £8,736. 8s. 3d. (an increase of £960. 3s. 9d. on the previous year), and the expenditure amounted to £6 348. 6s. 6d., leaving a gross profit of £2,388. 1s. 9d. (an increase of £450. 11s. 11d.), which, after deducting interest and sinking fund charges, leaves a net profit of £284. 1s. This amount, with £191. 3s. 4d. balance from previous years, makes a surplus of £475. 4s 4d. It was resolved to place £400 to a depreciation fund, and carry the balance of £75. 4s. 4d. forward. The Queen's-road extension has materially contributed to the increased receipts. The number of passengers carried during the year was 1,821,200. It is hoped that the Gorleston section will be ready early next month.

**Walsall.**—The following recommendations figure on the Town Council's agenda: "That an arrangement be entered into with the Wolverhampton and District Electric Traction Company, Limited, under which the Corporation shall have the right to run 'through' cars over the company's line to and from the Market-place, Willenhall, on such terms and conditions as may be agreed upon by the Tramways Committee and the company. That the Corporation extend their tramway from its present terminus on the Walsall-road, Willenhall, for about 18 yards, so as to form a junction with the tramway of the Wolverhampton and District Tramways Company, Limited, at an estimated cost of £200, and that the town clerk be authorised to make application to the Board of Trade for their approval to such work being carried out."

**Automatic Signalling.**—The North-Eastern Railway Company have had installed on the 11 miles' stretch of their main line, extending from Green Lanes, Thirsk, to Alne Station, a system of automatic signalling. Recently the system was examined by Lieut.-Colonel P. C. von Donop on behalf of the Board of Trade, and last week the new method was brought into regular operation. The system, which was installed by the Hall Signal Company, of New York, is designed to enable the services of signalmen, except at points of junction, to be dispensed with, and is purely automatic, the necessary connections being set up by the trains themselves. The valves for admitting the air to the operating cylinder are electrically controlled. The arrangement is expected to materially increase the capacity of the line.

**Woolton.**—The question of linking up Woolton with the Liverpool tramway system came before the District Council the other day, when Mr. M'Guffie moved the following resolution: "That the Council take steps to devise and determine the best route to bring electric trams into Woolton, and the course to adopt so that the ratepayers will participate in any profits arising therefrom." He asked to be allowed to divide his motion in three parts: first, as to the desirability of having electric trams; second, that parliamentary powers should be secured, unless advantageous terms could be made with the Corporation of Liverpool, or others; and third, as to the best route for the line to take. As no seconder was forthcoming, the matter dropped. The general opinion appeared to be that with two 'bus routes and three railway stations the district was sufficiently served.

**Belfast.**—At Tuesday's meeting of the Tramways Committee consideration was given to the question of the fares. The sub-committee, which had met on the 6th inst., recommended the adoption of a further report by the manager (Mr. Andrew Nance), submitting a scheme of lengthened 1d. stages, with a 2d. maximum fare, which the manager stated he had endeavoured to frame upon the principle of making it as convenient as possible to the greatest number. After some discussion, the report was adopted, subject, of course, to confirmation by the Council. The city surveyor (Mr. H. A. Cutler) reported that he was not yet in a position to proceed with the conversion of the trams on Shore-road as the Antrim-road was about to be taken in hand, and the Cavehill and Whitewell Tramway Company would commence work on their line simultaneously with the Corporation contractors, so that it was necessary that the Shore road should be kept open for the traffic which would be diverted from the Antrim road. A deputation attended and, on behalf of the residents of Ardoyne and Ligoniel, asked for tramway facilities, and after considerable discussion the manager was instructed to provide a service *via* Shankhill-road to Ardoyne.

**District Railway.**—Tuesday witnessed the disappearance of the steam locomotive from another section of the District Railway, the branch from South Acton to Hounslow Barracks being now worked by electricity. The new service of electric trains was successfully put into operation without ceremony. This new section is some 6½ miles in length. July 1 is the day on which electricity was expected to be adopted generally on the system of the District Company, but it may be that the period will have to be extended. There have been unlooked-for delays in the delivery of the rolling stock, and it is the intention of the company that the electric service on the circular system shall not be started until they are in a position to run it in its entirety, they being anxious to avoid the half-and-half policy. It is stated officially, however, that on the main stretch of line, running from east to west, electric trains will be running in the very near future, probably by the end of July. The whole line is, in fact, ready now, and the company only awaits a sufficient number of cars. Automatic signalling will come into operation with the working of the line by electric traction. This system has already been submitted to an exhaustive trial, lasting over two years, on the Mill Hill Park to Harrow branch and has given every satisfaction. It is claimed that this system is "fool-proof" and that it is impossible for a train to over-run a signal that stands at "danger." It is expected that this will enable something like double the number of trains to be run.

**Burnley.**—At the meeting of the Corporation the recommendation submitted by the Joint Tramways and Electricity Committee, that the duties of the tramways manager be revised so as to limit such duties strictly to the management of the traffic on the tramways, and that the duties of the borough electrical engineer be revised so as to include the management and supervision of all the electrical undertakings of the Corporation, was carried, subject to an amendment that the resolution read "be revised if found necessary." A sub-committee has been appointed to visit other towns for the purpose of making enquiries as to the duties of the borough electrical engineer and tramway manager respectively. A councillor has given notice of the following motion, which he has agreed to leave over until after the joint committee have reported: "That this Council is of the opinion that the public interest will be better served in regard to efficient service, economical administration, and freedom from official friction by a reform of our tramway and electrical departments so as to secure (1) the amalgamation of the two departments under one committee; (2) the appointment of an electrical engineer who shall have full control over both the electrical and tramway departments; (3) the appointment of a traffic manager who shall be subordinate to and under the control of the electrical engineer. Such rearrangement, subject to due regard being paid to existing contracts, to be brought into operation as soon as possible."

**Newcastle.**—At last week's meeting of the Corporation, the tramway returns for the year ended March 31 were presented. The income totalled £197,849 against £185,027 for the previous year, the receipts per car mile working out at 10·98d. against 10·94d., an increase of ·04d. The expenditure represented £127,018 against £121,557, the amount per car mile being 7·05d. against 7·19d., a decrease of ·14d. The car mileage for 1904-5 has been 4,326,152 as against 4,059,907 last year, an increase of 266,245. Salaries and wages showed a slight increase, and the cost of power and distribution expenses amounted to £10,628 against £9,751. The gross profit on the year's working, after adding a small amount for sundry items, is £70,936. 11s. 8d. as against £63,469. 18s. last year, an increase of £7,466. 13s. This is to be disposed as follows: to amount written off stocks on revaluation, £923. 0s. 7d.; amount deducted from profits for money stolen from traffic receipts at Byker depôt on Jan. 1, 1905. £57. 13s. 9d.; interest on loans, £33,944. 5s. 7d.; redemption, £89,717. 13s. 4d. These together leave a net profit on the year's working of £6 293. 18s. 5d. The balance remaining from the previous year was £3,681. 1s. 6d., so that the total surplus is £9,954. It is reported that in addition there is a sum of £10,000 to be taken into account. This had been lent to the Education Committee, but has been paid back and invested at 3¾ per cent. interest. This sum, added to the £9,945 mentioned above, brings the sum to be dealt with up to £19,954. It is proposed that the Council should invest this sum as a nucleus for depreciation. There has been paid off in redemption £83,371, of which £81,318 has been entirely extinguished, and £2,053 has been invested in a sinking fund. The accounts will be considered at a special meeting of the Tramways Committee to-night.

**Heywood.**—At the meeting of the Corporation the town clerk submitted draft agreement prepared by him with Bury and Rochdale Corporations for working the Heywood tramways, and it was resolved, "That the agreement be approved and submitted to the Corporations of Bury and Rochdale for their consideration." Councillor Popple subsequently proposed the adoption of the minutes of the Tramways Committee. He stated that during the past month the average of the daily receipts was £11. 16s. 6d.; for the previous month it was £11. 7s. 8d. and for the month prior to that £9. 18s. 2d. Referring to a communication received from the Lancashire Electric Power Company, he stated that the Heywood electrical engineer and the consulting engineer (Mr. Salter), travelling somewhat different roads, had come to the same conclusion, which was that they should be able to produce electricity at about 1½d. instead of 3d. per unit. Mr. Salter had stated that he would be disappointed if the cost of the current in Heywood did not come down to 1d. per unit If Heywood decided to purchase power from the Lancashire Electric Power Company, that company would have to lay miles of cables largely through a hostile country, and they would have to obtain wayleaves from landowners before they could lay their cables. Their nearest works were at Outwood. If Heywood bought electricity from the company they would receive the current at a high tension, and the Corporation would have to supply machinery to reduce the tension and distribute the current. Therefore, instead of getting the current for 1·3d. per unit, it would cost Heywood about 2½d. per unit. In the first report given by Mr. Salter it was stated that they would have to spend £8,000 on the electricity works in order to provide the required current, but that estimate had since been reduced to £6,000. Taking all things into consideration, the committee had decided to generate their own electricity. The minutes were adopted.

**Light Railways.**—Applications to the Light Railways Commissioners are now pending in reference to systems for Yorkshire and Lincolnshire. It will be remembered that an application was made early this year to the Commissioners by the promoters of the Ackworth and Immingham Light Railway, which it was proposed to construct from the Ackworth coal mines to the new Humber Dock at Immingham. An enquiry was held, and the Commissioners refused their sanction, stating that the undertaking, which proposed to cross the Trent, was of such magnitude that it needed a parliamentary enquiry. The proposal has now been revived in a modified form, but in two sections, and the projected bridging of the Trent has been abandoned. The new scheme differs considerably from the old, which was substantially for a line from the Ackworth mines roughly, parallel with the Lancashire and Yorkshire Railway from Pontefract to Goole, and thence parallel with the Marshland railway to Trent side, where it was proposed to carry a bridge across the river to the Lincolnshire shore. The main line in the present application will be, approximately, 12 miles in length, and will proceed in an easterly and south-easterly direction, from a junction with the Knottingley and Swinton

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Railway of the Midland and North-Eastern, east of Ackworth Station, and thence to Thorpe-in-Balne, where it will join the West Riding and Grimsby Railway (jointly owned by the Great Central and Great Northern) near Shaftholme Junction. This will give direct access from the collieries to Grimsby. The promoters also propose to take power to make a junction with the Hull and Barnsley Railway between Norton and Kirk Smeaton, thus giving access to Hull by this route, and also by the North-Eastern over the Knottingley and Swinton Railway. In its amended form the scheme is less contentious than in its original shape. The promoters of the North Lindsey Light Railway, now in course of construction, are seeking power to extend their line, this being virtually a rival scheme to the proposed Barton Light Railway.

**Yardley.**—At Tuesday's meeting of the District Council the following resolution was submitted: "That the Tramway Committee be instructed to report to the Council as soon as possible on the question of tramways from College-road, Sparkhill, to Shirley." The mover stated that in 1906 the period allowed the Birmingham and Midland Tramway Company to complete the electrification of the Stratford-road route expired, but, although the time was rapidly drawing to a close, no steps appeared to have been taken. His object in bringing the matter forward was to obtain information for the public. He had just received a letter from a Shirley resident pointing out how that district was suffering from the lack of the means of transit. Not only this, but the development of the outlying districts of Birmingham was necessary in order to deal with the slum question in the city. He had seen it urged that trams to Shirley would not pay, but there were many shopkeepers in that district whose businesses would not show any return for years to come, and the tramway company would have to look to the future also. Mr. Spires seconded the resolution, remarking that the time had now arrived to compel the tramway company to show their hand, and to declare whether they intended to lay down tramways or not. In the latter case, the Council should formulate some other scheme, and perhaps the Council itself might lay down the lines and arrange with the Birmingham Corporation to run its cars upon them. Eventually it was agreed to defer consideration of the matter until the next meeting. A letter was received from the Worcester County Council, stating that the attention of the City of Birmingham Tramways Company had been called to the granite setts laid by them in the Stratford-road, and the clerk stated that Mr. Lycett had been communicated with, and had promised to have the matter attended to. A communication has been received from the Board of Trade stating that the Board have made an order sanctioning the use of steam power on the tramway between Baker-street and College-road, Sparkhill, for a further period of 12 months.

**London County Council.**—The Highways Committee reported at last week's meeting of the Council that street widenings were being executed in connection with some of the authorised lines in West London, in consequence of which it will probably not be possible to proceed with the construction of these lines for some 12 months. The committee recommended, however, that the lines from Hammersmith Broadway to Putney should be undertaken early next year. It has been necessary to consider the question of the arrangements to be made for the erection and equipment of the car depôts, independently of the actual tramways construction, as the time occupied in acquiring sites and erecting the requisite buildings thereon is considerably longer than that required for the track. The only building required in the first instance for the tramways above referred to is a car-shed at Hammersmith, arrangements having been made for the temporary supply of energy. A site adjoining Hammersmith Broadway has been secured for the depôt, of which it is only necessary to construct part at present, but the committee propose that plans, etc., shall be prepared for the whole. The approximate cost of the car-shed is £31,000, and of the portion proposed to be first built, £21,000. The Council agreed to the committee's proposal that £300 should be voted for the preparation of plans and estimates. There are indications that an amicable arrangement will be arrived at between the City Corporation and the County Council. The Special Committee of the former body sat several times last week to consider the question from all standpoints, the object in view throughout their deliberations being to formulate, if possible, some scheme as a substitute for the veto previously decided upon. A deputation of the Highways Committee of the County Council waited upon the Special Committee, and a long and interesting conference took place, a welcome sign being the evident desire on the part of all to promote friendliness of feeling between the two bodies concerned. It is reported that the Special Committee will, with practical unanimity, present a report on June 22, recommending the Court to rescind the previous resolution. The idea in the mind of the Special Committee seems to be that the widening is desirable—not alone because of the trams, but for the purpose of accommodating the ever-increasing volume of traffic which pours over the bridge during the busy hours of the day. The widening, if their views receive acceptance, will presumably be undertaken by the Bridge House Estates Committee, and the money will be found out of the revenues of that trust.

**The Light Railways Act.**—A parliamentary paper recently issued contains a report of the proceedings of the Light Railway Commissioners and the Board of Trade in reference to light railways up to Dec. 31. Twelve out of the fifteen orders before the Board of Trade for confirmation on Dec. 31, 1903, were confirmed during 1904, the County of Hertford, Waltham Cross, and Enfield and the Dover, St. Margaret's, and Martin Hill orders being held over. During 1904 20 fresh orders were submitted to the Board by the Light Railway Commissioners, of which 14 had been confirmed. Confirmation was not refused in any case, but in that of the Southend and Colchester order powers were not granted in respect of certain proposed piers and ferries. During 1904 21 orders were confirmed, comprising 97 miles, at an estimated expenditure of £801,352. Since the commencement of the Act, in 1896, 257 orders have been confirmed by the Board of Trade, aggregating 97 miles, at an estimated outlay of no less than £11,279,780. From the date of the last report the Treasury have conditionally agreed to make a further advance of £5,700 by way of loan at 3½ per cent. in respect of the Welshpool and Llanfair Light Railway. The report of the Light Railway Commissioners states that a total of 485 applications for orders to authorise light railways (including applications for amending orders) have been made since the commencement of this Act. In respect of 278 applications (21 in the year 1904, and 257 in previous years) orders have been submitted to the Board of Trade; nine other applications, in respect of which orders are under settlement, have been approved by the Commissioners, and 176 applications have been rejected or withdrawn. The decisions with respect to four applications have been deferred, and 18 new applications, made in November last, remain to be considered. Up to Dec. 31 applications for lines on public roads, mostly electric motive power, totalled £18,058,644, of which proposals representing £5,661,643 were approved, and others representing £5,856,289 rejected, the Board of Trade dealing with applications aggregating £5,617,002. Amending orders up to the end of last year deal with lines representing £33,542,914, £13,039,261 being approved and £9,950,235 rejected, whilst proposals amounting to £12,535,340 were sent to the Board of Trade. In regard to steam lines during the same period, the schemes submitted represented some 14¼ millions, of which proposals to the amount of £6,900,000 were approved, £4,000,000 rejected, £1,453,710 withdrawn, and £6,500,000 sent to the Board of Trade. The Light Railway Commissioners have recently submitted the following orders to the Board of Trade for confirmation: Central Essex Light Railway (Amendment) Order, 1905, amending the Central Essex Light Railway Order, 1901, and Radfield and Sible Hedingham Light Railway Order, 1901 (June 6); Newark and District Light Railways Order, 1905, authorising the construction of light railways in the borough and in the rural district of Newark. The Commissioners have decided to approve the application for a light railway from Maidstone to Headcorn, subject to one or two stipulations.

## LIGHTING AND GENERAL.

**Govan.**—The extension of the electricity works in Govan-road was inaugurated last week.

**Telephone Company of Egypt.**—The register of transfers of 4½ per cent. debenture stock will be closed from 17th to 30th inst., both days inclusive.

**Walsall.**—The Electricity Committee recommend that an electric cable be laid in Buchanan-road at a cost of £194, and one in Portland-street at a cost of £60.

**Heywood.**—The consumption of electricity for April was 4,805 units as against 4,262 units for the corresponding period of last year, an increase of 543 units.

**Worcester.**—Application is to be made for sanction to borrow £6,009. 14s. 7d., overspent on the electricity capital account for machinery and equipment.

**Macclesfield.**—A scheme for lighting the town electrically has been adopted by the Town Council, and an electrical engineer is to be appointed at an early date.

**Boston.**—At a meeting of the Town Council last week a proposal to appoint an electrical engineer to prepare a scheme for installing electric light was referred back to committee.

**Paisley.**—At Wednesday's meeting of the Corporation it was stated that the total revenue to date for current supplied to the District Tramways Company amounted to £5,322. 4s. 8d.

**Hampstead.**—At the fortnightly meeting of the Borough Council the Chairman of the Lighting Committee stated, in reply to a question, that the proposal to introduce a new method of charging was still under consideration.

**Tunbridge Wells.**—It was reported at last week's meeting of the Town Council that there had been a profit in the electric lighting undertaking for the past year of nearly £1,000, which is to be applied in reduction of the rates.

**Press Telegrams.**—Press telegrams can now be accepted for transmission *via* France between the United Kingdom and Luxemburg, between the hours of 6 p.m. and 9 a.m., at the rate of 1½d. per word, with a minimum charge of 10d. per telegram.

**Darlington.**—A number of applications have been received for the installation of electric light. Messrs. Pease and Partners, Limited, it is reported, intend to introduce electric power, in the place of steam, for grinding corn at the granary in Whessoe-lane.

**Sleaford.**—The electric lighting accounts for the past year show receipts of £1,130 and expenditure amounted to £670. 2s. There has been a surplus since the commencement of the undertaking of £268, but £780 having been allotted to depreciation, there is now a deficit of some £550.

**Coventry.**—The Electricity Committee have decided to extend the mains to Rochester-road, Earlsdon, at an estimated cost of £280. It has also been decided to recommend the Council to undertake to maintain and replace consumers' electric lamps subject to a graduated scale of quarterly charges.

**Edinburgh.**—At a meeting of the Electric Lighting Committee, it was reported that the number of 8-c.p. lamps applied for from May 5 to 15 was 2,606, against 2,498 for the same period last year. The total number of applications for the year from May 15, 1904, to May 15, 1905, was 86,981.

**Islington.**—At to-night's meeting of the Borough Council the Lighting Committee will present reports from Prof. Kennedy and the borough electrical engineer upon the proposed extension of plant, with a recommendation that application be made to the London County Council for a loan of £15,500.

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**Telegrams to Japan and Korea.**—The Eastern Telegraph Company notifies that on and after the 1st prox. the tariff per word for telegrams from Great Britain to Japan and Korea, forwarded *via* Eastern, will be reduced as follows: Japan, 4s. 10d.; Korea, Seoul, Fusan, and Chemulpo, 4s. 10d.; other stations, 5s. 2d.

**Fareham.**—The Urban District Council have agreed to lay an electric light cable to Upland, the estimated cost being about £90. The engineer (Mr. Blake) said it was necessary for the Council to take into consideration the question of enlarging the main in West-street, and the matter was referred to the Electric Lighting Committee.

**Southwark.**—At the meeting of the Borough Council the General Purposes Committee recommended that the Council should oppose various Bills promoted by private companies for the supply of electricity. Some members of the Council deprecated the harassing of private enterprise, but eventually the recommendation was adopted.

**Glasgow.**—It is reported that the Electricity Committee have received numerous representations regarding the charges for current, and it is not improbable that reductions will be made to shops, warehouses, etc., from 6d. per unit for 365 hours per year maximum demand and 1d. thereafter to 3½d. per unit for the first two hours' use maximum demand.

**The Decimal Association.**—This association has issued a carefully-compiled chart of the metric system of weights and measures, which has been received with approval by such scientists as Lord Kelvin and Sir Oliver Lodge as affording a popular and clear explanation of the system. The chart can be obtained from the secretary of the association, Oxford-court, Cannon street, E.C., price 1s., or mounted on linen and fitted with rollers and varnished, 5s.

**Houghton-le-Spring.**—At the meeting of the Rural District Council reference was made to recent telegraphic difficulties, and the clerk read a letter from the postal sectional engineer, in which he stated that as he understood the tramway company intended turning the current on to their lines at an early date, he would not be in a position to make arrangements to prevent interference with the telegraph line by the tramway line until he was assured that the telegraph poles could be removed to the new route suggested by the Council. It was decided that steps be taken to have the poles removed.

**Thirsk.**—The Parish Council have decided in favour of electricity for lighting purposes. At their last meeting tenders were received from the electric lighting company to light the public lamps for the season 1905-6 at a cost of 29s. 6d. per lamp, or if a three years' contract was made a reduction of 5 per cent. on this amount. The Thirsk Gas Company's tender was 31s. per lamp, or 30s. if a three years' contract was entered into. After full discussion it was decided to contract with the electric lighting company for three years. This includes the lighting of the Station-road, which has previously not been lighted.

**Batley.**—The annual report of the electricity department for the past year shows that the total revenue has been £3,764 and the expenditure £2,167, giving a gross profit of £1,597, which, after paying interest and sinking fund, leaves a deficit of £334. There are 96 consumers, the average price for current being 3·8d. per unit. Taking lighting and power together the average price is 2·6d. per unit. The opinion is expressed in the report that, considering the heavy capital expenditure (£36 068), the scattered nature of the district supplied, and the low price obtained for current, the results of the first year's working are very favourable.

**California.**—It is reported that one of the largest electrical generating companies in California was recently organised at Ukiah, with a capital of half a million dollars fully subscribed. The new company will occupy the upper part of Potter Valley as a storage reservoir, and will utilise the waters of the Eel River for generating current. It is contemplated to run a tunnel 1½ miles long through the mountains, bringing the water of the river to the head of the valley, and then give a fall of 470ft. to the dynamos. A plant of 2,500 h.p. will be installed, and this will be augmented as fast as the service lines shall have been carried to other places. It is expected that a full electrical supply can be furnished all coast towns and cities, and carried over into the interior.

**Cooper-Hewitt Mercury Vapour Lamp.**—We learn that the British Westinghouse Electric and Manufacturing Company, Limited, are now prepared to supply all types of the Cooper-Hewitt mercury vapour lamp for direct current. The efficiency of this lamp is a point of considerable value, and, in addition, the lamp possesses several important characteristics, not the least of which is its value for photographic purposes or all processes of a similar nature. Its utility in this respect is accentuated by the fact that its light is of a highly actinic quality and almost entirely devoid of red rays. As an illuminant for workshops, factories, drawing offices, etc., the Cooper-Hewitt mercury vapour lamp has demonstrated its value, especially in America, where it has been largely employed.

**Trade Notice.**—A working arrangement has just been entered into between Messrs. Ferranti Limited and Messrs. Witting, Eborall, and Co., Limited, which is of considerable interest to the electrical industry, as it affords an instance of the combination of two competitors who at one time held widely divergent views in respect to various matters connected with the design of high-pressure switchgear and the like. In the future Messrs. Ferranti's interests in India, South Africa, and (largely) on the Continent will be looked after exclusively by Messrs. Witting, Eborall, and Co., who have in addition come to an understanding with Messrs. Ferranti in respect to work in Great Britain. For instance, it will now be possible to obtain Ferranti material through any of Witting, Eborall, and Co.'s branch offices or agencies under precisely similar terms as if ordered at Hollinwood. Further, each firm will have the benefit of the other's experience, and as both firms have made a speciality of high-pressure switchgear and the like, the combination, in this respect particularly, should prove a strong one.

**Stock Exchange.**—The Stock Exchange Committee have appointed the 21st inst. as a special settling day in connection with the British Columbia Electric Railway Company's £15,000 preferred ordinary stock, representing preferred ordinary shares Nos. 83,501 to 85,000; and the 23rd inst. for the further issue of £85 000 preferred ordinary stock, representing preferred ordinary shares Nos. 65,501 to 74,000, and £90,000 deferred ordinary stock. The committee have ordered the above-mentioned shares to be quoted in the official list; also 148 500 ordinary shares of £1 each, fully paid, Nos. 160,000 to 308,500, in John I. Thornycroft and Co., Limited. Applications have been made for the appointment of special settling days in connection with the following securities: American Telephone and Telegraph Company's 25 000,000 dol. 4 per cent. collateral trust bonds of 1 000dol. each, Nos. 53,001 to 78,000; Calcutta Tramways Company's shares of £5 each (issued in 1905).

**Yarmouth.**—The income for the year ending March last amounted to £15,196. 14s. 3d., an increase of £1,313. 12s. 1d. on the previous year, and the expenditure amounted to £8,426. 14s. 3d., leaving a gross profit of £6,770. After deducting interest, sinking fund, and rebate charges there was a net profit of £1,350. 15s. 8d. The report of the electrical engineer and accountant stated that during the past four years there had been a net profit of £3,910, out of which sum £2,100 had been applied in the relief of rates, and £1,223 voted for street-lighting extensions and additions to the power station. Thus all money borrowed from the rates during the first three years, amounting to £1,893, had been fully repaid. If the committee favoured the principle of reducing the prices, they proposed the following scale of charges: lighting—offer to all consumers an optional flat rate of 5d. per unit for all units used up to 3,000 per annum, and 4d. per unit for all over and above that quantity. For power taken from lighting mains a flat rate of 2½d. per unit. The committee recommended the adoption of the report, and the Council concurred without discussion.

**Bermondsey.**—At last week's meeting of the Borough Council the Electric Lighting Committee presented their report for the year ending March 31. Loans have been obtained to a total of £98 000. The capital expenditure to date totals £105,793. The income for the year amounted to £12,015, against an expenditure of £7,711. Interest and sinking fund charges absorb £3,163. There is a payment of £500 to the reserve fund, and an additional £1,000 has been allotted to this source, as the Council's order does not authorise the creation of a depreciation fund. During the year 1,039 503 Board of Trade units were supplied, of which 282,185 were sold for public lamps, 649,914 to private consumers, and 69,939 were used on the works. The number of arc lamps was 168; arc incandescent, 336; and in side streets, 200. The total maximum demand was 538 kw. As compared with the previous year, the quantity generated is practically double, as also the quantity sold to private consumers; whilst for public lamps 82,670 units were sold beyond the supply for 1904. The report was adopted. It was resolved to give a testimonial to Mr. W. H. Vincent, the late borough electrical engineer, recording the Council's appreciation of his services.

**Belfast.**—The Corporation notify the following reductions in charges to come into force on the 1st prox.:—For lighting purposes: on the maximum demand system—an initial charge of 6d. per unit for the equivalent of 182 hours' consumption at the consumers' maximum demand per half-year (equal one hour per day), and a subsequent charge of 1¾d. per unit for all in excess of this quantity, or an alternative flat rate of 4½d. per unit. Residential lighting—a flat rate of 4d. per unit, or on the maximum demand system. The whole of the supply to any one premises must be taken at one of either rates, and all consumers have the option of being transferred from one system to the other on July 1 of any year. For power and heating, and purposes other than lighting: on the maximum-demand system—an initial charge of 2½d. per unit for the equivalent of 182 hours' consumption at the consumer's maximum demand per half-year (equal one hour per day), and a subsequent charge of 1d. per unit for all in excess of this quantity. The initial charge will be reduced to 2¼d. per unit when the consumption exceeds 2,000 units per quarter, and to 2d. per unit when the consumption exceeds 5,000 units per quarter. Special prices to consumers using current during certain hours and for stand-by purposes. The above prices are subject to a minimum charge of 20s. per annum for each meter installed.

**Beckenham.**—At the meeting of the Urban District Council the Electricity Committee submitted the following report: "The sub-committee appointed for the purpose reported that they had been in communication with the British Insulated Company and recommend the arrangement embodied in a draft letter submitted to the committee. This arrangement will entitle the Council to at once enter upon the electric light station and carry out any extension of buildings and machinery they may think proper. The consideration to be the payment of £100 to the company, who will waive their claim to a larger sum which would become payable to them under the strict terms of the contract. The Council to concede the revised price for house services claimed by the company and the company to undertake to supply cables for two years from the expiration of their contract at prices set out in the correspondence. The company to continue to work the station at their own risk until their contract expires. The committee recommend the arrangement for confirmation by the Council. The committee recommend that the consulting electrical engineer and the surveyor be instructed to prepare plans and specifications and invite tenders for extending the buildings and providing a new 250 kw. machine with the necessary boilers, etc. The extension of the power-house to provide sufficient space to accommodate machinery for the supply of the Penge tramways." The report was adopted.

**Southwick.**—At the monthly meeting of the Urban District Council a letter from the County of Durham Electrical Power Distribution Company, Limited, was read stating that the company were about to give a supply of electricity for lighting and other purposes in the urban district of Southwick-on-Wear, under powers conferred upon

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them by the Sunderland Districts Electric Lighting Provisional Order, 1904, and asking for the consent of the Council to an application to be made to the Board of Trade enabling them to carry their high-tension and distribution mains overhead. The Council decided to refer the matter to the Highways Committee.

**Loughborough.**—At the meeting of the Town Council the electrical engineer reported that the cost of the recent exhibition was £44. 13s. 7d., the amount taken for admission being £25. 15s. The committee having considered the report of the electrical engineer as to the increase that would have to be made in the price per unit of electricity consumed in order to recoup the Corporation if free wiring of premises was adopted, it was resolved that the consideration of the matter be postponed *sine die*. The electrical engineer reported that he had made enquiries as to the probable demand for electricity by manufacturers and others for power purposes, but he was not yet in a position to report definitely upon the matter.

**London Gazette.**—A receiving order has been made out on debtors' petition in the estate of Alexander Holmes and Alexander McCallum, electrical engineers, Crown Works, Darwen. The first meeting in the estate of Alec. Gavan Inrig, electrical engineer, 16, Bruce-grove, Tottenham, Middlesex, will be held at 24, Railway-approach, London Bridge, S.E., on June 19 at 11.30 a.m. The first meeting in the estate of F. Shaw, electrical contractor, 258, Hessle-road, Kingston-upon-Hull, will be held at the official receiver's office, Trinity House-lane, Hull, on June 21 at 11 a.m. The last day for receiving proofs in the estate of Albert Smith, lately trading as the Electric Motor Supply Company at 54, Hounds-gate, Nottingham, is June 24.

**Telegraph Poles.**—At a meeting of the District Committee of the Lower Ward of Lanarkshire, it was stated that one of the members, when recently in London, had got Dr. Douglas, M.P., to bring before the Postmaster-General the objections of the committee to the continuance of telegraph poles and wires on the main roads in the district. The Postmaster-General replied that if the District Committee were prepared to bear the expense, amounting to about £2,000, of removing the wires from the roads to the railway line, he might arrange to have the work done. It was pointed out, however, that the committee had no power to spend public money on such work, and it was agreed to continue the pressure on the Postmaster-General to have the poles and wires removed from the public roads.

**Revocation of Patent.**—The Simplex Steel Conduit Company, Limited, having been threatened with proceedings by the Metallic Seamless Tube Company, Limited, of Birmingham, for an alleged infringement of the letters patent known as the Bayliss grip socket, and finding their business considerably impeded thereby, applied to the Attorney-General for authority to present a petition for the revocation of the said patent as the Metallic Seamless Tube Company took no steps to carry out their threat. The case was heard in the Chancery Division by Mr. Justice Ingle Joyce on the 3rd inst., when his lordship revoked the patent, and judgment was accordingly entered for the Simplex Company with costs. This decision should obviate the uncertainty which might have arisen in reference to patents connected with continuity methods for socket joint conduits.

**Dewsbury.**—The annual report of the Dewsbury borough electrical engineer (Mr. R. H. Campion) shows that during the year ended March 31 last 989,037 units of electricity were generated and 877,649 units sold, as follows: public lamps, 25 272 units; traction, 517,318 units; and private consumers, 335,059 units. The receipts amounted to £9,353. 10s. 3d., as compared with £8 814. 5s. 4d. in the preceding year, and the expenditure to £4,859. 7s. 6d., as against £4,160. 17s. 1d. in the previous year. The gross profit amounted to £4,394. 2s. 2d., as compared with £4,653 8s. 3d. After payment of interest and sinking fund there remains a net profit of £1,243. 7s. 6d., as against £1,951. 10s. 3d., a difference of £708. This is partly accounted for by a reduction in the charges for electricity and an increase in the wages bill owing to a breakdown in the cables and alterations at the station.

**Southampton.**—The Electricity Committee's report contained the following: "The Electricity Committee have for some considerable time had under their consideration a suggestion that an electrical exhibition should be held in Southampton in connection with this department. During the last few weeks several towns in the vicinity have done something in this matter, and in April the Electricity Committee visited Salisbury, where a small exhibition was being held. From information obtained there the committee are of opinion that the electricity department would benefit if an exhibition on similar lines were inaugurated in this town. The people of Southampton would then have an opportunity of seeing in operation the many uses to which electricity is adapted at the present day. The committee would like to have permission from the Council to make all arrangements for holding this exhibition at a cost to this department of £100." The Council sanctioned the proposal.

**New Atlantic Cable.**—The cable steamer "Cambria" started from Queenstown on Tuesday *en route* for Cape Canso, Nova Scotia, to take soundings across the Atlantic for the purpose of selecting the route for the new cable of the Commercial Cable Company. Soundings will be taken at intervals of about 20 miles, and this work will occupy about a month. Already the "Cambria" has successfully laid the Irish shore end of the cable for a distance of 190 miles from Waterville. Another cable steamer, the "Colonia," is to leave London with cable material and a technical staff direct for Cape Canso, whence the cable will be laid eastwards over the track that the "Cambria" will have charted until she makes the connection with the buoyed end off the coast of Ireland. The "Cambria" is a new vessel, owned by the Telegraph Construction and Maintenance Company, Limited, 370ft. in length, and 1,016 net register, specially designed and fitted with all the latest improvements for cable laying and overhauling.

**Llanelly.**—At a meeting of the Urban District Council a deputation of tradesmen was received in regard to the proposed electric lighting scheme. The leader of the deputation stated that the scheme was unnecessary, and it would add to the liabilities of the Council and increase the already heavy rates. The tradesmen did not want electric lighting, and would not take it. About a year ago an agreement between the gas company and the Council was signed, and it was hoped that it would have put an end to the dissension that had gone on for years. Scarcely had the ink on the agreement dried, however, than they found the Council giving notice to terminate it. The Chairman said the wisdom or otherwise of terminating that agreement had nothing to do with the electric lighting scheme, to which the leader of the deputation replied that it was very material, as affecting the cost of illumination in future. The Council decided, after the retirement of the deputation, to hold a special meeting to meet the tradesmen.

**Swansea.**—The financial statement in connection with the electricity works shows gross profit for the year ending March of £7,408. 1s. 5d. After allowing £103. 17s. 10d. for defective meters, bad debts, etc., £3,381. 19s. 2d. interest, and £2,651 for sinking fund, the net profit is £1,271. 8s. 5d. This, with the balance £744. 11s. brought forward from last year, amounts to £2,015. 19s. 5d., but inasmuch as £3,125. 18s. 9d. has to be put aside for sinking fund, in accordance with the requirements of the Local Government Board, so as to bring this fund up to date, there is a deficit of £1,109. 19s. 4d. In submitting his annual report, the electrical engineer (Mr. C. A. L. Prasmann) stated that the gross cost of coal and cartage of ashes was £1,279, a decrease of 24 per cent. Swansea was better by over 50 per cent. on the average than other provincial stations. "Wages on generation" came to £1,395. 13s. 2d. gross, a decrease of 14 per cent. The total costs this year (£6,983. 12s. 3d. gross) represent a decrease over last year of 7¼ per cent. The average price for private lighting had been reduced by about 10 per cent. From April 1 certain reductions to private consumers came into force for both lighting and power. The revenue was £13,307, and the costs of the station £6,003. It is expected that during the ensuing year private consumers for both lighting and power will be materially increased, in addition to which the Corporation tramways will be a large customer with very little increase in the capital expenditure.

**Barrow.**—From the annual statement of accounts it appears that the total capital expended on electricity works is now £92,655. The revenue this year was £11,623, having increased from £9,248 over the previous year, or an increase of £2,375. The expenditure during the year was £4,924, against £4,574, an increase of £350. The profit was £6,698, an increase of £2,025. The interest and sinking fund charges have risen from £4,195 to £5,499. After paying all charges there is a net profit on the year of £1,198. The loss the first year was £705, second year £961, and third year £341. In the fourth year a profit of £425 was made, and last year a profit of £478. The number of lamps connected showed an increase of 5,626; the figure this year being 50,508, against 44,882 last year. The number of units sold increased from 540,146 last year to 837,454 this year, an increase of 297,308. The cost of production per unit for the past year was brought down to 1·41. Adding interest and sinking fund (1·57d.) the total cost per unit was therefore 2·98d. The one feature which was unsatisfactory was the large amount of capital that had to be expended. If the department had been able to have the same length of period for the repayment of loans as for the gasworks, the net profit would have been £2,400, instead of £1,198. The chairman of the Electricity Committee and the electrical engineer have been authorised to attend the convention of the Incorporated Municipal Electrical Association at Edinburgh. The electrical engineer has been instructed to fix a price, subject to the approval of the committee, for the lighting of the street lamps at Vickerstown during the same hours as the lamps in the town.

**Nottingham.**—At the meeting of the City Council a petition placed before Parliament by the Manchester Corporation against the agreement between the Postmaster-General and the National Telephone Company was considered. The petition contends that the agreement will mean that it will be to the interest of the Postmaster-General not to grant licenses relative to the working and use of telegraphic and telephonic communication, and therefore tends to destroy competition between the two telephone systems, and to continue, if not to increase, the present excessive charges made. The memorial was referred to a joint meeting of the Parliamentary and General Purposes Committee. The electrical engineer reported that the distributing mains have been extended in 43 directions during the year, the total extensions being 2·41 miles. The mileage of the distributing mains at the end of the year was 49·81. In addition to the extension of the distributing mains three new feeders have been laid from the generating station in Talbot-street. The total mileage of feeder cables laid during the year was 4·9. The number of applications received for a supply of electricity on March 31 was 2,793, as compared with 2,557 on March 31, 1904. The number of 8-c.p. lamps or their equivalent connected up to the mains on March 31 was 267,401, as compared with 239,366 at the end of March, 1904. Seventy-six additional motors have been connected up during the year, representing 238 increased horse-power. The total power connected to the mains was 2,014 h.p., as against 1,776 at the end of March, 1904. The number of units sold during the year for various purposes was as follows: for lighting purposes, 3,431,964; for power purposes, 1,142,636; for tramway traction, 3,895,321—total, 8,469,921; 47·65 per cent. of the units sold for private lighting were at the reduced rate of 1½d. per unit. The total number of units sold for all purposes during the year ending March 31, 1904, was 8,101,810. The annual report was adopted. The spare set dynamo for the Easterofe destructor was erected in May of last year, increasing the available horse-power from 13,605 to 13,810. A strong demand for lighting and power still continues, and the Corporation have obtained sanction to a loan of £100,000 for extensions. This amount will be raised from time to time as occasion requires. During the past year the whole of the plant was maintained in good condition out of revenue.

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**Worthing.**—At the meeting of the Town Council, the members had before them an important report from the resident engineer (Mr. Geo. Porter) with reference to the extensions of plant and machinery, etc., which Mr. Porter considers will be essential to meet the demands of the near future. Mr. Porter pointed out that the three existing boilers will all be working together in the winter 1905-6, so that there will be no spare boiler available for use when any one of the others is opened up for cleaning or repairs. A new boiler with steam and water pipes must therefore be obtained before the heavy winter's works sets in. The foundations and part of the setting of the boiler were built when the plant was last extended, so that very little structural work will be entailed. During the past winter the engines in use were one of 400 h.p. and one of 160 h.p., two engines of 160 h.p. each being in reserve. The anticipated increase will require the use of the two reserve engines, and at the present rate of expansion of business an additional engine and dynamo will be required for the winter 1906-7. Mr. Porter accordingly recommended that an additional engine be obtained large enough to supply about 10,000 lamps on at one time. At the present charges for current (6d. per unit) this engine would probably be sufficient for the requirements of the winters 1906-7-8-9; but if the price of current be reduced, it was probable that an additional 20,000 lamps may be added in two years from the date of such reduction. For this proposed engine (about 600 h.p.) no additional buildings will be required, but a new condensing plant will be necessary, as the existing one will be taxed to its utmost capacity in the coming winter of 1905-6, and an additional boiler and feed pump will also be required. The cost of the additional boiler required for the next winter Mr. Porter puts at £860, and that of the extensions next year at £4,700. It will also be necessary to lay two new feeder cables this summer, as the three original feeders are very much over-loaded. The three existing feeder cables were put down to carry current to the distributing mains equivalent to about 9,000 8-c.p. lamps, but during last winter these feeders carried current equivalent to a load of 15,000 8 c.p. lamps in use together. To enable them to carry the additional current, the pressure at the generating station was increased beyond the normal. The estimated cost of the new feeders required at once Mr. Porter estimates at £1 287, and he also recommended the provision of a farther sum of £653 for consumers' connections, meters, etc., and £200 for distributing mains extensions. The Council decided to substitute £600 for the £200 recommended for distributing main extensions, and subject to that alteration the whole of Mr. Porter's recommendations were approved.

**Morley.**—At the meeting of the Town Council the electrical engineer (Mr. J. E. Ellis) reported that the output from the electricity works during the month ending April 30 was 9,587 units, against 10,089 for the same period last year, and that the actual units sold to consumers by meter was 6,296 against 4,573, being a decrease of 502 in units sold. There had, however, been an increase of 1,723 units sold to private consumers. Mr. Ellis also submitted his report of the working and financial results of the electric lighting undertaking for the year ending March 31, in which he said: "I regret to report that from a financial point of view we have not been quite so successful as the year previous. The following are details of the working for 1904-5 and 1903-4 respectively; total number of units generated, 199,427—202,840; total sold, 142,959—142,958; amount used in works, 13,238—14,532; magnetising units, free supply, and testing purposes, 43 230—45,550; units sold to private consumers, 95,217—96,834; motors, 742—714; arc lamps and side lights, 47,000—46,124. There are 32 more consumers than in the previous year, but the units sold are 875 less, besides which the ½d. reduction in price represents some £200." Mr. Ellis proceeds: "You will readily see that, had we not reduced the price last year ½d. per unit, our revenue would have been about £25 more than the year previous, notwithstanding the output practically remaining the same. The only explanation I can offer for the output remaining constant is—firstly, prejudice against the electric department; secondly, the tradespeople do not realise the advantages of the electric light; thirdly, remarks made in the Council-chamber in the past have not been of a consolidating nature to encourage the public to take a supply of electricity, but happily a better feeling appears to be coming on the horizon; and, lastly, a fit of all-round economy appears to be passing over the district. . . . Distribution is somewhat higher owing to the unfortunate burn-out of three converters which broke down in the town hall sub-station, which cost about £100, and is included in this item. Public lamps are a little higher owing to a portion of the costs of the new arc lamps being paid for out of revenue, and which is included in this item. Salaries of engineers are a little higher owing to the amount of new work on outside not being so plentiful as the year previous, notwithstanding the unfortunate breakdown, Messrs. Pollit and Wigzel repairs to plant and portion of arc lamp account being paid out of revenue, the total of which amounts to about £150. Our total expenditure is only some £7 more than the year previous. Our interest and sinking fund is £1,846. 1s. 7d., as against £1,789. 3s. 11d., being an increase of £56. 17s. 8d. The gross profit for the year is, before providing for interest and sinking fund, £605, equal to pay 2¼ per cent. on the total capital expenditure." After some little discussion, the report was adopted by a large majority.

## PROVISIONAL PATENTS, 1905.

JUNE 5.

**11756. Improvements in or relating to apparatus for preventing the "live" wires of electric tramways falling to the ground in case of breakage.** Samuel Sims and Alfred Roberts, 8, Quality-court, Chancery-lane, London.

**11745. Improvements in electric telegraphy.** Isidor Kitsee, 18, Fulham-place, Paddington, London. (Complete specification.)

**11770. An improved method of and means by which electrical bells may be employed on high-tension circuits.** Francesco Agaggio, 70, Chancery-lane, London. (Complete specification.)

**11773. Improvements in magneto-electric ignition apparatus.** Frederick Richard Simms and Robert Bosch, 4, South street, Finsbury, London. (Complete specification.)

**11774 Improvements in electric fuses and cut-outs.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

JUNE 6.

**11805. Improvements in switches for use for electric lighting and power.** William Cecil Kirwan and Kyran Quaney, 11, Brookfield-terrace, Donnybrook, Dublin.

**11813. An improved universally adjustable electric light bracket.** Edward James Overell, 62, Beacon Hill-road, Newark-on-Trent, Notts.

**11821. Load equaliser for alternating currents with automatic regulation.** Rudolf Braun, 68, Seymour-grove, Old Trafford, Manchester.

**11840. Electric block signalling and train-control system.** John Alexander Whyte, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**11860. Improvements in or relating to electric target setting apparatus.** Alfred Julius Boult, 111, Hatton-garden, London. (Phönix Elektrotechnische Ges. m. b. H., Germany.) (Complete specification.)

**11861. Improvements in battery plates.** Harry Cross Hubbell, 111, Hatton-garden, London. (Complete specification.)

**11862. Improvements in battery plates.** Harry Cross Hubbell, 111, Hatton-garden, London. (Complete specification.)

**11881. Improvements in arc lamps.** Bernard Mervyn Drake and John Marshall Gorham, 66, Victoria-street, Westminster, London.

JUNE 7.

**11899. Improvements in electrical relays for railway track circuits and telegraph purposes.** William Robert Sykes, jun., Wyndcott, Birchwood Park-avenue, Swanley, Kent.

**11901 Electrically operating stop-watches from more than one place automatically.** Basil Alexander Pilkington, 12, Atholl-place, Edinburgh.

**11921. Improvements in methods and apparatus for producing electric sound signals.** Charles Henry O'Brien, 5, Corporation-street, Birmingham. (Complete specification.)

**11923. Improved controlling apparatus for electrically propelled vehicles.** Willis Nelson Stewart, 45, Lansdowne-road, Clapham, London.

**11924. Improvements in driving gear for electrically-propelled vehicles.** Willis Nelson Stewart, 45, Lansdowne-road, Clapham, London.

**11931. Arrangement for suppressing harmonics in alternating-current machines.** La Société Anonyme Westinghouse and Maurice Leblanc, Westinghouse Patent Bureau, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, June 10, 1904, being date of application in France.) (Complete specification.)

**11949. Improvements in and relating to the manufacture of incandescent filaments for electric incandescent lamps.** Alexander Just, Franz Hanaman, and Vereinigte Elektricitäts Act.-Ges., 7, Southampton-buildings, Chancery-lane, London.

**11967. Improvements in connection with hoisting gear for arc lamps and other like purposes.** Crompton and Co., Limited, and Ernest William Abbott, 18, Southampton-buildings, Chancery-lane, London.

**11970. Improvements in and relating to electric switches.** The British Thomson-Houston Company, Limited, and Edmund Basil Wedmore, 83, Cannon-street, London.

**11971. Improvements in vapour electric apparatus.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

JUNE 8.

**11995. Armoured casing for electrical wiring and the like.** Louis Howell, 10, Victoria-road, Swindon.

**12023. Electric conductor rail insulator.** Charles Harold Roberts, Ashurst, Pinner-road, Harrow-on-the-Hill, Middlesex.

**12024. An improved electrical switch.** Andrew Wybrant Penrose, 28, New Bridge-street, London.

JUNE 9.

**12061. Improvements in methods and apparatus for producing and utilising electricity and steam power.** Henry Ernest Fry, 24, John-street, Bedford-row, London.

**12062. Improvements in connection with regulating rheostats and motor starters for electrical purposes.** George Elwin Fletcher, 17, St. Ann's-square, Manchester. (Complete specification.)

**12090. Improvements in electrical measuring instruments.** George Keith Buller Elphinstone, Century Works, Lewisham, London.

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**12697. Improvements in and relating to electric arc lamps.** Benjamin Zusman, 18, Southampton-buildings, Chancery-lane, London. (Oskar Könitzer, Germany.)

**12166. Improvements connected with electric tail lamps for motorcars.** George James Jackson, 15, Water-street, Liverpool.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published June 29.*

1904.

**13015. Electric telegraphy.** Brown.

**13051. Dynamo-electric machines.** Walker.

**13084. Electric incandescence vapour lamps.** Butler-Burke.

**13274. Means for controlling the trolleys of electrically-propelled vehicles.** Little.

**13276. Protective devices for electric generating and distribution systems and apparatus.** British Thomson-Houston Company, Limited. (General Electric Company.)

**13370. Casing for protecting electric leads.** Siemens Bros and Co., Limited, and Kerse.

**13709. Automatic electrical signalling apparatus for railways.** Algernon Hamo Binyon and Robert Percy Brousson.

**13736A. Apparatus suitable for detecting electrical oscillations.** Fleming. (Date applied for under Patents Rule 9, June 17, 1904.)

**13984. Electric fuses.** Pinkerton.

**14197. Methods of making electric armature coils and other hollow articles.** British Thomson Houston Company, Limited. (General Electric Company.)

**14792. Electric railways on the surface-contact system.** Rothwell.

**14879. Apparatus for controlling the lighting and extinguishing of gas, the flow of fluids, or the actuation of electric switches, and for analogous uses at predetermined times.** Harris.

**15069. Electric switches, especially applicable to fluid-pressure governers.** British Thomson-Houston Company, Limited. (General Electric Company.)

**15364. Electric controllers.** British Thomson-Houston Company, Limited. (General Electric Company.)

**15626. Dynamo-electric machines.** Sayers and Mavor and Coulson, Limited.

**15872. Arc lamps.** Viarmé.

**16662. Electric motor control systems.** British Thomson Houston Company, Limited. (General Electric Company.)

**16764. Electric switches.** Johnson. (Voigt und Haeffner Akt.-Ges.)

**17020. Emergency devices for railway vehicle and like brake and controlling systems.** British Thomson-Houston Company, Limited. (General Electric Company.)

**17101. Emergency brake control systems.** British Thomson-Houston Company, Limited. (General Electric Company.)

**17176. Electric vapour arc lamps.** Peritz.

**17287. Trolley pulleys for electric railways, tramways, and the like.** Welsh.

**17375. Terminal for electric cables.** Sardy.

1905.

**700. Electric transformers.** Heinicke.

**1589. Electric train-lighting systems.** Union Elektricitäts-Ges. (Date applied for under International Convention, Jan. 27, 1904.)

**2187. Safety lock with an electric warning device and detonator.** Audibert.

**2313. Electric furnaces.** Bosworth.

**4716. Telephone exchanges.** Lundquist.

**4786. Arc lamp.** Hearson. (Phönix Elektrotechnische G. m. b. H.)

**6838. Suspension of overhead conductors for electrically-operated railways and the like.** Jones. (Date applied for under International Convention, April 2, 1904.)

**8711. Distribution of electric energy to apparatus capable of being operated by direct and also by alternating currents.** Lamme. (Date applied for under International Convention, May 3, 1904.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ⅜-½ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 7/16-17/32 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | – | 5¼-6 |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | – | 5¾-6¼ |
| —— 4½ per cent. Mortgage Debentures | 100 | – | 102-105 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 100-102 |
| British Westinghouse Elec. and Manuf., 5 per cent. Pref., 275,001-375,000 | 5 | – | 2 11/16-2 13/16 |
| —— 4 per cent. Mortgage Debenture Stock | 100 | – | 89-91 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 | 2 | – | ½-⅝ |
| —— Non. Cum., 5 per cent. Pref. | 2 | – | 1¼-1⅜ |
| —— 4½ per cent. 1st Debenture Stock | 100 | – | 92-95 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | – | 79-82 |
| Callender's Cable, Debentures | 100 | – | 107½-109½ |
| —— Ordinary | 5 | – | 10 11 |
| —— 5 per cent. Pref. | 5 | – | 5¼-5⅜ |
| Crompton and Co. | 5 | – | 1¼-2¼ |
| —— 5 per cent. Debentures | 100 | – | 95-100 p.c |
| Edison and Swan United, "A" Shares, 1-99,261 | 5 | – | 1¼-1½ |
| —— "A" Shares, 01-017,139 | 5 | – | 2 2¼ |
| —— 5 per cent. Debentures | 100 | – | 89-94 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 84-89 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | – | ⅞ 1⅛ |
| —— 7 per cent. Cumulative Pref. | 2 | – | 2¼-2½ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | – | 95-99 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | – | 9⅝-10⅛ |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | – | 97-101 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | – | 11½-12½ |
| —— 4½ per cent. Preference | 5 | – | 5¼-5⅜ |
| —— 4½ per cent. Debentures | 100 | – | 109-111 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | – | 15½-16½ |
| —— 4 per cent. Debentures | 100 | – | 100-103 |
| Parker, Thos., Limited, Ordinary | 10 | – | 10-10½ |
| Telegraph Construction and Maintenance | 12 | – | 33 35 |
| —— 5 per cent. Bonds | 100 | – | 103-106 |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary | 10 | – | 11⅜-12½ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | – | 10-10½ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | – | 11½-12½ |
| —— 4½ per cent. Debenture Stock, Red. | 100 | – | 107-109 |
| Bromley (Kent) Electric Light and Power Co. | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. 1st Debenture Stock, Red. | 100 | – | 102-105 |
| Brompton and Kensington, Ordinary | 5 | – | 9⅜-10½ |
| —— 7 per cent. Preference | 5 | – | 9½-10½ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 | 5 | – | 8⅜ 9½ |
| —— Nos. 60,001-80,000 | 5 | – | 7⅜ 8½ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | – | 12½-13½ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 103-106 xd |
| Charing Cross and Strand, 70,001-80,000 | 5 | – | 7½-8½ |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 5 5¼ |
| —— 40,001-80,000 | 5 | .. | 5-5¼ |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | – | 106 108 |
| Chelsea Electricity Supply | 5 | – | 6¼ 6⅜ |
| —— 4½ per cent. Debentures | 100 | – | 109 111 |
| City of London, Ordinary | 10 | – | 10½-11½ |
| —— 6 per cent. Cumulative Pref. | 10 | – | 13⅜-14½ |
| —— 5 per cent. Debenture Stock | 100 | – | 124 128 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | – | 104-106 |
| County of London Electric Supply, Ordinary | 10 | – | 8¼-9 |
| —— 6 per cent. Cum. Pref. | 10 | – | 12 12½ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 103 105 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. | 100 | .. | 113-116 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | – | 5⅜-5½ |
| —— 6 per cent. Cum. Pref. | 5 | – | 6-6½ |
| —— 4½ per cent. First Mort. Deb. | 100 | – | 107-109 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 2¼-3 |
| —— 5 per cent. Debenture Stock, Red. | 100 | – | 86-91 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | – | 5¼-5⅜ |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | – | 101-104 |
| Havana Electricity, Limited, 1-15,000 | 10 | – | 9¼-10¼ |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | – | 7⅜-9¼ |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 100-103 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 | 1 | – | ⅜-½ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | – | 11½-12¼ |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red | 100 | – | 101-103 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅜-10¼ |
| London Electric, Ordinary | 5 | – | 2-2½ |
| —— 6 per cent. Pref. | 5 | – | 5-5¼ |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | – | 99-101 |
| Metropolitan Ordinary, 100,001-300,000 | 5 | – | 9⅜-10¼ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | – | 111-115 |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5¼-5⅜ |
| —— 5½ per cent. Mortgage Debenture, Red. | 100 | – | 99-100 |
| Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb. | 100 | – | 99-101 p.c. |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | – | 98-101 |
| —— Preference | 4 | – | 100-102 |
| Notting Hill Electric Lighting | 10 | – | 14½-15½ |
| —— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.) | 100 | – | 100-102 |
| Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,310 | 5 | – | 6¼-7 |
| —— 4 per cent. Debenture Stock | 100 | – | 99-101 |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures | 100 | – | 101-104 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 | – | 2⅜-3¼ |
| —— 4 per cent. Debenture Stock | 100 | – | 79-83 |
| South London, Ordinary | – | – | 3⅜-4¼ |
| South Metropolitan Electric Light and Power Co., Ord. | 1 | – | 13/16-15/16 |
| —— 7 per cent. Cum. Pref. | 1 | – | 1 11/32-1 13/32 |
| —— 4½ per cent. 1st Mort. Deb. | 100 | – | 105-108 |
| —— Ditto, June, 1904 | – | – | – |
| St. James's and Pall Mall, Ordinary, 101-30,080 | 5 | – | 13¼-14⅜ |
| —— 7 per cent. Pref. | 5 | – | 8¼-9 |
| —— 5½ per cent. Deb. | 100 | – | 98-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | – | 4 13/16-5 1/16 |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5¼-5⅜ |
| Westminster, Ordinary | 5 | – | 12-13 |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | – | 6¼-6⅜ |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 | 5 | – | 6-6¼ |
| —— Ord. | 5 | – | 8⅜-8⅝ |
| —— Permanent 5 per cent. Debenture Stock, 1888 | 100 | – | 141-144 |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 105-108 |
| Barcelona Tramways, Limited, Ord., 1-20,000 | 10 | .. | 12¼-13½ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 | 10 | .. | 9⅜-10½ |
| —— 5 per cent. Deb., Red., 1-600 | 100 | .. | 98-102 |
| —— 4½ per cent. Red. Deb. Stock | 100 | .. | 96-100 |
| Bath Elec. Tramways, Ld, Pref. Ord. Shs., 75,001-150,606 | 1 | .. | ⅜-½ |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 | 1 | .. | 15/16-1 1/16 |
| Belfast Street Tramways, Ord., 1-26,600 | 10 | .. | 10½-11½ |
| Blackpool and Fleetwood Tramroad | 10 | – | 13⅜-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | – | 1-1½ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | – | 3¾-4¼ xd |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 91-98 |
| British Columbia Electric Railway Co., Ord. Def. | 100 | – | 105-108 |
| —— Ord Pref. | 100 | – | 98-101 xd |
| —— 5 per cent. Cum. Perpetual Pref. Stock | 100 | – | 104-107 |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each | 40 | – | 105-105 p c |
| —— 4½ per cent. Vancouver Power Deb. | 100 | – | 100-103 |
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 | – | 9¼-9⅜ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | – | 11¼-11⅜ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | – | 122-124 |
| —— 4½ per cent. 2nd Deb. Stock | 100 | – | 97-99 |

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| Name. | Amount paid. | | Last price. |
|---|---|---|---|
| | £ | | |
| Buenos Ayres and Belgrano Trams | 5 | – | 3⅛ 3⅜ |
| —— 'A' 6 per cents. Cm. Pf., 1-40,000 | 5 | | 5¼-5⅜ |
| —— 'B' 6 per cent. Cm. Pf., 1-27,500 | 5 | – | 5¼-5⅜ |
| —— 5 per cent. Deb. Stock, Red. | 100 | – | 107-109 |
| —— Prov. Cert., all paid | 100 | – | 105-106 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 | – | 97-99 |
| Calcutta Tramways, Limited, 1-102,268 | 5 | .. | 8⅛-8¼ |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 | .. | 107-109 |
| Cape Electric Tramways Nos. 1-480,000 | 1 | – | 1¼-1⅜ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 | – | 4⅞-5⅛ |
| —— ½ per cent. 1st Mortgage Deb., 1-3,000 (1917) | 10 | – | 99-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | | 101-103 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | | 9½-10 |
| —— 5 per cent. Cum. Pref. | 10 | – | 11-12 |
| —— 4 per cent. Debentures | 100 | – | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 | – | 13½-14¼ |
| —— ½ per cent. Pref., Nos. within 1-60,000 | 10 | – | 15-16 |
| —— 4½ per cent. Mort. Debs., 1-5,000, Red. | 100 | – | 94-97 |
| Imperial Tramways Ordinary | all | – | 18-19 |
| —— ½ per cent. Cum. Pref. | all | – | 14-14½ |
| —— 4½ per cent. Deb Stock | 100 | | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 50,001-60,000 | 5 | | 3-3¼ |
| —— 4 per cent. Debenture Stock | 100 | – | 85-90 |
| Kidderminster and District Lighting and Traction, Pref. | 5 | – | 8-8½ |
| London United Trys. (1901), 5 per cent. Cum. Pref. | 10 | – | 10 10½ |
| —— ½ per cent. 1st Mt. Db. Stock, Red. | 100 | – | 100-103 |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 | .. | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016 | 1 | .. | 9/32-11/32 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 | .. | 1-1 1/16 |
| —— 4½ per cent. Deb. Stock, Red. | 100 | .. | 105-107 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000 | $1,000 | .. | 106-110 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 | .. | 101-104 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 | .. | 103-105 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000 | 5 | – | ½-1½ |
| Oldham, Ashton, and Hyde Tramway Ordinary | 10 | | 12 |
| —— 5 per cent Cum. Pref. | 10 | – | 9¾-9⅞ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk | 100 | – | 105-108 |
| Potteries Electric Traction, Ordinary 20,001-40,000 | 10 | – | 8¾ 9¼ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 | – | 9¼ 9¾ |
| —— 4½ per cent. Debenture Stock | 100 | – | 101-104 |
| South Lancashire Electric Traction and Power Company —— £250,000 Ordinary | 1 | | 1 |
| —— £101,152 5 per cent. Preference | 1 | | 1 |
| —— £597,170 4½ per cent. Debenture Stock | 100 | p.c. – | 100 p.c. |

## Electric Railways.—

| | | | |
|---|---|---|---|
| Central London, Ordinary | 100 | – | 91-93 |
| —— 4 per cent. Pref. | 100 | – | 101-103 |
| —— ,, ,, deferred | 100 | – | 80-85 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 | – | 111-113 |
| City and South London, Consolidated Ordinary | 100 | – | 39-41 |
| —— 4 per cent. Debenture Stock | 100 | – | 107-110 |
| —— 5 per cent. Pref. Stock '91 | 100 | – | 120-123 |
| —— ,, ,, ,, '96 | 100 | – | 118-121 |
| —— ,, ,, ,, '01 | 100 | – | 115-118 |
| Liverpool Overhead, 5 per cent. Pref. | 10 | – | 10-10½ |
| —— Ordinary, 1-50,000 | 10 | – | 3¾-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | – | – | 99-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | – | – | 98¼-99½ xd |
| Waterloo and City, Ordinary | 100 | – | 90-92 |

## Telephones.—

| | | | |
|---|---|---|---|
| National Telephone, Preferred | 100 | – | 111-112 |
| —— Deferred Stock | 100 | – | 102-104 |
| —— 6 per cent. Cum. First Pref. | 10 | – | 12¼-13½ |
| —— 6 per cent. Cum. Second Pref. | 10 | – | 11½-12¾ |
| —— 5 per cent. Non. Cum. Third Pref. | 5 | – | 5¼-5⅝ |
| —— 5½ per cent. Deb. Stock, Red. | 100 | – | 100½-102½ |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 103-105 |
| —— 4 per cent. Prov. Cert. | – | – | 103½-105½ |
| Oriental Telephone and Electric Company | 1 | – | 1¼-1⅛ |
| —— 6 per cent. Cum. Pref. | 1 | .. | 1¼-1⅛ |

# TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905. | 1904. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pass'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | June 10 | 1,337 | 1,419 | – 82 | – 194 | 19¼ | 19¼ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·14 |
| Ayr Corporation | ,, 3 | 280 | 369 | – 89 | — | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 336,049 | 1·03 | 10·11 | 1,770 | 5 0 |
| Barking Corporation | — | — | — | — | — | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 11 | 1,025 | 1,049 | – 41 | – 330 | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,319,701 | 1·158 | 9·98 | 2,383b | 6·1 |
| Birmingham Corporation | ,, 10 | 342 | 260 | + 102 | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | — | — | — | — | — | 6¼ | 6¼ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 7 | 1,046 | 1,032 | + 13 | + 234 | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10·94 | — | 4·59 |
| Blackpool Corporation | ,, 8 | 640 | 840 | – 170 | – 1,630 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 10 | 430 | 585 | – 145 | – 1,551 | 16½ | 16½ | Dec. 31 | 32,021 | 2,258,984 | 600,757 | 3·34 | 12·75 | 2,001 | 7·05 |
| Bolton Corporation | ,, 11 | 1,954 | 1,880 | + 74 | – 8 | 38 | 38 | March 31 | 94,161 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·89 |
| Bournemouth Corporation | ,, 7 | 950 | 1,023 | – 78 | — | 10·15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 3 | 4,507 | 4,596 | – 88 | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 11 | 950 | 913 | + 46 | + 337h | 9 | 7½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 9 | 5,122 | 5,118 | + 4 | — | 51½ | 51½ | Dec. 31g | 253,150 | 44,391,439 | 6,035,528 | — | — | — | — |
| Burnley Corporation | ,, 10 | 1,132 | 1,051 | + 81 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 11 | 331 | 331 | — | – 278 | 8¼ | — | March 31j | 11,574 | 2,566,134 | 282,378 | 1·08 | 9·84 | 1,570 | 7·57 |
| Cardiff Corporation | ,, 3 | 1,995 | 2,166 | – 170 | – 784 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 10 | 203 | 207 | – 4 | – 413 | — | — | Dec. 31g | 9,987 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 10 | 6,837 | 6,781 | + 55 | + 1,957h | 6 | 6 | ,, 31 | 362,471 | 44,953,988 | 1,292,674a | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 11 | 2,897 | 2,628 | + 269 | – 3,417h | 6¼ | 6⅜ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Colchester Corporation | ,, 7 | 202 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 8 | 539 | 558 | – 18 | + 415 | — | — | ,, 31g | 26,657 | 6,353,323 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | ,, 9 | 277 | 237 | + 40 | + 73 | 7·23 | 7·23 | March 31g | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·35 |
| Dover Corporation | May 13 | 198 | 195 | + 3 | — | 4½ | 4½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0·94 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | June 9 | 144 | 128 | + 16 | — h | 7 | 6⅔ | Dec. 31g | 6,231 | 388,905 | 107,164 | 3·88 | 14·09 | 932 | 7·39 |
| Dublin U. T., electric cars | ,, 9 | 4,111 | 4,380 | – 269 | } — | 47 | 46 | ,, 31g | 134,643 | — | 3,429,356 | — | — | — | — h |
| Dublin S. District, Electric | ,, 9 | 1,100 | 1,225 | – 125 | | | | | | | | | | | |
| Dundee City Tramways | ,, 7 | 877 | 870 | + 7 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 10 | 803 | 766 | + 37 | + 321 | 10·77 | 10·75 | March 31 | 34,312 | 12,950,269 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 10 | 15,595 | 15,370 | + 225 | – 1,951h | 145 | 123 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489b | 7·40d |
| Gloucester Corporation | ,, 7 | 302 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | May 17 | 3,042 | 2,624 | + 418 | + 627 | 33 | 30½ | March 31 | 68,289 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,069 | 8·77 |
| Huddersfield Corporation | June 10 | 1,358 | 1,305 | + 53 | + 192 | 35 | 35 | ,, 31 | 65,545 | 11,899,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | ,, 10 | 2,192 | 2,082 | + 110 | – 225 | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | — | — | — | — | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | ,, 7 | 123 | 139 | – 16 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 7 | 229 | 294 | – 65 | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 10 | 5,980 | 5,990 | – 10 | — | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | — | — | — | — | — | 7¼ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | ,, 3 | 10,818 | 10,882 | – 34 | — | 103 | 103 | Dec. 31g | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | ,, 11 | 1,550 | 1,613 | – 63 | – 1,892h | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — a |
| London County Council | ,, 3 | 15,092 | 11,949 | +3,143 | +21,425 | 46¼ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | ,, 8 | 117 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 10 | 12,980 | 12,559 | + 421 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 10 | 135 | 124 | + 11 | + 103 | 2¾ | — | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newcastle-on-Tyne Corptn. | ,, 10 | 3,728 | 3,726 | + 2 | — | 45 | 38½ | ,, 25 | 185,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111b | — |
| Newport (Mon.) Corporation | — | — | — | — | — | 15 | — | — | — | — | — | — | — | — | — |
| Oldham Corporation | ,, 11 | 1,663 | 1,155 | + 508 | — | 34¾ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 10 | 1,878 | 1,965 | – 87 | – 985 | 29 | 29 | ,, 31 | 94,448 | 18,204,426 | 1,828,193 | 1·16 | 12·39 | — | — |
| Reading Corporation | ,, 1 | 624 | 639 | – 15 | — | — | — | — | — | — | — | — | — | — | — |
| Rochdale Corporation | — | — | — | — | — | 4½ | 4½ | 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·55 |
| Rotherham Corporation | ,, 8 | 430 | 469 | – 39 | — | — | — | ,, 31 | 23,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·68 |
| Salford Corporation | ,, 5 | 4,444 | 4,118 | + 326 | + 210 | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 10 | 113 | — | — | — | 7¾ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 11 | 4,966 | 4,612 | + 354 | + 672 | 34½ | — | ,, 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 7 | 992 | 1,042 | – 50 | — | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 7 | 338 | 328 | + 10 | + 113 | 6¼ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 9 | 619 | 663 | – 44 | – 81 | 11¼ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | May 21 | 1,157 | 1,260 | – 103 | — | 19·54 | 18·48 | ,, 31 | 62,506 | 14,848,958 | 1,433,463 | 1·01 | 10·46 | — | 6·08 |
| Swindon Corporation | June 7 | 192 | — | — | — | 3½ | — | — | — | — | — | — | — | — | — |
| Wallasey U.D.C. | ,, 3 | 777 | 783 | – 6 | + 180 | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·50 |
| Warrington Corporation | ,, 1 | 326 | 321 | + 5 | + 90 | 7½ | — | — | — | — | — | — | — | — | — |
| West Ham Corporation | ,, 1 | 1,727 | 1,056 | + 671 | + 6,152 | 8·62 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 7 | 772 | 623 | + 149 | — | 7½ | — | ,, 31g | 20,878 | 4,263,066 | 417,335 | — | 12·006 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
Per mile of single track. b Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903.
h Half-year's figures.
Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**S.B.E.**—The June number of the Belgian Society of Electricians (Société Belge d'Electriciens) contains the proceedings of the last annual general meeting and papers by Monsieur Léon Versé on various methods indicating the poles, and by Maurice Leblang on the Cooper-Hewitt electric lamp.

**Economy in Firing.**—We have received No. 9 of the Library of the Mois Scientifique et Industriel, which has already reached its fourth thousand. It is entitled "L'Economie dans la Chaufferie," and is edited by J. Izart. An interview with Mr. Booth on the subject is appended. The various types of boilers and stokers now in use are treated and illustrated, and the whole system is threshed out in all its details.

**Radium and Therapeutics.**—Radium has been widely mentioned as a panacea for cancer, and eminent scientists are still hopeful that it may prove a valuable remedial agency, but so far the cures have been of an isolated character. It is reported, however, that a distinguished surgeon, lately the X-ray specialist at a large West-end hospital, is conducting experiments in conjunction with Sir William Ramsay with a view to evolving a new form of treatment.

**The Institution.**—The annual conversazione will be held, by permission of the Trustees, at the Natural History Museum, Cromwell-road, Kensington, on Thursday, the 29th inst., from 9 to 11.30 p.m. Visitors will be received by the President and Mrs. Siemens, and the President-Elect and Mrs. Gavey. Those travelling by railway to or from the museum will be allowed the free use of the District Company's subway, which leads from South Kensington Station direct into the south-east corner of the grounds of the museum.

**New York Lighting.**—The Governor of New York State has endorsed the lighting investigation committee's Bills fixing the price of gas and electricity in New York City. These fix the price of electric light furnished to private consumers at 5d. per kilowatt-hour, except that a rather higher rate may be charged in certain districts. The price for electric street lamps consuming 450 watts is fixed at £20 per annum, £18 for lamps consuming 325 watts, and £13 per lamp where two lamps are attached to a single pole.

**Radium.**—It is reported that Dr. Tizzoni, a professor at Bologna University, has presented to the Scientific Academy of that town the results of his experiments in the cure of hydrophobia by the radium rays. He injected several rabbits with violent hydrophobia virus, and then submitted them to radium rays. All the animals recovered within six days, including those whose treatment did not begin until the malady was at its climax. It is stated that experiments are likely to be made on human beings suffering from hydrophobia.

**Wireless Telegraphy.**—It is reported that the Admiralty have definitely fixed upon Marsden as the site of a new Marconi wireless telegraph station. A similar intimation was made to this effect some time ago, but it was afterwards announced that the decision had been cancelled. As a matter of fact, the Admiralty surveyors have been engaged in viewing other situations, and measurements were taken at Tynemouth. The position at Marsden, however, was found to be more suitable, the cliff top where the Marsden sub-division of the South Shields Coastguard Station is located being the highest and most prominent part of the coast between the Tyne and Wear. A commencement with the station will, it is stated, be made almost immediately. The position is between Marsden Hall and the cliff top, which is 50ft. above high-water level. It is stated that although intended primarily for naval purposes, the station will be extensively employed commercially.

**A.E.I.**—The *Proceedings* of the Italian Institution of Electrical Engineers (Associazione Elettrotecnica Italiana), vol. ix., Part 2, contain, besides the usual institution notices, etc., papers on "Electric Traction with Monophase Motors," by U. Segre, of Naples; "Monophase Motors in the U.S.A.," by E. Soleri, of Turin; "Various Electrical Measurement Instruments," by V. Arcioni, of Milan; "Coherers," by U. Crudelli, of Rome; two articles on the "Osmium Lamp," by G. Revessi, of Rome; an essay on the "Hydro-Electrical Plant of the Turin Municipality," by E. Silvano, of Turin; and an article on "Modern Incandescent Lamps," by Prof. P. Montù, of Naples. All these papers are, as usual, well supplied with illustrations and diagrams.

**Parcels Traffic.**—From the report for the past year of Mr. P. J. Pringle, manager of the Burton Corporation tramways, it appears that the parcels delivery system inaugurated last November has, contrary to expectation, met with scanty support so far, though the revenue from passengers' luggage and newspapers shows a satisfactory increase, the total number of parcels of all classes amounting to nearly 40,000. Over 600 parcels have been dealt with in a day. The traffic from the parcels delivery system is gradually increasing, and Mr. Pringle's prediction that a considerable improvement will occur when its advantages are better known has a good chance of being realised, excellent results having been attained in other towns where the system has been introduced.

**New Single-Phase Railway.**—The French Westinghouse Company, we learn, have recently secured the contract for the installation of the Westinghouse single-phase railway system on the Bergama, Valle Brembana Railway, Italy. This is the second single-phase railway contract secured by the French Westinghouse Company in that country, the first being the Rome-Civita-Castellana Railway. The preliminary details of this line are as follows: The length of the line is some 19 miles, and it will be served by five 30-ton locomotives equipped with four 75-h.p. Westinghouse single-phase motors, multiple-unit control, and pneumatically-operated bow trolleys. The gauge of the track will be 1·44m. The power station is to be situated about 1 km. out of Valle Brembana, and will be equipped with three single-phase 500-kw. Westinghouse alternators running at a speed of 500 revolutions per minute. These will generate a voltage of 6,000, at which pressure current will be delivered direct to the line.

**Electric Tramways and Football.**—In the days of the horse tram the winter pastime was looked upon as a valuable factor in increasing the revenue of tramway systems, but with electric traction the extra traffic is not an unmixed blessing. The report for the past year of Mr. S. J. Watson, engineer and manager of the Bury Corporation electricity works, furnishes a case in point. The normal maximum tramway load did not exceed 472 kw.; when a match was on it reached 715 kw., the extra generating plant increasing the fund for interest and sinking fund by £675 per annum. This amount, divided by the extra units used by football cars, which may be taken at about 4,750 units per annum, gives a cost of 2s. 10d. per unit for running this service, and spread over the annual consumption of 9,000 units means that an additional charge of ·18d. per unit has to be included in the price paid by the tramways department for current. If these excessive loads did not obtain, a further reduction of nearly ¼d. per unit would be practicable. Would there not

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be a chance of utilising the additional plant in mid-week by offering special terms to large power consumers?

**New Publications.**—The *Journal* of the Franklin Institute, Philadelphia, contains articles on "The Testing of Cast Iron," by Dr. R. Moldenke; "The Mississippi: Controlling Floods, Navigation Improvements," by Mr. H. Van Meerten; and "The Determination of Sulphur in Iron Ores," by Mr. J. H. Graham. The *Electric Journal*, Pittsburg, U.S.A., is the successor of the *Electric Club Journal*. It is now taking a wider range, having extended its field considerably. The issue for June contains articles on "Transformer Insulation: Relation of Ohmic Resistance and Dielectric Strength, by Mr. O. B. Moore; "Armature Windings of Alternators—Open-Type Windings," by Mr. F. D. Newbury; "Experiences on the Road," by Mr. B. C. Shipman; "A 135-ton Single-Phase Locomotive," by Mr. N. W. Storer; "How to Calculate Regulation," by Mr. J. S. Peck; "Static Disturbances in Transformers," by Mr. S. M. Kurtner; "Durability of Steam-Turbine Vanes," by Mr. J. R. Bibbins; "Protective Apparatus," by Mr. N. J. Neall; "Modern Practice in Switchboard Design" (continued), by Mr. H. W. Peck; and "Factory Testing of Electrical Machinery" (continued), by Mr. R. E. Workman.

**Radium.**—The results of his researches into the origin of radium are described by Mr. Bertram B. Boltwood in an article of which an abstract appears in the *Journal* of the Chemical Society. The author extended the general method of investigation previously employed to 22 different samples, comprising 12 distinct mineral species, and he found, in harmony with the earlier work, that the quantities of uranium and radium occurring together are directly proportional; hence, he states, the only possible conclusion is that uranium is the parent of radium. The participation of thorium in the production of radium is excluded by the fact that the radium-uranium ratio is independent of the percentage of thorium in the minerals. It is highly probable, as suggested by Rutherford, that intermediate stages exist between the uranium atom and the radium atom. The persistent appearance of lead as a constituent of uranium-radium minerals may indicate that this element is one of the final disintegration products of uranium. The only mineral examined by the author which was found practically free from lead was a sample of uranophane from North Carolina. This is geologically the youngest of the minerals examined, and it would naturally contain very little lead if this element was a final disintegration product. The author's experiments show that monazite from various sources contains 0·3 to 0·4 per cent. of uranium. The presence of notable quantities of uranium and radium in monazite explains the accumulation of helium in this mineral, for monazite is geologically very old, and the production of helium through radium from uranium has doubtless been going on for countless ages.

**Municipalisation in America.**—The outspoken utterances of Glasgow's tramway manager, Mr. James Dalrymple, now on a visit to the States, appear to have created a fluttering in the municipal dovecots of the Great Republic. Mr. Dalrymple is reported to have come to the conclusion that in America municipal ownership could not be completely successful on account of the way in which politics dominate the situation. This is certainly a factor to be reckoned with, for across the Atlantic politics enter into the methods of the community in quite a remarkable degree. When a Presidential election approaches, almost everybody deems it his business to "run on the ticket" of one or other of the candidates. So far as it has been tried, municipal trading has not proved a great success in the States, and it is not difficult to realise that under such administrations as the Tammany *régime* it would be highly undesirable. To judge by reports, however, the municipalities have been largely purged of this element during President Roosevelt's period of office. Mr. Dalrymple is stated to hold that the only antidote to political influence in municipal matters is to be found in a complete Civil Service system, while he is also credited with the opinion that "municipal ownership must be divorced from politics," with which most people will agree. Apart from this, he does not view the economic conditions of the big American as conducive to municipal success. Meantime, it is interesting to note that the advocates of municipal trams for Chicago, at whose invitation Mr. Dalrymple went to America, are much perturbed at his candour, and are seeking to explain his criticisms by stating that the opponents of the scheme have grossly misrepresented matters to him.

**The Embankment Scheme.**—When the committee of the House of Commons, in sanctioning the London County Council's embankment scheme, inserted a stipulation as to the widening of Blackfriars Bridge, it was feared by many that this proviso would amount to a continuation of the veto previously imposed upon the measure, especially as the City Corporation were still unrelenting. Representatives from Spring-gardens have interviewed the authorities at the Guildhall, however, and apparently to some purpose, as it is now announced that the special committee of the Corporation to whom, in conjunction with the Bridge House Estates and the Streets Committee, the matter was referred, have decided to recommend the Corporation to give their support to the scheme. The method of widening and the conditions under which tramways shall be admitted into the City remain for further discussion. The report was expected to come before the Corporation this week, when there is likely to be a spirited debate, as a section of the City Fathers are apparently irreconcilably opposed to the introduction of the trams within their domains. Assuming the Bill survives this ordeal, as it not improbably will, having regard to the considerable change that has taken place in the attitude of the Corporation as a whole, and that no prohibitive conditions are imposed, it has still to run the gauntlet of a third reading in the House of Commons and consideration by the Upper Chamber. It is scarcely likely now to be thrown out by the Commons when it is discussed "on the floor of the House," and if the measure succeeds in negotiating what is practically the final hurdle—the Lords—the much-talked-of scheme will presumably, for better or for worse, crystallise into an accomplished fact.

**An Electrical Aerial Ferry.**—There has just been completed at Duluth, U.S.A., an electrically-operated aerial ferry, the first structure of its kind in that country. A canal was constructed at Minnesota Point some four years ago, and communication was maintained between the banks by an ordinary ferry, which after a time was supplanted by a steam ferry. The latter proving expensive, it has in its turn been superseded by the contrivance referred to above, which is now in operation. The canal is 300ft. in width, and a steel bridge has been erected across it at an altitude of about 180ft. above the level of the water to permit of vessels passing through without lowering the masts. The car is suspended from the bridge by hangers, and the friction of all the working machinery is reduced to a minimum by the use of roller bearings. There are two 50-h.p. electric motors located under the floors of the car. These operate two drums, on which are wound 1in. cables, extending to the truss and thence to the tower, where they are fastened, thus producing the motion which causes the car to travel. The car has a normal speed of about four miles per hour, but the equipment is capable of propelling it at twice that

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speed, and the passage can be made in little more than a minute. The cost of the ferry totals between £20,000 and £25,000, and it is estimated that, including the interest on capital expenditure payable by the City Council to the State, it can be operated at a cost not exceeding £1,500 per annum, representing a saving of one-third of the cost of the steamboat ferry. The platform of the car measures 50ft. by 34ft., and contains two neatly-finished compartments, in addition to space for wagons or street cars, the total capacity being some 65 tons.

**Development at Niagara.**—From the current number of the *Canadian Engineer*, we observe that excellent progress is being made with the construction of the three great works on the Dominion side of the Falls. At the Ontario Power Company's works, work on the power-house distributing station and tunnel was carried on all the winter. The foundations for the intake piers have been laid, and preparations are being made to let the water into the fore-bays this month. The gate, which is of the "Stoney" type, is already in position. The power-house will have temporary ends put in to enclose the units as they are installed. It is expected that the works will be in operation by August. Good progress is also being made with the plant of the Electrical Development Company. The civil engineering works are practically completed, and the erection of the power-house is being proceeded with. The transformer station is well advanced, and the electrical and hydraulic machinery will shortly be installed. It is probable that the first unit of 12,500 h.p. will be ready to transmit current in the autumn. The Canadian Niagara Power Company's works are rapidly approaching completion in regard to the units it at present has in contemplation. The power-house will be finished next month. Three wheels of 10,000 h.p. each are already erected and in working order, one of them being connected up to the United States side of the river for use in case of accident to the big power works there, with which the Canadian Company is financially associated. Two more wheels are being installed, and will be completed during the summer. The 60,000-volt switches are nearly finished, and the low-tension 'bus-bar compartment is completed. The transformers are all in place. The contract has been let for the second section of the wheel-pit, and the work of excavation will be finished in about nine months. This section will contain six units of 10,000 h.p. each.

**Cast-Iron Magnets.**—Mr. B. O. Peirce presented recently to the American Academy of Arts and Sciences a useful contribution on the properties of magnets made from hardened cast iron. The work from which the data given in the paper were obtained was done in the Jefferson Physical Laboratory of Harvard University. The object of the experiment was to ascertain how far hardened cast-iron magnets could be used to replace steel permanent magnets in moving-coil galvanometers and other instruments requiring permanent magnet control. Mr. Peirce found from early experiments with iron castings that as they come from the foundry they make most unsatisfactory magnets as far as permanence is concerned. On the other hand, these magnets, if properly hardened and aged after being machined, compare favourably in strength, in permanence, and in the relatively small changes of their moments with room temperature, with the best of tool steel magnets, even if in strength, though not in their other qualities, they fall a little behind magnets made, in a forming press, of steel specially prepared for the purpose. It is in the hardening of the cast iron that the secret of success appears to lie, and the author points out that the castings must be raised to a very high temperature before being chilled. The temperature used for hardening steel is much too low to produce the results required with cast iron. If the casting is heated to a very bright red and then plunged into the bath, the outside may become hard to the file, while the interior, as magnetic tests clearly show, remains soft. In this case, however, the material will stand a higher temperature without injury, and if the mass be reheated, and when it is just below the melting point be suddenly chilled, the whole interior becomes hard. A number of experiments are then described with various forms of magnets, and curves are given by which the field of the cast-iron magnet when soft and when hardened can be compared with that of steel magnets of the same form. The curves clearly support the author's contention that satisfactory cast-iron magnets can be produced. For certain forms of instruments where the shapes of the magnets are such that they cannot be easily formed out of steel, cast-iron magnets can be successfully used and possess many commercial advantages.

**Turbine Vanes.**—An interesting article on the durability of steam-turbine vanes is contributed to the *Electric Journal* (Pittsburg, U.S.A.) by Mr. J. R. Bibbins. At the commencement the author refers to a report upon a life-test of a German-built Parsons turbine, of which the vanes and all interior parts, as well as the bearings, were stated to have shown not the slightest sign of wear after running 17,200 hours—practically day and night for two years. A British engineer who had been in charge of the same turbine station for eight years stated that during this period no wear was observed on the interior of the turbines. Two years later they were again opened for his inspection, when, to quote his own statement, "they were in as good a state as when they left the builders' works." The author then describes the results obtained at the turbine plant of the Westinghouse Air Brake Company. The first machine of 400 kw. was installed in August, 1899, and the plant has since been in continuous operation on the regular factory light and power load. This machine was opened in March of the present year. In order to show clearly the condition of the vanes, two sample blades were deliberately broken out of the eighth and twelfth rows respectively of the low-pressure rotor barrel. Here the greatest quantity of moisture occurs in the expansion of steam, and here wear from steam erosion would, if at all, be expected. Three facts are apparent from these exhibits: first, that the old vanes have retained their full cross-section, and consequently their full mechanical strength; second, the vane angles are unimpaired, and hence their efficiency is permanent; third, the working steam surfaces have not lost their original smoothness. The author remarks that the secret of the long life of vanes in the Parsons type of turbine lies in the low steam velocities employed. This desideratum is secured by utilising the principle of compounding. Instead of one expansion stage, there are 58 in this size of turbine. In each the energy of velocity is abstracted by the moving vanes as fast as it is generated, so that the steam velocities throughout the turbine range no higher than 150ft. to 600ft. per second, although the same result is accomplished as in the single-stage turbine, where a velocity of 4,000ft. per second may obtain. The excellence of the results obtained with the above-mentioned turbine is emphasised by the fact that the steam supply has been excessively wet.

**Canadian Telephone Enquiry.**—We have received further reports of the proceedings before the committee appointed to enquire into the telephone systems of the Dominion, bringing matters down to the 26th ult. Chief interest to our readers will centre in the views expressed by Mr. Herbert Laws Webb, who was examined at great length. Mr. Webb's views on municipal telephony are

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tolerably familiar to our readers, and it will be unnecessary to follow his remarks in detail, but there are a few points in this connection which are worthy of reproduction. The result of municipal telephony in England, he said, might be summed up by saying that it had wasted a great deal of money. All these systems were equipped with entirely obsolete plants, and were laid out quite wrongly from an engineering point of view. The net result of the five municipal systems in operation was that they had spent about half a million in serving 10,000 users not already served by the National Telephone Company. He differed on many points from Councillor J. Willock, chairman of the Glasgow Electricity Committee, whose evidence we referred to in our issue of the 26th ult., and stated that many of the figures given by the latter were inaccurate. He likewise held that the State telegraphic and telephonic system had been more or less a failure in England. Telephonic development had been greatly hindered in this and most of the Continental countries by legislative restrictions. The greatest progress had been shown by Norway and Sweden, which were comparatively free from State intervention. In further examination Mr. Webb stated that he did not condemn municipal telephony in principle, but that the great error on the part of the municipalities owning telephonic systems in Great Britain had been the selection of obsolete plant after they had had the accumulated experience of other telephone systems to judge by. Although the charges in Great Britain for trunk calls were only half those of the United States or Canada, he did not think they were nearly so satisfactory, as the facilities were much inferior, and there were frequently delays in obtaining communication over long distances. He deprecated the practice in England of limiting conversations over trunk lines to six minutes as being frequently quite inadequate, and contended that such restrictive regulations would not be permitted in the case of a private company.

**An Electro-Hydraulic Elevator Plant.**—An interesting description appears in the *Electrical Review* of a modern hydraulic elevator plant at a goods store in Kansas City, which is operated by three Worthington three-stage motor-driven turbine pumps. The power plant of the store contains three generators—two of 75 kw. and one of 160 kw., each direct connected to a tandem compound high-speed engine. These generating units supply power to motors for various services in the building. Power is distributed for electrically operating feed pumps, elevator pumps, a ventilating fan, an ice machine, circulating pumps, and other apparatus. A notable feature of this plant is a battery of three high-pressure turbine pumps. Two machines, each of 300 gallons per minute capacity, are driven by 45-h.p 220-volt motors. The third pump has a capacity of 500 gallons per minute, and is driven by a 220-volt motor of 70 h.p. These machines maintain a pressure of 140lb. in the system. Their motors are controlled by standard Cutler-Hammer automatic controlling apparatus, which is mounted on panels and assembled uniformly with the panels of the main switchboard. The three pumps supply the water required for the complete hydraulic system, to which all the elevators of the store are connected. The arrangement of piping for this system is of a novel character, and has proved highly satisfactory. There is one pressure main from the discharge openings of the pumps which runs through the whole building, past each of the elevator machines. This pressure main is connected to two compression tanks, one in each end of the building. These two tanks are set at the same level and carry their water lines at the same height. The connection for each elevator machine is taken from the main at a convenient point. There is a return main, paralleling the pressure main, into which each elevator machine discharges, and this return main is connected to each of two open, or "surge," tanks located near the compression tanks. These tanks are connected to the suctions of the pumps. With a suitable arrangement for removing entrained air from the suction line, the operation of the system is perfect. During the hours of light load, one of the 300-gallon units operating at normal capacity will carry the service. During the hours of heavier service the 500-gallon pump will take care of the load, and during the hours of maximum load either of the 300-gallon machines, together with the 500-gallon one, will carry the load.

**Library Illumination.**—An excellent article on the illumination of libraries appears in the *Western Electrician* of Chicago. The author points out that the use of gas is a serious mistake in any library where electricity is available, and that the relative prices of the two should have little weight in determining which illuminant to use. Favourable conditions of atmosphere are a fundamental requisite where intense mental work is to be performed, and in no gas-lighted room can the purity of the air be compared with the atmosphere of an electrically illuminated chamber, with any possibility of better conditions in the former case, granted the same ventilation facilities in each. It is well known, also, that the depreciation of books and pamphlets is much greater in the vitiated air of a gas-lighted apartment than in the room lighted by electricity, so that in the long run it is poor economy to use gas, even if its price in some cases is considerably lower than the charges for current. This is because many of the acquisitions of a progressive library cannot be replaced when they become worn out, and every effort to prolong the useful life of a book is therefore to be commended. A point is made by the author of the great importance of uniform illumination. The brilliance of new Welsbach mantles is attractive in this respect, but their rapid depreciation discounts them. Two kinds of illumination are ordinarily required in libraries—general and special. The former provides for the convenient movement of persons and books from place to place and the easy consultation of volumes upon shelves, determination of titles, numbers, etc. The latter is of a concentrated nature, enabling exacting eyework to be done in certain specific places, such as reading and study tables. For all library work it is probable that the incandescent lamp will in time be recognised as capable of being best fitted to meet the most varied conditions. In large public libraries the use of magnificent marble decorations constitutes a common feature of the architecture, and the requisite designs of ornamental electric lamps now available for such work far surpass in beauty anything that gas illumination has to offer. In fact, the equipment of such a building as the Congressional Library at Washington or the public library in Boston with gas lamps is practically inconceivable. Even the stacks demand the clean and flexible electric bulb, due care being taken to provide swinging lamps with guards as a prevention against fire. It would be difficult to name an installation, says the author, where the application of electric lighting to library work equals that of the Congressional Library. In decorative effects and brilliance of illumination the lay-out deserves the admiration of every electrical engineer and central-station man who visits Washington. The article concludes with the following admonition to central-station managers: "Wherever a gas-lighted library exists in the same town with a central station, it should be the constant effort of the manager to add the library lighting to his load."

**The Light Railways Act.**—The particulars we published last week of the report issued by the Light

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Railway Commissioners seem to indicate an unmistakable decline in the popularity of the Light Railways Act. The state of affairs in regard to procedure under this statute is concisely illustrated by the following table relating to the orders confirmed during the past four years:

| Year. | Number of orders confirmed. | Mileage. | Estimated cost. |
|---|---|---|---|
| 1901 ..... | 49 ..... | 337 ..... | £2,629,725 |
| 1902 ..... | 33 ..... | 149 ..... | 1,192 000 |
| 1903 ..... | 37 ..... | 179 ..... | 2 019,800 |
| 1904 ..... | 21 ..... | 97 ..... | 801,300 |

The orders confirmed by the Board of Trade since the commencement of the Act in 1896 down to Dec. 31 last number 237, representing an estimated expenditure of over 11 millions. These are tolerably substantial figures, though it has to be remembered, of course, that some of the schemes failed to arrive at fruition, and where the construction of light railways has set in on a large scale it cannot be expected that the returns will continue to show an increase year by year, especially with the comparatively limited area of this country; but it needs a much more extensive adoption of the Act than has been the case if its ostensible object is to be achieved. In France and Belgium, where light railways are largely State-aided or rate-aided, excellent results have been attained of recent years, and the inference appears to be that if our agricultural districts are to be adequately served in this respect, a larger degree of assistance from the public funds must be forthcoming. Such a step would probably be met with the usual chorus of disapprobation by the anti-municipal alarmists, but we think that this is a case where State or municipal aid might justifiably be rendered. The anti-municipal section have a good show of reason on their side in some of their protests, but private enterprise is not likely to do much unaided in the way of constructing lines in rural districts for goods traffic, while with a fair degree of municipal support they may find some inducement to do so. The Act of 1896 confers power on the Treasury and on local authorities to render facilities for such schemes, but to effect the object in view a much larger amount of support than has hitherto been available is necessary. A comprehensive scheme of light railways in rural districts should contribute materially in assisting our decadent agricultural industries. We gave in our issue of the 9th inst. some particulars of a scheme presented to the Chicago branch of the American Institute of Engineers by Mr. J. R Cravath for a modified type of light railway for passenger and goods traffic in rural districts. Mr. Cravath estimated that by using a 28in. gauge and lighter rails a light railway could be constructed for £1,570 per track mile, exclusive of expenditure for right-of-way. He estimated, from various data, that a revenue of £330 per mile would be possible, on which there would be a surplus of £80. Possibly his figures are a little optimistic, but some relaxation in the requirements of the Act, coupled with a larger measure of State or municipal support, would probably result in lines being constructed in suitable areas now unserved.

**Electroculture.**—Our contemporary the *Scientific American* has an interesting article on what it designates electroculture. The author remarks that the flora of the north polar region is remarkable for rapid growth, fertility, and brilliancy of colouring, phenomena which seem incompatible with the climate. The Arctic summer, though nightless, is very short, the sun is low, and its rays are often intercepted by fog and clouds, so that it cannot furnish an amount of light and heat favourable to very rapid growth. The investigations of Prof. Lemstrom, of Helsingfors, and others, tend to show that electricity exerts a great influence on the growth of plants, and this view is confirmed by the luxuriant vegetation of the zone of action of that violent electrical manifestation, the aurora borealis. Furthermore, a close connection has been found, in Finland, between fruitfulness and frequency of auroras. Finally, Lemstrom was led to attribute to the sharp points of plants, such as the beard of grains, the function of "lightning rods," which collect atmospheric electricity and facilitate the exchange of the charges of the air and the ground. His early experiments showed that electrified plants had more vigorous growth than others, the increase in weight approximating to 40 per cent. These experiments were made with barley, grain, and straw. In the following year the experiments were extended to various plants. The results were contradictory in some respects, and showed that the advantage derivable from electroculture depends also upon other factors, such as temperature, moisture of air and soil, and the natural fertility and the manuring of the latter. The supply of water proved to be of especial importance. Extensive experiments with potatoes, carrots, and celery showed increases in crop of from 30 to 70 per cent. Small differences, possibly due to extraneous causes, appeared when the direction of the current was reversed. Other field experiments gave increases of 45, 55, occasionally 85 per cent. for grain and 95 per cent. for raspberries, while cabbage, tobacco, flax, turnips, and peas grew better without electrification than with it. Lemstrom then, in order to test the effect of climate on electroculture, transferred his experiments from Finland to Burgundy, where he found his earlier observations confirmed, particularly in regard to the great influence of irrigation. Other investigators attacked the problem from a different side, endeavouring to affect by electrification, not the growing plant, but the seed. The Russian botanist, Spechniew, submitted grain to electrical action, and thought that it sprouted earlier and more vigorously than grain not so treated. Pautens, who repeated Spechniew's experiments on a larger scale, came to the conclusion that electricity had no effect on dry seeds, but that it promised excellent results when applied in connection with moisture—which in itself promotes germination. The same conclusion was reached by Kermey, who electrified grain strewn on moist sand in a glass cylinder through which it could be observed. The author considers that the cultivation of fruits and vegeables, particularly under glass, may become a commercial possibility, for electroculture promises not only greater but also earlier crops. Floriculture offers another promising field for the application of electrical methods. The author proceeds: "All this, however, belongs to the future. Much study and experiment and probably many failures must precede the general introduction of electroculture, though the results already obtained are certainly promising." In conclusion, the author gives an explanation of the effect of electricity upon plants. These transform the energy of the sun's rays into chemical energy. Though the heat produced by the electric current may have some direct effect, especially in germination, the electrical energy supplied cannot, in general, replace or even greatly reinforce the energy of sunshine. It is rather to be regarded as a stimulus to metabolism and all the vital processes. One of these is the capillary elevation of water, which is promoted by a positive electric current flowing upward. This is one possible explanation of the promotion of growth by electricity, and though in some cases the best effect is obtained by directing the positive current downward, or in the opposite direction to the assumed principal flow of sap, these exceptions may mean that more food is supplied by the leaves than is commonly supposed. Another possibility is an increase in activity in both leaves and roots.

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## THE CLYDE VALLEY ELECTRICAL POWER COMPANY, LIMITED.

For many years the Clyde and the neighbouring district has been famed as a centre of industrial and engineering importance, and it is the avowed object of the Clyde Valley Electrical Power Company, which was initiated by local enterprise, to help manufacturers in the district surrounding Glasgow to maintain the position they have so long held, and to aid them in competing as keenly as ever in the world's markets. The company was incorporated in 1901, and has obtained powers over an area extending along the Clyde Valley from Craigdoran and Port-Glasgow in the west to Lanark and Shotts on the east. This area, which comprises about 750 square miles, contains the most important manufacturing and coal-producing district in Scotland.

The company have taken over the provisional order which was granted to the burgh of Clydebank in 1901. This was sanctioned by Parliament in 1904, and enables the company now to supply electricity for both power and lighting in the burgh, for which purpose special plant has been installed. The city of Glasgow, and the burghs of Govan, Partick, Port-Glasgow, Paisley, and Hamilton, although actually situated in the above area, are not included in the company's schedule unless any of them should elect to take a supply. Under their Act of Parliament the company were empowered to acquire land for the erection of generating stations at Yoker and Motherwell, five miles and 15 miles out of Glasgow respectively, and in September, 1902, a contract was entered into with the British Westinghouse Electric and Manufacturing Company, Limited, for the erection and equipment of these two stations and the various sub-stations that are dotted over the area. Fig. 1 is a diagram showing the cable routes, present and future, and the positions of the generating and sub-stations.

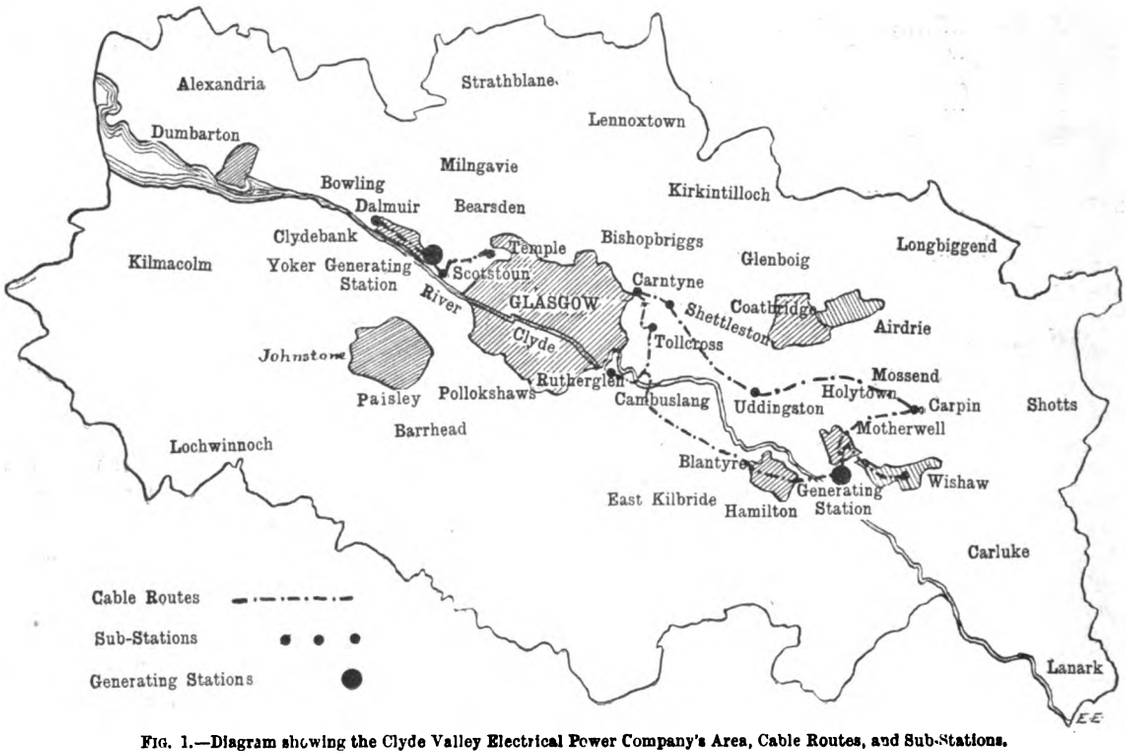


FIG. 1.—Diagram showing the Clyde Valley Electrical Power Company's Area, Cable Routes, and Sub-Stations.

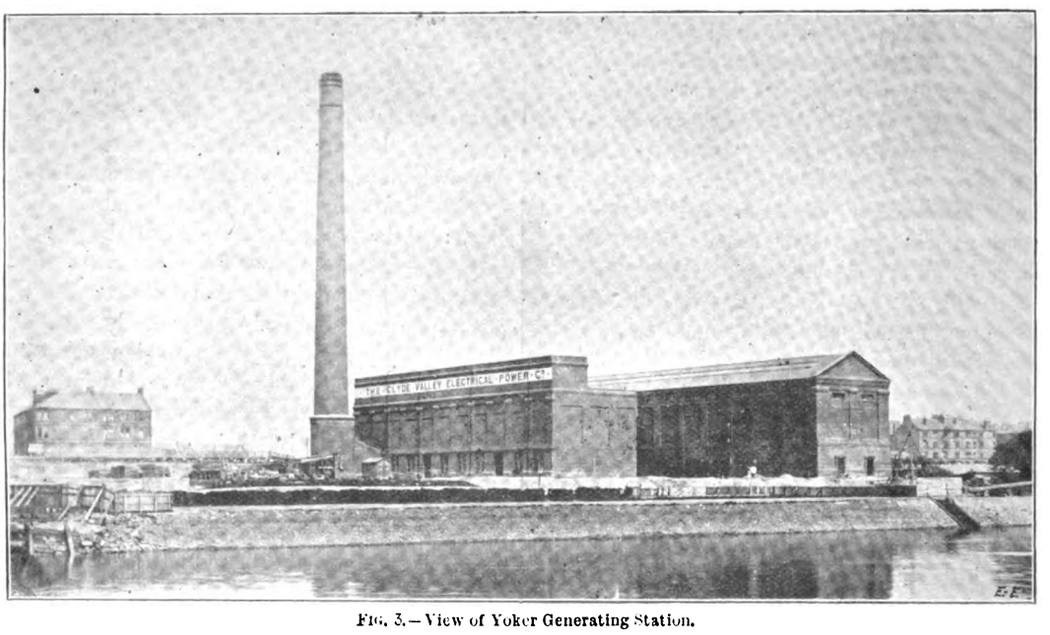


FIG. 3.—View of Yoker Generating Station.

### YOKER POWER STATION.

Figs. 2 and 3 are respectively a plan and view of the Yoker generating station, which is situated on the banks of the Clyde, where an unfailing supply of water for condensing purposes is available. The Motherwell station, being situated at a higher elevation and above the level of the River Clyde, depends for its water supply for condensing purposes on electric pumps working against

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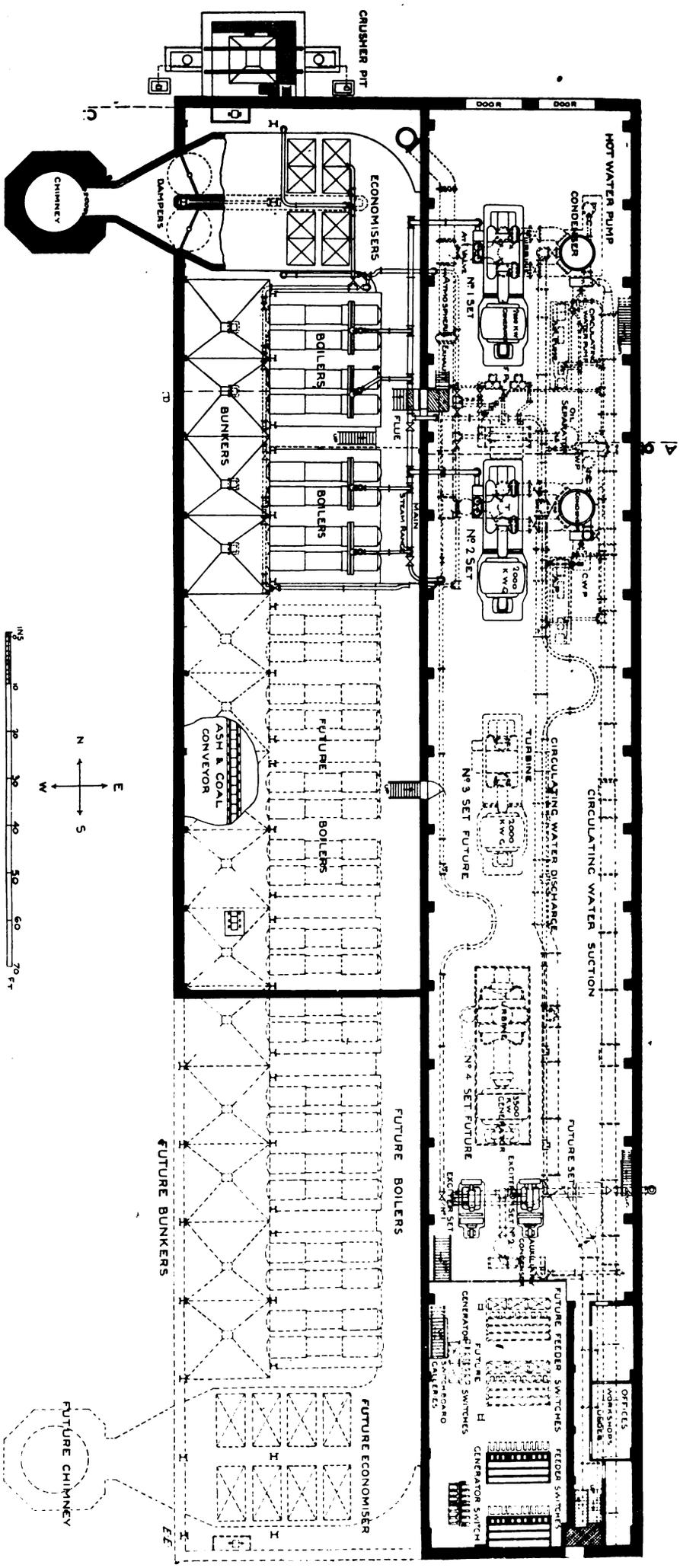


Fig. 2.—Plan of Yoker Generating Station.

a head of 140ft. As shown in Fig. 2, the offices occupy part of the south end of the engine-room, being placed adjacent to the switchboard galleries. Accommodation is provided here for the station superintendent, storekeepers, and timekeepers. The offices are divided off from the switch galleries by iron doors, and everything is of a thoroughly fireproof construction, special attention having been paid to this important matter.

*Boiler-House.*—The boiler-house has an internal measurement of 186ft. long by 50ft. wide. It is well lighted, and is designed in every way to afford the maximum of convenience. There are at present four double-drum Babcock and Wilcox water-tube boilers in position, each having a heating surface of 4,400 square feet and fitted with superheaters capable of imparting 150deg. F. of superheat. The steam pressure is 175lb. per square inch. The boilers are connected to a main flue passing along the back, and a Green's economiser of two sections and 432 10ft. tubes is installed between this flue and the chimney, the usual by-pass flue being provided. The chimney is built of special perforated and moulded bricks on the Alphons Custodis system, and is 225ft. high above the foundations, with an internal diameter at the top and bottom of 11ft. and 14ft. respectively. It is lined with firebricks up to a height of 85ft. above the top of the foundations, which extend to a depth in the ground of 22ft. The base of the foundation occupies a space of 2,116 square feet, and the weight divided over the entire area is two tons per square foot, allowance being made for wind pressure. Each of the boilers is fitted with a Roney mechanical stoker, manufactured by the British Westinghouse Company, and adapted for burning efficiently a cheap class of coal. These are driven through a special worm gearing by two 4½in. by 4in. 5-h.p. Westinghouse standard engines, running at 400 revolutions per minute, and situated in the boiler-house. The coaling arrangements of the power station are most complete, and from start to finish the fuel is untouched by hand. Coal is brought in wagons to the company's private siding, where it is dumped by a hydraulic ram into the crusher-pit, passing through a crusher and screen

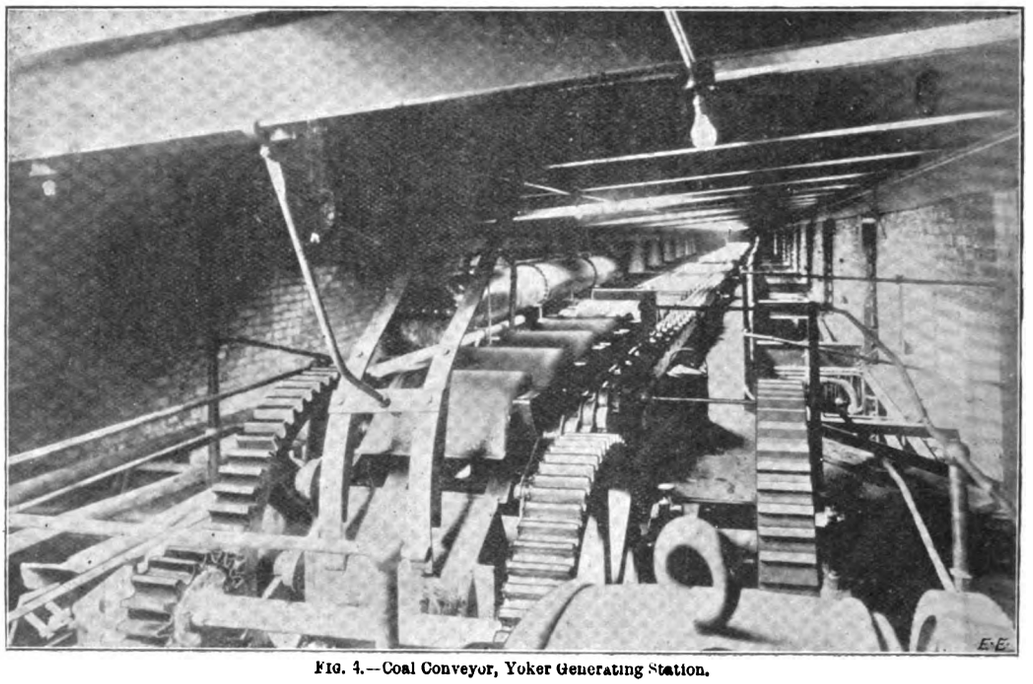

FIG. 4.—Coal Conveyor, Yoker Generating Station.

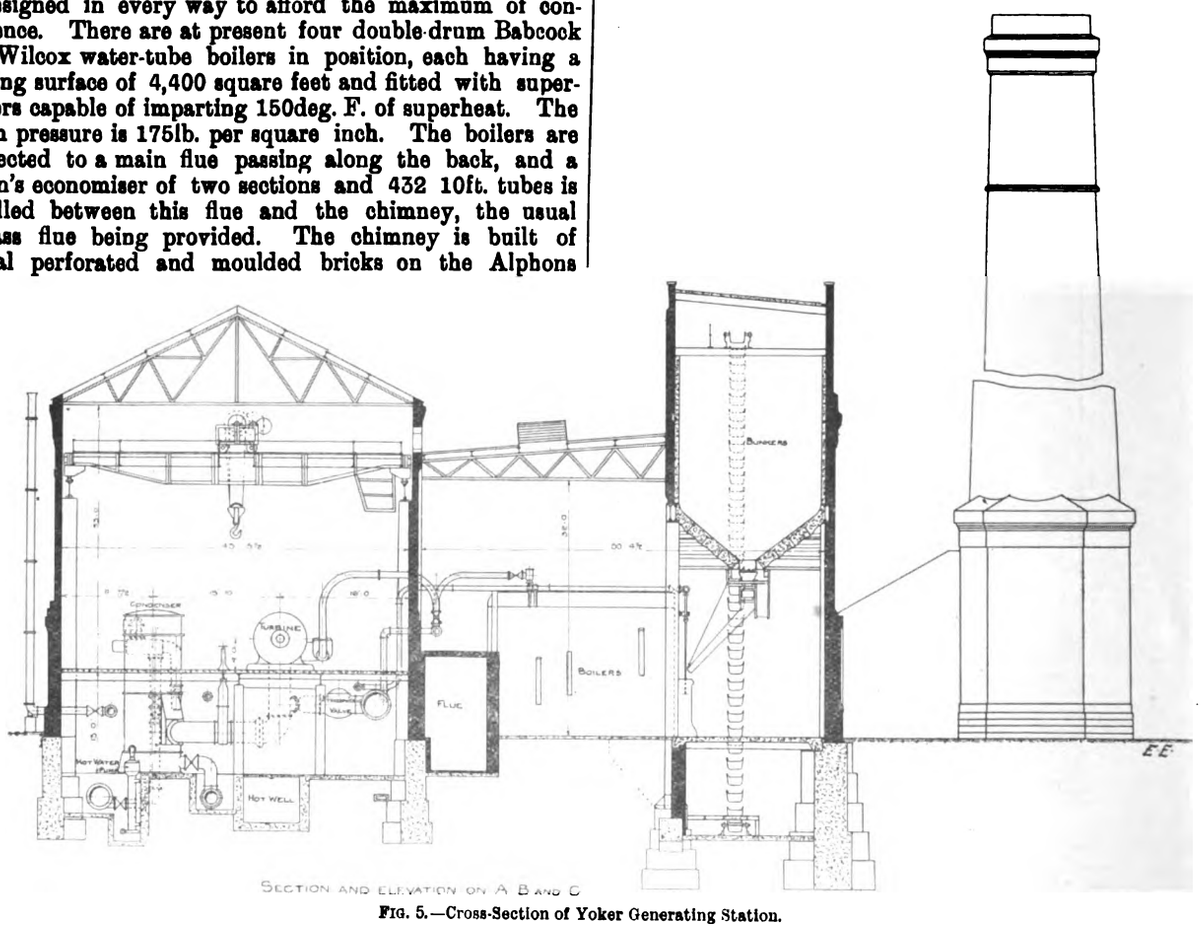


FIG. 5.—Cross-Section of Yoker Generating Station.

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operated by a 10-h.p. enclosed shunt-wound motor running at 650 revolutions per minute. It is there picked up by a bucket conveyor (Fig. 4) constructed by Messrs. Graham, Morton, and Co., and carried to the storage bunkers over the boiler-house. This conveyor, which is driven by a 15-h.p. enclosed shunt-wound motor, is also used for carrying the ashes away from the boiler-house. From the bunkers the coal passes automatically to the stokers, being weighed—also automatically—in transit, and the number of hundredweights used recorded on an indicator. To prevent the coal sticking in the shoots a motor-operated agitator is installed, which keeps it constantly on the move.

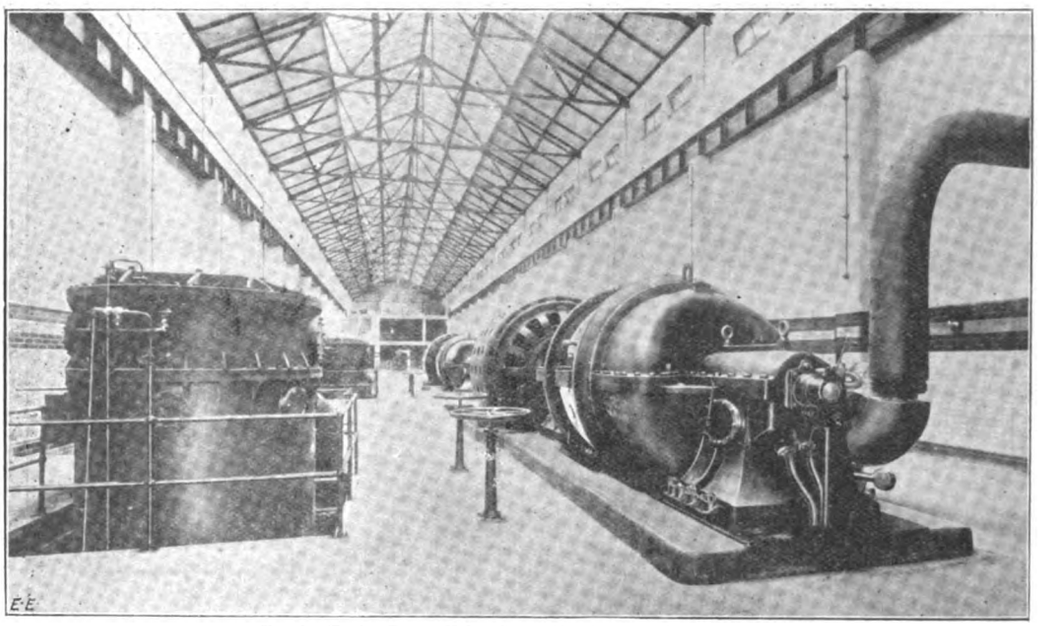

FIG. 6.—Engine Room, Yoker Generating Station—General View.

*Engine-Room.*—The engine-room consists of two floors, one on the ground level (Fig. 5) and one in the basement, the latter containing most of the auxiliary machinery. The turbine condensers, which are of the Mirlees-Watson vertical surface type, each with 6,250 square feet of cooling surface, are placed here, their upper ends projecting through the main floor a few feet. Each turbine exhausts directly into its own condenser, and each condenser is provided with a steam-driven, two-stage, dry-air pump situated in the basement. Arrangements have also been made for exhausting to atmosphere if necessary. The circulating water for the condensers is drawn from the Clyde, running by gravity into a large circular well 18ft. in diameter and of a depth below water-level of 9ft. There are two 30in. pipes leading into the well from the river, and the water is drawn out through a 36in. cast-iron pipe by means of a steam-driven centrifugal pump placed in the basement. After passing through the condensers the water is discharged by a 36in. pipe into a tank on the bank of the river. The condensed water is pumped into the hot-well, which is also in the basement, by a centrifugal pump driven by a 6-h.p. vertical-shaft shunt-wound motor running at 625 revolutions per minute. From here it passes to the suction of the two feed-pumps, which are of Messrs. J. and P. Hall and Son's tandem, compound, double-acting type, each capable of delivering 9,600 gallons per hour against a boiler pressure of 175lb. The make-up water is taken from the city mains, that of the Clyde being unsuitable for boiler-feed purposes; there is, however, a stand-by suction from the river for use in case of emergency. The exciter sets have their separate surface condenser, which is of the Worthington Pump Company's make, and has 600 square feet of cooling surface. In addition to the above auxiliary plant, there is installed a feed-water heater by Messrs. Joseph Wright and Co., having a heating surface of 700 square feet.

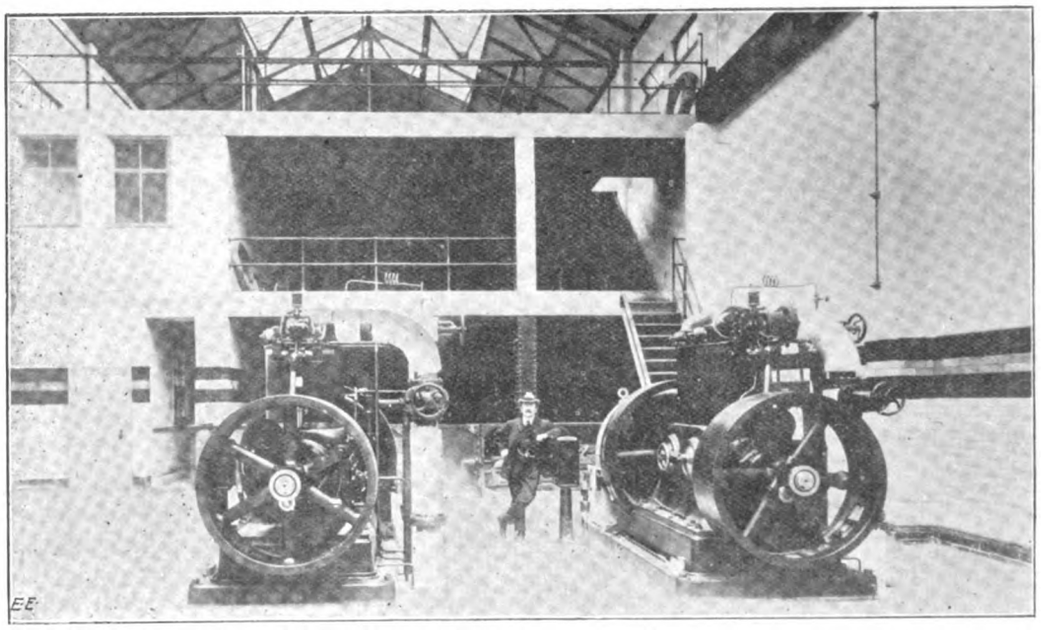

FIG. 7.—Exciter Sets, Yoker Generating Station.

*Generating Plant.*—The upper and principal floor of the engine-room measures 252ft. long by 43ft. 5½in. wide. It is well lighted from the roof, the walls are faced with white

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glazed bricks, and the floor throughout is paved with Italian mosaic work. At the north end are situated the switchboard galleries and offices, which have an inside measurement of 53ft. by 43ft. 1in. wide. The main generating plant at present installed consists of two Westinghouse-Parsons steam-turbine units (Fig. 6), each with a normal capacity of 2,000 kw. and an overload capacity of 3,000 kw. The speed is 1,500 revolutions per minute, which corresponds to a peripheral velocity of the rotating part of five miles per minute. The turbines are of the latest double-flow pattern, steam entering at the centre and exhausting at both ends, and each contains no less than 20,000 blades. These are securely fixed to the steel drum, and are of drop forged steel in the first series, and special metal at the low-pressure end so as to prevent corrosion due to the wetness of the steam. The cylinder is of close-grained cast iron, and the rotor consists of a rolled-steel drum fixed to the shaft by the aid of forged-steel umbrella-shaped discs shrunk into the drum and pressed on the shaft. Each of the turbines is directly connected to a Westinghouse 2,000-kw., 11,000-volt, three-phase, 25-cycle generator of the rotating-field type. These are of the normal Westinghouse design. The two-pole field magnets consist of a solid forging of Whitworth fluid-pressed steel combining high magnetic properties with strength, and the armature of laminated iron wound with copper bars in practically closed slots is supported by a heavy cast-iron frame divided horizontally. The starting, stopping, and speed variations of the generators is under control from the switchboards by electrical means, current for this purpose being taken from the exciters. The oiling of the turbines is carried out on the gravity system. A large tank in the basement of the engine-room receives the oil overflowing from the bearings, which is then passed through coolers and raised by a special oil-pump to a tank in the roof of the boiler-house, flowing from thence by gravity under a head of 50ft. back to the bearings. Oil-pressure gauges are provided on the latter in order to indicate at a glance how the apparatus is working. The engine-room as at present constructed will accommodate one more 2,000-kw. set and a fourth unit of 3,500 kw which will eventually make the total capacity of the station 9,500 kw. The additional sets will be added as soon as one of the present units is loaded up, so that there will be always one spare set ready at any moment in case of accident.

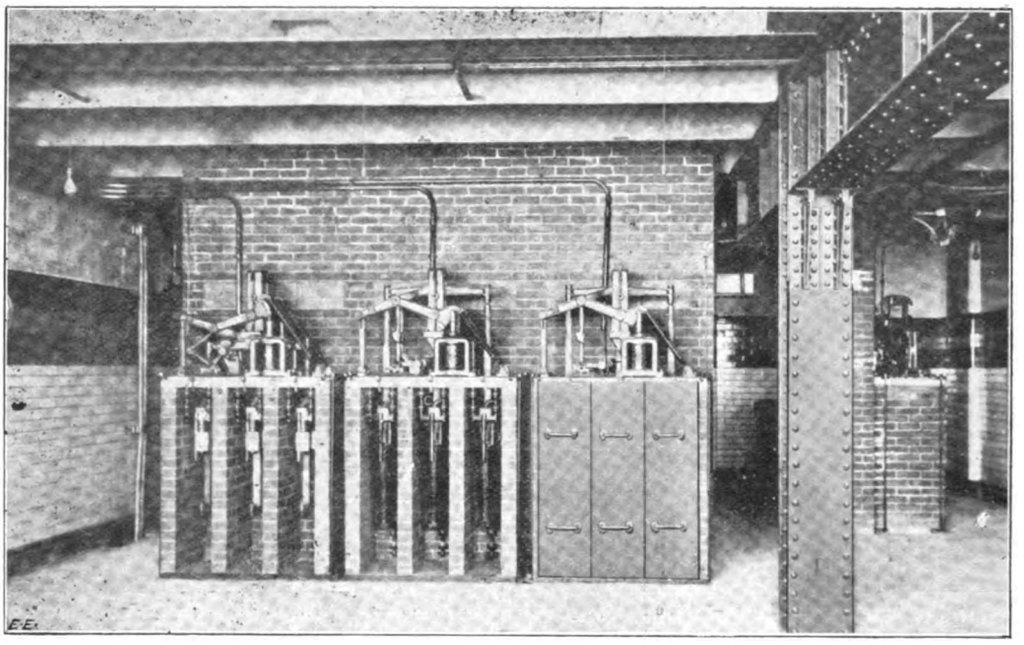

FIG. 8.—Switchgear, Yoker Generating Station.

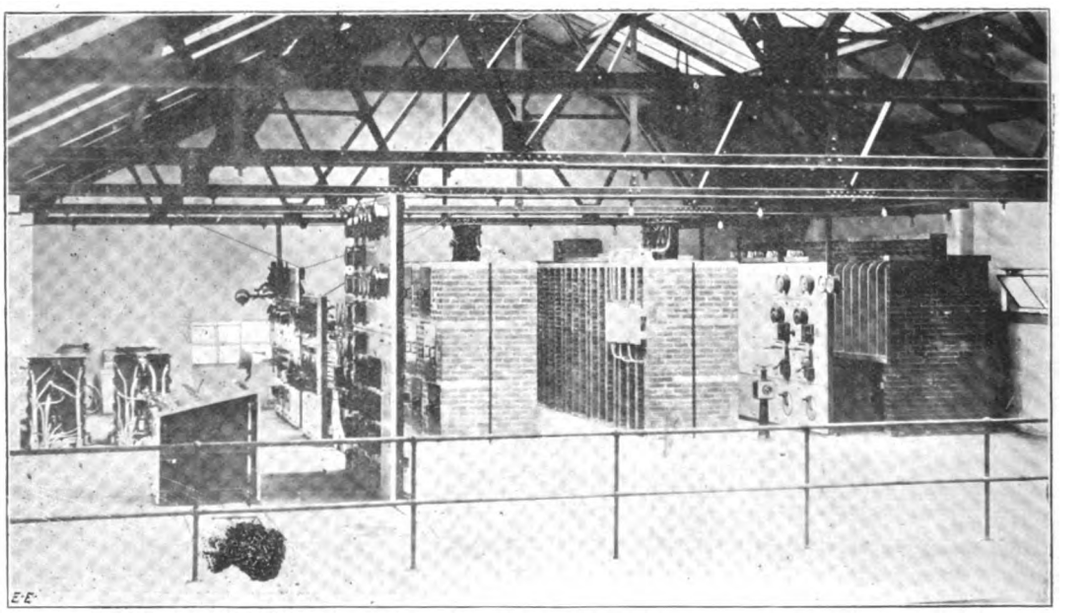

FIG. 9.—Top Switch Gallery, Yoker Generating Station—General View showing 'Bus Bar Chambers and Motor-Generator Switchboard on right and Control and Instrument Boards on left.

*Exciters.*—The two exciter sets (Fig. 7), situated at the south end of the engine-room, are each capable of furnishing the exciting current for both the main generating units at present installed. They are of 75 kw. capacity each, and

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consist of a Westinghouse 11in. by 19in. by 11in. vertical compound engine, running at 290 revolutions per minute, coupled direct to a 125-volt compound-wound dynamo. In addition to their natural function, these exciters supply current for operating the motors of the coal and ash conveyor, crushers, agitators, economisers, pumps, travelling crane, etc., and also for the electrically-operated main and other switches.

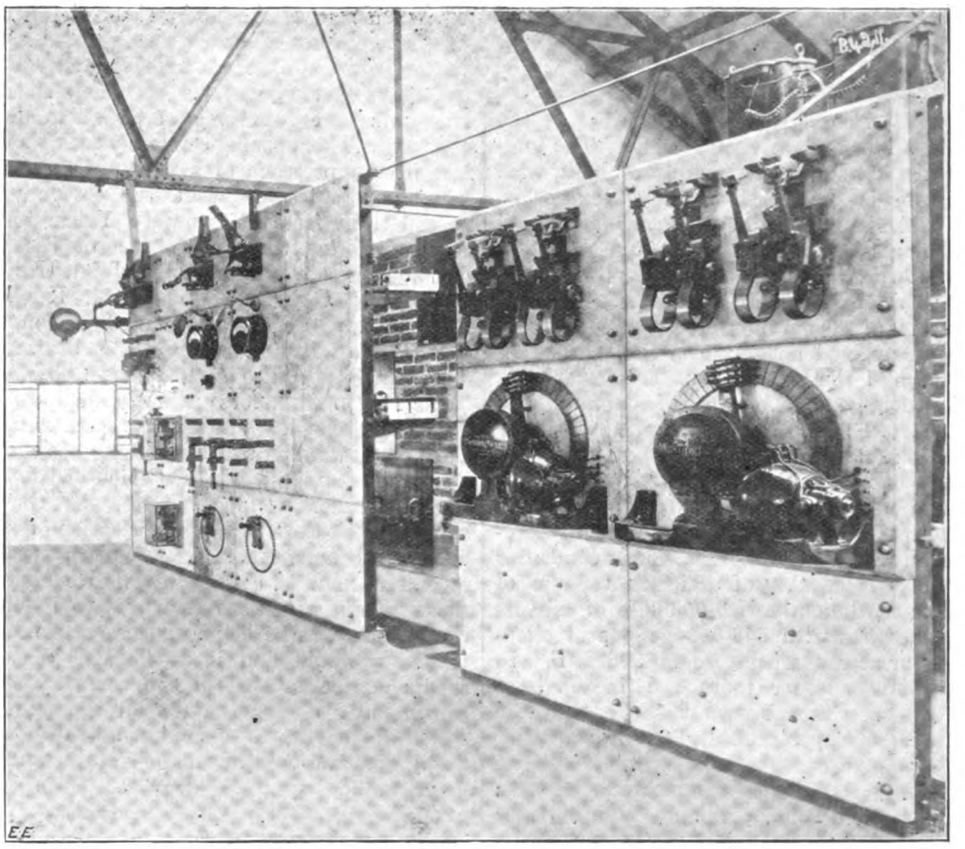

FIG. 10.—Automatic Rheostats, Yoker Generating Station.

*Travelling Crane.*—The travelling crane is by Messrs. C. and A. Musker and Co., and has a span of 42ft. It is of 30 tons capacity, having three motors of the Westinghouse type S.B., totally enclosed pattern, series wound. These motors are of the following horse-powers and speeds: lifting, 25 h.p., 460 revolutions per minute; longitudinal travel, 10 h.p., 650 revolutions per minute; transverse travel, 4 h.p., 935 revolutions per minute.

*Switchgear.*—The whole of the switchgear is contained in the three galleries (see Fig. 7) at the south end of the engine-room. That on the ground floor and the first gallery are devoted to the oil switches (Fig. 8) and feeders.

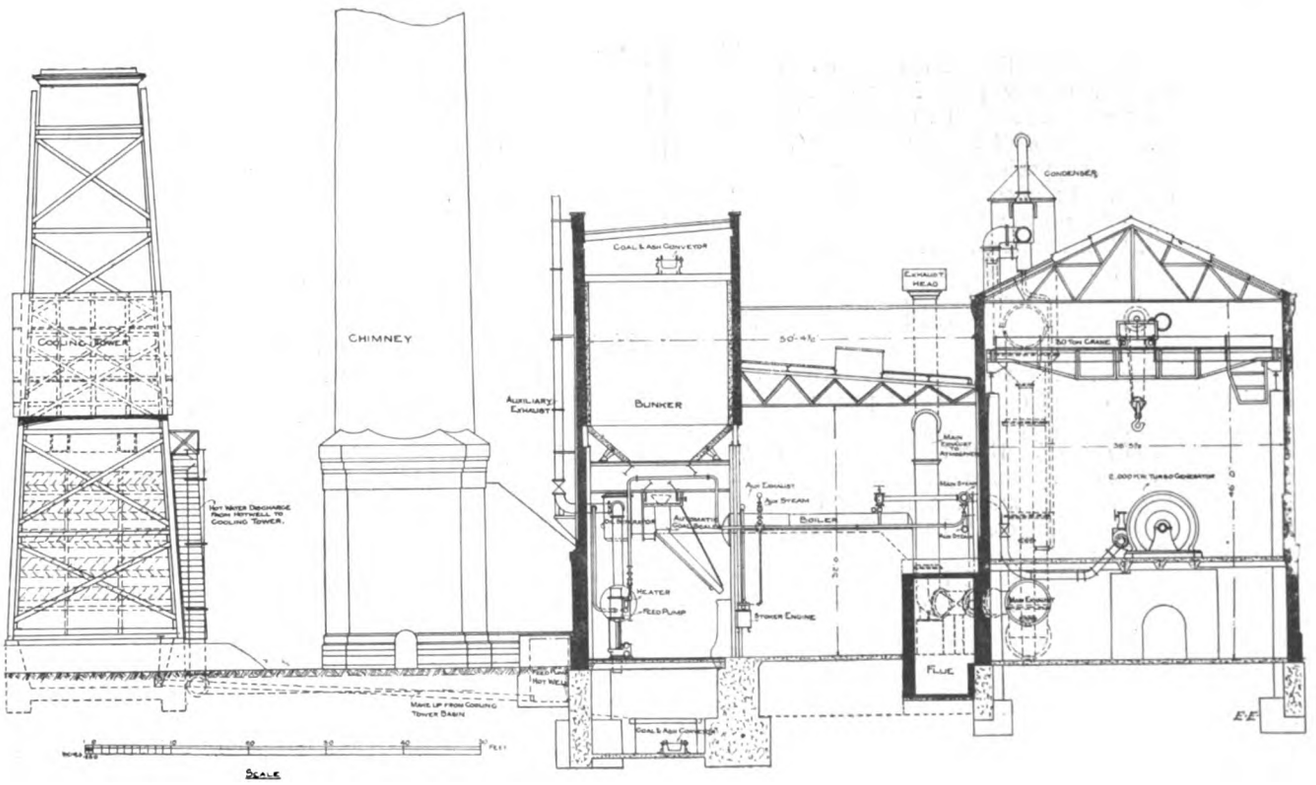


FIG. 11.—Cross-Section of Motherwell Generating Station.

On the third or top gallery of the switchboard (Fig. 9) are placed the main 'bus bars in brick compartments, and the main controlling board, as well as the resistances, etc. Following the latest practice, the control board consists of

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a small desk directly facing the various instruments, such as ammeters, voltmeters, power factor indicators, relays, etc. All the main switches and smaller gear are electrically operated from this desk by the exciter current, as before mentioned, and the speed of the turbo-generators and their starting and stopping is also controlled from here. Automatic rheostats (Fig. 10) are provided.

MOTHERWELL GENERATING STATION.

The Yoker and Motherwell power stations are of the same size and almost identical in arrangement. The foregoing description therefore applies generally to both, with the following exceptions. The Motherwell station (a cross-section of which is shown in Fig. 11) is not so favourably placed as Yoker, being 400 yards from and 140ft. above the level of the river. A cooling tower of Messrs. Balcke and Co.'s make has, therefore, been installed for cooling the circulating water. It is of the natural-draught enclosed type, 73ft. high, and is constructed entirely of wood thoroughly soaked in carbolineum of the best quality. The tower has a normal capacity for cooling 200,000 gallons of water per hour from 120deg. to 80deg. F., when the temperature of the air is 70deg. F. or less; and the amount evaporated under ordinary conditions of atmospheric temperature does not exceed 2½ per cent. of the water circulated. The condensing plant is another of the features in which the Motherwell station differs from Yoker, a barometric jet condenser being installed. This is capable of giving a vacuum of 27·5in. when dealing continuously with 80,000lb. of exhaust steam per hour, if supplied with 348,000 gallons of circulating water per hour at a temperature of 80deg. F. In connection with this condenser there are installed at Motherwell two Alberger-Corliss two-stage dry vacuum pumps, one of which is capable of dealing satisfactorily with the air in the condenser when one turbine only is in operation. The dimensions of these pumps are as follows: diameter of steam-cylinder 10in., diameter of air-cylinder 24in., stroke 24in. Their normal speed is 100 revolutions per minute, but they are capable of working at a lower rate if necessary. The steam and exhaust valves are of the Corliss type, and so designed as to permit of a high speed in cases of emergency without noise or jar.

DISTRIBUTION.

Six feeders are provided for distribution from Yoker, and all are protected where they enter the building in the basement by Westinghouse lightning arresters. The cables for supplying power to any part of the district between Clydebank and Scotstoun as well as to Temple are practically finished. They are all laid in duplicate, so that in case of any accident happening to one of them, the spare one can be connected immediately while the duplicate is being repaired. As previously stated, the Clyde Valley Electrical Power Company are authorised to supply in the adjacent burgh of Clydebank. For this purpose special plant has been installed, consisting of two 150-kw. motor-generator sets. Each set is provided with a small motor coupled direct to the shaft, which serves for starting and running up to speed. These motor-generators are situated in the first switch gallery of the Yoker power station, and the switchboard controlling the distribution to this area is placed on the top gallery. Both the high and low tension cables for the Clydebank district were supplied and laid by Messrs. Henley and Co., and the British Insulated and Helsby Cables have been entrusted with the extra high-tension cable work throughout the entire area. The number of sub-stations at present provided is 10 for the Motherwell district and two for Yoker. These two districts will not at present be connected in any way, although they may be in the future. All the transformers were supplied and erected by the British Westinghouse Electric and Manufacturing Company, Limited.

The general arrangement of the entire plant was designed by Messrs. Strain and Robertson, consulting engineers, of Glasgow. Mr. H. A. Barnett, resident engineer to the Clyde Valley Company, has had the supervision of the erection and installation of both power stations and the distributing system since the commencement.

The company's charges for lighting are a flat rate of 3½d. per unit or on the maximum demand system of 6d. and 1d. For power their prices vary from 3d. to ·68d. according to the quantity taken.

## Opening of Yoker Power Station.

By the opening of their first power station at the little town of Yoker, on the banks of the Clyde, the Clyde Valley Electrical Power Company inaugurated not only the real setting to work of their own large undertaking, but a most important development in the electrical industry in Scotland—viz., the supplying of power in bulk by a private company. This opening ceremony took place on Wednesday last in the presence of a party of some 300 gentlemen, who, on the invitation of the company, journeyed by special train from Glasgow to Yoker for that purpose. Among others, there were present Sir David King, a director of the company; Sir John Ure Primrose, Lord Provost of Glasgow; Charles M. King, Esq., Andrew Rintoul, Esq., Prof. Barr, Prof. Jamieson, W. W. Lackie, Esq, Provost Taylor, of Clydebank, Prof. Magnus Maclean, J. M. M. Munro, Esq, and Robert Robertson, Esq.

Sir DAVID RICHMOND, who presided, said that it was 2½ years since they had commenced operations, and it was only their determination to have nothing but the best machinery and the most up-to-date plant which had delayed the completion of the work so long, but now that they were ready to start to work they had the satisfaction of knowing that for economical and satisfactory working they had a plant second to none in this country. He hoped that many of those present would see their way to become customers of the company, as he believed there was no doubt whatever that they would find it economical to take energy from such a station as that of the company, which would run continuously day and night all the year round, and in which the chance of breakdown was so remote, owing to the duplication both of the generators and the conductors. They would be able to see that their site permitted of extensions on all sides. Their machinery would be ready for continuous running in the course of a month or so, and in two months' time their second power station, situated at Motherwell, would also be ready to give a supply.

The LORD PROVOST OF GLASGOW (Sir John Ure Primrose) was then called upon by Sir David to say a few words. He said he had great pleasure in being present at this very important departure in commercial adventure. It was commerce linking itself with science, and placing the joint product within the purchasing power of the community. He thought that in this undertaking they had one of their greatest hopes for a purer atmosphere. He heartily wished the company every success.

Sir David Richmond then formally started one of the turbo-generators, and called upon Sir John Ure Primrose to start the other one.

## THE VERBAND DEUTSCHER ELEKTROTECHNIKER.

### Thirteenth Annual Meeting—Dortmund and Essen.

[FROM OUR SPECIAL CORRESPONDENT.]

(*Continued from page 848.*)

Business proceedings were commenced on Monday morning in the old town hall, Dortmund, a building of some historical interest, whose quaint appearance before restoration is shown in the accompanying illustration (Fig. 1). Contrary to what one might surmise from an exterior view, the accommodation afforded was good and ample. Prof. Budde presided over the meeting. The honorary guests included the mayor, a Post Office official, and representatives of local industries. A few words of greeting having been addressed to them from the chair, these deputies then proceeded in turn to welcome the meeting to the town. It has often appeared to me that this sort of thing is a trifle overdone on these occasions. When representatives of various local institutions, followed, as has sometime happened, by a Government official or two and deputies from neighbouring universities, feel called upon to make tedious speeches, it entails a sacrifice of valuable time which would otherwise be available for serious discussion. True, it is indicative of the value at which the work of the

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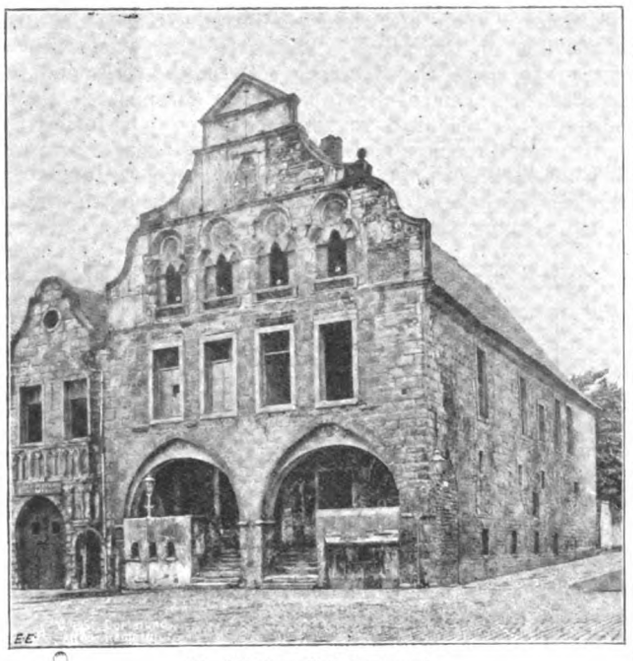
association is estimated in wide circles, and may thus serve to stimulate effort, but the practical recognition obtained is far better.

In the course of his address which followed, Prof. Budde briefly reviewed recent progress of the German electrical industry. He said he regarded the improvement of the single-phase motor as one of the most important developments of modern times, since it promised to be the means of superseding steam traction on railways. Electric traction had already been introduced on the Hamburg-Altona-Blankenese line of the Prussian State Railways. Other and longer sections would follow when it had been conclusively demonstrated that energy could be conveyed to the trains through a simple system of twin overhead conductors. A magnificent opportunity had been lost in regard to the Simplon Tunnel, traffic through which, report had it, would be worked by steam locomotives from the autumn of the current year. It seemed to him extraordinary that in a country so cut out for electric traction the newest and greatest tunnel should be relegated to such a fate.

After the great and justifiable sensation caused by the success of the express train trials in 1903, the fact remained that no tangible commercial progress had been made in this direction, and unless the spirit of enterprise increased at home it was not unlikely that the first express railway of German invention would be constructed, say, between



The Old Town Hall, Dortmund.

Philadelphia and Baltimore or between New York and Milwaukee, and that Germans would thus be robbed of the fruits of the pioneering work by their enterprising cousins across the Atlantic.

With regard to submarine telegraphy, the laying of the second German Transatlantic cable by way of the Azores was worthy of note, as was also the laying of a cable by the German Netherlands Telegraph Company, which completed the connection between Berlin and the Caroline Islands, and the new cable between Constance and Constantinople, which put Germany into direct communication with the near East.

The increasing employment of metal returns for land telegraphs and the laying of the wires underground in large towns also represented noteworthy progress. Wireless telegraphy had been subjected to a severe test at the seat of war, and had proved its worth. It was now rapidly winning way into all armies and marines. Nor had its commercial possibilities been neglected, but development in the latter direction would apparently have to be subservient to patriotic considerations in case of war.

Electric transmission of power, especially in mines and ironworks, continued to make steady progress. During 1904 legislators in Prussia, Bavaria, and Saxony had busied themselves with measures relating to the inspection of electrical installations. In Prussia a Bill had been passed to enable official inspection of such installations at the expense of the owners.

It appeared from the annual report, which was next presented to the meeting, that the membership of the V.D.E. is now 3,636, an increase of 250 on the year, while the funds in hand amount roughly to £6,400.

Last year's report*, it will be remembered, made reference to steps taken by the Verband in connection with the introduction of the above-mentioned Government Bill dealing with the cost of inspecting and testing electrical installations It was their object to secure that the Bill would not be detrimental to the further development of the industry. Other associations co-operated in this endeavour, with the result that the measure as passed by the Abgeordnetenhaus duly safeguarded the interests involved. Unfortunately, however, the Herrenhaus, before which the Bill came for final sanction, did not take the same view of the matter, and cut out the clause which had been added in response to the wishes of the Verband. It is to be inferred, then, that the Bill as it now stands provides no guarantee than the inspection shall be by practical electrical engineers, nor that the regulations adopted by the Verband shall be taken as a basis for judgment on the condition of an installation inspected.

*(To be continued.)*

## CORRECT POSITION OF LIGHTNING ARRESTERS IN THE CIRCUIT AND THE EFFECT OF CHOKING COILS.

In a recent number of the *Elektrotechnische Zeitschrift* F. Neeson describes some interesting tests carried out at the Reichsanstalt for the purpose of determining whether

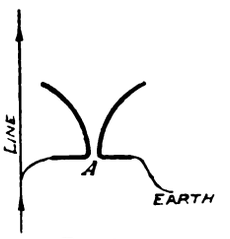



Fig. 1.

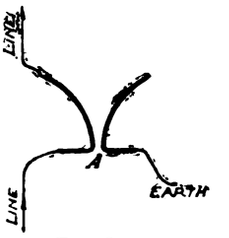



Fig. 2.

a lightning arrester is most effective when connected as a shunt to the circuit to be protected, as in Fig. 1, or when in series with the circuit as in Gola's system (Fig. 2). (See *Electrical Engineer*, March 3, 1905. p. 339.) The results of the tests point uniformly to the latter as being the most effective, although the former is the arrangement most commonly adopted at present.

The tests were only on a laboratory scale, but they bring out the point in question quite clearly. The connections employed are shown in Fig. 3, where J represents an influence machine, L a battery of Leyden jars arranged to discharge over a spark-gap, F. The voltage across this gap could be measured by means of a Braun electrometer (not shown). R represents a Riess air thermometer, the reading of which is a measure of the amount of energy which passes into the line protected by the lightning arrester, A; the smaller this reading the better the protecting qualities of the arrester. N is a choking coil whose turns can be varied at will, and U is a mercury switch of which the two contacts, 1 and 2, are connected to the ends of one side of the arrester, so that by inserting the thermometer lead, *a*, into 1 the arrester is placed as a shunt to the circuit to be protected (equivalent to Fig. 1), and by placing *a* in 2 the "series" arrangement is obtained (Fig. 2).

The first tests were carried out with a single-plate hand-driven Töpler influence machine and a battery of five large Leyden jars giving a 6mm. spark about every 40 seconds. The jars were left permanently connected to the spark-gap (as in Fig. 3), and the slow changing up was found to lead to rather variable results. Later, a large 20-plate motor-driven influence machine with a battery of eight Leyden

* *Electrical Engineer*, vol. xxxiv., p. 7.

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jars was used, and their sparks of 11mm. at regular short intervals were obtained. Before taking a reading with this latter machine, several sparks were allowed to pass to earth across the gap, F, through a separate earthing switch (the connections between U and F being broken), and then this earthing switch was opened, and the next spark allowed to pass through the arrester and the air thermometer. In this way the gap, F, was prepared by the sparks to earth before the actual reading was taken, and much more uniform results were obtained, the variations between successive readings under the same conditions not exceeding 5 per cent. The two series of tests gave qualitatively the same results, but differed a good deal quantitatively, the tests with the single-plate machine making the series arrangement appear even more favourable than those with the 20-plate machine. Variations in the applied voltage were produced by adjusting the gap, F, whilst variations in the quantity of electricity discharged were produced by charging the number of Leyden jars used.

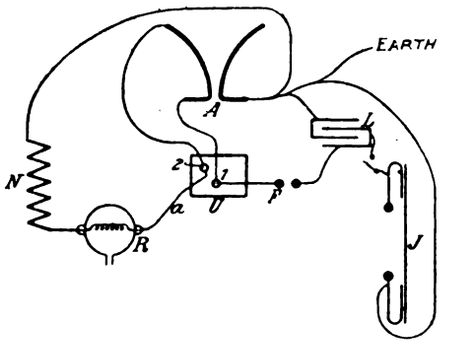


FIG. 3.

Seven different types of arrester were tested: (I.) telegraphic lightning arrester with ridged plates; (II.) Siemens and Halske horn lightning arrester; (III.) Allgemeine Elektricitäts-Gesellschaft horn lightning arrester; (IV.) Wurts roller lightning arrester; (V.) an arrester similar to (I.), but with smooth plates, the distance between which could be adjusted; (VI.) an arrester with bent smooth plates; (VII.) a horn lightning arrester similar to (II.), but fitted with flat sheet-metal horns, 2cm. wide, in place of the usual round wire horns.

The results of the various tests are collected below.

*Experiment A.*—To show the effect of varying the length of gap, F, and the effect of varying the number of Leyden jars in use, carried out with the single-plate machine. The

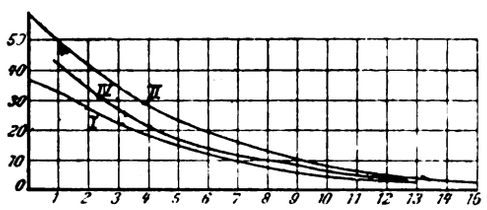


FIG. 4.

air thermometer reading with the shunt arrangement of the arrester is in each case taken as 100.

| Arrester No. | Length of gap, F, in millimetres. | Number of Leyden jars in use. | Relative reading on air thermometer with the series arrangement, calling the reading with the parallel arrangement 100. |
|---|---|---|---|
| I. | 5 | 4 | 57 |
| ,, | 4 | ,, | 51 |
| ,, | 3 | ,, | 55 |
| ,, | 2 | ,, | 57 |
| ,, | 5 | 1 | 52 |
| ,, | ,, | 2 | 55 |
| ,, | ,, | 3 | 52 |
| ,, | ,, | 5 | 54 |
| VI. | 6 | 5 | 45 |
| ,, | 5 | ,, | 51 |
| ,, | 4 | ,, | 50 |
| ,, | 3 | ,, | 52 |
| ,, | 2 | ,, | 49 |
| ,, | 5 | 1 | 41 |
| ,, | ,, | 3 | 44 |
| ,, | ,, | 5 | 46 |

These figures show that, within the range of the experiment, the relative effectiveness of the arresters is not appreciably affected by the voltage or the quantity of electricity discharged.

EXPERIMENT B.—To show the Effect of varying the Air-gap between the two sides of the Arrester.

| Arrester No. | I. | | V. | | II. | | III. | | IV. | | VI. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Influence machine used† | A. | B. | A. | B. | A. | B. | A. | B. | A. | B. | A. | B. |
| Air-gap in arrester (mm.). | Relative readings on the air thermometer with the series arrangement, calling the parallel arrangement reading 100. | | | | | | | | | | | |
| ·8 | 55 | 86 | — | — | 9 | 56 | 6 | — | — | — | — | 67 |
| 1 | 53 | — | 33 | — | 9 | — | — | — | — | — | — | — |
| 2 | — | — | 28 | — | 11 | — | 6 | — | 46 | 60 | — | — |
| 3 | — | — | 42 | — | 35 | — | 14 | — | — | — | — | — |
| 4 | — | — | 54 | — | 63* | 59 | 18* | 30 | — | — | — | 63 |

† A. Single-plate. B. Twenty-plate.

The readings marked with an asterisk are somewhat doubtful. The differences between the tests taken with the single-plate and the 20-plate machines are probably due to the difference in length of time taken to charge up the battery of Leyden jars in the two cases. During this interval the air-gap in the arrester undergoes changes which facilitate the breakdown, and thereby increase the relative advantages of the series arrangement. That this is the case is confirmed by the fact that when a small liquid resistance of about 300 ohms was introduced into the earth connection of the arrester, so as to delay the rush of current to earth, the difference between the series and the parallel arrangement of the arrester disappeared almost entirely. It also had the effect of greatly reducing the individual differences between the various types of arrester. It is interesting to note that when the liquid resistance was replaced by a small additional air-gap in the earth-wire no

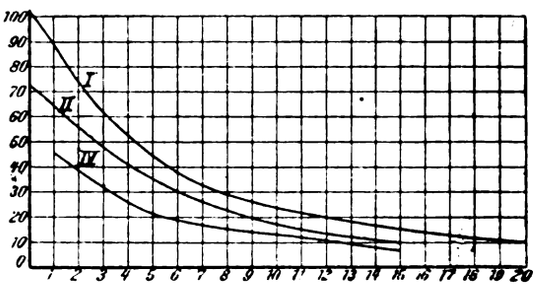


FIG. 5.

such effects occurred. It would seem, therefore, that for slow discharges the parallel and the series arrangement of lightning arresters are equally effective, but that for rapid discharges, such as those which cause the damage in practical cases, the series arrangement is much to be preferred. The insertion of a liquid resistance in the earth line, in order to avoid the risk of a short-circuit following a lightning discharge, is objectionable, the breaking of the short-circuit being more satisfactorily obtained either by employing a number of air-gaps in connection with a magnetic blow-out or by simply relying on the combined electro-dynamic and hot-air action in an ordinary horn lightning arrester.

*Experiment C.*—To show the effect of inserting choking coils between the line to be protected and the arrester (as at N, Fig 3), two choking coils were employed, consisting of spirals of bare wire wound on glass cylinders. The smaller coil had a cylinder diameter of 5cm. and a distance of 1cm. between successive spirals. The length of one turn was 17·5cm., of five turns 87·5cm., and of 20 turns 352cm. The larger coil had a diameter of 12·2cm. and a distance of 1·5cm. between spirals, and the length of one turn was 39cm. and of five turns 195·5cm. The smaller coil was sometimes used with an iron wire core. Figs. 4 and 5 show the results respectively with the large coil and with the small coil without iron core. The 20-plate machine was used for these tests. The ordinates give the air thermometer readings, and the abscissæ the number of turns in use. The numbers on the curves refer to the number of the arrester used. It will be seen that as the number of turns increases, the effectiveness of the arrester increases, at first rapidly, and

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then more and more slowly. When an iron core was employed slightly fewer turns were required to produce the same result, but the improvement was not nearly in proportion to the increase in the self-induction coefficient, probably because, with the rapid fluctuation in use, the flux in the iron could not reach its full value. The figures show that equal lengths of wire in the two choking coils produce about equal effects. The writer considers that the effect of additional choking coils has been considerably over-estimated, for in practically all cases the apparatus to be protected already contains far greater self-induction than that of the choking coils added, so that the apparatus itself already causes the flat part of the curves (Figs. 4 and 5) to be reached where additional self-induction has little effect. This point was actually tested by employing an iron-cored choking coil permanently in the air thermometer circuit, and noting the effect of adding various numbers of turns of the above small choking coil. This effect, as might be expected, was practically negligible.

## THE ALTERNATING-CURRENT SERIES MOTOR.*

BY F. CREEDY, STUDENT.

(*Continued from page 845.*)

### APPENDIX II.

*On the Construction for the Efficiency of the Series Motor.*

The construction given in the paper for the efficiency of the series motor is only approximately true†, as may

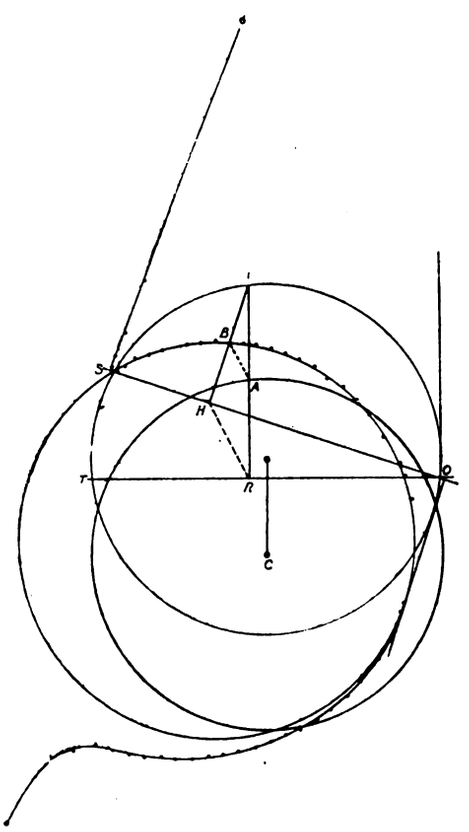


FIG. 16.

easily be seen by considering the case when O I = O T (Fig. 16). In this case I R is zero, but I H, the perpendicular from I on O S, is not zero. Therefore $\frac{I H}{I R} = \frac{I B}{I A} = \infty$ and the point B must move off to an infinite distance. Thus its *locus* cannot be a circle, but is a cubic curve as shown in Fig. 16. However, as the only part of the *locus* in which we are interested is the part corresponding to points on the current circle between S and the origin, it is worth while to consider whether this part is not sufficiently near to a circle for all practical purposes. Such a simple construction as the one under consideration should not be abandoned, without full investigation, in favour of constructions which, though exact, are far more complicated. In the first place, it is clear that if it be possible to represent that part of the *locus* in which we are interested by a circle, this circle may be drawn by the rule given in the paper. The *locus* obviously passes through S, and since the point B always lies upon I H (produced if necessary), the *locus* must be entirely contained between two lines parallel to I H and touching the current circle. Each of these lines will touch the *locus* at one point. Moreover, by suitably choosing the position of the point C (Fig. 16), the point B corresponding to any position of I may be made to lie anywhere on the line, I H. Thus *any* circle through S, touching a line drawn parallel to I H, and tangent to the current circle near the origin, will do.

A complete investigation, by the aid of the calculus of variations, into the difference between the actual *locus* and a circle described in this manner, would be far too complicated to be given here. However, it appears to be possible to show briefly that in all practical cases the curve does not differ much from a circle.

In one case the curve actually is a circle—viz, when O S coincides with O T. In this case the point B coincides with the point A, and its *locus* is, therefore, a circle of centre, C, and radius equal to that of the current circle. Thus we see that the nearer O S approaches to O T—*i.e.*, the greater the angle of lag of the standstill current—the nearer is the curve to a circle. Consequently, if we can show that when the angle of lag of the standstill current is small, say not more than 45deg. (and a motor having

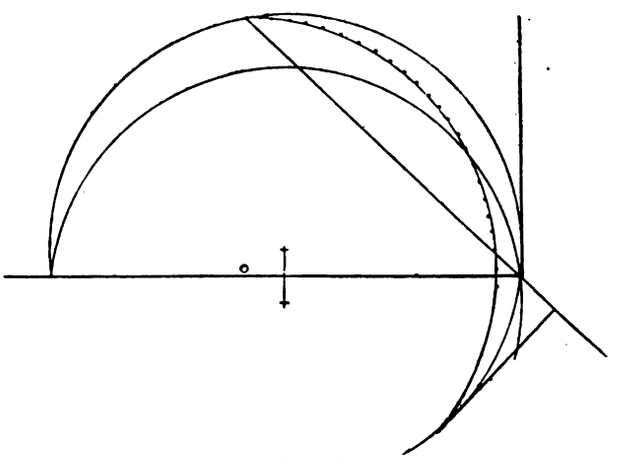


FIG. 17.

such losses would never be tolerated in practice), the curve is nearly a circle, it will follow that in all practical cases it may be represented by a circle. Anyone sufficiently interested may show for himself that, in such a case, the difference between the *locus* and a circle is barely perceptible. In Fig. 17 I have drawn out such a case as carefully as I could. It may be seen that the circle represents the *locus* of the points exceedingly well.

### APPENDIX III.

*Further Experiments on the Series Motor.*

The following appendix contains an account of some further investigations on the series motor. Since the investigations described above had rendered the method of designing an alternating-current series motor fairly clear, it was decided to endeavour to redesign the experimental motor, so as, if possible, to make it into a practical machine. The working out of the design from the constants of the carcase $p$, $p_1$, and $\nu$, which had been measured before, is given as an example above. However, as it had been decided to make a pair of slots in the pole-faces, and to put a compensating coil therein, this was rather a leap in the dark, as, of course, the slots and compensating coil entirely alter the constants of the carcase, and no means were at hand to estimate the effect they would produce. However, it was thought that if the motor was designed so as to be as good as possible with the unmodified carcase, it could not but be better when fitted with the compensating coil. A scale drawing of the shape of the stampings is shown in Fig. 18.

* Paper read before the Institution of Electrical Engineers.

† I am indebted to Mr. L. M. Rampal for pointing this out.

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When the motor returned after these alterations had been made, the first thing done was to ascertain the effect of the slots on the constants of the carcase, first, before the compensating coil was put in, and, second, after it was in place. The following results were obtained as the mean of a number of observations of the impedance of the armature:

Before the making of the slots $\left(\frac{2}{\pi}\right)^2 p_1 = 60$ nearly.

After „ „ „ „ $\left(\frac{2}{\pi}\right)^2 p_1 = 48$ nearly.

After the compensating coil was put in $\left(\frac{2}{\pi}\right)^2 p_1 = 31{\cdot}5$ nearly.

Thus the effect of the slots and the compensating coil was practically to halve the impedance of the armature.

The compensating coil consisted of a single turn of $^{19}/_{14}$ cable passed through both slots, and the ends sweated up. As a result of making these slots, however, the leakage coefficient was slightly increased. The reason of this, of course, is that the slot increases the reluctance of the main magnetic circuit as compared with the leakage magnetic circuit. With a suitable design of the carcase—*i.e.*, a design in which the iron is disposed symmetrically round the armature so that none of the main flux need pass across the narrow neck at the back of the slot—this need not occur. Such designs of field magnet are the iron-clad type

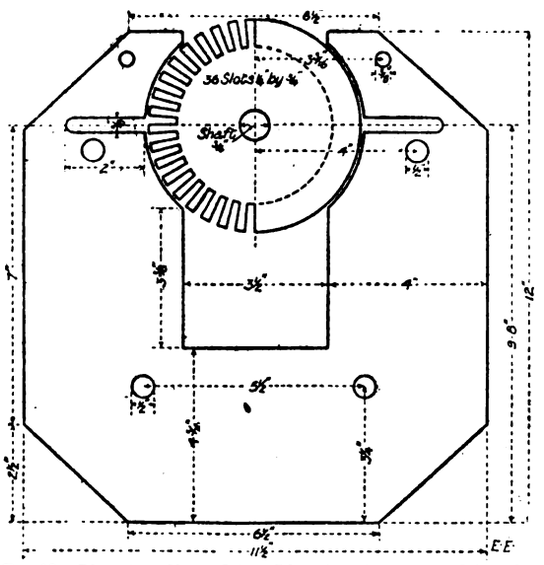


FIG. 18.—Diameter of bore, 5⅜in. Diameter of armature, 5¼in. Depth of stampings parallel to shaft, 3¼in.

or the ordinary multipolar type. By comparing the counter E.M.F. of the motor with the E.M.F. induced in the field coils, and also by means of direct experiments, it was found that the leakage coefficient, although it varied somewhat, averaged about 1·3. On account of the flux being alternating, its measurement was a very easy matter. A search coil containing 52 turns of fine wire was made, and solidly taped round. This made an extremely flexible coil of round section (¼in. diameter), which could be placed anywhere on the machine. If it be desired to measure the flux through a given area, it is only necessary to place this coil round the area; and the ratio of the E.M.F. induced in it to the E.M.F. in another coil of 52 turns wound directly over the exciting coil will be the ratio of the flux through the given area to the total flux. By means of this coil it was found that, as the mean of a number of observations, about 0·36 of the total flux passes through the part of the pole-face above the slot, and 0·41 through the part below. It was also found that by giving the brushes a lead in the direction of rotation, the leakage coefficient could be reduced slightly. With the aid of this flexible search coil, some leakage tests were taken during the progress of a brake test, the machine running under normal working conditions. It was found that the leakage coefficient did not vary much with the load, but remained constant at about 1·3. A considerable number of brake tests were next made in the endeavour to ascertain the efficiency, and also the effect on it of varying the number of field turns, of using different sizes of brush, etc, a direct-current shunt motor being used throughout as brake. It must be understood that the figures for the efficiency, given below, were not made to include the friction and windage of the series motor, since these present no features of special interest.

As a result of these experiments it was found that the efficiency was distinctly low. In the hope of raising it, experiments were tried with an increased number of field turns. It was found that above about 2,000 revolutions per minute the efficiency became practically constant at about 65 per cent. whatever the number of the field turns, the nature of the brushes, etc., though occasionally higher values were obtained, never exceeding 70 per cent.

The fact that increasing the number of field turns beyond a certain limit produces very little effect on the efficiency is very well illustrated by Fig. 19, which contains a number of curves in which the efficiency at various speeds is plotted against the number of field turns. These curves are derived from the same series of experiments on which Figs. 6, 10, and 11 are based. They show clearly that the efficiency at first rises quickly with the number of field turns, but soon ceases to do so, only increasing very slowly with increasing field turns. Before leaving these experiments it ought to be mentioned that the efficiency curve corresponding to 54 turns in Fig. 10 is almost certainly a good deal too high. During the test the output was so small that most of it was consumed by the friction of the two machines, and consequently a small error

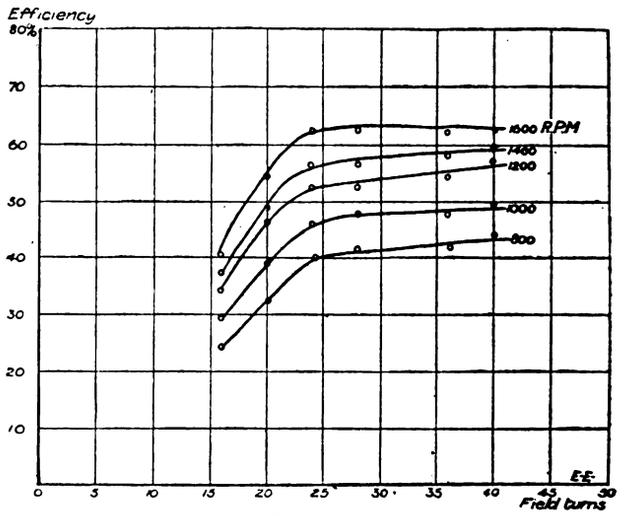


FIG. 19.

in determining this produced a large error in the efficiency. Fig. 15, the complete circle-diagram, also shows us the same thing as Fig. 19. As we increase the number of field turns, keeping the speed constant, the current vector will travel along one of the lines of constant speed. Now it can be seen from the diagram that for large values of $n$, the number of field turns, the efficiency lines, and the lines of constant speed are nearly parallel. Consequently, to obtain a given increment of efficiency, we must move a considerable distance along the speed line. Now, when $n$ is large, a given increment of $n$ only produces a small change in the position of the current vector, as the diagram shows. Thus, to obtain a given increment of efficiency, we shall have to make a very large increase in the number of field turns, or, in other words, the efficiency only rises very slowly with increasing field turns.

At the commencement of the experiments the motor was fitted with very broad brushes of hard carbon, covering about four segments. As it was feared that the large number of coils short-circuited under the brush might cause considerable loss, copper-carbon brushes covering three segments, and narrow brushes of very soft carbon covering one segment, were tried in succession. Neither of these produced any material effect on the efficiency, but perfect commutation was obtained with all three types of brush. It seemed as if the narrower the brush the softer the carbon allowable.

Thus, from these experiments, it appeared that the efficiency could not be raised much above 65 per cent. by

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any modifications of field turns, brush resistance, etc. The next step appeared to be to ascertain the cause of this low efficiency. In order to do this an analysis of the losses occurring during a brake test was made in the three cases corresponding to 52, 84, and 104 turns.* This analysis was carried out in the following manner: Taking advantage of the fact that the same current flows through both field and armature, it is possible to read either the total input of the motor, or the watts given to the armature, direct on the wattmeter, according as the P.D. coil is placed across the whole machine, or across the armature only. The difference between these readings will be the field losses, which may thus be measured under actual running conditions during the progress of the test. The field losses could, of course, be measured by placing the wattmeter direct across the field, but as this involves taking readings at a very low power factor the above method is to be preferred. The field losses include the $I^2 R$ loss in the field, the hysteresis and eddy loss due to the alternation of the flux, and the losses in the coils short-circuited under the brush. The $I^2 R$ loss in the armature, the loss in the compensating coil, and any other stray armature losses, were measured in the following manner: Arrangements were made, by means of a two-way double-pole switch, for switching on either alternating or direct currents of equal magnitudes to the armature. The power consumed by each of these was measured on the wattmeter, and the difference taken as the loss in the compensating coil. The power consumed by the direct current is, of course, the $I^2 R$ loss only. By reading this on the wattmeter, we eliminate any error in the ammeter, or in determining the resistance. By switching on the field of the series motor while being driven by a direct-current machine, and noting the increase in the input of the driving machine, the iron losses due to rotation were measured. Lastly, by lifting the brushes and again observing the loss in the field when the current is switched on, we may separate out the loss in the coils short-circuited under the brush.

*(To be continued.)*

## JOHNSON AND PHILLIPS, LIMITED.

This long-established and well-known firm, it will be seen, is issuing further capital. We have known this concern most intimately for more than a quarter of a century, and throughout the whole of its life it has done exceptionally good work. It will be seen from the prospectus that the sole proprietor and remaining partner, Mr. Walter Claude Johnson, has been assisted gradually more and more till the incoming managing directors have been, during the last few years, carrying on almost the entire management of the business. When the inner history of cable work comes to be written, it will be found that the practical and successful laying and maintenance of submarine cables has been largely due to the perfection of apparatus supplied by Messrs. Johnson and Phillips. Probably almost every cable ship that has been equipped has had this equipment partly supplied by Messrs. Johnson and Phillips, and the work that they have done has been well done. From the commencement of what may be termed the electrical era Messrs. Johnson and Phillips have played their part in the construction of the apparatus for lighting and for power purposes, and, again, what they have done has been well done. The prominent part which they took in regard to the development of the arc lamp is also well known. We trust that under the new *régime* the works, carried on, as they will be, with continuity, will continue to produce the best apparatus that can be obtained of its various kinds, and will continue to be busily employed. We are quite sure that a firm possessing the reputation that this firm posseses will, under the new conditions, strive to retain and enhance that reputation. So far as values are concerned, the prospectus must speak for itself. The figures given are perfectly easy to read, and seem to us to indicate that as an industrial concern it will take a high place amongst those which have of recent years proved eminently successful.

* These analyses were all made at 25 frequency.

## HEATING BY ELECTRICITY.

BY H. ALLEN.

In the arts and crafts there are an exceedingly large number of processes in which the application of a high temperature is an absolute necessity, and a still greater number of cases where high temperature would be a source of considerable utility in reducing the length of time of many operations, as well as greatly facilitating many such operations as soldering, brazing, welding, melting, etc., if a convenient method of heat development was available at a reasonable cost. So far the electric current has not yet been exploited greatly in this direction, owing to the electric arc not being a suitable and convenient method for so many special cases, while the resistance method, when coils, etc., are brought into use as a heating medium, is subject to many inherent defects.

The resistance material called "Kryptol," consisting of a patented mixture partly composed of graphite, carborundum, silicates, and clay in a granular form, can be so readily handled by any ordinary skilled operator that a few details of its applications for such purposes as boiling, melting, etc., may be of service to many readers. The most simple form of apparatus (Fig. 1) may be described as consisting of a bed of refractory material having an electrode of carbon or other material at each end, to which the electric conducting wires are connected. These electrodes are situated some distance apart, according to the size of the stone, and the only further accessory that is required is Kryptol of proper sized granules to suit the available voltage of the current. If a quantity of "Kryptol" is spread, say, by means of a spoon, in a layer between the two electrodes, more or less current will pass through it in proportion to the thickness and width of the layer. For

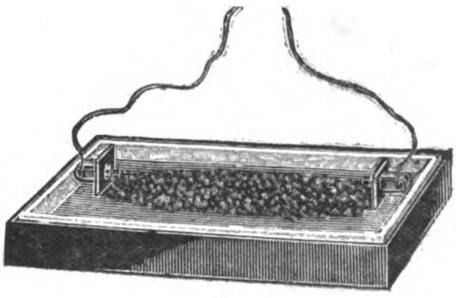

FIG. 1.

simply heating liquids, melting of lead solder and any metal of low melting point, the containing vessel may be simply laid on the bed of Kryptol. There are no regulating apparatus required to adjust the temperature, as all regulation is effected by manipulating the loose granules on the bed of the stone.

Supposing it was desired to weld two pieces of iron, in this case the pieces to be heated can be simply placed in the "Kryptol," while by thinning down the layer, or making it narrower, the heat rapidly rises to any desired temperature up to about 3,600deg. F. Another feature about this material is that it is made in different-sized granules to suit the voltage, the usual range being from 100 volts to 250 volts. In a simple test the writer melted a cube of copper weighing 8 45 grm. in one minute. The metal was contained in a small porcelain crucible resting upon the Kryptol, which had been brought up to the required temperature. The electric supply was at 240 volts, and 15 amperes were applied. This may not seem very economical in regard to cost of current, but a short time only is required to raise the temperature to a welding heat, and the current can be shut off immediately the required temperature has been attained. Several different forms of stones have been designed for use with this material, but the simple flat stone would be a great convenience for jewellers, dentists, chemical laboratories, etc.

**Trams Across the Bridges.**—At the meeting of the City Corporation yesterday the Court assented "to the bringing of tramways over a widened bridge at Blackfriars *or a new bridge*, subject to a satisfactory arrangement being *previously* arrived at with the London County Council as to cost, management, control, *construction*, and maintenance; and that the resolution of the Court of Feb. 2 last be varied accordingly," the italicised words representing the amendments.

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*All communications intended for the Editor should be addressed* C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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### COMMISSIONS.

We have thought the time opportune to direct attention to this question of commissions. The whole subject brings us upon such delicate ground that it is difficult to handle. The general question is the only one that concerns us or our readers—special cases are altogether outside our purview. They cannot be touched except in a court of law, hence references must be without accurate definition of when, where, and whom. Business depends very largely upon commissions, and there is no suggestion of aught contrary to true business principles when commissions are given and taken under normal conditions. Many a traveller is paid partly or wholly by commission—and why not? That is certainly legitimate, and intended as an incentive to make the man work with energy. It is almost a necessity in many instances, because of the "human nature in man." We think Artemus Ward was wrong when he gave utterance to these words, and would prefer to think it "the artificial nature in man." The tendency of modern progressive civilisation is to make man lazy—to take away all natural desire to excel. There is little or no personal interest in making the work successful. The majority of workers are fully imbued with the idea that they are underpaid and overworked. Each thinks he ought to be a Carnegie and a Rockefeller rolled into one, without any of the early experiences of these men. Hence masters who have employment to offer have come to think that an honest wage does not necessarily bring about an honest day's effort, so the agreement purports to be "payment by results." Now there is one fact perfectly clear to all who have studied the question, and that is, payment by commission is scarcely or never payment by results. In numberless instances the true result is never known to the man who did the work in opening the account. But in a rough-and-ready manner the system may be passed. Some time ago the London Chamber of Commerce tried its hand in obtaining information about illicit commissions—commissions that cannot for a moment be accepted as necessary in true business, and which pertain really to the nature of bribes. One of our contributors has again brought up this question. He is evidently of the opinion that the strongest action should be taken to put a stop to such things, and so are we, but neither the London Chamber of Commerce nor any other body or individuals has suggested a method. Journalists cannot do it. A bald statement of fact—though after trial it may not be held to be libellous—often puts them to the expense of hundreds, if not thousands, of pounds to show it is non-libellous. Quite innocently a little time ago a journal said that an authority had authorised certain work to be done to supersede other work which had not come up to expectation. It was a mere statement of fact, but it involved a libel suit, and though the case was abruptly dismissed, we doubt if five hundred pounds will cover the costs to the paper. The cases as suggested by our correspondent are clearly of the illicit class. The latest phase which has been discovered legally is the Holborn case, though this is outside the category of those described by our correspondent. Practically, his communication hints that commissions are sometimes offered and sometimes received by consulting engineers. There can be no doubt, if the practice exists, it is bad. We trust that the suggestion even of its existence will meet with emphatic protest, and we have every reason to believe that the profession of consulting engineers is almost free of illicit commissions. There are black sheep in every fold, but the whole body of professional men must not be condemned for the actions of the few. Unfortunately, that view seems to prevail more and more, and when a unit is found doing something which cannot be commended, the man in the street is prone to tar a pro-

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fession with the bad brush. The profession of a consulting engineer is one of responsibility. He is the expert advising the paymaster, and receives a recognised honorarium for his work. The successful man has no reason to complain of the honorarium. It is enough, and the whole body politic of paymasters expects to receive the utmost consideration from those who guard its interests. We trust there is no widespread giving or taking commission. Nor do we believe there is, and it may be that the publicity now given will lead all parties to enquire whether the tendency suggested to change professional etiquette is existent, and if it proves to be, to prevent further expansion.

## AT THE ARC WORKS.

The outing to Chelmsford which Messrs. Crompton and Co., Limited, arranged for Saturday last in connection with the Arc Works Club sixteenth annual athletic race meeting was unfortunately marred by the inclement weather, otherwise it would have been an unqualified success. A large party journed down from Liverpool-street Station in reserved saloons attached to the 10.55 train, and on arrival in Chelmsford were conveyed in brakes to the Arc Works, where a halt was made to inspect the different shops After all that has been heard of late about trade depression, it was refreshing to discover here an abundance of work. Every tool in the main shops seemed to be hard pressed. Perhaps the most interesting machines seen under construction were three generators destined for Calcutta. These generators are of the turbo type, and will be coupled to Parsons turbines. They combine some novel features, details of which must, however, be held over till a later date. Several large alternators were under test, and it was noticeable that Messrs. Crompton and Co., Limited, are doing a large amount of three-phase work. Motors of various standard sizes in process of wholesale manufacture were also much in evidence. Passing on to the instrument and lamp shops, which are quite apart from the main building, we noticed a similar state of activity. Here were potentiometers and their accessories, reflecting galvanometers, standard resistances, ampere-meters, voltmeters, and electric pyrometers in different stages of manufacture, and further on a number of switchboards in course of erection; also arc lamps, small fan motors, and projectors in great profusion. The fan motors represented part of an order for no less than 3,000 and the projectors an instalment of 600 for the Admiralty. With regard to the latter order, it is interesting to note that the Admiralty have at last abandoned the hand feed and are having all new projectors constructed on the automatic feed principle. We noticed a flame arc lamp and also a midget arc lamp burning steadily on test—representatives of types not yet on the market. It may be mentioned here that the lamp shop is undergoing considerable extensions.

The inspection over, an excellent luncheon was served in the employés' messroom. "Prosperity to the Arc Works" was proposed by the Mayor of Chelmsford. In his reply to that toast Colonel Crompton dwelt upon the success which had attended the efforts of masters and men to maintain the output and prosperity of the works, in spite of increased competition. After luncheon the brakes were again boarded, and a move made to the sports ground, which, despite a steady downpour of rain, tried to look gay with the aid of a plentiful display of flags and bunting. The afternoon was productive of some good sport under difficulties.

## ILLICIT COMMISSIONS.

[*Communicated.*]

Although the question of illicit commissions is a matter which has been ventilated by the technical Press on more than one occasion, the moral has never been pointed, or the tale adorned by the confession of any engineer who has acted as an accessory either before or after such criminal offence. This is not to be wondered at, but the unexpected does sometimes happen, as the following extraordinary story shows.

Quite recently a consulting engineer reported on the heating of a large building, and was asked to state his terms for preparing the necessary plans and for supervising the alterations recommended. In his reply to the authorities he stated that "he was prepared to give his clients credit for all commissions." His clients not unnaturally enquired what was meant by this statement. The engineer explained the giving clients credit for commissions. There are several ways in which work such as proposed is carried out. Either the authorities advertise for estimates on specifications made by the engineer, *in which case the successful contractor commonly hands the commission to the engineer to, what might be called, "lubricate" the work in progress Such commissions the engineer receives, but hands them over to his clients, as they would otherwise place him in a false position, and prevent his "jumping" on the contractor for bad work.* The other way of working, and which is far the better and cheaper way, is for the engineer to send out the specification and particulars, and receive estimates from the contractors. He is then put on trade terms with them, which are considerably lower than prices to authorities, and it is in this way that work is carried out. Practically, all engineering purchases carry a commission to the engineer—no doubt commercial immorality, but such is the custom, and a most objectionable one it is. Comment is superfluous! The statement that a successful contractor commonly hands a commission to the engineer may be at once stigmatised as a most scandalous libel on the general body of both engineers and contractors. The fact that it should ever have been made gives one furiously to think.

It is difficult to know what to admire most in this statement. The unblushing impudence with which the admission of the professional custom of accepting a bribe is made is only equalled by the virtuous manner in which forsooth the situation is saved by handing the spoil to clients. If ever an engineer under such circumstances is called in to carry out any engineering scheme, what a unique account must be sent in! Something on these lines presumably:

| | £ |
|---|---|
| Five per cent. commission on capital outlay ..... | — |
| Less — per cent. commission on capital outlay received from contractor ..... | — |
| Total ..... | — |

*O tempora! O mores!* What a shining example for the rising generation. Is it to go forth to the world, or even to a portion of it, that the members of the Institution of Civil Engineers and the members of the Institution of Mechanical Engineers "commonly" offer and accept commissions—*anglice*, bribes—to "lubricate" work in progress, and that while at least some of them do not approve of this practice, they continue to accept bribes and merely show disapproval by passing on such largesse to their clients? Is such a statement as this to be made to a public body, presumably in good faith, and to remain uncontradicted by the councils of the respective institutions concerned?

It may be that no one who knows would accuse the engineers of accepting such commissions for their own benefit, but they expose themselves to the gravest suspicions, and it is obvious cannot "jump" on any contractor after taking his money whatever its ultimate destination may be. How does the contractor know what becomes of his "peace offering" in such a case? Surely the engineer does not write to inform him that the money has been placed to his client's credit, and if he did, would the contractor believe him? The mere fact of any engineer receiving a present of any kind from a firm whose work he has to check on behalf of his clients, places himself hopelessly in the wrong. The aim of a consulting engineer, or of any other engineer who orders plant, should be, and in the majority of cases is, to get the most suitable machinery at the lowest price consistent with good workmanship and materials; all else is beside the mark.

The plain facts concerning the question of commissions

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are these: No contractor offers an engineer a commission unless the latter first seems to hint that such tribute is within the region of practical politics, and no engineer of any position would dream of acting in such a way. If a commission is accepted—and this may occur in some isolated instances with men who have lost what little self-respect they ever possessed—its value is simply added to the total of the tender.

It therefore appears that an engineer who accepts commissions and hands them over to his clients, is only giving himself unnecessary trouble by going through a series of useless arithmetical operations assisted by the contractor. But how many men who once lowered themselves to take a commission would pass it on to their clients? Again, if a consulting engineer sends out specifications for work to be done under any public body, he is by no means put on trade terms. The greater part of the explanation is incorrect, in so far as it applies to the engineering business as a whole.

It will be instructive to notice the future action, or inaction, of "the powers that be," also to hear any further explanation for taking commissions to hand over to clients. Meanwhile, the most suitable motto for such cases seems to be:

"One hand stuck out behind the back, to signal 'bribe again';
The other on your dress-shirt front, to show your heart is clane."

## GLASGOW LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The last monthly meeting of the present session of this section of the Institution of Electrical Engineers was held on May 9 at 207, Bath-street, Glasgow, Mr. R. Robertson being in the chair. Mr. P. D. Ionides read a paper on "Alternating-Current Motors in Industrial Service." The following is a summary of the paper:

Besides the growing recognition of the possibilities of the alternating-current motor, there were three factors which tended to make its use more general: (1) the increasing extent to which power was being supplied over long distances; (2) the growing popularity of the steam turbo-generator in private industrial plants; and (3) the new regulations issued by the Home Office for the use of electricity in mines. Alternating currents had been more generally adopted in America and on the Continent than in Britain, but the author was of opinion that the great municipalities and power companies in Britain would shortly offer alternating current for power purposes at a lower rate than direct current, for the reason that the converting apparatus for the former was less expensive. Before proceeding to describe some applications of the alternating-current motor, the author described at some length the best known types of this class of motor—*e.g.*: (1) The squirrel-cage polyphase motor, which consists primarily of the stationary parts carrying the windings, which receive current from the supply circuit, and the rotating part, which has no connection with the supply circuit. The stationary part is wound with coils similar to those used on the ordinary direct-current armature, while the rotating part carries the squirrel-cage winding, which gives its name to this type of motor. This winding consists of copper bars laid in the slots of the core, and connected at each end to heavy copper rings, the whole construction very closely resembling a squirrel-cage. The coils of the primary or stationary part, although resembling the coils of a direct-current armature, are connected in groups overlapping each other, so as to form a certain number of poles. The polyphase currents connected to these windings set up a revolving magnetic field. The speed at which this magnetic field revolves is dependent on the number of poles and the frequency of the supply—*e.g.*, at 3,000 alts., or 25 periods in a motor wound for four poles the magnetic field will revolve at 750 revolutions per minute. To determine this figure, divide the number of alternations by the number of poles with which the motor is wound. (2) The slip-ring motor, which differs from the squirrel-cage motor only in the secondary, which is coil-wound, the windings being connected to three slip-rings for starting with resistance in the secondary circuit. Once the motor is started, and the secondary short-circuited, its characteristics are similar to those of the squirrel-cage type. (3) The single-phase series motor, which is nothing more than a direct-current series motor constructed to operate satisfactorily with rapid reversals of polarity, in which the difficulties of commutation have been overcome by the use of compensating windings in the armature.

The squirrel-cage motor was used for all constant-speed work. It was very simple, both in itself and in its starting devices. The auto-starter consists of two auto-transformers mounted in an iron box with a double-throw four-pole switch. For starting, the switch is thrown to one side, connecting the line with the auto-starter, and furnishing current at a reduced pressure to the motor. After the motor has attained a fair speed the switch is thrown in the opposite direction, which connects the motor straight to the line. Motors up to 10 h.p., obtaining their supply from a 200-h.p. to 300-h.p. power station, could be started up direct without the use of an auto-transformer, but it was not advisable to do without the auto-transformer where the generating plant was of small capacity as compared with the motors, owing to the heavy rush of current taken by the latter at starting. A third starting arrangement was from a close-coil two-phase generator. The starter could be placed remote from the motor, which was a matter of great convenience. In regard to the starting torque, it is frequently stated that the squirrel-cage motor is incapable of starting up against full load. This is quite incorrect, for as much as three times the full-load torque can be developed at starting, while in the smaller sizes two to 2½ times the full-load torque can be developed; but, at the same time, the current to obtain such starting torques would be very heavy. To obtain a starting torque equivalent to full-load torque it requires, roughly, 2½ times full-load current in almost all sizes of motors, but as this requirement is only momentary it is of little consequence. For driving spinning machinery it is particularly suitable, by reason of the fact that within certain limits the speed is constant in relation to the speed of the generating plant, and independent of slight fluctuations in voltage. In spinning mills and such industries, it is of the utmost importance that all machinery should be started simultaneously. The squirrel-cage motor lends itself to this requirement very readily, as it is possible to leave all the motors in an installation connected direct to the line, and to start them all simultaneously by separately exciting the generator and then running up the engine. The squirrel-cage motor is particularly suitable for mining work, as there are no parts other than the bearings requiring attention, and the oil-immersed auto-starter, which can be made water and gas tight, needs no skill or knowledge in handling. In many pits where there are explosive gases, no other type of motor could be used with the same safety. For driving the lift turbine pump, which is becoming increasingly popular with mining engineers, a motor with a speed of 1,400 to 1,500 revolutions per minute is frequently required, and the squirrel-cage motor is particularly suitable in such a case.

For the driving of large haulages which must be started slowly and gradually, the slip-ring motor was preferable, the proportion of current to torque developed being almost similar to that for shunt-wound direct-current motors. For continual starting and stopping, the slip-ring motor possessed considerable advantages over the direct-current motor. The tramway type controller was generally used in each case, and while with the direct-current motor the currents broken by the controller were always at line pressure, with the slip-ring motor the currents broken were those in the secondary circuits of the motor and at a low pressure—a feature which added to the life of the contacts. Again, for electric braking the slip-ring motor could be used to great advantage by so proportioning the resistance in the secondary circuit with the first or second notches of the controller as to produce a gradual braking effect when the controller was reversed. That has been applied with marked success to a 150-h.p. slip-ring motor driving an endless haulage.

The requirements of variable-speed work (the making of

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paper, printing, dyeing, etc.) were met by a small auxiliary motor driving the main motor through a worm gear and free-wheel clutch to give slow speed. The main motor is wound and connected to a controller of the tramway, so that the coils of the stator can be grouped to form eight poles for medium speed or four poles for full speed. It would be equally feasible to wind the moter with 12 and 8 poles to give three-quarter and full speed. A modified form of this arrangement can be used for the thriving of air compressors, hydraulic pumps, etc. In connection with work where it is necessary to have a speed of 6 or 8 to 1, the single-phase series motor offers a method which is simpler and more efficient than the direct-current apparatus. This method consists of a single-phase motor controlled by an induction regulator, which raises or lowers the voltage depending on the relative position of the primary which it moved in relation to the secondary by a worm-wheel and worm.

From the standpoint of the user, the author thought the alternating-current apparatus was probably the cheapest both in first cost and maintenance.

The following discussion took place:

The CHAIRMAN said that he was interested and surprised to find the author stating that the cost as well as the efficiency of the alternating-current motor was as favourable, if not more so, than the direct-current motor. The cost had always been one of the objections to alternating-current plant. It had also been generally believed that variable-speed work could only be managed with the direct-current motor.

Mr. H. A. MAVOR (Glasgow) said that, broadly speaking, the points raised in the paper were such as they could all cordially subscribe to. It was interesting to find that the polyphase motor showed signs of being only a passing phase in the development of the work, and that being so it did not emerge that there was any conflict between the continuous-current motor and the alternating-current motor, because the two machines were in all essential particulars alike. There was, however, a tendency to strain the argument in favour of polyphase plant, and the speaker felt he would not be justified in agreeing with everything which Mr. Ionides had said. The control of the polyphase motor was not a simple thing. It tied the user down to a specific speed much more closely than was the case with continuous-current plant. He could safely say that in all factories where polyphase machinery was being manufactured continuous-current motors were still used for a large number of purposes, because they were found more convenient to handle and easier to apply to a large number of details. The speaker regretted that Mr. Ionides had not made any mention of the use of alternating currents for traction work. The arrangement of generating three-phase current and transforming it down for traction did not seem a permanent solution of the difficulty, and if the experiments presently being carried out in America with single-phase plant for traction induced the people on this side to adopt similar plant, it would lead to a very interesting simplification of a difficult problem. The areas of distribution for traction seemed even in America to show signs of limitation. If it were the case that for distances of over 20 miles they must fall back on the steam locomotive, then the problem of distribution was less complicated than it was in some parts of America, where attempts had been made to deal with longer distances.

Mr. H. B. MAXWELL (Partick) said the paper was a particularly appropriate one in Glasgow, because he did not suppose there was any class of work where the polyphase motor could show to such advantage as in shipyard work. He thought the three-phase induction motor was most useful for extremes. He did not see that the complications required by the polyphase system were any more serious than those with a direct-current system. With regard to the single-phase series motor, nobody seemed to know anything about its capabilities and characteristics except the manufacturers, and he thought a guarantee of its good points should be taken when placing the order.

Mr. SPENCE (Alloa) said he approached the paper as a direct-current advocate. It would seem from the remarks of the author that in controlling a three-phase motor only the current on the motor was dealt with. He would like to ask if, in stopping a three-phase motor, the stator was always left alive on the line? The author stated that three-phase plant cost no more than direct-current plant. He had no doubt that must be a reference to manufacturer's costs, for he knew that it could not refer to the cost to the purchaser. He would like to know if Mr. Ionides considered a punching and shearing machine to be a constant-speed machine suitable for a slip-ring motor.

Mr. W. B. HIRD (Glasgow) said he was pleased to hear Mr. Ionides praising the squirrel-cage motor as contrasted with the slip-ring motor. He quite agreed with Mr. Ionides that the question of rapid variation such as can be obtained from a shunt-wound motor was often much exaggerated when the relative merits of continuous and alternating currents were compared, and the number of cases where a shunt control could give what was wanted were very limited.

Dr. J. B. HENDERSON (Glasgow) spoke at considerable length strongly in support of the alternating-current motor, and in the course of his remarks gave a very lucid description of the "Heyland" diagram, a detailed account of which, he said (in answer to a question), is not yet accessible in English.

Mr. IONIDES, in reply, said that Mr. Mavor had referred to the series motor as a possible means of doing away with the polyphase motor. The single-phase motor seemed to have its own particular field, just as the series direct-current motor had, and if Mr. Mavor could construct a motor of the squirrel-cage type without a commutator or slip-rings let him stick to it until he could get one without bearings. He had not dealt with traction, as it was out of the scope of his paper. He very cordially agreed with Mr. Maxwell, that people were apt to consider the variable-speed requirements of a few cases instead of looking to the constant-speed requirements of the great majority of cases. The loss in the alternating-current motor through variation of speed was very small compared to the cost of keeping a direct-current plant in a state of efficiency. One of the greatest advantages of electricity over steam plant was its low maintenance cost, and the speaker maintained this was a feature which was accentuated in the alternating-current plant. He agreed with Mr. Stevenson that, in regard to turbine pumps, it was not necessary to vary the speed. In regard to the slip-ring motor control, Mr. Spence wanted to know what happened to the primary circuits; whether they were left closed or not. They were not left closed, but at the time they were open the resistance in the secondary circuits was usually such as to make variations in the primary infinitesimal. The question of comparative cost was a very wide one. In actual practice, when it came to working the two kinds of plant side by side, the first cost was practically the same.

The results of the voting for office bearers and committee for next session were then announced as follows: Mr. John M. Munro (chairman), Mr. F. A. Newington (vice-chairman), Mr. E. G. Tidd (secretary and treasurer), Messrs. W. W. Lackie, E. T. Goslin, J. K. Stothert, J. Macfee, Sam Mavor, W. Stevenson, Blackwood Murray, J. Lowsen, A. W. Stewart (members of committee).

A vote of thanks, proposed by Mr. Lackie, to Mr. R. Robertson for his occupancy of the chair throughout the session closed the meeting.

## REPLY TO DISCUSSION ON MR. A. M. TAYLOR'S PAPER ON "STAND-BY CHARGES AND MOTOR-LOAD DEVELOPMENT."

Following is the full text of Mr. A. M. Taylor's reply to the discussion on his paper read before the Birmingham Local Section on Dec. 14 last, and presented at a later date in amplified form to the parent Institution. An abstract of the paper and a report of the discussion will be found in our issues for Jan. 13, May 5, and May 19 last.

In reply to the various speakers who have taken part in this discussion, there are four principal points on which the discussion has centered, and I think it will conduce to clearness if these points are, in most cases, referred to, rather than direct replies given to the various speakers. The four points alluded to are: (1) objection to departure from the ordinary methods of treatment; (2) criticism of the values taken for the diversity factor and the nomenclature adopted; (3) refusal to accept 1d. per unit as a bed-rock price for "interest-paying" loads; (4) difficulties suggested in the application of the restricted-hours' system.

In reference to (1), I would suggest that the method of considering things only from the station point of view is apt to lead to an overlooking of what goes on at the consumer's end of the line. My method, on the contrary, works back from the consumer to the station, and is less likely to overlook these points. The outcome of the discussion would seem to show that through confining investigations principally to the station, the important point has been overlooked of the very low load factor possessed by the average motor (I could adduce a prominent illustration of this). The diversity factor has been hailed as a sort of undeveloped gold mine, and no explanation has been given of the fact—indeed, I have nowhere seen it observed before—that the station load factor is, with a motor load, occasionally several times that of the motor load factor.

In reply to Mr. Arthur Wright, the principle adopted in the lower half of p. 3 of the paper is to split up the present charge per unit for management, etc., into two parts—viz.: a part which would be unaffected by taking on a large non-interest-

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paying load (the station capacity remaining unaltered) and a part (such as the office staff) which would be increased almost in direct proportion to the number of consumers and hence to their diversity factor. The proportion of present charges which must be so divided up varies, of course, in different towns, but for lighting stations of 2,000 kw. it should not be materially different from what I have taken, and each engineer can determine it for himself quite readily. In further reply to Mr. Wright, the size of station is assumed constant at 2,000 kw. all through pp. 3 and 4, and the net profit is assumed to be a constant sum per annum.

In reply to Mr. Cooper, I have assumed that cost of land for generating station is included in the sum sanctioned by the Local Government Board, on which interest is paid. Depreciation should, it seems to me, be met out of net profit, where it is provided for at all.

In reply to Mr. Vignoles, I have not forgotten the cost of service connections. He will find them alluded to on p. 24 of the paper. His figures, too, are greatly over-estimated. He will find that 400 (not 5,000) customers of Class I. would account for 5,000,000 units; hence his figures are just 12 times too high. The actual cost of a service connection is about £2, and 7 per cent. on this would be only 3*s.*, which on a £25 bill per annum (5-h.p. motor) is almost negligible. No stiffening of mains has to be considered, on a restricted-hours' system, in most cases, hence I allow nothing for this.

As regards (2): The diversity factor considered on pp. 18 and 19 of the paper is the average value of the *true* diversity factor taken over a period sufficiently long, say for at least an hour, and sufficiently frequently (say at several different times of the week) to ensure a representative average for the class of load in the town. The method adopted in the paper of considering a cyclic load factor has, it appears, introduced confusion. This it might be well to avoid by omitting as far as possible all reference to any but the "annual" load factor of the motor, or that of the station. In the case considered the "cyclic" load factor has merely to be multiplied by the ratio of $\frac{49\frac{1}{2}\text{ (hours per week)}}{168\text{ (hours per week)}}$ = say 0·3, in order to convert it to the "annual" load factor. Thus, 100 per cent. "cyclic" load factor becomes 30 per cent. annual, and 25 per cent. "cyclic" becomes 7½ per cent. "annual," as they are designated in Table A. The statement that the diversity factor is the *reciprocal* of the cyclic motor load factor may then be altered as follows: the diversity factor is (in the limit) equal to the reciprocal of the annual motor load factor multiplied by a constant.

An example will make the case clear. Taking the motor load curves just published by Mr. Jeckell for Coventry (see the *Electrical Engineer* for May 17), and working out the diversity factor for each hour of a typical day, by dividing the kilowatts observed at station into the total kilowatt capacity of the motors connected (1,150 h.p. × ·85) = 980 kw.), we get the following values: 7 to 8 a.m. = 3·32; 8 to 9 a.m. = 3·16; 9 to 10 a.m. = 2·65; 10 to 11 a.m. = 2·08; 11 a.m. to 12 noon = 2·08; 12 noon to 1 p.m. = 2·20; 1 to 2 p.m. = 3·63; 2 to 3 p.m. = 3·44; 3 to 4 p.m. = 2·04; 4 to 5 p.m. = 2·0; 5 to 6 p.m. = 2·25; 6 to 7 p.m. = indeterminate; 7 to 8 p.m. = indeterminate. The average through the day is 2·62, but the true figures, when all the motors are on (if we eliminate the breakfast, dinner, and tea hours', is nearer 2·1.

Now, units per brake horse-power installed per hour of working

$$= \frac{\text{236 units per B.H.P. per quarter}}{\text{say, 13 hours} \times 5\frac{1}{2}\text{ days} \times \text{13 weeks}} = 0\cdot254\text{ unit per hour}$$

(0·3 unit if we take 11 hours per day).

"Cyclic" load factor

$$= \frac{0\cdot254\text{ unit}}{(1\text{ h.p.} \times \cdot85) \times 1\text{ hour}} = 0\cdot299 = \text{say, 30 per cent.}$$

$$\therefore \text{Diversity factor (my method)} = \frac{1}{\frac{30}{100}} = 3\cdot3\text{ (in the limit).}$$

Hence for a diversity factor of 3·3 (in the limit) the *observed* diversity factor = 2·1 (with all motors on), and I therefore accept Mr. Arthur Wright's suggestion that in taking 1·5 as the average for a limit of 4, I have done injustice to the electric motor. It should be nearer 2·5 for a motor having a 7½ per cent. annual load factor, as per my Class II. The annual load factor at Coventry works out to about 12·7 per cent. (236 units per brake horse-power installed per quarter).

Now compare the above with Mr. Tapper's figures for Stepney:

Units per brake horse-power installed per hour of working

$$= \frac{\text{113 units per H.P. per quarter}}{\text{say, 13 hours} \times 5\frac{1}{2}\text{ days} \times \text{13 weeks}} = 0\cdot122\text{ unit per hour.}$$

"Cyclic" load factor

$$= \frac{\cdot122\text{ unit}}{(1\text{ h.p.} \times \cdot85) \times 1\text{ hour}} = \cdot143 = 14\cdot3\text{ per cent.}$$

$$\therefore \text{Diversity factor (my method)} = \frac{1}{\frac{14\cdot3}{100}} = 7\text{ (in the limit).}$$

Hence it is easy to understand how it is that Mr. Tapper gets 4·4 for the observed value of his motor diversity factor. The annual load factor at Stepney works out to 6·1 per cent. (113 units per brake horse-power installed per quarter).

The two above examples, covering largely different classes of load, appear to me to fully corroborate the deduction that diversity factor varies inversely as load factor of motor. As a further proof I suggest the following considerations.

In the *traction* examples cited below the product of diversity factor and motor load factor (annual) and the observed station load factor are given in parallel columns.

| — | Theoretical station L.F.* | Observed station L.F. | Motor L.F. | Observed D.F. |
|---|---|---|---|---|
| | Per cent. | Per cent. | Per cent. | |
| Wolverhampton... | 34·6 | 34·4 | 11·9 | 2·9 |
| Liverpool ..... | 47 | 46½ | 12·5 | 3·75 |
| Glasgow ..... | 40 | 35 | 5·7 | 7·0 |
| Sheffield ..... | 37 | 45 | 8·8 | 4·2 |

* Product of motor load factor and diversity factor.

I venture to suggest that these figures bear out the statement which Mr. Arthur Wright disputes—viz., that there is any relation between the diversity factor of a motor business and the station load factor. I think it has not been sufficiently emphasised in this discussion that it is not the combined diversity factor of motors and lights (taken over a mid-winter "peak" load of at least an hour's duration, so as to take the full overload capacity of the plant) which is the divisor which should be used in obtaining interest charges per kilowatt of consumers' maximum demands. The diversity factors of lights and motors during this period are capable of being, and should be, determined separately and used as divisors for obtaining interest charges. I wish to point out that the motor diversity factor will vary considerably according to whether the combined "peak" occurs before or after 5 p.m., and this again will depend on the class of lighting load in the town, whether shops and offices on the one hand, or residential on the other. We all owe a great debt to Mr. Wright for his masterly enunciation of the fundamental principles of economical supply in days when it was not generally understood, and it is a source of much gratification to me to receive from him such an eminently fair criticism on these points, though I regret we seem to agree to differ on the "diversity factor" question. I think he will see, however, that the final sentence of his reply is directly contradicted by the results at Coventry, which were 2·08 before lunch and 2·04 after it.

We now come to (3), and in reply to this I would say: nobody has indicated how we are to charge a "bed-rock" price of anything less than the 1·45d. per unit of my Table A in a small station of 2,000 kw. capacity except by a possible reduction of 0·25d. on the works cost. This latter would be justified if the load were *exclusively* a motor load. As, however, there will always be a fair proportion of lights as well, so there will *always* be a "peak," and stand-by charges will be incurred in boilers and pipework, etc., which would be avoided on the restricted-hours' system. It would seem that engineers are, for the most part, counting on the "diversity factor" to reduce their capital costs and stand-by charges. One of the speakers even goes so far as to divide his "stand-by cost" by the aggregate kilowatts of the consumers' motors, and then *again* by the diversity factor, which in the case concerned has a value of 4. This is equivalent to taking account of the diversity factor twice over, and making the stand-by losses per kilowatt just four times too cheap! Other engineers, I believe, do the same. What is the result? The lighting consumers have to pay the piper! This is the only way the station is saved from bankruptcy.

The point I wish to emphasise is this. Take a station, as in Class I. of my Table A, where the motor connections aggregate 2,000 kw., there being no lighting, and the station load is also 2,000 kw. all day long (nine hours). Surely nobody will deny that here, at least, the diversity factor is unity. On such a station interest charges will come to 0·45d. per unit. If now, instead of this, we take Class II. of motor, and if the diversity factor—which, let us assume for the sake of argument, varies inversely as the motor load factor—were to reach its limiting value of 4, in a station consisting (exclusively) of motors of this class, the interest charges per unit would be the *same* as for Class I., excepting that part relating to mains and service connections, the latter of which would, of course, be raised fourfold. But, by however much the diversity factor may be short of the theoretical limiting value at times of maximum load on the station, by that amount will the interest and other stand-by charges (per unit) be *greater* than for Class I., and it has to be borne in mind that the smaller the average load factor of the

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motors the greater is the amount by which the diversity factor falls short of the theoretical limit for the motors only. That this must be so will be apparent when we consider that for a "cyclic" load factor of 100 per cent., the "limiting" and the "observed" values of the diversity factor must coincide, each having a value of unity. When, in addition to this, we have a lighting load superposed on a motor load, the resultant diversity factor (at the time of peak load) is much less, and the increase of the station load factor is not, I anticipate, in the same proportion as the decrease in the diversity factor (though I have not, as yet, completed investigations on this point). Hence the interest charge where the motor load factor is, say, only 4 per cent., as at Sunderland, will be much nearer 0·75d. per unit than the figure of 0·45d. given by me for Class I., and higher still if we take account of the extra cost for services and mains.

As regards the items for management and office expenses, rates, and taxes, etc., it is surely obvious that, if diversity factor is inversely proportional to motor load factor, we require four times the office staff for a change from Class I. of motor to Class II., and hence the "office" charge per kilowatt of motors connected is constant, and must *not* be divided by the diversity factor to obtain the annual charge per consumer's kilowatt, while the "office" charge *per unit* will be quadrupled (the station output and load factor remaining as before). Again, if it be once granted that diversity factor varies inversely with motor load factor, it follows that for a station of a given kilowatt capacity the charge for management and technical staff (including the outside consultant if there is one) may be divided by the diversity factor to obtain cost per consumer's kilowatt, but the cost per unit remains unchanged, as the aggregate number of units sold, with a change from Class I. of motor to Class II., will be unaltered. Strictly speaking, it will be somewhat increased, as the limiting value of the diversity factor is less closely approached. Similar arguments applied to rates and taxes and net profit charges have been duly weighed by me in framing my Table A, in which, I submit, the only uncertain element is my estimate of 1·5 for the diversity factor for Class II.; which, in view of the Coventry analysis, I now agree to raise to 2·5. All things considered, I think that the onus of showing how current can be supplied for motive power at a lower rate than 1d. per unit from an average municipal supply station, except on a restricted-hours' basis, still rests with my critics and not with myself.

With reference to (4), there are no doubt difficulties in the application of the restricted-hour system, which, however, even in its most unattractive form seems to have been an unqualified success in Montreal, Brighton, Wednesbury, and numerous smaller towns, and, if we may judge from Mr. Vignoles's remarks, it has been successful at Grimsby in capturing motor loads, while I understand that at St. Pancras and in the stations of the County of Durham Company it is also being tried; but with what results I do not know. The question as to whether it will prove a success or otherwise seems to me to depend largely, if not entirely, on the prices that can be offered. Hitherto nothing less than 1d. has been offered, but if my figure of 0·54d. per unit (see Table A) can be justified, the arguments adduced on p. 10 of my paper should weigh with factories and other consumers having a good load factor. Where accumulator substations are warranted in a district, these would form a valuable supplement to the restricted-hours' system, and practically put it on all fours with an interest-paying load.

According to Mr. Snell, of Sunderland, the capital cost of accumulators and accessories for a sub-station of 2,000 kw. capacity is only £3 per kilowatt, and the maintenance of the cells under such conditions can be undertaken at 5 per cent. per annum. No doubt there are extra costs in connection with stiffening the mains locally, telephone connections to the main stations, cost of the sub-station building, etc., which will increase this total somewhat, and in the running cost there is the item for wages. All these, however, added together would probably not amount to more than from 0·1d. to 0·2d. per unit; which would give a figure of 0·65d. to 0·75d. per unit for the total cost. Such a combination would practically place the restricted-hours' supply on equal terms with interest-paying motor loads, as far as the convenience of the consumer is concerned, and would, in addition, give the former an advantage of at least 0·25d. to 0·35d. per unit. Such a difference would, in the case of double-shift (continuous) motor loads, be in many cases sufficient to turn the advantage in favour of the electric motor.

The suggestion to use batteries scattered about in small groups on the premises of isolated consumers was made by me to meet the case where sub-stations were not warranted, or where station engineers were not favourably disposed towards their adoption for the purpose of meeting the peak load. It would, of course, be futile, unless means could be devised for protecting the batteries from damage by the ignorance or carelessness of the consumers, and unless the battery makers themselves were prepared to find the capital for and maintain batteries under such conditions. This, however, I have reasons for believing to be the case. With motors of Class I., a 10-h.p. motor working two shifts could be supplied with current at only 0·12d. per unit above the restricted-hours' charge, this figure covering all charges for interest and maintenance of cells, charging dynamo, etc. For a day load only, the charge would be 0·25d. per unit. It will thus be seen that there is not much to choose between a battery sub station and private installations of batteries, while the latter offer an incentive to the outlay of private capital, and meet the case of scattered consumers in small towns where batttery sub-stations would be unjustifiable.

Mr. Gaster asks me to specify some of the uses to which the restricted-hours' system can be put. In reply, I have to say that the Dominion Cotton Mills at Montreal have 3,590 h.p. working on this system, employing motors of 300 h.p., 200 h.p., 100 h.p., and smaller capacities; the Montreal Steelworks take 175 h.p. in small motors in 15 h.p. to 20 h.p.; the Wire and Cable Company have a 300-h.p. motor; the Oil and Cloth Company, two 200-h.p. motors; the Cement Works, 300 h.p.; and the Water and Power Company, 350 h.p. for pumping purposes. In this country they have at Brighton some 300 h.p. in motors, ranging from 30 h.p. downwards, used in breweries, mineral water factories, laundries, printing works, stone-polishing and sawmills, ventilating motors, etc. An investigation of the average number of units sold per brake horse-power installed per quarter taken over the principal towns of the kingdom will, I believe, be found to show that the average load is only a quarter of the rated load as taken for Class II. of my Table A. It follows that the statements on p. 2 of my paper are correct, and that if continuous loads are in the market electric power stations are not obtaining them in any quantity. Until it can be shown that power can be supplied to interest paying motors at less than 1d. per unit on a sound financial basis, it seems to me that the restricted-hours' system, supplemented by batteries, offers the only prospect to our smaller provincial towns of obtaining such motor loads, and until these are obtained bottom prices will never be reached, for the reasons set forth in the paper.

In reply to Mr. Jeckell, the fundamental difference between us is that he had obtained his brake horse-power hours in what, I submit, is a totally wrong manner. To properly compare them with my Table C most of his figures have to be divided by 4, when it will be found that there is no material difference between his figures and mine. I am sorry that through misunderstanding Mr. Jeckell's verbal question at Birmingham I confirmed him in a wrong impression.

In reply to Mr. Patchell's remarks regarding my Fig. 7, I think he will find it helpful to study Figs. 11 and 12 (especially the latter) in connection with Fig. 7, also the remarks in appendix. No doubt, however, the fault is partly mine in not supplementing for London the explanations I was allowed to give verbally during the reading of the paper in Birmingham.

Mr. Boot's remarks show that my figure of 0·45d. for works costs, on a restricted-hours' basis, is about right. But as he does not enter into other costs, I cannot say anything with regard to his suggested selling prices.

In reply to Mr. Dawbarn's remarks, I think this gentlemen will concede that, if the diversity factor is really inversely proportional to the load factor, the ampere-hour capacity of the private cells would, in the aggregate, be the *same* as that of batteries in a sub-station, though the maximum rate of discharge might be somewhat higher. The private battery method may be a horribly inefficient way of carrying out extensions into unpopulous districts, but in a similar case the use of small direct-current booster for long feeders in 440-volt supply, though equally inefficient, has often saved the refusal of customers where there was not enough demand to warrant a sub-station, whether of the high-tension or of the battery type.

## FORTHCOMING EVENTS.

**King's College.**—Annual dinner at the Hotel Cecil, June 26.

**Electrical Contractors' Association.**—Dinner at the Holborn Restaurant, June 27.

**Incorporated Municipal Electrical Association.**—June 27-30, annual convention.

**City and Guilds of London Institute.**—Exhibition at the Imperial Institute, to be opened on June 28, at 3.30 p.m.

**Municipal and County Club.**—House dinner (W. H. Grenfell, Esq., M.P., principal guest), June 29.

**Civil and Mechanical Engineers' Society.**—Visit to Lots-road generating station, June 29, at 2.30 p.m.

**Institution of Electrical Engineers.**—Conversazione, June 29.

**Junior Institution of Engineers.**—Summer meeting commences June 30. For particulars see another column.

**University of Liverpool.**—Opening of new electrotechnics laboratory by Sir J. Swan, July 8.

**Permanent-Way Institution.**—Summer convention begins on July 21, continuing till July 27, in the course of which a visit will be paid to Holland.

**University College, London, Union Society.**—Foundation oration, "The Academic Side of Technical Training," to be delivered by Dr. A. B. W. Kennedy on June 29, at 3.30 p.m.

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## SOUTH SHIELDS ELECTRICITY ACCOUNTS.

From the accounts of the South Shields electricity department for the year ended March 31, 1905, it appears that the total expenditure on capital account to that date amounted to £151,838 Abstracts of the revenue account and general balance-sheet are appended.

REVENUE ACCOUNT.

| Dr. Expenditure. | £ | s. | d. |
|---|---|---|---|
| Generating expenses, wages, etc. | 2,602 | 16 | 1 |
| Maintenance of plant | 704 | 15 | 3 |
| Distribution expenses, wages, etc. | 255 | 10 | 0 |
| Rents, rates, and taxes | 864 | 14 | 3 |
| Management expenses, salaries, etc. | 1,735 | 10 | 8 |
| Law expenses and insurances | 57 | 11 | 1 |
| Attendance and repairs to public lamps | 715 | 0 | 10 |
| | 6,935 | 18 | 2 |
| Balance, being gross profit | 11,196 | 6 | 11 |
| | £18,132 | 5 | 1 |

| Cr. Income. | £ | s. | d. |
|---|---|---|---|
| Sale of current, less discounts, etc. | 14,227 | 18 | 2 |
| Public lighting | 3,406 | 10 | 10 |
| Meter rents | 473 | 17 | 1 |
| Rents, etc., Holborn Quay | 23 | 19 | 0 |
| | £18,132 | 5 | 1 |

BALANCE-SHEET.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Redeemable stock and mortgage loans | 133,695 | 1 | 11 |
| Sundry creditors, dividends, interest, etc. | 1,954 | 16 | 2 |
| Borough treasurer | 6,256 | 8 | 4 |
| Balance reserve fund | 2,491 | 7 | 8 |
| Excess of assets over liabilities | 27,343 | 11 | 3 |
| | £171,741 | 5 | 4 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Capital account—amount expended for works | 151,838 | 7 | 2 |
| Sundry debtors for current supplied | 5,815 | 14 | 2 |
| Stores on hand | 917 | 4 | 0 |
| Sinking funds invested and in hand | 10,668 | 12 | 4 |
| Reserve fund invested and in hand | 2,491 | 7 | 8 |
| Cash in hand | 10 | 0 | 0 |
| | £171,741 | 5 | 4 |

## BURY ELECTRICITY ACCOUNTS.

From the accounts of the Bury Corporation electricity department for the year ended March 31, 1905, it appears that the total expenditure on capital account to that date amounted to £76,408. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are appended.

REVENUE ACCOUNT.

| Dr. Expenditure. | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 2,331 | 16 | 0 |
| Repairs and maintenance of plant, etc. | 456 | 14 | 6 |
| Management expenses, salaries, etc. | 780 | 8 | 0 |
| Distribution of electricity | 472 | 8 | 1 |
| Attending and repairs to public lamps | 96 | 1 | 3 |
| Rates and taxes, interest, insurance, etc. | 1,088 | 9 | 5 |
| Amount carried to net revenue account | 6,130 | 17 | 6 |
| | £11,356 | 14 | 9 |

| Cr. Income. | £ | s. | d. |
|---|---|---|---|
| Sale of current for private lighting | 6,368 | 0 | 5 |
| Sale of current for traction | 3,857 | 14 | 6 |
| Sale of current for public lighting | 585 | 5 | 0 |
| Rental of meters, etc. | 171 | 14 | 2 |
| Rental of motors, etc. | 304 | 5 | 9 |
| Private construction | 56 | 14 | 11 |
| Incidental receipts | 13 | 0 | 0 |
| | £11,356 | 14 | 9 |

GENERAL BALANCE SHEET.

| Dr. Liabilities. | £ | s. | d. |
|---|---|---|---|
| Loans on mortgage | 73,269 | 0 | 0 |
| Sundry creditors | 2,874 | 14 | 3 |
| Sinking fund, less loans paid off | 1,500 | 1 | 10 |
| Debt extinguished | 7 566 | 0 | 0 |
| Balance, being income over expenditure | 2,931 | 9 | 11 |
| | £88,141 | 6 | 0 |

| Cr. Assets. | £ | s. | d. |
|---|---|---|---|
| Amount expended on capital account | 76.408 | 2 | 11 |
| Sundry debtors for current supplied | 4,241 | 18 | 3 |
| Stores on hand | 1,161 | 4 | 9 |
| Cash at bankers | 6,330 | 0 | 1 |
| | £88,141 | 6 | 0 |

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

| | | | |
|---|---|---|---|
| Quantity generated in B.T.U. | | | 1,326,907 |
| Quantity sold: Public lamps | 62,801 | | |
| Quantity sold: Tramways | 652,250 | | 1,280,461 |
| Quantity sold: Private consumers by meter | 555,410 | | |
| Quantity used on works | | | 16,420 |
| Total quantity accounted for | | | 1,296,881 |
| Quantity not accounted for | | | 30,026 |
| Total maximum supply demanded (kilowatts) | | | 1 158 |

Number of public lamps, 34 arcs, 18 incandescents.

## BLACKPOOL ELECTRICITY ACCOUNTS.

The following is an abstract of the revenue account for the year ended March 31, 1905, taken from the accounts of the Blackpool Corporation electricity department.

| Dr. *Expenditure.* | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 10,284 | 0 | 0 |
| Distribution of electricity | 1,326 | 17 | 5 |
| Public lighting | 967 | 9 | 11 |
| Rents, rates, and taxes | 1,355 | 4 | 8 |
| Management expenses, salaries, etc. | 1,331 | 19 | 9 |
| Miscellaneous expenditure | 187 | 16 | 5 |
| | 15,453 | 8 | 2 |
| Balance, being excess of income over expenditure | 17,403 | 14 | 3 |
| | £32,857 | 2 | 5 |

| Cr. *Income.* | £ | s. | d. |
|---|---|---|---|
| Sale of current for private lighting | 17,749 | 3 | 6 |
| Sale of current to Tramways Committee | 8,354 | 15 | 3 |
| Sale of current to tramways company | 964 | 13 | 10 |
| Sale of current for public lighting | 5,438 | 17 | 3 |
| Rents, rates, and taxes | 276 | 11 | 2 |
| Hire of meters, transformers, etc. | 73 | 1 | 5 |
| | £32,857 | 2 | 5 |

## COLCHESTER.

The following is an abstract of the revenue account of the Colchester electric light and power department for year ended March 31, 1905.

| *Expenditure.* | £ | s. | d. |
|---|---|---|---|
| Generation of electricity | 4,572 | 12 | 9 |
| Distribution of electricity | 155 | 16 | 8 |
| Rates and taxes | 246 | 15 | 4 |
| Management expenses—salaries, etc. | 646 | 17 | 5 |
| Miscellaneous—insurance | 49 | 5 | 0 |
| Interest on mortgages, etc. | 1,582 | 5 | 2 |
| Repayment of loans—sinking fund, etc. | 1,746 | 18 | 0 |
| | 9,000 | 10 | 4 |
| Excess of income over expenditure | 2,432 | 8 | 0 |
| | £11,432 | 18 | 4 |

| *Income.* | £ | s. | d. |
|---|---|---|---|
| Sale of electricity, less discounts | 10,922 | 19 | 9 |
| Interest and specifications | 21 | 5 | 3 |
| Rent of premises | 101 | 0 | 0 |
| Trading account (profit) | 362 | 13 | 4 |
| Pupil's premium | 25 | 0 | 0 |
| | £11,432 | 18 | 4 |

## PERSONAL.

Sir John Wolfe Barry, F.R.S., K.C.B., has been elected to succeed the late Mr. James Mansergh, F.R.S., past-president of the Institution of Civil Engineers, as chairman of the Engineering Standards Committee, which post Mr. Mansergh had occupied since the formation of the committee in 1901.

The Bury St. Edmunds Town Council have accepted the resignation of Mr. L. P. Greig, borough resident electrical engineer. The Council have resolved that the present staff be given a trial for three months from July 1, and have increased the salary of the chief engineer and his assistant, and propose to engage an improver.

The Watford Urban Council have increased the salary of the engineers-in-charge, Messrs. Osborne and Hick, to £75 per annum, and the salary of their electrical engineer, Mr. J. R. Weston, to £150 per annum.

The Southport Town Council have increased the salary of their tramways manager, Mr. T. J. Kendrew, as from April 1 last, to £225 per annum, and by annual increments of £12. 10s. to the sum of £250 per annum.

On Wednesday week, the 14th inst., the staff at the Hammersmith electricity works presented to the chief engineer, Mr. G. Gilbert Bell, a handsome silver salver on the occasion of his marriage.

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## CITY OF SHEFFIELD—PUBLIC LIGHTING.

**The following is the conclusion of the report of Mr. S. E. Fedden, manager, Sheffield Corporation Electric Supply Department, on the public lighting of the city of Sheffield:**

*The Electric Lighting of Side Streets and Unimportant Thoroughfares.*

In many towns the electric lighting of side streets and unimportant thoroughfares has been undertaken by the use of various forms of incandescent lamps placed in existing gas pillars and lanterns, in some cases with great success and a very considerable improvement in the thoroughfares so lit. It seems probable that a great impetus may be given to side-street lighting by the introduction of a really successful lamp of greater efficiency than the present carbon-filament lamps. Amongst many new forms at present being developed the "Tantalum" lamp appears very promising. It is much more expensive at present than the carbon-filament lamp, but not prohibitively so, and no doubt the price will fall rapidly when larger quantities are made. Its consumption of current for light given is little more than half that of the carbon lamp, and its life may be considerably longer. My tests, so far, bear out the claims of the inventors to an encouraging degree. The filament is made of a rare metal, and is very long, the principal result of these two conditions being that it is less sensitive to fluctuations in the supply pressure than the carbon lamp, a point of very great importance to both supply undertakings and consumers.

*Some Notes and Curves by the Reason Manufacturing Company on the Application of their Patented System of Reflectors for Side-Street Lighting and After-Midnight Lighting.*

In one important respect it is astonishing how little attention has been paid to the utilisation of the light of public lamps so as to concentrate the rays upon the roads and pathways, instead of dissipating them upon the sky. This defect has been apparent with electric as well as gas lighting, especially with the arcs which are left to disperse their rays upwards and in all directions, besides, in many cases, notably in the city of London, obscuring the light by the character of the thick glass in the lanterns, and casting more objectionable shadows where the light is most needed. The Reason Manufacturing Company, of Brighton, have introduced some excellent types of reflectors, which overcome the defects to which we have alluded. One of their latest and best developments is adapted for either small arcs, Nernst, or the ordinary incandescent lamps. Having two burners in each lantern, there are no shadows, and all the light is diverted by the reflectors into the direction where it is needed. They are dustproof, reducing the cost of cleaning to a minimum, and the lamps and internal fittings are readily accessible by merely unscrewing the top finial, removing the cover and exposing a 12in. opening in the globe. Another type is the double-bracket fitting, which is specially adapted for tramway poles or arc light columns, when arrangements are made for switching off the arcs at a certain hour, and substituting smaller candle-power lamps during the remainder of the night.

The question of distribution of candle-power in streets is so important that I reproduce the following diagrams and particulars, which are of much interest. It must be borne in mind that in street-lighting, unless reflectors are used, not only all the rays of light directed above the horizontal are wasted, but also nearly all the rays of light directed into that half of the lower hemisphere which is occupied by the houses or land adjacent to the path; in other words, that when using a source of light giving a practically even spherical illumination, the upper hemisphere and practically half of the lower hemisphere are wasted unless suitable reflectors are used, which means that, theoretically, the efficiency would be increased by 300 per cent. In practice the Reason Company's patented system of reflectors and globes increases the efficiency by about 200 per cent. Thus it will be seen that two 16-c.p. lamps, instead of giving a mean of 32 c.p., give a maximum of 80 c.p. and a minimum of 32 c.p., or a mean of about 60 c.p." Although considerable improvement can be effected by the use of reflectors, I should not be prepared to endorse to the full the statements of the Reason Company.

PUBLIC ARC LIGHTING IN VARIOUS BRITISH TOWNS AND METROPOLITAN DISTRICTS.

*Corporations.*

| Name of place. | Population. | Public arc lamps. | Price of gas. s. d. |
|---|---|---|---|
| Aberdeen | 165,000 | 289 | 2 6 |
| Accrington | 43,100 | 9 | 2/6 to 2/9* |
| Airdrie | 22,288 | 10 | 2 11 |
| Beckenham | 29,000 | 17 | 2 6 |
| Bedford | 37,000 | 15 | 2 7 |
| Belfast | 380,000 | 4 | 2/3 to 1/9½ |
| Bermondsey | 130,486 | 132 | 2 0 |
| Bexhill | 12,210 | 47 | 4/- to 4/9 |
| Birkenhead | 113,343 | 58 | 2/8 to 3/2 |
| Blackburn | 129,116 | 219 | 3 3 |
| Blackpool | 50,000 | 270 | 2 4 |
| Bolton | 171,082 | 8 | 2 6 |
| Bootle | 60,000 | 173 | 2 8 |
| Bradford | 285,069 | 51 | 2 3* |
| Bray | 8,000 | 30 | 5 10 |
| Bridgend | 6,600 | 15 | 4 0 |
| Bridlington | 13,000 | 32 | 2 8 |
| Brighton | 125,000 | 372 | 2 11 |
| Bristol | 365,000 | 674 | 1 11 |
| Broughty Ferry | 10,500 | 12 | 3 6* |
| Burnley | 100,000 | 3 | 2 6* |
| Bury | 58,000 | 28 | 1 11 |
| Bury St Edmunds | 16,255 | 14 | 3 9 |
| Buxton | 11,000 | 30 | 2 6* |
| Canterbury | 24,599 | 12 | 2 10 |
| Cardiff | 200,000 | 491 | 2 9 |
| Carlisle | 45,484 | 47 | 2 3 |
| Cheltenham | 55,000 | 342 | 2 4* |
| Chester | 39,000 | 211 | 2 10 |
| Chesterfield | 27,000 | 20 | 3 6 |
| Cleckheaton | 13,000 | 3 | 2 8* |
| Colwyn Bay | 9,000 | 33 | 3 9 |
| Coventry | 73,000 | 40 | 2 6 |
| Crewe | 45,000 | 8 | 2 8 |
| Croydon | 141,157 | 410 | 2 8 |
| Darlington | 45,000 | 44 | 2 1 |
| Dartford | 18,615 | 6 | 2 8* |
| Darwen | 40,000 | 19 | 2 9 |
| Derby | 125,000 | 104 | 2 0 |
| Devonport | 70,437 | 20 | 2 6 |
| Dewsbury | 28,060 | 32 | 3 0 |
| Doncaster | 30,000 | 2 | 2 9 |
| Dover | 43,000 | 40 | 2 11 |
| Dublin | 360,000 | 487 | 3 2 |
| Dudley | 48,733 | 56 | 2 10 |
| Dundee | 163,500 | 71 | 2 10* |
| Ealing | 205,000 | 73 | 2 5 |
| Eastbourne | 51,000 | 96 | 2 8 |
| East Ham | 106,000 | 171 | 2 11 |
| Eccles | 34,369 | 21 | 2 3 |
| Edinburgh | 410,000 | 997 | 2 8 |
| Elland | 10,412 | 5 | 2 6 |
| Epsom | 11,000 | 12 | 3 9 |
| Erith | 31,000 | 17 | 4 3 |
| Exeter | 47,500 | 37 | 3 1 |
| Falkirk | 30,000 | 41 | 3 0 |
| Fareham | 7,934 | 27 | 4 2 |
| Farnworth | 26,000 | 45 | 2/4 to 2/8 |
| Fulham | 143,000 | 265 | 3 0 |
| Glasgow | 1,000,000 | 814 | 2 1 |
| Gloucester | 48,000 | 183 | 2 4 |
| Govan | 88,868 | 195 | 2 2 |
| Gravesend | 27,100 | 32 | 3 2 |
| Grimsby | 63,138 | 80 | 2 5 |
| Greenock | 68,142 | 50 | 2 9 |
| Hackney | 220,000 | 342 | 3 0 |
| Halifax | 112,000 | 69 | 2 0 |
| Hammersmith | 117,000 | 257 | 2 5 |
| Hampstead | 81,942 | 122 | 3 0 |
| Hanley | 75,000 | 70 | 2 9 |
| Harrogate | 29,600 | 60 | 2/8½ to 2/6 |
| Hastings | 80,000 | 104 | 3 0 |
| Heckmondwike | 9,600 | 10 | 2 6 |
| Heywood | 26,000 | 4 | 2 10 |
| Holyhead | 10,079 | 9 | 5 0 |
| Hornsey | 81,221 | 50 | 2 10 |
| Horsham | 10,610 | 21 | 4 2 |
| Huddersfield | 95,008 | 39 | 2 9 |
| Hull | 240,259 | 12 | 2/- and 2/8 |
| Ilford | 55,000 | 57 | 3 4 |
| Islington | 334,991 | 488 | 3 0 |
| Keighley | 41,600 | 14 | 2 3 |
| Kettering | 20,500 | 30 | 2 10 |
| King's Lynn | 20,288 | 22 | 3 6 |
| Kingston-on-Thames | 50,000 | 76 | 2 10 |
| Kirkcaldy | 34,063 | 104 | 3 4 |
| Lancaster | 42,000 | 35 | 2 3 |
| Leeds | 443,559 | 122 | 2 3 |
| Leith | 80,000 | 278 | 2 10 |
| Leyton | 110,000 | 72 | 2/11 and 3/10 |
| Lincoln | 50,000 | 35 | 2 3 |
| Liverpool | 702,247 | 189 | 2 8 |
| Llandudno | 10,000 | 68 | 3 4* |
| Londonderry | 40,000 | 187 | 3 0 |
| Long Eaton | 15,000 | 2 | 3 0* |
| Lowestoft | 23,842 | 72 | 3 9 |
| Luton | 36,404 | 10 | 2 4 |
| Maidenhead | 13,000 | 46 | 3/6 to 3/9 |
| Maidstone | 35,000 | 61 | 2 4 |
| Manchester | 659,100 | 45 | 2 3 |
| Mansfield | 27,000 | 30 | 2 6 |
| Marlborough | 12,000 | 15 | 3 6 |
| Middleton | 25,000 | 9 | 3 5 |
| Monmouth | 5,400 | 2 | 3 0 |
| Morecambe | 13,000 | 104 | 3 9 |
| Morley | 25,000 | 16 | 2 9 |
| Motherwell | 34,000 | 60 | 2 6 |
| Newport (Mon.) | 67,299 | 76 | 2 6 |

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| Name of place. | Population. | Public arc lamps. | Price of gas. s. d. |
|---|---|---|---|
| Nottingham | 239 753 | 160 | 2 10 |
| Nuneaton | 24,996 | 20 | 3 6 |
| Oban | 5 400 | 31 | 7 6 |
| Oldham | 137,238 | 20 | 2 3 |
| Paisley | 84,000 | 91 | 2 6 |
| Partick | 60,600 | 290 | 2 1 |
| Pemberton | 22,000 | 14 | 3 0 |
| Pembroke | 25,524 | 23 | 3 9 |
| Perth | 33,000 | 70 | 3 0 |
| Peterborough | 34,000 | 64 | 2 11 |
| Plymouth | 121,000 | 74 | 1 9 |
| Poplar | 168,822 | 320 | 2 6 |
| Portsmouth | 194 960 | 264 | 2 4 |
| Rathmines | 33 203 | 108 | 3 5 |
| Reigate | 25 935 | 3 | 3/4 and 3/6 |
| Rhyl | 8,461 | 56 | 3 10 |
| Rothesay | 9,323 | 36 | 2 10* |
| St. Annes-on-Sea | 8 000 | 32 | 3 9 |
| St. Helens | 90,000 | 35 | 2 3 |
| St. Pancras | 235,284 | 461 | 3 0 |
| Sale | 13,988 | 2 | 2 9 |
| Salford | 350,000 | 116 | 2 7 |
| Shipley | 26,800 | 40 | 3 4 |
| Shoreditch | 118,705 | 322 | 3 0 |
| Shrewsbury | 28,395 | 50 | 3 0 |
| Sleaford | 5,467 | 16 | 3 4 |
| Southampton | 100,000 | 75 | 2 10* |
| Southport | 68,000 | 69 | 2/4, 2/9, and 2/11 |
| South Shields | 165,000 | 91 | 2 10 |
| Southwark | 205,180 | 90 | 2 0 |
| Stafford | 22,532 | 8 | 2/10 and 2/- |
| Stepney | 298,600 | 331 | 2 6 |
| Stirling | 18,400 | 60 | 2 10 |
| Stockport | 94,422 | 41 | 2 4 |
| Stockton-on-Tees | 51,478 | 44 | 2 3 |
| Stretford | 33,000 | 94 | 2 9 |
| Sunderland | 158 877 | 165 | 2 0* |
| Sutton Coldfield | 17,500 | 14 | 1/11 to 2/6 |
| Swansea | 94,505 | 63 | 3 0 |
| Taunton | 20,000 | 72 | 3 6 |
| Tonbridge | 12,736 | 18 | 3 0 |
| Torquay | 33,800 | 52 | 3 0 |
| Tunbridge Wells | 35 000 | 81 | 3 0 |
| Tynemouth | 51,514 | 12 | 2 2 |
| Victoria Embankment | — | 150 | — |
| Wakefield | 41,413 | 58 | 2 6 |
| Wallasey | 56,000 | 61 | 2 9 |
| Walsall | 86,430 | 19 | 2 6 |
| Walthamstow | 110,000 | 94 | 3 8 |
| Warrington | 67,000 | 31 | 2 6 |
| Watford | 35,000 | 5 | 3 1 |
| West Bromwich | 65,172 | 81 | 1/6 to 2/9 |
| West Ham | 275,308 | 167 | 2 10 |
| West Hartlepool | 63 000 | 39 | 2 2* |
| Weymouth | 19,831 | 40 | 3 6 |
| Whitby | 11,755 | 31 | 3 9 |
| Whitehaven | 19,324 | 9 | 3 8 |
| Wigan | 60,764 | 22 | 2 10 |
| Willesden | 131,930 | 140 | 2 5 |
| Wimbledon | 45,000 | 6 | 3 8 |
| Wolverhampton | 94 187 | 55 | 2 6 |
| Woolwich | 122 229 | 81 | 2 1 |
| Worcester | 43,000 | 57 | 2 3 |
| Worksop | 16 112 | 35 | 3 6 |
| Worthing | 26,000 | 117 | 3 6 |
| Wrexham | 15,000 | 34 | 2 9 |
| Yarmouth | 51,000 | 98 | 3 4* |
| York | 81,000 | 63 | 2 0 |
| *Companies.* | | | |
| Aberystwyth | 19 000 | 29 | 4/3 to 3/10 |
| Alloa | 13,000 | 20 | 2 2 |
| Banbury | 12,967 | 2 | 3 0 |
| Barnet | 8,000 | 14 | 3 10 |
| Berwick | 13,467 | 16 | 3 9* |
| Bournemouth | 59 000 | 110 | 3 0 |
| Cambridge | 45,000 | 1 | 3 0 |
| Carlow | 9,962 | 13 | 5 6 |
| Charing Cross and Strand Company | — | 113 | 3 0 |
| Chelmsford | 12,581 | 21 | 3 9 |
| City of London | — | 508 | — |
| Coatbridge | — | 22 | 2 2 |
| Cork | 90,000 | 85 | 3 4 |
| Cromer | 3,781 | 10 | 4 2 |
| Dartmouth | 6,579 | 10 | 3 9 |
| Fleetwood | 21,000 | 12 | 3 6 |
| Folkestone | 30,000 | 66 | 3 4 |
| Fort William | 3,000 | 6 | — |
| Godalming | 10,000 | 10 | 4 3 |
| Guildford | 15,000 | 1 | 2 10 |
| Hamilton | — | 65 | 2 1 |
| Hartlepool | 22 737 | 40 | — |
| Hawick | 17,303 | 12 | 2 8 |
| Hereford | 9,322 | 10 | 3 7 |
| Kensington | — | 44 | 3 0 |
| Lymington | 4,551 | 2 | 4 6 |
| Lynton | 3,000 | 1 | — |
| Melton Mowbray | 7,454 | 8 | 3 5* |
| Metropolitan Electric Supply Company | — | 6 | 3 0 |
| Montrose | 14,000 | 20 | 4 4 |
| Newport (Isle of Wight) | 10,911 | 30 | 3 9 |
| Northallerton | 4 009 | 31 | 3 6 |
| Oxford | 50,000 | 32 | 3 0 |
| Pontypool | 6 100 | 6 | 3 9 |
| Prescot | 20 599 | 23 | 3/4 to 4/- |
| Preston | 119,000 | 45 | 3 5½* |
| Queenstown | 10,000 | 18 | 4 2 |
| Redruth | — | 2 | 4 9 |
| St. James's and Pall Mall Company | — | 68 | 3 0 |
| Sandown | 8,650 | 15 | 4 0 |
| South London Company | — | 25 | 2 0 |
| Trafford | — | 50 | — |
| Ventnor | 7,000 | 24 | 4 6 |
| Windsor and Eton | 19,000 | 37 | 3 10 |
| High Wycombe | 23,000 | 11 | 4 2* |
| Yale | — | 22 | 4 2 |

Number of lamps by corporations, 17,209; number of lamps by companies, 1,716—total, 18 925.

* Less discount.

The report concludes with the description of what it is proposed should be done at Sheffield.

# LEGAL INTELLIGENCE.

## AN ELECTRIC CURRENT ACCOUNT.

### A Novel Defence.

In the City of London Court on Thursday, before Mr. Registrar Wild, a claim was made by the City of London Electric Lighting Company, Limited, of 1, Great Winchester-street, against William Henry Stoneman, of 45, Queen Victoria street, E.C., for the sum of 10s. 2d., balance of account for electric current supplied. The defendant paid a sum of 4s. 4d. into court, and said he was not indebted to the plaintiffs for the balance of their claim. He said upon his commencing to be supplied with current by the plaintiffs he paid a deposit of £1, upon which sum he was entitled to interest. The deposit was held by the plaintiffs for the purpose of meeting any unsatisfied account. The plaintiffs' representative put in an account which, he said, showed the amounts due and the dates of payments made by the defendant, and said that by Act of Parliament, when a customer entered into a contract with them for the supply of current, he had to deposit a sum of £1, and when an amount became due the plaintiff company's contention was that they were entitled to appropriate the deposit or part of it, after which appropriation the amount left ceased to be a deposit. The Registrar said he was inclined to think that the amount deposited by the customer was to be treated as a deposit for the whole period, and was to continue as such until the plaintiffs gave notice that it was no longer to be treated as a deposit. The deposit was made to secure the plaintiffs against bad debts, and if they got security they must pay for it in the shape of interest, which was provided for by the Act of Parliament. When the time came for the plaintiffs to strike a balance, and there was money due to the plaintiffs, then they were entitled to give credit for the deposit and sue for the balance. The plaintiffs' representative said their contention was that they had an exercisable lien upon the deposit while the account was running. The Registrar said that the Act of Parliament said that "the company shall pay £4 per cent. per annum during the time it (the deposit) remains in their hands." The plaintiffs' representative said that in 1902 they regarded the plaintiffs' contract as closed, but they gave no notice that they considered the deposit as closed. They were of opinion that the matter settled itself automatically. The Registrar said he saw there was a further payment by the defendant at that time of £1. This sum, the plaintiff's representative said, they regarded as a reinstatement of the £1 deposit. The Registrar said he was of opinion that the money had remained in the hands of the plaintiffs from the commencement as a deposit, and remained so still, and the defendant was entitled to be paid interest upon that deposit. Directly the plaintiffs chose to put an end to the contract and disconnected the customer, the plaintiffs could not get out of payment of the interest while they held the sovereign. The plaintiffs' representative said their original claim was £1. 10s. 2d., then they credited the defendant with £1, leaving the 10s. 2d. Under the Act of Parliament they were entitled to make a charge of 2s. 6d., the cost of disconnecting a customer by reason of the non-payment of his account. The defendant said he did not consider he was in arrear. The account at the time was only £1, and the plaintiffs had £1 in hand of his. The Registrar said that, strictly speaking, the plaintiffs might then have put an end to the contract, the defendant owing money and being in default. The plaintiffs' representative said they had waived the charge for the first disconnection in 1902. The Registrar was of opinion that the defendant was clearly liable to pay the disconnecting charge of 2s. 6d. The defendant was entitled to a sum of 3s. 4d. against the plaintiffs for interest, and there would be judgment against him for 2s. 6d. The plaintiffs' representative said that it was a novel defence for the defendant to raise at the last moment. All their other customers had accepted their version of the reading of the Act of Parliament, and they thought under the circumstances they should be allowed some expenses against the defendant. The Registrar said he could not allow the plaintiffs any costs. He had given them his version of the reading of the Act of Parliament. The case might

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be an important one to them, and he should be happy to facilitate them in any way they liked.

# COMPANIES' MEETINGS AND REPORTS

## CHADBURN'S (SHIP) TELEGRAPH.

The seventh annual meeting of shareholders in Chadburn's (Ship) Telegraph Company, Limited, was held on Friday last at Liverpool, Mr. William Chadburn (the chairman) presiding. Particulars of the report appeared in our last week's issue.

The CHAIRMAN, in moving the adoption of the report and accounts, said that the new freehold works in Cyprus-road, Bootle, had been fully equipped with additional tools and also with modern machinery. The concentration of all the manufacturing work under one roof had resulted in greater efficiency and economy of working.

Mr. T. R PENNINGTON seconded the motion, which was carried unanimously.

A sum of £100 was voted to the directors, other than the managing director, for their services during the year.

Messrs. T. Bassnett and T. R. Pennington were re-elected directors, and Messrs. Pannell and Co. as auditors.

A vote of thanks to the directors and staff for their services during the year was passed.

An extraordinary meeting was then held, when the following resolutions were submitted: 1. "That the articles of association of the Company be altered by substituting for Article 48 the following article—namely: 'The remuneration of the directors shall be determined by the Company in general meeting, and such remuneration shall be divided among them in such proportions and manner as the Company shall direct, or, in default of such direction, as the directors shall determine. In addition to such remuneration, each director shall be paid out of the funds of the Company all expenses incurred by him when absent from his place of residence on the business of the Company, including travelling and hotel expenses incurred by him in attending meetings of the directors or of the Company.'" (2) "That all payments hitherto made to any of the directors on account of the expenses incurred by them in attending meeting of the directors or of the Company be and they are hereby confirmed."

Mr. A. W. BIRKETT, solicitor to the Company, having explained briefly the circumstances under which the resolutions were deemed desirable, they were moved by the CHAIRMAN, and duly seconded, and carried unanimously.

## KALGOORLIE AMALGAMATED.

An extraordinary general meeting of this Company was held last week at the Great Eastern Hotel, under the presidency of Mr. M. F. Armstrong, for the purpose of appointing further directors to make up the minimum number of directors prescribed by the articles of association.

The CHAIRMAN stated that he had just received a circular outlining a scheme of reconstruction of the Company, but, so far, the Board had had no opportunity of considering it. If it were the desire of the shareholders, a meeting would be called for the purpose of considering the whole position of the Company.

After a brief discussion it was agreed to adjourn the meeting for a month.

## DUDLEY, STOURBRIDGE, AND DISTRICT ELECTRIC TRACTION.

The report of this Company for 1904 states that gross receipts for the year amounted to £46,383, and expenditure to £35,252, including £500 placed to depreciation and renewals account, interest on debentures, cost of repairs and maintenance, and all other expenses properly chargeable against revenue, leaving a balance of £10,031. After deducting the dividend on the preference shares accrued to Dec. 31, 1904, and adding the balance of £343 brought forward from the last account, there remains an amount available for allocation of £5,374. The directors recommend that there be placed to reserve (sinking) fund £2,100, and after paying a dividend at the rate of 3 per cent. per annum on the ordinary shares, there remains to be carried forward £274. There has been added to capital account during the year £6,483, expenditure on additional cables and other necessary works. The negotiations between the Birmingham and Midland Tramways, Limited, and all other companies owning and working tramways in the district for joint working under one management referred to in the last annual report have been concluded, and since July 1 last this Company's undertaking has been worked as an integral part of the whole system of over 90 miles of tramways in the Birmingham district. Considerable economies, it is anticipated, will accrue from this arrangement, and the possibilities of through running and interchange of traffic should result in increasing the Company's revenue. A further amount of £25,000 4½ per cent. debenture stock has been issued since the closing of the account for the year, and the liabilities to the Birmingham and Midland Tramways, Limited, have been reduced.

## BABCOCK AND WILCOX.

An extraordinary general meeting of this Company was held last week, at Cannon-street Hotel, for the purpose of considering and, if thought fit, passing resolutions for altering paragraph 14 of Clause 97 of the articles of association, and for increasing the capital of the Company to £900,000 by the creation of 270,000 new ordinary shares of £1 each, to rank *pari passu* with the existing ordinary shares.

Mr. JOHN DEWRANCE presided, and stated that the directors proposed to make a distribution of 10s. per share, and to ask them to subscribe a corresponding amount in the new issue of shares, which would be allotted to them in the proportion of one new share for every two ordinary shares held.

Mr. C. A. KNIGHT seconded the resolutions, which were carried unanimously.

## ELECTRICITY SUPPLY FOR SPAIN.

The report of the Electricity Supply Company for Spain, Limited, for 1904, to be submitted at the meeting on the 28 h inst., states that the rent of 1,100,000 pesetas, receivable under the lease of the Company's undertaking in Madrid to the Compañia General Madrilena de Electricidad, has been regularly paid to this Company's bankers, and has been remitted to London, except such sums as were retained for interest and other payments in Madrid. Owing to the high exchange ruling during the greater part of the year, the rent has only realised £31,669, as against £32,122 in 1903. The average exchange for the year 1904 was 34·65 pesetas to the £, as compared with 34·25 pesetas in 1903 and 34·10 pesetas in 1902. The rate, however, fell considerably in the month of December, and has since been more favourable than for some time past. Including interest on investments and deposits and other receipts, the gross revenue for the year amounted to £32,359. After deducting debenture interest, interest on loans, income tax, and all other charges, amounting to £17,524, there remains a net sum of £14,834. Of this, £13,337 has been applied to the redemption of debentures, leaving £1,497, which, with £5,043 brought forward from last year, makes a balance on profit and loss account of £6,540, which the directors propose to carry forward. The appropriation of £13,337 out of the year's profits to the redemption of debentures is in accordance with the policy previously approved by the shareholders of devoting the money, which would otherwise be available for dividends, to paying off the debenture debt of the Company. At the same time, this is unavoidable, as, owing to the war, the state of the money market renders it inadvisable to make an issue of consolidated debentures. The liabilities in Spain have been reduced during the year by about £4,600, and are now reduced to practically the amount represented by the unissued preference shares. The sum of £761 has been charged to revenue in respect of the settlement of Government and municipal claims for arrears of taxes for the years 1892 to 1900. Debentures amounting to £13,400 have been paid off during the year. This includes £300 first mortgage debentures purchased by the Company and held as an investment; but in view of a recent legal decision that a company cannot acquire its own debentures without extinguishing the security, they have been written off this year in the books of the Company. The amount of the debentures to be redeemed during 1905 is £14,100. The investment in Spanish Government 5 per cent. amortisable stock has been sold, and has realised a small profit.

# NEW COMPANIES REGISTERED.

**Catania Electric Lighting and Tramways Company, Limited.** Capital, £1,000 in £1 shares. Object: to construct or acquire tramways, electric lighting works, plant, and machinery in Sicily or elsewhere, and to carry on the business of tramway proprietors, suppliers of electric light, electrical engineers, etc.

### Liens Registered.

**South African Lighting Association, Limited, London, E.C.**—Lien registered June 2, for £1,800 4½ per cent. debentures (renewals), part of £20,000 issued; no trustees; charged on the undertaking and all the real and personal property.

**Stanley Electric Carriage Company, Limited, Chelsea, S.W.**—Debenture registered June 3, for £625; holder, Major-General E. H. Sartorius, V.C., C.B., Old Swan House, Chelsea-embankment S.W; charged on the undertaking and all the property, present and future including the uncalled capital.

**Auto-Electric Rifle and Target Company, Limited.**—Issue on May 18 of £50 debentures, part of a series created Dec. 5, 1904, to secure £5,000, charged on the company's undertaking and property, present and future. No trustees. Total amount previously issued of same series, £2,900.

# APPOINTMENTS VACANT.

**Assistant** in installation department. See advertisement.

**Shift-Engineer Foreman.** Applications to Box S 92, *Electrical Engineer* Office. See advertisement.

**Electrical Engineer**, Handsworth Urban District Council. Salary, £350 per annum. Applications by June 30.

**Principal** of the Paddington Technical Institute, Saltram-crescent, W. Commencing salary, £500 a year. Applications to the London County Council by July 3. See advertisement.

**Various.**—Northampton Institute, St. John-street-road, London, E.C. Mechanical engineering department: drawing office and lecture assistant, full time, £120; pattern maker and instructor in pattern making, full time, £120; junior drawing office instructor, full time, £100; laboratory demonstrator for the engineering laboratories, full time; junior technical assistant full time; evening instructor in automobile work, two evenings per week. Electrical engineering department: junior technical assistant, full time; junior lecture assistant, full time. Applications by June 29. See advertisement in last issue.

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## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Fregenal (Spain).**—The Municipality require tenders for public electric lighting. Tenders by July 3.

**Mazarron (Spain).**—The Municipality require tenders for public electric lighting. Tenders by July 5.

**Liria (Spain).**—The Municipality require tenders for public and private electric lighting. No date fixed.

**La Rambla (Province of Cordoba, Spain).**—The Municipality require tenders for public electric lighting. Tenders by July 1.

**Fulham.**—The Council invite tenders for extension of cables, feeders, etc. Tenders by noon on July 12. See advertisement.

**Cataquoxes (Spain).**—The Municipal Electric Light and Power Company require tenders for electric plant. Tenders by July 1.

**Orense.**—The Telegraph Department of Madrid require tenders for installation of municipal telephones at Orense. Tenders by 28th inst.

**Orense.**—The Telegraph Department at Madrid require tenders for installation and working for 20 years of telegraphs in Orense. Tenders by June 27.

**Leigh (Lancs.).**—Tenders are invited for the supply of one water-tube boiler for the electricity department. Tenders by July 1. See advertisement in last issue.

**Rosario de Santa Fe Argentine.**—The Municipality require tenders for the construction and working of electric tramways in the town. Tenders by July 30.

**Talavara de la Reina (Prov. Toledo).**—The Telegraph Department of Madrid require tenders for installation of municipal telephones at Talavara. Tenders by 30th inst.

**London.**—The London County Council invite tenders for two low-tension feeder switchboards. Tenders by 10 a.m. on July 11. Full particulars in advertisement columns.

**Flushing.**—Tenders are required for the construction of the permanent way for the electric railway, Middelburg-Vlissingen-Domburg. Tenders to the Walcheren Railways Company, Flushing, by June 24.

**Burton-upon-Trent.**—The Corporation invite tenders for the electrical equipment on the overhead system of about 1¾ miles of tramway (Contract No. 10). Tenders by noon on July 7. See advertisement.

**Brighton.**—The Town Council invite tenders for supply, erection, and maintenance of a 260-cell storage battery, having a capacity of 1,000 ampere-hours, at their power station, Southwick. Tenders by 10 a.m. on July 3.

**Stepney.**—The Electricity Committee invite tenders for the supply during the year ending June 30, 1906, of ampere-hour meters, demand indicators, and arc lamp carbons. Tenders by noon on 28th inst. See advertisement in last issue.

**Rotherham.**—The Corporation invite tenders for the supply and delivery of cable and meters according to their requirements between July 1, 1905 and June 30, 1906. Tenders by 25th inst. See advertisement in last issue.

**Stalybridge.**—The Stalybridge, Hyde, Mossley, and Dukinfield Tramway and Electricity Board require tenders for the supply, delivery, and erection at the Stalybridge sub-station of a 400-kw. motor-generator, together with the necessary switchgear for same.

**London, W.**—The Great Western Railway Company invite tenders for the supply, delivery, and erection of the following plant in connection with their electricity generating station at Park Royal: (Specification 18) pipework, feed and other pumps, tanks, feed heaters, water-softening and oil-separating plant, etc. Tenders by 10 a.m. on 26th inst.

### RESULTS OF TENDERS.

**Johannesburg.**—The Corporation have awarded Dick, Kerr, and Co., Limited, the contract for 30 miles of overhead equipment.

**Hammersmith.**—The Board of Guardians have accepted the tenders of W. J. Fryer and Co., of Bravington-road, Paddington, for electric wiring at £4,580, and for transforming apparatus at £1,061.

**Bracebridge (near Lincoln).**—The tender of C. Pullan, 57, King's-arcade, Bradford, has been accepted for the installation of fire alarms, telephones, bells, and tell-tale clocks at the Bracebridge Asylum.

**Walsall.**—The Town Council have accepted the tender of Messrs. Callender, Limited, for laying the wires for the extensions in Park-street and Cross-street and a cable in Buchanan-road and Portland-street at a cost of £254.

**Alternators.**—Messrs. Johnson and Phillips report orders for 350 kw. three-phase alternator, 96 r.p.m., for supplying power in large works in the Midlands; a 35-kw. combined set, direct-current, for power in a manufactory in Ireland; also two 200-kw. three-phase alternators, 120 r.p.m., for colliery.

**St. Pancras.**—The tender of the Sloan Electrical Company for the supply of carbons, etc., for the sum of £476. 19s., has been accepted. Also the tender of Facer and Co. for the supply of coal to the Regent's Park and King's-road power stations for a period of 12 months from July 1, 1905. The following quotations for the supply of cables for laying feeder mains from Tavistock-place sub-station to the Somers Town district have been received:

| | | | |
|---|---|---|---|
| Western Electric Company * | £1,265 | 14 | 8 |
| British Insulated and Helsby Cables | 1,293 | 17 | 8 |
| Siemens Bros. and Co. | 1,318 | 13 | 6 |
| Callender's Cable and Construction Company | 1,332 | 18 | 0 |
| W. F. Dennis and Co. | 1,343 | 14 | 0 |
| Henley's Telegraph Works Company | 1,361 | 8 | 0 |
| Electrical Company | 1,360 | 3 | 1 |

* Recommended for acceptance.

# BUSINESS NOTES.

## TRACTION.

**Mansfield.**—A successful trial trip has been run on the Chesterfield-road section.

**Hull.**—The Corporation have appointed a deputation of five to attend the tramways exhibition next month.

**Colchester.**—Tenders are to be invited for the construction of the track in connection with the extension along Military-road.

**Limerick.**—The East Clare Railway Company, Limited, have published notice of their intention to apply for sanction to construct a tramway in Limerick.

**Rhondda.**—The Board of Trade have held an enquiry into the suggested agreement of the Rhondda Urban District Council for the leasing of the proposed tramways to a syndicate.

**Glen Valley.**—The Chirk Rural District Council have decided to support the application of the tramway company for permission to increase the speed of their cars to 15 miles an hour.

**St. Helens.**—The strike of tram drivers and conductors continues, though the company are gradually introducing additional cars on the various sections, and a regular service is now maintained throughout the day.

**Halifax.**—The Corporation have decided to construct the line, referred to in our last week's issue, from Salterhebble to Calder at an estimated cost of £6,400. The line will be a double one, except for one short length.

**Metropolitan Railway.**—The test match at Lord's last week provided the company with an opportunity, which was utilised, of demonstrating the promptitude with which, as the result of electrification, they can cope with extra traffic.

**Newport.**—As one of the cars was proceeding round Clifton-place the other day it commenced to move backwards. After proceeding some 10ft. or 15ft. it came to a standstill, the automatic running-back brake preventer having come into action.

**New South Wales.**—The earnings of the tramways for the quarter ending March 31 show a decrease of £4,623, and the expenditure a decrease of £2,653. The tram miles run show a decrease of 94,188, and 830,119 fewer passengers were carried.

**North Dublin.**—The Rural District Council have passed a resolution to the effect that the "time has arrived for the tramway company to give facilities for travelling from the city to outlying districts, as Cabra, Castleknock, and Blanchardstown."

**Maidstone.**—To-day has been fixed for the Board of Trade enquiry to consider the Maidstone Light Railways Extension Order, recently granted by the Light Railway Commissioners. Several traders will attend to give evidence in opposition to the order.

**Batley.**—A cheque for £20,000 was signed on Monday at a meeting of the Electric Traction Committee of the Batley Corporation for the purchase of so much of the present steam tramway system as is within the borough. The Corporation will later sell their holding to the British Electric Traction Company, who are to electrify the system.

**Light Railways.**—The Board of Trade has confirmed the following order made by the Light Railway Commissioners: North Wales Narrow-Gauge Railways (Light Railway) Order, 1905, authorising the working and maintenance of the Moel Tryfan undertaking of the North Wales Narrow-Gauge Railway Company as a light railway, and other matters.

**Walsall.**—The Corporation have adopted the recommendation, referred to in our last week's issue, in regard to running over the Wolverhampton and District Electric Traction Company's line to the Market-place, Willenhall. The Corporation will extend their terminus at Willenhall so as to form a junction with the company's system, the estimated cost being £200.

**Belfast.**—Nearly half of the work in connection with the reconstruction of the tramway system is now completed so far as the relaying of the lines is concerned. The York-street section is almost finished, and the lines are being put down on the various roads in the section. This week the reconstruction of the Cavehill and Whitewell tramway was commenced by Messrs. J. G. White and Co.'s men.

**Colombo.**—The new type of car recently got out by the tramway company is eight-wheeled, mounted on bogie trucks, and will seat 54 passengers. The most noticeable improvement is said to be that for keeping out the rain without in any way interfering with the ventilation of the car. Another striking feature is the automatic lifeguard for picking up objects between the rails.—*Indian Engineering.*

**Glasgow.**—The Corporation tramways continue to show a flourishing record. There is a net profit of £93,257 on the past year's working. The gross revenue was £768,000, and the expenditure £387,000, while the sum of £153,000 was allowed for depreciation. Interest and other charges absorb £134,000, leaving over £93,000 net profit. Of this £68,000 is to be written off for special depreciation, and the balance carried to reserve.

**Oxford.**—At a meeting of the inhabitants the following resolution was carried unanimously: "That in the interests of the ratepayers it is expedient to postpone the purchase of the present tramway company's undertaking until the City Council has given to the public every information as to the best system of public conveyances that can be adopted to replace it and reliable details of the approximate cost of alternate schemes."

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**Bournemouth.**—The Corporation have now taken over the Poole and District Electric Traction Company's lines, the sum of over £117,000 being paid for the undertaking. The construction of a new line from Bournemouth to Christchurch is being rapidly proceeded with, and before the end of the summer season it is expected there will be a service of trams from Poole to Christchurch running right through the centre of Bournemouth.

**Hythe.**—The Town Council have received a letter from Mr. Stephen Sellon stating that he is prepared to submited his proposals in connection with a tramway service through the town, and that he should be pleased to have an interview with the Council. An interview is to be given to Mr. Sellon after a deputation of the Corporation has attended the conference of the municipalities of the neighbourhood on the question of tramways.

**Kirkcaldy.**—The annual tramway report of the borough electrical engineer states that there is a net deficit of £1,575. 2s. 11d after paying all interest on sinking fund and depreciation charges. From this must be deducted a credit balance of £50. 13s. 2d. carried forward from last year. The traffic receipts advanced from £9,934. 18s. 7d. to £11,752. 19s. 9d., an increase of 18 per cent. The total number of passengers carried showed an increase of 31 per cent. To meet the deficiency the electrical engineer proposes a readjustment of fares.

**Carthagena and Herrerias Tramways.**—Mr. E M. Underdown, K.C., presiding at the meeting of this company, said that they had been unable to declare a dividend last year, and he could not say that the business had increased to an extent that would enable them to do so this year; but they had an accumulation of money carried over, and that enabled them to divide 2 per cent., or 4s. per share. Their prospects were more favourable. They had a very fair increase of business up to the end of May, amounting to nearly £2,000, and that had been earned without any perceptible increase in working expenses. The report was adopted.

**Middlesex Light Railways.**—Sir Francis Cory Wright, Bart., chairman of the County Light Railways and Tramways, on June 7 opened a further section of the County Council's scheme of light railways and tramways, extending from the Archway Tavern, Islington, to Whetstone, where it will eventually join the light railway proposed to High Barnet. About 10 track miles is the length of the section, which has been equipped on the overhead system. The double-deck cars are similar in pattern to those already running on the other lines of the county. Mr. H. T. Wakelam, M.I.C.E, the county engineer, designed and supervised the work.

**London United Tramways.**—The London United Tramways offer £300,000 4 per cent. first mortgage debenture stock, forming part of the authorised issue of the 4 per cent. debenture stock of the company, at the price of £98 per cent., to existing stockholders of the company only. The money is sought for further capital outlay on the construction of tramways, and the amount is fixed in accordance with the trust deed, which provides that any issue beyond the original issue of £825,000 shall only be made to the extent of 50 per cent. of such outlay after an equal amount shall have been first provided by calling up capital or from other funds of the company.

**Ipswich.**—The report for the past year shows that the passengers numbered 5,693,680, the car miles run 692,310, and the receipts from passengers, parcels, etc., £23,327. The average speed obtained, including standing times at termini, was 5·79 miles per hour. The number of parcels dealt with has been 639, yielding £6. 0s. 9d., the expenses of this department being £29. 13s. The number of parcels is slowly increasing. The rolling-stock now consists of 36 double-deck cars, each seating 50 passengers. The working expenses total £18,868, which the revenue exceeds by £4,521, but interest requires £4,079, and for repayment of loan £1,264 is needed. This leaves an excess of expenditure over income for the year of £822. 6s. 9d., and there was also a deficit at March 31, 1904, of £1,919. The Corporation have adopted the report.

**Folkestone.**—A petition is to be presented to the Board of Trade by the Corporation for sanction to an extension of time for the construction of the tramways. The Corporation now has under consideration the offers of two companies to construct tramways from the harbour through Cheriton to Shorncliffe Camp and Hythe. The Traction and Powers Securities Company proposes to put down the overhead system, and the National Electric Construction Company specifies the Dolter surface-contact plan. Each company offers to pay the Town Council £15,000 towards the expense which it has incurred in widening Cheriton-road and £1,200 to reimburse the Corporation in regard to the cost incurred in securing a provisional order to construct its own tramways. Under that order there is an agreement with the Earl of Radnor not to adopt the trolley system, and his lordship has refused to waive his objection.

**London and District Motor Omnibus Co.**—At the meeting of this company, Mr. A. A. Campbell Swinton, who presided, said that a very careful investigation as to the best type of motor omnibuses had been made, and in this connection the Board had had to keep in view what could be obtainable within a reasonable time, and which was the most economical vehicle to be had. A first order had been given for a number of motor omnibuses, and the greater portion of them would be built in this country. In order to expedite delivery, certain portions of the machinery had to be made in Germany. It was hoped that some of the vehicles would be running early in August. All further orders would be entirely placed in this country. The Board had received information about the takings of various motor omnibuses now running to the effect that they were exceedingly satisfactory. If the company's omnibuses did equally well their success was assured.

**Dundee.**—One member of the Corporation, undaunted by the result of the last *plébiscite*, which was adverse to Sunday running, proposes that another shall be taken. The accounts of the Corporation tramway department for the past year are of a satisfactory character. The receipts on all the routes, notwithstanding dull trade, exceeded the estimate. Some 12 million passengers were carried, which represents an increase of fully half a million on the preceding 12 months. The total earnings amounted to about £45,000. Deducting the working expenses, there remains a gross profit of £16,900. From this balance provision has to be made for interest, sinking fund, etc., absorbing about £11,000, and the balance of some £5,500 is to be allocated to renewal fund, depreciation, and suspense account. There will remain a surplus of £100 to be carried forward. The committee express satisfaction at the state of the finances, and the manager has been instructed to print and circulate details of the accounts for the information of members.

**Sunderland.**—The annual report of the Corporation tramways has just been issued. The report states that the permanent way, rolling-stock, and overhead lines are in an efficient condition. The receipts for the year ending March 31, 1905, were £64 293. The cars ran 1,495,685 miles, and carried 15,364 463 passengers. The figures for the previous year were: receipts, £62,506; passengers, 14,848 958; and miles run, 1 433,463. The gross profits were £24,727, as against £26,748, being 8 6 per cent. on the average capital outlay for the year. The decrease in gross profit is accounted for by an increase in rates, due to an increased assessment, and to the fact that the tramways are assessable in full for general district rate purposes, whereas previously they were assessed upon one-fourth, as is the case with light railways. The tramway department contributed £1,125 more in the shape of rates this year than last. The report draws attention to the fact that the receipts for the east-end route averaged 6d. per car mile. As the expenses of the whole system, including capital, depreciation, and renewal charges average 1·34 per car, while the car mileage on this section was 118,810 miles for the year, it is evident that the loss amounted approximately to £2 149 But for these facts there would have been a net balance of profit, after paying interest, sinking fund, and depreciation, of £3,822, which would have been appropriated to the relief of the rates as in former years. The report also states that several more covered-in double-deck cars will be available for the winter.

**Whitsuntide Receipts.**—The Whitsuntide holidays appear to have been something of a boom to the tramways in the North, where the weather was finer than that experienced in the Metropolis. The total receipts for the week from the Wolverhampton Corporation trams were £1,321. 8s. 4d., while no fewer than 258 684 passengers were carried. This result is the highest yet attained. During the week 60,000 more passengers were carried than in any previous week, and not a single accident happened to mar the record. Halfpenny fares appear to have been highly popular. At Leeds the returns from Saturday to Tuesday show an increase upon last year's takings on the corresponding days to the extent of £731. 19s. 4½d., the receipts this year totalling £5,551. It is calculated that something like 1,200,000 passengers were carried during the four days. At Bradford the receipts for the Tuesday constituted a record for one day. The total amount was approximately £1,450, as against £1,345 last year, and £1,439 on May 4 of last year, on the occasion of the Royal visit, which was the previous highest total. The receipts on Monday were £1,311, against £1,307 on the corresponding day of last year. For the two days the total receipts this year were £2,761, against £2,652 for the corresponding days of last year. At Huddersfield the receipts for the four days amounted to £1,391, an increase of £159. At Halifax the receipts on the Tuesday amounted to £653, as against £555 on the corresponding day last year. The receipts for Tuesday broke the record established on Monday, when the takings were £642, the previous highest being £614 on Whit Monday, 1903. At Sheffield the Corporation beat their Whit Monday record, the takings amounting to £1,157, against £1,096 last year.

**Tramway Fatalities.**—An enquiry was opened on Monday at the Bristol General Hospital into the circumstances attending the death of Benjamin Trelawney Coates, who was crushed between an electric car in Victoria-street, near the Neptune Statue. The deceased was driving a van in Victoria-street, and it appears that he attempted to cross the road in front of a car approaching the city. He evidently did not notice another car which was going towards Brislington until it crashed into the vehicle he was driving, causing him to be thrown between the metals, the car passing over and severely crushing Coates. Efforts were made to extricate the body, but it was 20 minutes before they were successful. The man was hastily driven to the General Hospital in the marine ambulance wagon, but on that institution being reached it was found that life was extinct. The solicitor for the company remarked that his clients wished to express their deep regret for the sad accident, and to add that they would give every possible assistance they could in making the enquiry a complete one.—An enquiry was held at Liverpool concerning the death of James Hinds, who expired from injuries sustained through a fall from one of the Corporation cars. A witness stated that the deceased, who seemed to be a steady man, boarded the car with about a dozen other men. When the car started there were four men on the platform. After proceeding about 50 yards, the car, in going round a curve, swayed, and deceased fell backwards off the platform. The conductor said that when the car started from the stopping station deceased was standing on the platform near the door with a pipe in his hand. He seemed to be undecided whether to go upstairs or inside, and while the turn was being made he toppled over into the road without attempting to save himself. The jury returned a verdict of "accidental death."

**Rating of Trams.**—The town clerk of Wakefield has addressed a letter to the various local authorities through whose areas the lines of the Wakefield and District Light Railway run, inviting support in a proposal to contest the refusal of the company to pay in full the district rate levied by the Corporation on the ground that they are entitled to be rated at one-fourth only by virtue of Section 211 of the Public Health Act, 1875. The Corporation contend that the light railway is not a railway within the meaning of the section, but if it be

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so, then the company are not occupiers of land used only as a railway (*vide* "Swansea Improvement and Tramway Company *v.* Swansea Urban Sanitary Authority, 1892," 1 Q.B., 351). The local authorities are invited to appoint representatives to attend a conference to discuss the matter at Wakefield Town Hall on the 23rd inst. At a meeting of the Swansea Corporation Finance Committee, the assistant solicitor read a letter from the Swansea Tramways Company in respect of the rating of the new sections of tramways constructed under the Light Railways Act, which provides that the basis of rating of light railways shall be to the extent of three-quarters of the general district rate. The Wakefield Corporation had written asking the Swansea Corporation to co-operate in fighting a test case under precisely similar circumstances to those that had arisen at Swansea, with a view to getting the question settled. The Chairman said the chairman and manager of the company had agreed to pay one-quarter of the general district rate pending the result of the test case, and undertaking to pay the full rate if the judgment went in favour of the Corporation. Mr. Tutton said it would be wise to join with Wakefield if a reasonable number of other towns joined in the common cause. The Chairman said they could adopt the principle, but not bind themselves until they were in receipt of further information, and this was agreed to.

**Edinburgh-Queensferry.**—At a meeting of the Lord Provost's Committee of the Edinburgh Town Council on Tuesday, the memorandum of agreement between the Corporation and the Edinburgh and Queensferry Tramway Company relative to the proposed tramway from Edinburgh to Queensferry was under consideration. It was agreed to recommend that permission should be refused to the company to take their tramway to Princes-street over the Dean Bridge, but a conditional approval was given to the proposal that the lines might go from the west end of Princes-street by Belford Bridge. The Town Council, however, it is understood, favour most the idea that the electric tramway should pass from the Queensferry-road down Comely Bank-road, and have the same terminus there as the Stockbridge cable car, by which passengers would be carried to and from the city. A question is under consideration whether the Town Council should not construct the section of electric car line from the Comely Bank terminus of the cable car to the city boundary at Blackhall, so as to save an outside company coming into the city at all. The memorandum of agreement, however, contemplates the company coming into the city. The fifth clause provides that the part of the undertaking within the city shall be executed by the promoters to the satisfaction of the Corporation or their engineer. The promoters are to keep in repair so much of the street as lies within their rails and 18in. on each side of them, and there is a clause protecting the drains, etc. The ninth clause gives the Corporation power to say what system of electrical traction is to be used; the tenth prohibits the company from erecting their power station within the city or of selling electric power or light within the city boundaries; and the eleventh clause contains powers of purchase by the Corporation of the tramways in whole or in part upon specified conditions. There are clauses also dealing with running powers, workmen's cars, etc., and the company are to be bound to carry passengers for three miles beyond the city boundary at 1d. a mile. A special meeting of the Town Council was fixed for yesterday to further consider the matter.

**Australia.**—We extract the following notes from the *New South Wales Budget*: Instructions have been received by Mr. L. Waxman, solicitor for Mr. A. E. Morgans, the promoter of the Essendon and Flemington (Victoria) electric tramway and electric lighting scheme, to place the necessary work in the hands of Messrs. Noyes Bros., of Queen-street, representing Messrs. J. G. White and Co., Limited, electrical engineers, London. Operations will be proceeded with immediately, and the power-house will be erected on a site purchased in Mount Alexander-road, on the property known as Glass's estate. The tramway will consist of two arms, diverging from the Flemington Bridge, one running past the Flemington racecourse to the Saltwater River, and the other along the Mount Alexander-road, past the Essendon Town Hall, to the junction of Bulla and Keilor roads. The cost of the whole work will be about £120,000. The machinery has been shipped, and the engineer in charge has left London for Australia. Mr. Bradford, electrical engineer, has furnished the Premier with his estimate of the proposed electric tramway from St. Kilda to Brighton, in length three miles. The estimate for the track is £18,965, and £4,750 for the cars—a total of £23,716, or £216 in excess of the amount authorised by Parliament. The Premier has given Mr. Bradford instructions to proceed. Speaking at the opening of the tramway from Hampton to Perseverance (Queensland), the Premier said that the Government were taking means to make land available, and one of the means of doing it was the construction of light lines of railway to districts where there were large areas of unalienated Crown lands. This was rather a new principle in railway construction. Hitherto it has been held that a railway must not be built until all the land was taken up and population had preceded it. There was no direct return secured from the land towards the cost of construction. It was undoubtedly true that the best of the lands in the coastal districts had passed into the hands of private owners, and if the Government built railways in a majority of cases it would be to lands with which the Crown had already parted, and from which they could get no direct return. He was trying the policy of building lines to districts where there were areas of Crown lands not available for settlement because it would not pay people to occupy them and transport the produce, say, 25 miles over black soil plains. The thing was to build the railway and arrange to get the price of the land and sufficient to pay for the railway. That was a sound policy. Even at the enhanced value the lands would be more valuable to the people taking them than if they selected otherwise.

**Grimsby.**—The following are particulars of the extensions agreed upon between the Corporation and the company, as described in a letter from the secretary of the company: (1) The company would be prepared to extend the present tramway line at the Park terminus for a distance of about 300 yards along Welholme-road West to a point near the Great Northern Railway level crossing. The line to be a single line with a passing place at Farebrother-street. (2) The company would be prepared to extend their present tramways in Hainton-street to Weelsby-lane, but would suggest that, in place of taking Hainton-avenue, the tramway should deviate into Welholme-road East and thence into Heneage-road. (3) The suggestion of a tramway extending from the Park terminus into Ainslie-street and Wintringham-road, and connecting up with the tramway in Hainton-street, could not be realised, as double-deck cars would not pass under the railway subway. (4) The company would be prepared at some future date to consider the desirabily of an extension in the direction of Stanley-street and Grant-Thorold Park, joining up with the Hainton-street tramways *via* Patrick-street East or other convenient thoroughfare. If the Sub-Highways Committee should regard this extension as one that should be considered at some period between the next three to five years, it appears to the directors that it would be unwise to construct the extension from Hainton-street into Heneage-road beyond, say, Patrick-street. If this were agreed, it would be feasible for the cars to run in a circle from the top of Freeman-street to Riby-square, *vid* Hainton-street, Heneage-road, Patrick-street, Durban-road, Stanley-street, and Cleethorpe-road. The company would be prepared to apply for powers and to construct the tramways under the following conditions: (1) No extra rent to be charged. (2) No increase in fares. (3) In the event of the Corporation exercising their right of purchase in 1921 of the existing tramways, the company shall sell and the Corporation shall purchase as a going concern, and according to the provisions of the Land Clauses Act, all extensions which may be constructed under the present agreement. After 21 years' tenure of such extension the Corporation may purchase pursuant to Section 43 of the Tramways Act. (4) The construction of the extensions to be according to the plans and specifications approved by the borough surveyor; the company will not, however, be required to pave the tracks of these extensions with granite setts in their entirety; 8in. setts shall be laid next the rail on each side, and the track between the setts shall be made up with tarred macadam. (5) The company will agree to the issue of transfer tickets from a point, say the Wheatsheaf, available for Hainton-street and Freeman-street. The Corporation have agreed to these terms, except that the Corporation require to exercise their right of purchase, under the Act of 1901, by valuation, and not as a going concern, that all the leases must expire in 1921, and that the whole of the track be paved with granite setts.

## LIGHTING AND GENERAL.

**Croydon.**—The electric light is to be installed in the borough hospital.

**Walsall.**—The total units generated in May were 118,313 and the output 114,456.

**Southall-Norwood.**—The Southall electric lighting order has received Royal assent.

**London and Rome.**—Telephonic communication has now been established between the post offices of London and Rome.

**Leigh.**—The Corporation have this year experienced a loss on their electricity works of £190, as against a profit of £336 last year.

**Hull.**—An enquiry was held yesterday into the application of the Corporation for a loan for further extensions at the electricity works.

**Warrington.**—An enquiry has been held into the application of the Town Council for sanction to borrow £4,150 for purposes of electric lighting.

**Kirkintilloch.**—An estimate has been prepared for carrying out an electric lighting scheme, and will come before a Town Council committee shortly.

**Bermondsey.**—The Council have decided to oppose the Administrative County of London and District Electric Power Company's Bill now before Parliament.

**Welshpool.**—The Council will consider next week the question of combining an electric generating station with the scheme for disposing of the refuse of the town.

**Goole.**—The Town Council have decided to put down an electric light and power station, and have appointed Mr. Walter Emmott, M.I.C.E., of Halifax, as their consulting engineer for the scheme.

**Calcutta Electric Supply Co.**—The number of units delivered to consumers during the four weeks ending May 26 were 369,487, compared with 304,350 in the corresponding four weeks of the preceding year.

**Bo'ness.**—There was a stormy meeting last night over a question of placing six arc lamps on the cross roads. Ex-Bailie Grant resigned the convenership of the Lighting Committee, which was, however, not accepted.

**Agency.**—The Union Cable Company, Limited, 23, College-hill, E.C., inform us that Messrs. James T. Donald and Co., Limited, 35, McAlpine-street, Glasgow, are now their sole representatives for Scotland for electric cables and wires.

**Sunderland.**—The Rural District Council have consented to an application of the County of Durham Electrical Power Distribution Company, Limited, to the Board of Trade for leave to carry overhead distributing mains under their order of 1904.

**Bath.**—The Baths Committee have instructed Mr. A. J. Taylor, architect, to obtain tenders for various works at the baths, estimated at £1,000, and including the provision of electric radiators to supersede gas stoves and other present means of heating.

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**Explosion.**—A small explosion occurred just before eight o'clock on Saturday morning in one of the distributing boxes belonging to the Metropolitan Electric Supply Company. The brigade extinguished the fire with sand.

**Ashton.**—Tenders are to be obtained for a new boiler and the disposal of the old ones and for a large additional generator. Plans are to be prepared for the extensions to the engine-room and alterations in the boiler-house. A loan of £3,157 is required.

**City and Guilds of London Institute.**—Particulars of the courses of instruction at the Institute's Central Technical College, Exhibition-road, S.W., and at the City and Guilds Technical College, Finsbury (Leonard-street, E.C.), will be found in another column.

**Telegraph Messengers.**—Major-General L. G. Oliphant, commanding the Home District, on Friday inspected in Hyde Park about 1,000 London postal telegraph messengers. The lads were accompanied by their bands, and a march past, physical drill to music, and various exercises were gone through.

**Richmond.**—The Richmond Electric Lighting Company will oppose the Administrative County of London Electric Supply Bill. It appears that the Council are bound to petition against the Bill under the agreement with the company, and the matter has been left to the General Purposes Committee.

**Alloa.**—The British Electric Plant Company have offered to accept £10,000 to terminate the agreement with the Town Council. The Town Council, however, have decided to cut off the street arc lamps, believing that £168 saving might be effected by the substitution of incandescent lamps in the place of arc lamps.

**Wilmslow.**—Electricity is to be introduced for street-lighting purposes by the Alderley Edge and Wilmslow Electric Supply Company. About 15 miles of cables are being put down, and about 210 lamps will be erected, many of which will be of 70 c.p., but lamps of 140 c.p. will be provided for certain points.

**Worthing.**—The Corporation have decided to apply for sanction to borrow the sum of £3,300 for electric lighting purposes. Mr. Porter, the Corporation electrical engineer, estimates that the total outlay during the period 1905 09 required to cope with the normal increase of business in the present area of supply is £10,847.

**Lowestoft.**—During May 10 new consumers were connected, representing 807 8-c.p. lamps. There are now 619 consumers, representing 31,573 8 c.p. lamps. As a result of last year's work the district rate profited by £1,500—or 3d. in the £ towards the reduction of the rate—a balance of £1,390 being kept as working capital.

**City of London Electric Lighting Co.**—The directors have declared the following dividends on account of the distribution for the year 1905: 6s. per share on the preference shares, 5s. per share on the ordinary shares. The dividends will be subject to the deduction of income tax, and will be payable on and after July 15 next.

**King's Lynn.**—The annual accounts of the electricity department for the year ending March 31 show a profit of £386 as compared with a profit of £486 for the previous year. The income amounted to £5,909. 18s. 1d. and the expenditure to £5,543, the latter item including £2,948 paid for interest and the reduction of capital account.

**City of Wellington Electric Light and Power Co.**—The directors have declared a dividend on the ordinary shares of the company at the rate of 10 per cent. per annum for the half year ended Dec. 31, 1904, making 7½ per cent. for the year, and after placing £5 000 to a reserve and contingency account, £2,044 remains to be carried forward.

**Electrical Standardising, Testing, and Training Institution.**—Prof. C. A. Carus-Wilson, M.A., M.I.E.E., commenced a special course of lectures to the senior students of the above institution on June 15 upon "Direct-Current Motor Construction." The lectures will be delivered on every subsequent Monday and Thursday for the remainder of the term.

**Newfoundland.**—It is proposed to tax the Anglo-American Telegraph Company for five cables at 4,000dol. each, regarding the other four cables as extensions of the former. Another cable company is seeking landing privileges on the island, and the Canadian Marconi Company have established three wireless stations on the island, which are to be taxed at 4,000dol. each.

**Northampton Institute Engineering Courses.**—At the entrance examination for the day courses in engineering to be held next September, the governing body of the institute has decided to offer three scholarships for open competition. These scholarships will give exemption from fees, amounting to £52, during the whole of the four years' course in mechanical or electrical engineering.

**Brentford.**—The Board of Trade, after considering the representations made on behalf of the District Council and the two companies, who had applied for provisional orders, have decided to dispense with the consent of the District Council in regard to the application of the Brentford Electric Supply Company, and to grant the order. The application by the Metropolitan Electric Supply Company was refused.

**Stock Exchange.**—The Stock Exchange Committee have ordered the undermentioned securities to be quoted in the official list: County of London Electric Supply Company's £250,000 4½ per cent second debenture stock, in lieu of the provisional certificates now quoted, together with a further issue of £150,000 4½ per cent. second debenture stock; Wellington (City of) Electric Light and Power Company's £75 000 5 per cent. registered first debentures of £50 each, Nos. 1 to 1,500.

**Leeds.**—The returns of the Electricity Committee for May show the largest increase hitherto recorded in the lamps and motors connected to the mains. Expressing the additional connections in the equivalent of 35-watt lamps, the greatest figure in any previous month was 10,561 in October, 1903. The corresponding figure for last month was 10,955. The increase is mainly accounted for by orders for the supply of power, the motors added during the month having a total capacity of 252 h.p.

**Kirkcaldy.**—The annual report on the electric lighting and tramway schemes show that on the electric lighting there is a net deficiency of £403 after paying all interest on the sinking fund charges, and to this must be added a debit balance last year of £42. The net revenue from private lighting increased by £388 last year. It is proposed to hold an electric household apparatus exhibition to advertise the undertaking.

**Coventry.**—The Electric Light Committee have considered the question of making arrangements for the maintenance of electric lamps on consumers' premises by the Corporation, with a view to minimising complaints as to inferior light caused by worn-out lamps. It is now proposed to undertake the maintenance and renewal of these lamps at the following rate of charges: 25 lamps and under, 2s. 6d. per quarter; over 25 and under 50, 4s. 6d.; over 50 and under 75, 6s. 6d.; over 75 and under 100, 8s. 6d.; over 100, 8s. per 100.

**Lincoln.**—The accounts of the electricity works and tramways undertaking for last year show a net profit of £1,161, and a balance at credit of £254. The total capital expenditure was £51,333 and the debt on the undertaking was £44,904. The tramways undertaking showed a gross profit for the nine months of £967, and a net profit of £241. The traffic receipts were £2,759, as compared with £2 869 for the corresponding period of the previous year. The total capital expenditure on the undertaking had been £16,115 up to March 31.

**Handsworth.**—The public and private electric lighting scheme is rapidly approaching completion. The cables are laid in all the scheduled area, the columns are nearly all erected, and the lamps themselves will shortly be fixed. The chimney shaft at the generating station in Piers-road is not quite completed, but the engines and the switchboard are erected and being connected up. The charge for current will be 6d. per unit for the first 100 units per quarter, and 4d. after. Churches and chapels will be supplied at a uniform rate of 4d. per unit.

**Islington.**—The Borough Council have decided upon the extension of generating plant at the electric lighting station, as follows: one 1,500-kw. turbo-alternator, including exciter, condenser, pumps, etc., £9,000; foundations for above, £250; steam-pipes, hot-feed apparatus, etc., £1,500; one cooling tower capable of dealing with water for above, £3,750; motors, fans, piping, etc., £500; contingencies, £500—total, £15,500. It has also been decided to apply for power to borrow £632 for the erection of additional buildings at the rear of the disinfection station in Seven Sisters-road.

**Southport.**—The year's working of the Corporation's electricity department shows a net profit of £3,355. The total revenue amounted to £22,583 and the gross profit to £14,771. Interest and sinking fund absorbed £11,415. The amount already paid in reduction of debt amounts to £32,878. The surplus has been dealt with as follows: in aid of rates, £2 500; rates' expense account, £284; and balance and profit and loss account, £570. For the next financial year £2,500 has been promised in aid of the rates. A sub-committee has been appointed with power to approve a plan and accept a tender for galvanised store sheds at the Eastbank-street yard.

**New Issues.**—The Oriental Telephone and Electric Company, Limited, are issuing £100,000 of 4 per cent. redeemable debenture stock at the price of £92 per cent. for the purposes of providing the cost of converting the company's lines to metallic circuits, of extending and developing its telephone and electrical business, and of assisting the subsidiary companies so far as they may require financial assistance. The Electric Supply Company of Victoria, Limited, are issuing £160,000 of 5 per cent. first mortgage debenture stock for further expenditure on the electric lighting, power, and tramway concessions for the cities of Ballarat and Bendigo in the State of Victoria.

**Louth.**—The Town Council are raising £17 000 in respect of the installation of electric light within the borough. Messrs. Hancock and Dykes, the consulting engineers, propose in the first instance to put down two vertical oil-engines at a cost of £1,950 each, coupled to a 75-kw. dynamo, and a battery of accumulators. In those streets in which electric light mains are laid it is proposed to convert the present gas street lamps to electric lamps, fitted with arc and incandescent lamps for after-midnight service. The estimated cost of the works shows the necessary immediate outlay to amount to £12,230, while prospective expenses to be incurred during the first two years bring the estimated cost up to £16,980.

**Iceland Cable.**—Captain J. Boyle, the British Consul at Copenhagen, in his report to the Foreign Office for 1904, states that during September negotiations were concluded between the Danish Government and the Great Northern Telegraph Company for the establishment of telegraphic cable communication with Iceland. Under the terms of a 20 years' concession the company undertake to lay down and work a telegraph cable between the Shetland and Faröe Islands and Iceland. The cable end will be landed at Seydisfjord or Reydarfjord on the east coast of Iceland, and the company is to receive an annual subsidy of £3,000 from the Danish and £1,950 from the Icelandic Exchequer. It is stipulated that the cable shall be opened and ready for work by Oct. 1, 1906, at the latest.

**Electric and General Investment Co.**—The directors recommend the payment of the following dividends for the year ended May 31: On the ordinary shares, a dividend of 4s. per share, of which 1s. per share was paid on account in January last, leaving 3s. per share to be distributed. The trustees for the ordinary shares reserve fund propose to distribute out of the dividends received 1s. per share, making a total present distribution of 4s. per share, or £0 per cent., or a total distribution of 5s. per share, or 25 per cent., for the year. On the founders' shares, a dividend for the year of £20 per share is proposed, and the trustees for the founders' shares reserve fund propose to distribute out of the dividends received £10 per share, making a total present distribution for the year of £30 per share.

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**Cardiff.**—The borough electrical engineer and manager (Mr. A. Ellis) in his last report states that there are now 1,149 consumers connected with the mains, with a total equivalent of 135 384 8-c.p. lamps. The total number of lamps at the corresponding period last year was 111,335, an increase of 21 per cent. in the total connections. The estimated revenue from street lighting was £630, that from private supply was £1,814, as against £1,653 for the corresponding month last year. A number of leading tradesmen having asked for a 10 per cent. cash discount in the price of current, Mr. Ellis, reporting upon this petition, said the department's income for the last year was £33,000. If they allowed a 10 per cent. discount they would lose £3,300 per annum, and while granting their consumers 10 per cent. they would only get 4 per cent. from the bank.

**Gillingham.**—The Council's decision to supply the Kent Electric Power Company, in consequence of the Chatham fire, with electrical energy for their customers for a minimum period of six months at 2½d. per Board of Trade unit, is subject to an agreement embodying, amongst others, clauses to the effect (1) that in the event of a breakdown occurring which makes it impossible to supply both the Kent Electric Power Company and the Gillingham area, it must be understood that the Council have power to disconnect the supply to the Kent Electric Power Company until the breakdown is rectified; (2) the Kent Electric Power Company to lay down the connecting main across the Great Lines at their own expense and risk, and provide a step-up transformer at the Council's generating station. A new boiler will have to purchased and fixed at the generating station capable of evaporating 5,000lb. of water per hour at an estimated cost of £1,000.

**Ipswich.**—The Electric Light and Tramways Committee's report for the year ended March 31, 1905, shows that the number of consumers was on March 31, 1904, 98, and at the end of the year 209, and there was an increase of 19,977 in the equivalent number of 8-c.p. lamps connected to the mains during the year. The units generated during the year amounted to 1,189,872, the units sold to 1,066,285, of which 797,370 were for traction and the remainder for lighting and power. There was 12·2 per cent. of units generated for lighting and power unaccounted for, and 76,039 units used on the works. The total length of lighting mains now laid is 22,806 yards, or 12·96 miles. The receipts were £8 938 which leaves a balance of £2 605 over the working expenses. Interest on loans amounted to £2,522, and repayment of loan (net) £1 761, leaving a total deficiency (including £1,350 from the rate in aid and £742 deficiency at March 31, 1904) of £2,420, the net deficiency for the year being £387.

**Stirling.**—Mr. A. C. Hanson, the burgh electrical engineer, in his annual report gives the number of units generated during the year ending May 15 as 260,755, as compared with 228,790 for the previous year. During the year 2,514 equivalent 8-c.p. lamps were connected to the mains, representing an increase in the possible demand of 81 kw. The total maximum demand was 207 kw. on Dec. 22, as compared with a maximum demand of 176 kw. the previous year. This demand represents 6,300 equivalent 8 c.p. lamps alight at one time. The average price obtained from the whole private supply was 4·131. per unit, as compared with 4·421. last year. The capital expense for interest for the year was £2,128. The revenue amounted to £4,137, compared with an estimated revenue of £4,130 and last year's revenue of £3,642. The running costs amounted to £1,740, as compared with an estimate of £1,775. The expenses of management, etc., amounted to £436. Owing to a sum of £177 having to be taken from the capital to the revenue account on the instructions of the Secretary for Scotland, being part of the cost of securing the provisional order, a sum of £305 will be required from the rates, as compared with the estimate of £110.

**Dundee.**—The Gas and Finance Committees have resolved to recommend that the price of current to ordinary consumers, otherwise than by agreement and otherwise than for motive power, per quarter should be as follows: for any amount up to 20 units per quarter, 6s. 8d.; and for each unit above 20 units, 4d.; and that all consumers who consumed above 10,000 units per annum be supplied at 3d per unit in excess of that figure, in all cases a discount of 5 per cent. being allowed if payment be made within 28 days. Public electric lamps are to be charged at the rate of £15 each per annum for those burning the whole night, and £7. 10s. for those burning a part of the night. The charge for motive power is to be on the maximum demand system, at a variable rate from a maximum of 2½d. per unit downward; and for heating, cooking, and radiators at 2d. per unit (each consumer to use or pay for current up to a minimum of 6s. 8d. per quarter) if taken through a separate meter, but if not taken through separate meter at the ordinary rate of 4d. per unit, subject to discount. The rate for the supply and distribution of current for tramways was fixed at 1½d. per unit. The commissioners will supply new consumers at the standard pressure of 200 volts, and by special agreement 400 volts at consumer's terminals.

**Darlington.**—The Northern Counties Electric Supply Company, Limited, have erected a new generation and refuse destructor works at New Shildon, near Darlington, and they were formally opened this week, although the light has been supplied to the district for six weeks. At the ceremony, the members of the local District Council, the Spennymoor Urban District Council, and a number of other interested people were conducted over the works while in operation by Messrs. Fairweather and Vesey-Brown, representing the company. The destructor, which will be a great boon to this thickly-populated colliery district, and will save fully £300 per annum, has four cells, and is of the Heenan patent type, working in connection with two Babcock and Wilcox water-tube boilers, with a heating surface of about 3,900 square feet. The intercommunicating grate system of furnaces is used, and they have a guaranteed combined capacity of from 40 to 45 tons of refuse per 24 hours. At the official test the furnaces burned at the rate of 64 tons, with an evaporation of over 1¾lb. of steam produced at 200lb. per square inch pressure, and an average temperature of 1,700 deg. F. was maintained throughout. At present three cells are sufficient to deal with the daily deliveries, amounting to about 30 tons, largely made up of crude sewage, coal, and shale. The whole supply of electric light, which is being largely adopted in the district, is developed from the cremation of the refuse. The Electricity Committee of the Corporation have decided to extend their cable to Albert-hill, an important industrial district of the borough, on account of the proprietors of the Darlington Wireworks having expressed their desire to manufacture with electric power instead of steam.

**Manchester.**—The annual statement for the year ended March 31 shows an income for the year of £302,200, including £182,560 for lighting and power and £117,590 for traction. The working expenditure was £174,320, and after interest on the mortgage debt and the sinking fund had been provided for there remained a net surplus of £4 544. The reserve fund at the beginning of the financial year stood at £32 561, but now only amounts to £20,387, the decrease being mainly due to expenditure in respect of vibration and explosion lawsuits. The capital outlay shows a total at March 31, 1905, of £2,199 689. Application has been made to the Local Government Board for further borrowing powers to the extent of £60,000 for additional machinery to be erected at several of the distributing substations. Provision has been made in the 1906 estimates for a reduction in the charges for current supplied for lighting purposes, and the Council will be asked to sanction a reduction to short-hour consumers from 5½d. to 4½d. per unit, to take effect from Sept. 29 next. An agreement has been entered into with the Gorton Urban District Council taking over their provisional order for the supply of electricity in their district. The total output of electricity from the works during the past 12 months amounted to 47,170,721 units, as compared with 38 610,922 units of the previous year, an increase of 22·17 per cent. The quantity measured and accounted for during the same time was 36,979,552 units, showing a difference of 10,191,169 units, or 21·60 per cent., being the quantity used in distribution or otherwise not accounted for. The total mileage of mains laid at March 31, 1905, equals 892 miles 165 yards. The Electricity Committee are prepared, for the purpose of illumination on the night of Thursday, July 13, to supply current from existing services at a charge of ½d. per 8 c.p. lamp per night from dusk to midnight.

**Administrative County of London and District Electric Power Bill.**—This Bill will come up for second reading in the House of Commons about Wednesday next, having been approved by Lord Camperdown's Committee. Notices of intended opposition have been given on behalf of the Corporation of London, the London County Council, the Corporations of East and West Ham, Southwark, Battersea, Lambeth, Wandsworth, Bermondsey, Islington, Stepney, Lewisham, Camberwell, Deptford, Poplar, Fulham, St. Pancras, Shoreditch, Woolwich, Croydon, Richmond, Kingston-on-Thames, Bromley, and Gravesend, the Urban District Councils of Beckenham, Bexley, Dartford, Barnes, and Wimbledon, the Rural District Councils of Bromley and Croydon, the Chelsea Electricity Supply and St. James's and Pall Mall Electric Light Companies, Richmond Electric Light and Power Company, Central Electric Supply Company, County of London Electric Supply Company, Charing Cross, West End, and City Electricity Supply Company, South Metropolitan Electric Tramways and Lighting Company, Empire Electric Light and Power Company, Metropolitan Electric Supply Company, Metropolitan Water Board, the Commissioners of Sewers, the Gaslight and Coke, South Metropolitan, Mitcham and Wimbledon, and Wandsworth and Putney Gas Companies, London United Tramways Company, Great Northern, Piccadilly and Brompton, Baker-street and Waterloo, and Charing Cross, Euston, and Hampstead Railway Companies, and Messrs. Brunner, Mond, and Co. The Bill of the North Metropolitan Electric Power Supply Company will be opposed in the Commons by the London County Council, the Charing Cross, West End, and City Electricity Supply Company, and the Urban District Councils of Wood Green and Walthamstow. Mr. J. Falconer has written to the London County Council on behalf of the promoters of the Administrative County of London and District Power Bill in regard to a letter sent by the Council to members of Parliament requesting them to oppose that Bill and that of the Metropolitan Electric Supply (Various Powers) Bill, pointing out that in their letter the only prices mentioned were 1d., 8d., and 7d. per unit, leaving it to be inferred that these prices, which only applied in isolated and special cases, represented the prices generally charged, whereas the returns furnished by the companies and local authorities themselves showed that in the case of both the average price paid by consumers for power was over 2d. per unit, or more than double the figures stated. The figure of 114,000,000 units per annum was mentioned as representing the business of the existing undertakings. This left it to be inferred that the whole of this would be affected by the Bill, whereas it was admitted that the new company would not compete for their existing business to any practical extent, except as regarded supply to manufacturers in the industrial area, or less than 6 per cent. of that figure. Similarly the statement suggested that the whole capital of the existing undertakings in London—namely, £17 983,000—would be affected by the Bill, whereas, as a matter of fact, but a small percentage of that amount has been expended in connection with the supply of power. He also complains that in the said letter no reference was made to the interest of the consumer in a supply of electricity at an average price of ¾d. per unit, and points to the advantages which would accrue to manufacturers being supplied at the low rate.

**Plymouth.**—The accounts of the fifth year's working of the Corporation's electricity undertaking shows that during the year ending March 31 114 additional consumers had been added, with an equivalent of 9,246 lamps. The total number of consumers is 667, the total connections of lamps, etc., on private consumers' premises being equal to 50,770 lamps of 8 c.p., against 553 consumers and 41,524 lamps in 1904. The use of electric motors was increasing, there being about 50 in use by private consumers. The total units sold during the year

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was 1,699,460, being 190,367 units more than during the preceding year. The cost of production was less than during any preceding year. The works costs this year were 1·05d. per unit sold, against 1·13d. in 1903-4, and the total costs 1·41, against 1·49. The expenditure on coal had been reduced from ·71d. in 1903-4 to ·64d. per unit sold in the past year, a gain of 11 per cent. The machinery, plant, and buildings had been fully maintained out of revenue at a cost of £1,350. The sum of £3,130 had been paid off by way of rates since the commencement of the undertaking. Notwithstanding the reduction made in the charges to private consumers, the gross profits showed a substantial increase over the previous year, the figures being £10,325 for 1904-5 and £9,175 for 1903-4. The balance in the reserve fund now stands at £4,869.

**South Shields.**—An enquiry has been held into an application of the Corporation for sanction to borrow £15,625 for extensions at the electricity works at Holborn to meet the requirements of the electric tramway service. The town clerk, Mr. J. Moore Hayton, said the undertaking which was inaugurated in 1896, had now reached considerable dimensions, and had had a successful career. The capacity of the plant installed was 1,600 kw., and the maximum demand at any time last year was 953 kw., so that there was a large margin of plant available for the supply of current. The plant, however, being on the alternating system, was not altogether suitable for tramway purposes, or for the supply of power to works, therefore it was proposed to instal plant for traction and power purposes supplying a continuous current of 500 volts. This would take the form of two units of 550 kw. capacity each, with a reciprocating engine and dynamo. A boiler, additional pumps, switchboard, and some other items of machinery would be necessary for the purpose of completing the installation. The estimated cost of the work in the electrical engineer's department was £14,425, and there would be, in addition, a little architectural work to cost, it was estimated, £1,200, mainly for the foundations, the engine, dynamo, the construction of the switchboard platform, etc. The capital expenditure on the electricity undertaking had been £151,838; the loan outstanding amounted to £133,444, less sinking funds in hand £11,056, leaving a net indebtedness to the amount of £122,388. The reserve fund accumulated was £4,500, and the net profit last year was £2,055. Mr. James Albert Cawthra, borough electrical engineer, detailed the work which had been carried on, the progress which had been made since the commencement of the electricity undertaking, and the additions it was proposed to make.

**South Africa.**—Electric motors have now been installed for the working of the batteries of the Cason and Angelo mines, and the results achieved will be looked for with considerable interest in this country. Germane to the same subject is the projected installation of an electric hoist on the Village Main Reef mine, which, we understand, is the first to be adopted for deep-level mining. The problem of length of haul will be met by placing the winder at a vertical depth of 1,100ft., where it will haul on a 1,700ft. incline. The generating plant will be of 900 h.p., and the hoist 500 h.p. The A.E.G. Electrical Company of South Africa, Limited, is supplying the electrical portion of this equipment, Messrs. Fraser and Chalmers, Limited, the mechanical parts of the hoist, and Messrs. W. H. Allen, Son, and Co., Limited, the steam plant. The several electrical undertakings in course of construction in the Cape Colony and Natal continue to make steady progress, and add considerably to the budget of oversea orders being duly given out, while some new schemes have also been launched which will eventually afford their measure of business. At Port Elizabeth the tender of Messrs. Wills and Davey, for the erection of the generating station, has been accepted, and will involve the placing of orders for ironwork and builders' material. The Corporation of Cape Town have taken in hand the work of replacing many of the overhead lines by underground feeder cables, and with a large increase in the demand for light in the district near the Opera House, and for the service of the new City Hall, have been under the necessity of indenting for further electrical material, a portion of which has been placed with Messrs. Ingram and Kemp, Limited. No time has been lost by the King William's Town Town Council in enlarging its newly-acquired electric installation to meet the increased calls for light, and among the new plant already contracted for is a 100-kw. alternator, placed with the Electrical Construction Company, Limited, an "Economic" boiler, supplied by Messrs. Davey, Paxman, and Co., Limited, and four 20-kw. transformers of Messrs. Ferranti and Co.'s make. Orders for 50 electric meters have also been given out. Among the new electric schemes for which material will shortly be called for is that of Beaconsfield, in Cape Colony; Greytown, in Natal; and Bloemfontein, the concession for which is in the hands of Messrs. Hubert Davies and Spain, Johannesburg.—*South African World.*

**Bermondsey.**—At the Borough Council on Tuesday a long debate arose over a report from the Electric Lighting Committee respecting breakdowns which occurred on June 8 and June 10 in connection with the municipal electric light. Mr. Doran, the electrical engineer, said the breakdowns were due to the dampness of the places where the service had been laid in the past. The cable could have been laid in another manner. The drop in the whole system only lasted whilst another machine was being got in. At the same meeting the Electric Lighting Committee reported that since May 5 the number of equivalent 8-c.p. lamps applied for for private lighting was 130, making a total of 36,498 8-c.p. lamps applied for to date, or, including public lighting, a grand total of 39,484. The number of customers up to date was 216, and 6,840 8-c.p. lamps had been applied for in excess of the capacity of the present plant. The committee also reported that it had considered a statement, marked private and confidential, outlining the heads of the terms upon which the promoters of the Administrative County of London and District Power Bill were prepared to negotiate with the Borough Council with a view to the withdrawal by the Council of its opposition, and the supply by the company to the Council of electrical energy. Having very carefully considered the matter, the Council said they were not prepared to recommend the Council to withdraw its opposition to the Bill. The Council endorsed the opinion of the committee. The committee also reported having received from the Board of Trade an intimation with reference to the London Electric Supply Corporation's application for an additional system for the supply of energy for the purposes of its 1889, 1900 (Metropolitan), and 1897 (Westminster) orders, the Board of Trade had after full consideration given its approval. The Electric Light Committee reminded the Council that in March last it had written asking the Board of Trade before approving of the additional system to afford it an opportunity of appearing before them on the matter, as the additional system would enable the company to come into more direct competition with the Council's undertaking, and also calling the Board's attention to the fact that there was already another company in the borough besides the one mentioned. The chairman of the committee together with the town clerk and electrical engineer waited on the Board of Trade regarding the matter. The Council said they had directed that a reply be sent to the Board of Trade protesting against the granting of the approval, especially as another company is now seeking powers to come into the borough. This action the Council approved.

**Norwich.**—The report of the Electricity Committee for the year ended March 31 last shows a gross profit of £16,574, as against £15,147 for the previous year, and subject to the charge for interest on the loan debt and contributions to sinking fund for the year, there is a balance of £5,433, as against £4,432 for last year, which, with the balance brought forward for the three months to March 31, 1903, makes an accumulated total of £10,018 to be dealt with. The report states: "The committee in considering how this sum should be appropriated have been met first of all with the necessity for writing off the balance of outlay on certain small engines which were taken over when the undertaking was purchased, but which, owing to the development of the business, require to be replaced by engines of a larger type, not only on grounds of efficiency, but also of economy. The difference between the price at which these engines stood in the accounts of the company after allowing for depreciation already provided and their selling price is £3,765, a sum which must be met out of the above balance of £10,018. The committee have also very carefully considered the necessity for setting aside a substantial depreciation fund which will serve to provide not only for the obsoletion of machinery, but also for depreciation. They therefore propose carrying £6,000 as a first contribution to this fund, which will leave the sum of £253. 11s. 4d. in the net revenue account to be carried forward to next year. The total amount provided for sinking fund towards the extinguishment of the loan debt is now £6,465. This sum covers the requisite contributions to March 31, 1905, and is calculated on the terms of years allowed under the Norwich Corporation (Electricity, etc.) Act, 1902, for the repayment of the loan debt. The following is a comparison of the results of the last two years' working: Units sold, 1903-4, 1,819,708; 1904-5, 2,087,942; increase, 278,234. Receipts, 1903-4, £28,733; 1904-5, £30,259; increase, £1,526. Working expenses, 1903-4, £13,585; 1904-5, £13,684; increase, £99. Proportion of expenses to receipts, 1903-4, 47 per cent.; 1904-5, 45 per cent. Remembering that your committee with the sanction of the Council in November last decided to reduce the charge for electric current from 5d. to 4½d. per unit to take effect as and from Jan. 1 last, the increase compares well with previous years, for if there had been no reduction the increase in the receipts would have been about £2,300. This, it is satisfactory to note, has been obtained with additional expenditure of only £99. The economy that has been effected has been principally in the coal consumption, but it is also due partly to the change of pressure completed during the past year, which has very much reduced the loss in the mains, and also to the fact that we are able to make much more use of our large engines. The other expenses have not increased in the same proportion as the output, and are not likely to do so in the future. It is interesting to note that although the increase in output has been maintained the capital expenditure has not been so high as in previous years. At the end of 1902 the total amount expended by the Corporation on the undertaking including the purchase was £240,558, and during that year 1,481,000 units were sold; that is to say, £162 had been spent for each 1,000 units sold. Since the end of 1902 £21,296 more has been spent, but the output per annum has been increased from 1,481,000 to 2,093,000 units, or by 617,000 units. The expenditure for this increase is, therefore, only £35 per 1,000 units, and this will probably be about the cost for future development. The progress in new connections has been practically the same as previously, 273 having been added as compared with 279 the year before. The total number of consumers now is 3,283, with lamps equivalent to 102,000 8 c.p., and 250 motors, with an aggregate of 1,105 h.p. A special feature of the year has been the introduction of a system for the maintenance of lamps on consumers' premises. It was found that a great many people were not getting satisfactory results simply because the lamps were not renewed as often as they should be, and your committee, realising that their obligations did not end with the supply of current, but that every endeavour should be made to give the best possible results that could be obtained, decided to offer to keep any consumer's lamps in good order for such an amount as was estimated to be sufficient to cover the cost. This has met with great success, and during the year some 300 consumers have accepted the offer. When the benefits are more fully realised, there is little doubt but that the department will be asked to attend to the great majority of the consumers' lamps. As a recent instance of the growing appreciation of this, it may be mentioned that one of the most important local companies, after fully considering the whole question, have decided to take current from the Corporation for working some new machinery they are putting down to the extent of 120 h.p., rather than put down their own plant. Other large firms are considering the working of their machinery by electric motors, and your committee hope to be

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able to report some substantial additions in this direction during the present year. In conclusion, they wish to impress upon the citizens that the prospect of further reductions and of future benefits depend on the way in which the business increases. They consider that there are great possibilities of further development with reduced cost of production, but these results cannot be obtained without a considerable increase in the output." The report came before the Council this week, and consideration was deferred.

## PROVISIONAL PATENTS, 1905.

JUNE 10.

**12150. Improvements in apparatus for compressing or setting the bonds of electric railways and tramways, and for other analogous purposes.** John Shaw, 18, St. Ann-street, Manchester.

**12170. Improvements in electrical cables.** Henry Edmunds and Philip Dawson, 47, Lincoln's-inn-fields, London.

**12171. Improvements in and connected with electrical cables or conductors.** Henry Edmunds and Philip Dawson, 47, Lincoln's-inn-fields, London.

**12182. Improvements in arc lamps.** Richard Philip Myers, 322, High Holborn, London.

**12193. Improvements in and relating to means for starting and controlling alternating-current motors.** William Edward Evans, 27, Chancery-lane, London. (The Allgemeine Elektricitäts-Ges., Germany.)

**12202. Improvements in electric bells.** Shanker Abaji Bhisey, 38, Chancery-lane, London.

JUNE 13.

**12205. Means for joining up two or more electric circuit wires or like conductors.** Verity's, Limited, and William George Pipkin, 11, Burlington chambers, New-street, Birmingham. (Complete specification.)

**12212. Improvements in trolley fittings for use in connection with overhead electric traction systems.** Frank Woodhead, 24, Temple-row, Birmingham.

**12218. A pricker or bit for perforating electric casings ready for insertion of screws.** John Dugdill, 305, Oldham-road, Failsworth, Manchester

**12221. Improvements in or relating to electrolytic apparatus.** George Grant Hepburn, 4, St. Ann's square, Manchester.

**12241. A swivelling mercury contact for use on electric tramcars and the like.** William Glennon, 22, Hulme-street, Elton, Bury, Lancs.

**12249. An improved process for depositing metals from solutions with a specially-constructed brush by electricity without the aid of baths.** George William Hartopp Simpson and Percy May, St. Amant, Park Fields, Putney, London.

**12253. Improved electric accumulator plates for the storage of electricity.** Frederick Thomas Kelley, 8, Elders-street, Scarborough, Yorks.

**12263. Electrolytic ship-bottom cleaner.** George Washington Frazier, 7, Staple-inn, Holborn, London. (Complete specification.)

**12284. Improvements in and relating to electric tremblers.** Jean Baptiste Minoggia and Léon Emile Mére, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, June 19, 1904, being date of application in France.) (Complete specification.)

**12291. Process for the electrolytic production of lustrous metallic coatings upon metals.** Alexander Classen, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

**12294. Improved trolley pole for conducting electric current to vehicles.** John Lindsay and Robert Lindsay, 53, Chancery-lane, London.

**12296. Improvements in devices for magnetically increasing the adhesion between truck wheels and the rails upon which they roll.** Robert Charles Lowry, 1, Queen Victoria-street, London. (Complete specification.)

**12307. Improvements in time-limit devices for electric switches or circuit breakers.** The British Thomson-Houston Company, Limited, Edmund Basil Wedmore, and James Whitcher, 83, Cannon-street, London.

**12315. Improvements in galvanic batteries.** Benjamin Jacob Blameuser, Elsie Corine Blameuser, Nicolas Kribs, and William Joseph Burle, 40, Chancery-lane, London. (Complete specification.)

JUNE 14.

**12341. Improvements in sanitary attachments for telephones.** Isaac Michael Slocum, 65, Chancery-lane, London. (Date applied for under Patents Act, 1901, June 22, 1904, being date of application in United States). (Complete specification.)

**12367. Improvements in electrical exosmosers.** Carl Adolph Sahlstrom, 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1901, June 21, 1904, being date of application in United States.) (Complete specification.)

**12382. Improvements in automatic selecting apparatus for use in telegraphy and telephony.** Paul Arnheim, 322, High Holborn, London.

**12386. Improvements in supports for electric overhead conductors.** Edgar Douglas Machray, 18, Southampton-buildings, Chancery-lane, London. (Herbert John Machray, Constantinople.)

**12388. Improvements in alternating-current generators.** Giovanni Battista Marzi, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, June 15, 1904, being date of application in Italy.) (Complete specification.)

JUNE 15.

**12399. Magneto-electric dumb bell.** James Moores, St. Lesmo, Hastings-avenue, Chorlton-cum-Hardy, Manchester.

**12406. Improvements in and connected with telephone mouthpieces.** Rudolf Knoll, 4, Corporation-street, Manchester. (Complete specification.)

**12418. Improvements in or relating to the distribution of energy to commutator electric motors from a three-phase alternating-current source.** Benjamin Garver Lamme, Westinghouse Patent Bureau, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, June 30, 1904, being date of application in United States.) (Complete specification.)

**12420. Combined electric railway cab signal and automatic block system.** Joseph Whitman Buell, 601, McGill-building, 903 to 914 G. Sts, N.W., Washington, D.C., United States. (Complete specification.)

**12424. Improvements in electric telegraphy.** Isidor Kitsee, 18, Fulham-place, Paddington, London. (Complete specification.)

**12431. Improvements in or relating to electrical instruments.** Michael Birt Field, 111, Hatton-garden, London.

**12432. Improvements in or relating to automatic cut-offs or interrupters for electric current.** Domingo Carvera Cañizares, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, June 30, 1904, being date of application in Spain.) (Complete specification.)

**12454. Improvements in the electro-deposition of copper and other metals.** Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

**12455. Improvements in removing metallic cylinders from mandrels on which they are electro-deposited.** Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

JUNE 16.

**12473. An improved junction box for electric cables.** Thomas Bertram Reader, 62, Belmont-road, Beckenham.

**12485. Improvements in magnetic compasses and the like.** Walter Taylor St. Aubin, 1, Langham-chambers, All Souls'-place, London.

**12496. Helix spark plug for the electric ignition of motors.** Emile Evrard, Birkbeck Bank-chambers, Holborn, London. (Date applied for under Patents Act, 1901, March 6, 1905, being date of application in Belgium.) (Complete specification.)

**12507. Improvements in and relating to prepayment mechanism for electric meters.** The British Thomson-Houston Company, Limited. Wiliam John Lloyd, and Kenneth Francis Kingwell, 83, Cannon-street, London.

**12536. Improvements relating to electric incandescent candle fittings.** Frederick Roberts Pope, 322, High Holborn, London.

**12543. Universal telephone call.** Madeleine Fouques, 40, Chancery-lane, London. (Complete specification.)

JUNE 17.

**12546. Improvements in apparatus for use with Nernst lamps and the like.** Robert William Paul, Newton-avenue Works, New Southgate, London.

**12559. Improvements in the construction of electrical resistances.** George Keith Buller Elphinstone, Century Works, Lewisham, London.

**12586. Improvements in or relating to electric telegraphy** Edmund Raymond-Barker, 111, Hatton-garden, London.

**12590. Improvements in electrical igniters for explosion motors.** Karl Mann, 65, Chancery-lane, London. (Date applied for under Patents Act, 1901, July 11, 1904, being date of application in Germany.) (Complete specification.)

**12591. Improvements in electrical accumulators.** Guglielmo Marconi, 24, Southampton-buildings, Chancery-lane, London.

**12593. Improvements in magnetically-operated switches.** George Henry Hill, 83, Cannon-street, London. Date applied for under Patents Act, 1901, June 18, 1904, being date of application in United States.) (Complete specification.)

**12594. Improvements in electric railway systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.) (Complete specification.)

**12595. Improvements in and relating to vapour electric apparatus or devices.** Sir Oliver Joseph Lodge, Alexander Muirhead, and Edward Ernest Robinson, 323, High Holborn, London.

**12598. Improvements in and relating to incandescent electric lamps.** Stephen Horvath and the "Utility" Company, Limited, 57, Chancery-lane, London.

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## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published July 6.*

1904.

**12949. Electric apparatus applicable for exercising and therapeutic purposes.** Burks. (Rohlfs, partly.)

**13016. Method of and apparatus for obtaining a constant potential current from a variable-speed dynamo.** Loppé and Compagnie Générale d'Electricité de Creil. (Date applied for under International Convention, Nov. 10, 1903.)

**13017. Method of and apparatus for obtaining a constant potential current from a variable-speed dynamo.** Loppé and Compagnie Générale d'Electricité de Creil. (Date applied for under International Convention, Feb. 20, 1904.)

**13253. Manufacture of filaments for incandescing electric arc lamps.** Crawford.

**13278. Electric transformers, reactances, and the like.** British Thomson-Houston Company, Limited. (General Electric Company.)

**13283. Means for supplying or cutting off current in connection with single or polyphase alternating-current electric motors.** Union Electricitäts Ges. (Date applied for under International Convention, June 30, 1903.)

**13564. Regulation of electric motors.** Johnson-Lundell Electric Traction Company, Limited. (Lang.)

**13585. Electric motors.** Latour. (Date applied for under International Convention, June 19, 1903.)

**14163. Movable overhead frogs or switches for electric railways and tramways.** Merz and Redman.

**15616. Single-phase alternate-current motors.** Crompton and Co., Limited, and Goldschmidt.

**15701. Instruments for determining the drop of potential in electric transmission systems.** Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, July 14, 1903.)

**16408. Electric circuit controllers, especially applicable in connection with the governing of elastic fluid turbines.** British Thomson-Houston Company, Limited, Warwick Machinery Company, Limited, and Samuelson.

**16664. Starting resistances for electric motors.** British Thomson-Houston Company, Limited. (General Electric Company.)

**17478. Electric light fittings.** Marsden.

**17562. Printing telegraphs.** White.

**17621. Electric arc lamps.** Veritys, Limited, and Worsley.

**17738. Telephone switchboards.** Parsons.

**17764. Means of regulating electric circuits.** Hill.

**20788. Winding for monophase or polyphase alternating-current electric machines.** Elektricitäts Akt.-Ges. vorm. W. Lahmeyer und Co. (Date applied for under International Convention, Nov. 12, 1903.)

**22100. Certain parts of electrical circuit breakers and automatic switches.** Electric and Ordnance Accessories Company, Limited, and Hall.

**26293. Dynamo-electric generators.** Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, Dec. 3, 1903.)

1905.

**618. Method of controlling the feeding mechanism of electric arc lamps of the open and enclosed types.** Fry.

**1665. Incandescent electric light bulbs.** Bury.

**1912. Electric railway system.** Kinsman.

**2628. Electric ignition arrangements for explosion motors.** Schoeller.

**4168. Telephone transmitters.** Bines.

**7495. Contact devices for electric switches.** Elektricitäts Akt.-Ges. vorm. W. Lahmeyer und Co. (Date applied for under International Convention, May 9, 1904.)

**8613. Apparatus for electrical drying of insulation of electric cables.** Nisbett.

**11360. Manufacture of copper sulphide for thermo-electric couples.** Cie. Thermo-Electrique (Système Hermite) Soc. Anon. (Date applied for under International Convention, April 27, 1905.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. £ | | Last price £ |
|---|---|---|---|
| **Commercial and Industrial.—** | | | |
| Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ½-¾ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 7/16-17/32 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | – | 5¼-6 |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | – | 5¼-6 |
| —— 4½ per cent. Mortgage Debentures | 100 | – | 103-106 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 100-102 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | – | 2⅛-2⅜ |
| —— 4 per cent. Mortgage Debenture Stock | 100 | – | 83-91 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,731 | 2 | – | ½-¾ |
| —— Non. Cum., 6 per cent. Pref. | 2 | – | 1-1¼ |
| —— 4½ per cent. 1st Debenture Stock | 100 | – | 92-95 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | – | 79-82 |
| Callender's Cable, Debentures | 100 | – | 106-108 xd |
| —— Ordinary | 5 | – | 10-11 |
| —— 5 per cent. Pref. | 5 | – | 5⅛-5⅜ xd |
| Crompton and Co. | 5 | – | 1¼-2¼ |
| —— 5 per cent. Debentures | 100 | – | 96-100 p.c |
| Edison and Swan United, "A" Shares, 1-98,251 | 5 | – | 1¼-1½ |
| —— "A" Shares, 01-017,139 | 5 | – | 2-2¼ |
| —— 5 per cent. Debentures | 100 | – | 89 94 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 84-89 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | – | ¾-1¼ |
| —— 7 per cent. Cumulative Pref. | 2 | – | 2¼-2½ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | – | 95-98 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | – | 9⅜-10¼ |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | – | 97-101 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | – | 11½-12½ |
| —— 4½ per cent. Preference | 5 | – | 5¼-5⅜ |
| —— 4½ per cent. Debentures | 100 | – | 109-111 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | – | 15½-16½ xd |
| —— 4 per cent. Debentures | 100 | – | 100-103 |
| Parker, Thos., Limited, Ordinary | 10 | – | 10-10¼ |
| Telegraph Construction and Maintenance | 12 | – | 32-34 |
| —— 5 per cent. Bonds | 100 | – | 103-105 |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary | 10 | – | 11⅜-12¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | – | 10 10¼ |
| —— 6 per cent. Cum. Second Pref., 15,001-22,500 | 10 | – | 11¼-12¼ |
| —— 4½ per cent. Debenture Stock, Red. | 100 | – | 107-109 |
| Bromley (Kent) Electric Light and Power Co. | 5 | .. | 5¼-5⅜ |
| —— 4½ per cent. 1st Debenture Stock, Red. | 100 | – | 102-105 |
| Brompton and Kensington, Ordinary | 5 | – | 9⅜-10¼ |
| —— 7 per cent. Preference | 5 | – | 9¼-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 | 5 | – | 9 9½ |
| —— Nos. 60,001-80,000 | 5 | – | 7⅜ 8¼ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | – | 12¼-13¼ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 103-105 |
| Charing Cross and Strand, 70,001-80,000 | 5 | – | 7⅛-8 |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 5 5¼ |
| —— 40,001-80,000 | 5 | .. | 5-5¼ |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | – | 105 107 xd |
| Chelsea Electricity Supply | 5 | – | 6¼ 6⅜ |
| —— 4½ per cent. Debentures | 100 | – | 109-111 |
| City of London, Ordinary | 10 | – | 10⅜-11¼ |
| —— 6 per cent. Cumulative Pref. | 10 | – | 14-14¼ |
| —— 5 per cent. Debenture Stock | 100 | – | 124-128 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | – | 104-106 |
| County of London Electric Supply, Ordinary | 10 | – | 8¼-9 |
| —— 6 per cent. Cum. Pref. | 10 | – | 12¼-12⅝ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 103-105 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. | 100 | .. | 113-116 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | – | 5⅜-6¼ |
| —— 6 per cent. Cum. Pref. | 5 | – | 5-6¼ |
| —— 4½ per cent. First Mort. Deb. | 100 | – | 107-109 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 2¼-3 |
| —— 5 per cent. Debenture Stock, Red. | 100 | – | 86-91 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | – | 5¼-5⅜ |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | – | 101-104 |
| Havana Electricity, Limited, 1-15,000 | 10 | – | 9¼-10⅛ |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | – | 7⅞-8¼ |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 100-105 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 | 1 | – | ¾-⅞ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | | 11⅛-12¼ |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red | 100 | – | 101-103 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅜-10⅛ |
| London Electric, Ordinary | 5 | – | 2-2½ |
| —— 6 per cent. Pref. | 5 | – | 5-5¼ |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | – | 97-99 xd |
| Metropolitan Ordinary, 100,001-300,000 | 5 | – | 9⅜ 10¼ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | – | 111-115 |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5¼-5⅜ |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | – | 93-100 |
| Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb. | 100 | – | 100-102 p.c. |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | – | 98-101 |
| —— Preference | 4 | – | 100-102 |
| Notting Hill Electric Lighting | 10 | – | 14⅛-15½ |
| —— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.) | 100 | – | 100-102 |
| Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,310 | 5 | – | 6¼-7 |
| —— 4 per cent. Debenture Stock | 100 | – | 99½-101½ |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures | 100 | – | 101-104 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 | – | 2⅜-3⅛ |
| —— 4 per cent. Debenture Stock | 100 | – | 79-83 |
| South London, Ordinary | | – | 3¾-4¼ |
| South Metropolitan Electric Light and Power Co., Ord. | 1 | .. | ¾-⅞ |
| —— 7 per cent. Cum. Pref. | 1 | – | 1 9/32-1 11/32 |
| —— 4½ per cent. 1st Mort. Deb. | 100 | – | 105-108 |
| —— Ditto, June, 1904 | | – | |
| St. James's and Pall Mall, Ordinary, 101-20,080 | 5 | – | 13½-14¾ |
| —— 7 per cent. Pref. | 5 | – | 8¼-9 |
| —— 3½ per cent. Deb. | 100 | – | 98-100 |
| Urban Electric Supply Co., Ordinary, 8-50,007 | 5 | – | 4¾-5 |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5¼-5⅜ |
| Westminster, Ordinary | 5 | – | 12-13 |
| —— 5 per cent. Cum. Pref., 110,101-138,251 | 5 | – | 5¼-5⅜ |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 | 5 | – | 5-5¼ |
| —— Ord. | 5 | .. | 8⅜-8¾ |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | – | 140-143 |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 106-108 |
| Barcelona Tramways, Limited, Ord., 1-20,000 | 10 | .. | 12¼-13¼ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 | 10 | .. | 9⅜-10¼ |
| —— 5 per cent. Deb., Red., 1-600 | 100 | .. | 99-102 |
| —— 4½ per cent. Red. Deb. Stock | 100 | .. | 96-100 |
| Bath Elec. Tramways, Ld, Pref. Ord. Shs., 75,001-150,606 | 1 | .. | ¾-⅞ |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 | 1 | .. | 15/16-1 1/16 |
| Belfast Street Tramways, Ord., 1-26,600 | 10 | .. | 10¼-11¼ |
| Blackpool and Fleetwood Tramroad | 10 | – | 13⅜-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | – | 1¼-1⅜ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | – | 3¾-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 91-96 |
| British Columbia Electric Railway Co., Ord. Def. | 100 | – | 105-108 |
| —— Ord Pref. | 100 | – | 96-101 |
| —— 5 per cent. Cum. Perpetual Pref. Stock | 100 | – | 101-107 |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each | 40 | – | 103-105 p c |
| —— 4½ per cent. Vancouver Power Deb. | 100 | – | 100-103 |
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 | – | 9¼-9⅜ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | – | 11¼-11⅜ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | – | 122-124 |
| —— 4½ per cent. 2nd Deb. Stock | 100 | – | 98-100 |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | |
| Buenos Ayres and Belgrano Trams | 5 – | 3¼-3⅜ |
| —— 'A' 6 per cents. Cm. Pf., 1-40,000 | 5 | 5¼-5⅜ |
| —— 'B' 6 per cent. Cm. Pf., 1-27,500 – – – – | 5 – | 5¼-5⅜ |
| —— 5 per cent. Deb. Stock, Red. – – – – – – – – – – | 100 – | 107-109 |
| —— Prov. Certs., all paid – – – – – – – – – – – – | 100 – | 103-105 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 – | 99-101 |
| Calcutta Tramways, Limited, 1-102,268 – – – – – – – | 5 | 8 3/16-8 7/16 |
| —— 4½ per cent. 1st Deb. Stock, Red. – – – – – – – | 100 .. | 107-109 |
| Cape Electric Tramways Nos. 1-480,000 – – – – – – – | 1 – | 1¼-1½ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. – | 5 – | 4⅞-5⅛ |
| —— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917). – – | 10 0 – | 99-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. – – – – – – – – | 100 | 102-104 |
| Cork Electric Tramways and Lighting Co. Ordinary – – | 10 | 9½-10 |
| —— 5 per cent. Cum. Pref. – – – – – – – – – – – | 10 – | 11-12 |
| —— 4 per cent. Debentures – – – – – – – – – – – | 100 – | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 – – | 10 – | 13¾-14½ |
| —— 5 per cent. Pref., Nos. within 1-60,000 – – – – | 10 – | 15-16 |
| —— 4½ per cent. Mort. Debs., 1-3,000, Red. – – – – | 100 – | 94-97 |
| Imperial Tramways Ordinary – – – – – – – – – – | all – | 18-19 |
| —— 5 per cent. Cum. Pref. – – – – – – – – – – – | all – | 14-14¼ |
| —— 4½ per cent. Deb Stock – – – – – – – – – – – | 100 | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cm. Pref., Nos. 30,001-60,000 – – – – – – – – – | 5 | 2⅞-3¼ |
| —— 4 per cent. Debenture Stock – – – – – – – – – | 100 – | 85-90 |
| Kidderminster and District Lighting and Traction, Pref. | 5 – | 8-8½ |
| London United Trys. (1901), 5 per cent. Cum. Pref. – – | 10 – | 10 10¼ |
| —— 4 per cent. 1st Mt. Db. Stock, Red. – – – – – | 100 – | 100-103 |
| Madras Elec. Trams. (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 .. | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016 | 1 .. | 9/32-11/32 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 – – – – | 1 .. | 1-1 1/16 |
| —— 4½ per cent. Deb. Stock, Red. – – – – – – – – | 100 .. | 106-108 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000 – – – – | $1,000 .. | 106-110 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 – – – – – – – – – – – – – – – – – | 100 .. | 101-104 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 – – – – | 100 .. | 103-105 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000 – – – – – – – – – – – – – – | 5 – | ¾-1¼ |

| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Oldham, Ashton, and Hyde Tramway Ordinary – – – – – | 10 | 12 |
| —— 6 per cent Cum. Pref. – – – – – – – – – – – | 10 – | 9¼-9½ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk | 100 – | 105-108 |
| Potteries Electric Traction, Ordinary 20,001-40,00 [illegible] | 10 – | 8¾ 9¼ |
| —— 5 per cent. Cum. Pref., 1-20,000 – – – – – – – | 10 – | 9¼ 9⅝ |
| —— 4½ per cent. Debenture Stock – – – – – – – – | 100 – | 101-104 |
| South Lancashire Electric Traction and Power Company | | |
| —— £250,000 Ordinary – – – – – – – – – – – – | 1 | 1 |
| —— £101,138 6 per cent. Preference – – – – – – – | 1 | 1 |
| —— £597,170 4½ per cent. Debenture Stock – – – – | 100 p.c. – | 100 p.c. |
| **Electric Railways.—** | | |
| Central London, Ordinary – – – – – – – – – – – | 100 – | 91-93 |
| —— 4 per cent. Pref. – – – – – – – – – – – – – | 100 – | 101-103 |
| —— ,, ,, deferred – – – – – – – – – – – | 100 – | 80-83 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid). | 100 – | 111-113 |
| City and South London, Consolidated Ordinary – – – – | 100 – | 39-41 |
| —— 4 per cent. Debenture Stock – – – – – – – – | 100 – | 107-110 |
| —— 5 per cent. Pref. Stock '91 – – – – – – – – | 100 – | 120-125 |
| —— ,, ,, ,, '96 – – – – – – – – | 100 – | 118-121 |
| —— ,, ,, ,, '01 – – – – – – – – | 100 – | 115-118 |
| Liverpool Overhead, 5 per cent. Pref. – – – – – – | 10 – | 10-10¼ |
| —— Ordinary, 1-50,000 – – – – – – – – – – – | 10 – | 3¾-4 |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700. | – – | 99-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes – – – – – – – – – – | – – | 99-100 |
| Waterloo and City, Ordinary – – – – – – – – – – | 100 – | 90-92 |
| **Telephones.—** | | |
| National Telephone, Preferred – – – – – – – – – | 100 – | 111¼-112½ |
| —— Deferred Stock – – – – – – – – – – – – – | 100 – | 102-104 |
| —— 6 per cent. Cum. First Pref. – – – – – – – – | 10 – | 13-14 |
| —— 6 per cent. Cum. Second Pref. – – – – – – – | 10 – | 11¼-12¼ |
| —— 5 per cent. Non. Cum. Third Pref. – – – – – – | 5 – | 5¼-5⅝ |
| —— 5¼ per cent. Deb. Stock, Red. – – – – – – – | 100 – | 100¾-102¼ |
| —— 4 per cent. Deb. Stock, Red. – – – – – – – – | 100 – | 103-105 |
| —— 4 per cent. Prov. Cert. – – – – – – – – – – | – – | 103¼-106¼ |
| Oriental Telephone and Electric Company – – – – – – | 1 – | 1¼-1½ |
| —— 6 per cent. Cum. Pref. – – – – – – – – – – – | 1 .. | 1 1/16-1 3/16 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905. | 1904. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Receipts per Pass'nger | Receipts per Car mile. | Receipts per Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | June 17 | 1,560 | 1,501 | + 58 | – 1304 | 19¼ | 19¼ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·14 |
| Ayr Corporation | ,, 10 | 389 | 337 | + 2 | — | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 336,049 | 1·03 | 10·11 | 1,770 | 5·0 |
| Barking Corporation | — | — | — | — | — | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 18 | 1,212 | 1,117 | + 95 | – 214 | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,349,701 | 1·158 | 9·98 | 2,383b | 6·1 |
| Birmingham Corporation | ,, 17 | 401 | 288 | + 113 | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | — | — | — | — | — | 6½ | 6½ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 11 | 1,336 | 1,016 | + 230 | + 530 | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10·94 | — | 4·59 |
| Blackpool Corporation | ,, 15 | 2,122 | 793 | +1,329 | – 280 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 17 | 1,532 | 559 | + 953 | – 589 | 16½ | 16½ | Dec. 31 | 32,021 | 2,258,984 | 600,757 | 3·34 | 12·75 | 2,001 | 7·05 |
| Bolton Corporation | ,, 18 | 2,332 | 1,849 | + 503 | — | 38 | 38 | March 31 | 94,161 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·89 |
| Bournemouth Corporation | ,, 14 | 1,906 | 1,019 | + 787 | — | 10·15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 10 | 4,553 | 4,796 | – 246 | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 18 | 1,342 | 933 | + 507 | + 894h | 9 | 7½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 16 | 6,468 | 5,146 | +1,322 | — | 51½ | 51½ | Dec. 31g | 253,150 | 44,391,439 | 6,035,528 | — | — | — | — |
| Burnley Corporation | ,, 17 | 1,286 | 1,080 | + 206 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 18 | 402 | 355 | + 47 | – 231 | 8¼ | — | March 31j | 11,574 | 2,556,134 | 282,378 | 1·08 | 9·84 | 1,570 | 7·87 |
| Cardiff Corporation | ,, 17 | 2,712 | 2,090 | + 622 | – 173 | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 17 | 240 | 203 | + 37 | – 376 | — | — | Dec. 31g | 9,987 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 17 | 6,416 | 6,532 | – 116 | + 1,814h | 6 | 6 | ,, 31 | 362,471 | 44,953,988 | 1,292,674a | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 18 | 2,387 | 2,521 | – 134 | – 3,551h | 6¼ | 6⅜ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Colchester Corporation | ,, 14 | 321 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 15 | 601 | 489 | + 112 | + 528 | — | — | ,, 31g | 26,657 | 6,353,323 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | ,, 16 | 267 | 231 | + 36 | + 115 | 7·23 | 7·23 | March 31g | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | May 13 | 198 | 195 | + 3 | — | 4½ | 4½ | ,, 31 | 11,255 | 2,871,332 | 280,901 | 0·94 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | June 16 | 193 | 129 | + 64 | + 244 | 7 | 6⅔ | Dec. 31g | 6,231 | 388,905 | 107,164 | 3·88 | 14·09 | 932 | 7·39 |
| Dublin U. T., electric cars | ,, 16 | 4,859 | 4,167 | + 692 | } — | 47 | 46 | ,, 31g | 134,648 | — | 3,429,356 | — | — | — | — h |
| Dublin S. District, Electric | ,, 16 | 1,662 | 1,000 | + 662 | | | | | | | | | | | |
| Dundee City Tramways | ,, 14 | 859 | 859 | — | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 17 | 1,072 | 774 | + 298 | + 620 | 10·77 | 10·75 | March 31 | 34,312 | 12,950,269 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 17 | 16,252 | 14,650 | +1,602 | – 343h | 145 | 123 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489 b | 7·40d |
| Gloucester Corporation | ,, 7 | 302 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 14 | 2,576 | 1,493 | +1,033 | + 844 | 33 | 30½ | March 31 | 68,289 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,069 | 8·77 |
| Huddersfield Corporation | ,, 17 | 1,871 | 1,312 | + 559 | + 751 | 35 | 35 | ,, 31 | 65,545 | 11,899,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | ,, 17 | 2,452 | 2,167 | + 285 | — | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | — | — | — | — | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | ,, 14 | 176 | 139 | + 37 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 14 | 216 | 221 | – 5 | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 17 | 7,710 | 5,798 | +1,912 | — | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·94 | 3,407 | — |
| Leicester Corporation | — | — | — | — | — | 7¼ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | ,, 10 | 10 809 | 10,917 | – 108 | — | 103 | 103 | Dec. 31g | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | ,, 18 | 1,819 | 1,575 | + 244 | – 1,643h | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — a |
| London County Council | ,, 10 | 13,382 | 12,303 | +1,079 | — | 46¼ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | ,, 15 | 156 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 17 | 15,804 | 12,613 | +3,191 | — | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 17 | 159 | 126 | + 33 | + 136 | 2½ | — | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newcastle-on-Tyne Corptn. | ,, 17 | 4,252 | 3,805 | + 447 | — | 45 | 38½ | ,, 25 | 185,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111b | — |
| Newport (Mon.) Corporation | — | — | — | — | — | 15 | — | — | — | — | — | — | — | — | — |
| Oldham Corporation | ,, 18 | 1 598 | 1 089 | + 509 | — | 34½ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 17 | 2,655 | 1,964 | + 691 | – 235 | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·16 | 12·39 | — | — |
| Reading Corporation | ,, 15 | 797 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Rochdale Corporation | — | — | — | — | — | 4½ | 4½ | 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·65 |
| Rotherham Corporation | ,, 15 | 664 | 489 | + 175 | — | — | — | ,, 31 | 23,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·68 |
| Salford Corporation | ,, 19 | 5,746 | 3,994 | +1,752 | + 2,559 | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 17 | 328 | — | — | — | 7½ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 20 | 5,557 | 4,704 | + 853 | + 1,525 | 34½ | — | ,, 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 14 | 1,197 | 980 | + 217 | – 374 | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 14 | 518 | 345 | + 173 | + 237 | 6¼ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 15 | 1,007 | 618 | + 389 | + 255 | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 19 | 1,871 | 1,314 | + 557 | + 107 | 19·54 | 18·48 | ,, 31 | 62,506 | 14,848,958 | 1,433,463 | 1·01 | 10·46 | — | 6·02 |
| Swindon Corporation | ,, 14 | 213 | — | — | — | 3½ | — | — | — | — | — | — | — | — | — |
| Wallasey U.D.C. | ,, 17 | 1,049 | 783 | + 266 | + 462 | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·50 |
| Warrington Corporation | ,, 1 | 326 | 321 | + 5 | + 90 | 4·71 | — | — | — | — | — | — | — | — | — |
| West Ham Corporation | ,, 15 | 1,921 | 1,108 | + 813 | + 7,105 | 8·62 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 14 | 1,321 | 607 | + 713 | — | 7½ | — | ,, 31g | 20,878 | 4,263,066 | 417,335 | — | 12·006 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
Per mile of single track. b Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.
Only eight months—expenditure includes large special items incidental to starting new department.

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## NOTES.

**Electric Tramway and Railway Exhibition.**—The third international exhibition will be opened at the Agricultural Hall, London, on Monday, July 3, at noon, by the Earl of Derby, and will continue until the 14th.

**International Association of Municipal Electricians.**—The convention of the International Association of Municipal Electricians will be held at Erie, Pa., on Aug. 23, 24, and 25, in lieu of the date previously announced. All indications point to this convention being one of the most successful the association has ever held. The location of the city, by the way, is a happy one, and at the time of the year when the convention will be held the weather conditions are said to be exceptionally good. The list of papers so far announced includes a number of important subjects. The secretary is Mr. Frank P. Foster, Corning, N.Y.

**Belt Creep.**—At the recent meeting at Scranton, Pa., of the American Society of Mechanical Engineers, Mr. W. B. Bird presented a paper, in which he described a number of experiments made on 4in. and 6in. single and double belts. The belts were run without load, and the sum of the tensions was made twice the desired tension, which was taken as 50lb. and 80lb. per inch of width of single and double belt respectively, on the tight side. The corresponding figures for the slack side were 20lb. and 32lb. The average of 10 tests showed a percentage of creep for the various belts as follows: 4in. single, 0·70; 6in. single, 0·67; 4in. double, 0·67; 6in. double, 0·66. The author analyses the test and draws the conclusion that for conditions which exist in good practice the creep should not exceed 1 per cent.

**The Administrative County of London Bill.**—There is likely to be a more or less exciting debate when this measure comes up for discussion in the House of Commons. The Standing Orders Committee have overruled the examiner's decision that, on account of a technicality, the Bill had not complied with standing orders, publication in the *Gazette* of some formal alteration being deemed by him insufficient. Meantime the promoters feel rather sore over the action of the London County Council in addressing various London M.P.'s, asking them to vote for the rejection of the Bill on second reading, instead of its being referred to committee, so that a usually formal proceeding may be transformed into a spirited one on the Bill being dealt with by the Commons, probably in the early part of next week.

**Electrocution.**—An inquest was held the other day concerning the case of Mr. Alfred Edwin Grey, late an electrician of South Lambeth-road, London, the verdict returned being accidental death. The deceased was engaged in wiring a shop for electric lighting. It appears that after the installation had been completed and the current switched on—the voltage being 220—he was using a pair of pliers to cut the wire which was hanging from the casing when he fell back and expired. Medical testimony went to show that death was attributable to asphyxia. Some evidence given by the deceased's partner, however, tends to exemplify that the effects of electricity are psychical as well as physical. A voltage of 220 would scarcely cause death under normal conditions, but the last-mentioned witness stated that the deceased was always apprehensive of a shock from a live wire.

**Mineral Production in 1904.**—The statistics for 1904 relating to mines and quarries in the United Kingdom show that the total output of minerals at the mines under the Coal Mines Act was 245,775,315 tons, of which 232,411,784 were coal, 3,043,045 fireclay, 7,557,733 ironstone, 2,333,062 oil shale, and 429,691 sundry minerals. Adding 16,488 tons from open quarries, the total output of coal was 232,428,272 tons, an increase of 2,093,803 tons on that of the previous year. In 1903 the average output of minerals at mines under the Coal Mines Act was 359 tons per person employed underground. Last year the corresponding output was 361, an increase of two tons per man. The total output of minerals at the mines under the Metalliferous Mines Act was 3,246,336 tons, of which 1,603,855 tons were iron ore. The total quantity of stone and other minerals obtained from the quarries under the Quarries Act was 45,701,818 tons, of which 3,597,764 tons were iron ore. Adding to the produce of mines and of quarries over 20ft. deep 1,014,930 tons obtained from shallow open workings, a total output of iron ore of 13,774,282 tons is shown.

**Wireless Telegraphy on Trains.**—Having given evidence of its utility both by land and sea, it seems that wireless telegraphy aspires to enter other fields of commercial usefulness. In our issue of the 16th inst. we briefly chronicled the fact that the Chicago and Alton Railway had prepared a section of its system for the use of a wireless telegraphic device, with the object of exchanging signals between trains so as to avoid accidents. Recently a train running on this line kept in touch with the dispatcher's office by this means. The trial was so successful that the railway officials announce their intention of installing the system on their fast trains, and using it not only as an additional safeguard, but for transmitting commercial messages to and from passengers on the train. This use of wireless telegraphy for this purpose was suggested some years ago. It was, in fact, tried on one of the Canadian roads experimentally with reported success, but its adoption by the Chicago and Alton Railway is apparently the first attempt to put it to regular use. The movement of the trains may add difficulty to the scheme, but the distance to be covered will not be great, and reliability of service will be the primary consideration.

**Edison on "Wireless."**—The New York correspondent of the *Daily Telegraph* had an interview last week with Edison, who is credited with the opinion that radium is likely to be as cheap as coal "one of these days," and as to its possibilities, they defied imagination. Asked what he considered the most wonderful thing in the scientific world now being developed, Edison replied: "Wireless telegraphy, beyond doubt." He stated that the British companies were absolutely correct in adopting Marconi's system, and the feat of the Atlantic liners in maintaining communication with the shore throughout their journey was very remarkable. He believed that wireless telegraphy was still in its infancy, and that Marconi would perfect it within a few years. In a short time he considered that there would be no more difficulty in using a wireless system between New York and London than in using the cable. It should be just as easy to send 20 messages at once over wireless as it is now to send one over by cable, and at a rate of 1,000 words a minute. At the same time, he did not think the cables would be superseded by the wireless system. Business, he considers, will only be increased for both wireless and cable companies, just as the telegraph and telephone now supplement each other.

**The Commercial Status of the Nernst Lamp.**—At the recent Denver meeting of the American Electric Light Association Mr. E. E. Roberts presented a paper dealing with the results of a series of life and photometric tests of Nernst lamps recently made by the manufacturers. The method of making the tests and the photometer used

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were fully described. During the life tests the lamps were operated under what is considered good maintenance conditions, the globes and holders being cleaned every 200 hours. The decrease in mean hemispherical candle-power amounted in 1,000 hours to 22 per cent., the greater part of which took place in the first 300 hours. The initial consumption per mean spherical candle-power was 3·31 watts, and per mean hemispherical candle-power was 1·95 watts. At the end of 1,000 hours the values had increased to 3·78 and 2·27 respectively. It is stated that, while the Nernst lamp properly belongs to the class of incandescent lamps, from the maintenance standpoint it is more akin to the arc. From the reports of the 7,000 glower units in service in the Pittsburg district it is learned that the total maintenance cost per glower per month is 9·56 cents, and it is estimated that the cost for maintenance per kilowatt-hour of energy used is 5·2 cents. This figure agrees closely with the average cost reported by a number of companies who use the lamp on a large scale.

**Royal Meteorological Society.**—The final meeting of this society for the present session was held on the afternoon of the 21st inst., Mr. Richard Bentley, F.S.A., president, in the chair. Mr. G. C. Simpson read a paper on the "Normal Electrical Phenomena of the Atmosphere." In no branch of physics, he remarked, has the discovery of ions, electrons, and radioactivity produced a greater revolution than in that devoted to atmospheric electricity. The author defined the chief line along which during the last few years investigations have been made and the conclusions arrived at, and pointed out some of the problems awaiting solution. The amount of radioactive emanation in the lower regions of the atmosphere is increased by all those meteorological conditions which tend to keep the air stagnant over the earth's surface. The meteorological conditions which either cause or often accompany stagnant air are calm, low temperature and high relative humidity, while, on the contrary, high winds, high temperature, and low humidity generally accompany the mixing of large masses of air. This all agrees with the observed facts that the atmospheric radioactivity increases with falling temperature, rising humidity, and increasing wind strength. The author is of opinion that a solution of the problems of atmospheric electricity can only be expected from the results of extended measurements in the atmosphere itself, and from laboratory experiments directed towards the problem. A paper by Mr. G. P. Ferguson, entitled "Two New Meteorological Instruments," was also read, in which the author described two new meteorological instruments: the "automatic polar star light recorder," for recording the amount of cloudiness at night; and the "ombroscope," an instrument for determining the time and duration of rain. Both of those instruments are in use at the Blue Hill Observatory, Mass., U.S.A.

**Wireless Telegraphy in Lightships.**—It is reported that the Board of Trade and Trinity House have concluded a contract with Marconi's Wireless Telegraph Company, Limited, providing for the installation of the Marconi system in lightships. The arrangement is expected to materially facilitate communication with the shore and between different lightships for the ordinary purposes of the lightship service, and also to report ships in distress. It is now more than six years since the Marconi Company installed wireless telegraphic apparatus on the East Goodwin lightship, and the communication that has been established with a shore station has apparently demonstrated to the satisfaction of the Board of Trade and Trinity House that good telegraphic communication can be maintained by these means. Communication was maintained for several months, during the latter part of which period the station on the lightship was worked by the lighthouse crew. The installation was found of great service to the lightship for ordinary communication, and on one or two occasions were of special utility in reporting damage from storms and in securing prompt assistance. When, after several months, it was found that the Board of Trade and Trinity House were not in a position to make a contract for the continuance of the arrangement, the apparatus was removed, the Trinity House expressing their satisfaction at the service rendered. Representations have from time to time been made to the Government by persons interested in the protection of shipping upon the desirability of effecting telegraphic communication between the lightships and the shore. Cable communication has, however, been found somewhat expensive and uncertain, and until recently various difficulties have prevented the Board of Trade and the Trinity House from concluding an arrangement with the Marconi Company for a wireless service. Apparently, however, these difficulties have now been surmounted, and presumably there will be an opportunity of testing the efficacy of the system for this purpose on a larger scale.

**The Efficacy of Advertising.**—Amongst the subjects that engaged the attention of the American National Electric Light Association at their recent Denver meeting was that of "Advertising Methods," a paper under this title being read by Mr. Percy Ingalls. Mr. J. C. Hammond, of the Denver Gas and Electric Company, opened the discussion, and stated that his company had not fallen below an advertising return of 10 per cent. of prospects. In some classes of advertising it had averaged 12 per cent., and in one particular class 63 per cent. Mr. J. F. Gilchrist remarked that in the branch of residential lighting the sale of current-consuming devices, such as electric heaters, etc., had increased 250 per cent. since advertising had been started. Mr. C. W. Lee recommended advertisers not to put all their eggs into one basket, but to spread their outlay over several organs, issuing varied matter at intervals of two or three weeks. In reply to a question, he stated that his company expends about ½ per cent. of its gross earnings for advertising. Mr. L. E. Watson stated that on particular days, and especially on New Year's Day, he sends out a neat letter to the business people of the town, setting out some point in connection with electric lighting. Mr. R. E. Allen related that when he took charge of the plant he now manages he began advertising to the extent of a full page weekly in each of the electrical papers, with the result that in two months the gross output increased by 40 per cent. as compared with the corresponding month of the previous year, while the output during the present year has increased by 55 per cent. compared with a twelvemonth ago. Mr. T. C. Martin suggested that part of the money offered to the association for advertising purposes should be expended in getting up albums containing samples of advertising in the form of circulars, "dodgers," follow-up letters, etc., these being circulated from one member of the association to another, such albums to be prepared once or twice a year. Our American friends are keenly alive to the value of the ad., and their ledgers generally reflect a favourable result at the end of the year.

**Trams over the Bridges.**—As the result of the City Corporation's decision, briefly chronicled in our last week's issue, and a conference between the House of Commons Committee and counsel for the Corporation and the London County Council another stage has been surmounted in the scheme for carrying the Council's trams along the Embankment, and it really seems now that the line will become an

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accomplished fact, and that at no distant date. In the face of the conversion of the City Corporation it will be rather surprising if the Commons, or even the Lords, go back upon the decision arrived at in committee. The chairman of the special committee, Sir George Faudel-Phillips, gave the Corporation, in lucid terms, the reason why they considered the resolution previously arrived at should be rescinded on conditions to be agreed with the Council. The representatives of the latter, in an interview with the committee had fully recognised the rights and privileges of the City, and were agreed upon the desirability of the Corporation undertaking the widening of Blackfriars Bridge, while they were also prepared to meet the financial aspect of the question in a liberal spirit. Personally, he believed that trams along the Embankment would prove a boon to thousands. An amendment was moved by Mr. H. D. Kimber, who, while willing to assent to the proposal on suitable terms, considered the Corporation, before committing itself to any particular scheme, ought to be afforded an "opportunity of considering its feasibility, and all details involved, so as to adequately safeguard the position of the City as a county of itself, and as the tramway authority for such county, and also to protect the interests of the Bridge House Estates Trust." He was apprehensive of precipitancy, and considered that the scheme had been insufficiently discussed! Sir David Evans's objection to the motion was that if the Corporation reversed their earlier decision, they would discount their prestige at St. Stephen's. Sir William Treloar's objection apparently consisted of a protest against municipal trading. Mr. W. Cooper considered that, as the fringe of the City, the Embankment was just the place for trams, and Mr. A. H. Barber, a member of the special committee, submitted that if the Corporation steadily obstructed the scheme they would be denounced as a hopelessly antiquated body. After this the amendment was put to the vote, and was negatived by a majority of 31. A proposition was then adopted confirming the recommendation of the committee in favour of trams, with the alternative that a new bridge exclusively for trams might be substituted for Blackfriars, a satisfactory arrangement to be previously arrived at with the County Council as to construction, as well as to cost, management, control, and maintenance. These terms were submitted to the House of Commons Committee on Monday, it being agreed that the County Council should not, without the consent of the Corporation, make a commencement with any part of the line until Blackfriars Bridge has been widened or a new one constructed. Seemingly, it only remains now for the Corporation and the Council to agree upon terms, and as the well-loaded coffers of the Bridge House Estates will be largely available for the work of widening the existing bridge or building a new one this should not prove a very difficult matter.

**The Telephone Transfer.**—The enquiry by a committee of the House of Commons into the merits of the provisional agreement between the National Telephone Company and the Postmaster-General was resumed last week, when Bailie Stevenson, of Glasgow Corporation, who had also been requested by other telephone-owning corporations to state the case for municipal telephony, proceeded to state it at considerable length. Coming to the immediate question of the agreement, he gave it as his opinion that the question of whether it was in the public interest must be answered in the negative, except under the following circumstances: (*a*) Unless the plant is purchased at a cost not greater than the expenditure which would be required to enable the Postmaster-General to put equally good plant in position by the end of 1911. The experience of the municipalities showed that, apart from London, all the plant required throughout the country could be installed in three or four years. There was, therefore, no immediate urgency for completing the agreement. If the company was unwilling to make the modifications necessary to prevent the price paid being excessive, the matter could well stand over for a year or two for further negotiations. (*b*) Unless the Postmaster-General could show that the result of the purchase would be a cheaper and more efficient service. The evidence given before the committee, however, led him to a contrary conclusion. Returning to the municipal aspect of the question, he considered that the development of telephony on a huge scale, and the varying conditions prevailing in different parts, would render it exceedingly difficult for the whole service to be adequately performed by one central authority, which was an argument against nationalisation. On Tuesday Alderman Carden, ex-chairman of the Telephone Committee of the Brighton Corporation, gave it as his opinion that local authorities would be able to manage local telephone services better than the Postmaster-General. Alderman Southern said the Manchester Corporation were of opinion that cities and towns which had not established a telephone service should not be placed at a disadvantage in the future as compared with places which had such a service. Though he could not point to anything in the agreement which prevented the establishment of new municipal services, he apprehended that a policy of discouragement would be pursued. He thought, with other witnesses, that local services should be managed by the local authorities. Mr. A. R. Bennett emphasised the grave significance of the schedule for minimum charges which the transfer agreement proposed to authorise. Under the minimum schedule the National Telephone Company would be legally entitled to lease telephones at a cost of only 20s. per annum. That amount would be altogether unremunerative. As corporations necessarily had to charge remunerative rates for telephones, the sanction given to that and other unremunerative rates in the schedule must prove destructive to the corporations businesses. Another charge sanctioned which was also unremunerative was the charge of £2. 2s. per annum rental and ½d. for each outward call for a direct exclusive line. The committee will sit again on July 3, when the evidence for the London County Council and the City Corporation will be heard.

**Income from Patents.**—The report of the committee appointed to investigate the question of income tax assessment has been issued, and one section at least will be read with interest by inventors. The committee have not apparently much sympathy for the spirit of genius, as the paragraph is prefaced by the statement that invention "is usually accidental in its manifestation," and when it leads to patent rights with a marketable value the sale of them has but little of the character of annual income. The profits from patents may be received in various ways, but the patentee who does not himself work his patent usually receives his remuneration in one of the two ways of "royalty" or "lump sum payment." Where a royalty is paid the income from it is assessed in the hands of the patentee, the user of the patent treating the payments made by him as trade outgoings. Where the user of a patent purchases it outright the transaction is treated as a capital transaction on both sides, and no assessment is made on the original patentee in respect of the lump sum received by him. At first sight it may appear that this results in relieving the original patentee of income tax on a profit or gain that would seem to be taxable. Such, however, is not really the case, seeing that as the purchaser

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of the patent is purchasing an income on which he will have to bear the whole of the tax, he presumably takes that fact into consideration when fixing the amount of the purchase money, and gives so much less in consequence. The case is, in fact, analogous to the numerous other cases, such as sales of leasehold interests, of annuities, and so forth, in which a future income is discounted and assigned to a purchaser in exchange for a present capital sum. In theory, the committee say it might be economically possible to treat the sale outright of a patent right in the same exceptional way that the sale outright of a copyright is now treated for the purpose of assessment to income tax. But the present law does not admit of this course, and in practice it would be exceedingly difficult and complicated, and there would be great uncertainty about collecting the revenue on the several occasions on which a patent might pass from one holder to another. The committee, therefore, cannot recommend that any change should be made in the present method whereby the whole of the profits derived from the working of a patent are charged upon those profits at their first source—viz, as earned by the user of the patent, leaving the distribution of the burden of the tax, as between the vendor and the purchaser of a patent, to be regarded as one of the elements of the bargain between them. They do, however, recommend that the principle of taxation of income at its source should be applied to all forms of profit derived from the working of patents, and consequently that, even where a patent is worked under a license or royalty, the manufacturer using the patent should be directly assessed on the whole of his profits, including those derived from use of the patent, but with a title to deduct tax from his payments of royalty to the patentee. The report remarks that this method, besides being more consistent with the general principles of assessment under the Income Tax Acts, would secure collection of the tax on the profits derived from the working of patents in the United Kingdom but payable to patentees who reside abroad and have no agent resident in this country.

**Acyclic Dynamos.**—A patent has recently been granted in the United States to Mr. J. E. Noeggerath, of Schenectady, for an acyclic dynamo, which is stated to embody the latest phases of its development. Its simplicity of construction and the consequent absence of commutation troubles render the acyclic or homopolar dynamo especially suitable for operation at high speeds, while the machines may be designed to develop readily at high speeds the necessary counter E.M.F. for operating at ordinary voltages. Mr. Noeggerath's invention consists in so arranging the connections between the armature conductors and the stationary conductors of the machine that these connections themselves serve to magnetise the machine, and that by varying the effective length of these conductors the field strength may readily be varied. This variation may be obtained by simply shifting the position of the brushes relatively to the stationary conductors. In the first diagram, which shows a side elevation partly in cross-section of a unipolar machine arranged with adjustable brushes, A represents the armature and F a structure that corresponds to the field. An armature conductor, *a*, is preferably formed as a flat strip held in place by a cylindrical binding ring, *b*. The armature conductor, *a*, is connected at each end to collector rings, C C; B B representing brushes bearing on the collector rings and mounted on bars, D D, which are carried by the adjustable rings, E E. These rings are mounted in the manner ordinarily employed for brush-holder yokes, enabling the rings to be rotated so as to shift the position of the brushes. A return conductor or frame conductor, *f*, is employed, by means of which any two brushes at opposite ends of the machine may be connected so as to place two armature conductors in series. The frame conductors are formed in the same shape as the armature conductors, and as they are adjacent to the latter, and are carrying an equal amount of current in opposite direction, they serve to neutralise the armature reaction. It will be seen from the second diagram that each brush instead of being connected to the nearest frame conductor is connected by a flexible connection, *h*, to a frame conductor, *f*, which is slightly displaced from the brush. The several flexible connections, taken together, form one or more complete turns encircling an armature and carrying a

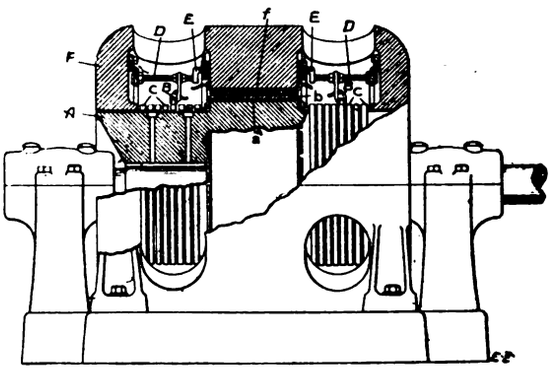


FIG. 1.

current equal to that in each armature conductor. Reference to the first diagram will show that if a coil were placed outside of and parallel to a collector ring, and energised by by a current, it would set up a flux, which would pass down from the central portion of the frame across the central air-gap of the machine into the armature, cutting the armature conductors, then outward to the end of the armature, and across the outer air-gap to the end of the frame, thus generating an E.M.F. in the revolving armature conductors. It will be evident from the second diagram

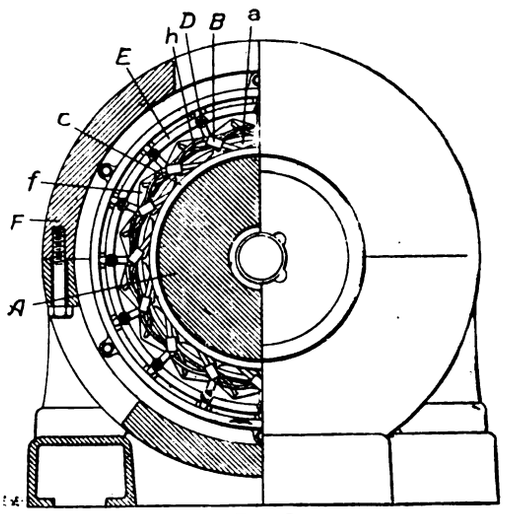


FIG. 2.

that the flexible end connections form such a magnetising coil, and as the end conductors carry the armature current the dynamo will act as a series-wound machine, and as a motor will exhibit the characteristics of a series motor. Furthermore, it will be seen that by shifting the brushes in one direction or the other the effective length of each flexible conductor, and consequently the effective turns of the field, will be varied. This furnishes a convenient means for controlling the speed of the motor or for reversing the direction of rotation. The excitation produced by the end connections can, if desired, be supplemented by a field coil, but for high speeds the end connections themselves will usually be found to provide sufficient excitation.

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## INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

The tenth annual convention of this association was opened in Edinburgh on Tuesday last, when the LORD PROVOST (Sir Robert Cranston) welcomed the members. He wished them a pleasant and profitable time in the city of Edinburgh, which he claimed was unequalled for historic interest. They were in Edinburgh proud of their electrical department, which held no mean place amongst municipal undertakings. He extended a hearty welcome to them on their own account, as he was pleased to have Edinburgh chosen as the meeting place of such an association; he also welcomed them because they had selected as their president Mr. F. A. Newington, the city electrical engineer. He was pleased to see with them that day Bailie Mackenzie, who was the originator of the Edinburgh undertaking. After some amusing remarks as to the accuracy of electricity meters and the distribution of profit of the electrical undertaking, the Lord Provost concluded his speech by wishing the convention every success.

Councillor STEVENSON, the chairman of the Electric Lighting Committee, hoped that the Edinburgh visit would be a profitable one. They were fortunate in having as Lord Provost Sir Robert Cranston. He would be pleased to show them the electric lighting undertaking, which in Edinburgh had been a conspicuous success. It was inaugurated 10 years ago, and in the first year's working they secured 450 consumers and sold 880,000 units. Last year there were 8,000 consumers on the mains and they sold 11,000,000 units. They had laid up a reserve fund of £78,000, and had an annual income of £112,000. The policy of the committee was to reduce the charges as quickly as possible, and they now charged only 3½d. per unit for lighting. From the commencement of the undertaking there had been no difficulty in making a profit, but they had had a fight to keep this profit out of the hands of the city treasurer. He believed that after building up a reserve the profit should be used to reduce charges rather than go to reduce the general rates. He extended a cordial welcome to all present.

Mr. F. A. NEWINGTON then read his presidential address.

### Presidential Address, 1905.

BY FRANK A NEWINGTON, CHIEF ELECTRICAL ENGINEER, EDINBURGH.

I have to thank you for the great honour you have done me in electing me your president for this year. This is our tenth annual meeting, and it is interesting to note the increase in membership since the formation of the association. In the first year our members were: representatives of committees, 39; engineer members, 48; associates, 36; and now they are: committees, 148; engineer members, 159; associate members, 13; associates, 71. That is, our membership has increased nearly four times during this period.

Mr Arthur Wright, in his presidential address at the first annual meeting, expressed the opinion that there was a pressing need for an association of this kind, and the rapid rate at which we have grown proves that he was correct. It will, perhaps, not be waste of time if we look back at some of the points raised by our first president, and see what has been done during these 10 years. The period for repayment of loans has been very carefully considered, and this association has come to the conclusion that about 30 years is the average life of electrical plant There is, however, still no standard period for repayment. Quite recently the Local Government Board has granted loans on what appears to be far too short a term for repayment. This matter will be brought before you at the general business meeting on Friday, so that some concerted action may be taken.

The methods of dealing with the profits of electricity supply undertakings is still a difficult question. In the event of the general rates not being sufficient to meet the expenditure, it is a very easy way out of the difficulty to take a few thousand pounds of the surplus of the electricity undertaking, and so save an increase in the rates the following year, but this seems to be a short-sighted and dangerous policy, at any rate until the full statutory amount of 10 per cent. of the capital expended has been placed to the reserve fund. And, further, unless a similar sum is contributed by the gas undertaking it is unfair. It does not seem right for the users of electricity to be asked to assist the users of gas to pay their rates. This is really what it amounts to. If electricity was universally used, a contribution to the rates, although undesirable, would then be borne more evenly than under present conditions. Perhaps with a tramway undertaking it is rather different, as at present there is not, as a rule, any direct competition, but even here it seems that the poorer part of the population—that is, those who most use the tramways—are being asked to bear part of the taxation of the rich. The other side say that, as any loss would have to be borne by the rates, it is only right that the undertaking should pay something for this security. But is there much in this argument? As a rule, the undertaking pays its way after the first year or two. Although the majority of undertakings are building up their reserve fund as quickly as possible, still it seems that we are not any nearer to a fixed rule about this than we were 10 years ago.

Depreciation of plant is closely connected with the reserve fund. If the loans are paid off in 25 or 30 years, and the reserve fund is made up to the full amount, is it necessary to further depreciate the plant This largely depends upon the life of the plant, and if this will on the average last the period of the loan, there does not seem to be any need of a depreciation fund as far as the life of the plant is concerned. Municipal undertakings in this respect are working under different conditions to companies. Electricity supply companies have a definite number of years—42 in most cases—during which they are given statutory powers to supply electricity in a given area, but at the end of that period the local authorities can buy up the undertaking, not as a going concern, but simply at the then value of the plant—that is, the business connection which the company has built up during these years, or goodwill, is not worth anything. Now, consider a municipal undertaking. The capital has to be paid off in from 25 to 30 years as a rule. At the end of this period how do we stand Buildings will still be quite good; the copper in the mains will be of very considerable value even if the insulation is not, and if our machinery has been kept in good order by general maintenance and perhaps by calling on the reserve fund for special cases, our successors will be in the very comfortable position of having a good business bequeathed to them along with a very considerable amount of plant without having to pay anything for it. The loan having been paid off they will be free to borrow again to replace machinery if necessary. Moreover, if the local authority at any time during the period of the loan or after is desirous of selling the undertaking, judging from towns where the local authority has purchased from a company, they will be able to command a very considerable sum for goodwill. It seems, therefore, that the local authorities are very much better situated in this respect than are companies.

There is another side, however, to this question of depreciation which must be kept in view. It would be very unwise to say that the type of machinery in use to-day will also be installed 20 or 30 years hence. But unless some entirely new method of generating electricity is discovered, any improvements that can be made in either steam or gas engines would not warrant the displacement of the present very efficient steam-engine. With coal costing about ¼d. per unit (and this figure we are all gradually reaching) enormous economies would have to be obtained with any new method of generation before it would pay us to do away with our present machinery. But we must not forget that we may have to face some altogether new form of artificial illuminant, and, therefore, it would seem a sound business policy to form a depreciation fund over and above the reserve fund in order to meet an emergency of this kind. At the start of an electricity supply undertaking the output is frequently underestimated, and so small units of machinary are put down. After a few years these are found to be inconvenient to work, although still quite suitable in other respects. Second-hand plant of this kind seems to have an extremely small value—in fact,

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very little more than the value of the material—unless a purchaser can be found who wants exactly this kind of machinery. Plant of this description, therefore, may depreciate in value very rapidly. This also should be provided for by means of a depreciation fund.

In connection with the finance of municipal electrical undertakings, it is exceedingly satisfactory to notice how many more towns are now making a profit, and in many instances large profits, as compared with a few years ago. In the table of costs in the *Electrical Times* of May 25, 1905, the number of municipal electric supply undertakings, not including tramways, making a profit is 115, the surplus being about £436,000. Those showing a loss are 67 in number, the amount being £69,480. Of these 67 towns, 42 have only completed their third year of working. The figures given in the table of costs for a corresponding date in 1902 are 46 towns with a surplus of about £89,000, and 53 towns with a loss of £86,500. Gas experts have succeeded in very much improving the incandescent gas mantle, so much so that it is now very suitable for the lighting of streets where a large amount of light is not necessary, and where, therefore, arc lamps would be too powerful. Just at present there does not seem to be any form of electric lamp that can quite compete with the incandescent gas mantle for this purpose. There are some new forms of electric lamps, more or less in the experimental stage at present, that appear to be very promising, as they are exceedingly economical. We may, therefore, very soon expect to have a lamp that can be used for side-street lighting at a less cost than the incandescent gas mantle. The paper on street-lighting that will be read this morning is of special interest to us just now on account of the recent improvements in the gas mantle.

During the last 10 or 12 years enormous improvements have been made in the manufacture of machinery for generating electricity, but, unfortunately, very little, if any, advance has been made in the wiring of houses or other buildings for electric light. This work, as a rule, does not come directly under our care, but it is a matter that may very seriously affect us. The poor quality of the material used and the unsatisfactory way in which the work is carried out, are certain to give trouble. So-called indiarubber insulation for electric conductors frequently contains from 50 per cent. to 60 per cent. of something that is not rubber at all. The elastic properties of this mixture soon disappear, and it becomes hard and brittle. If there is any moisture in the pipes the insulation fails, and then the house has to be rewired. What will be the result of this? Will the consumer be content to be frequently having some of his lamps out of order, and after a period of, say, 10 years find it necessary to rewire his house? Will he not rather be inclined to think that electric light wiring and fittings are too uncertain and expensive to keep up, and so go back to some other form of artificial illumination? The material now very generally used for insulation is not nearly so good, on account of the high price of rubber, as that employed 10 years ago. Contractors for electric installation work naturally buy the cheapest material they can, especially as competition in this class of work is very severe, but, as a rule, they have not any idea of what the insulation is composed of, nor have they the means of testing it. They simply trust to the makers of insulated cables to provide them with material that will pass the official test made by the supply authority. As iron pipes are now very generally used for protecting the wiring, a better insulation for the conductors is required than in the days when wood casing was practically the only material used. I do not suppose that the larger users of electric light would discontinue it on account of these troubles, as its convenience and other advantages will with them outweigh these, but to the consumers using only a few lights the expense of rewiring their houses might be a very serious matter. As these smaller consumers are probably more profitable to us than the larger, it will be to our advantage to do all we can to improve the existing unsatisfactory way in which this work is done. We do not want to increase the cost of installing electric light, as this would prevent the smaller householders from using it. If possible, we should try to make it less costly. For small houses where exposed wires would not be objectionable is there any need for iron pipes or other expensive protection for the wires? During the last year or two fire-proofed cables have been introduced. As a rule the fire-proofing is quite efficient, and as far as can be seen at present does not have any harmful effect on the rubber. A system in which fire-proofed cables are used, carried on suitable insulators fixed to the walls or ceilings, should be perfectly good. The insulation of the cables would require to be of high quality, and good workmanship would be necessary, but the cost should be considerably less than with the present system with poor quality material. The rewiring of this when necessary would also be an easy matter. On the Continent it is usual to see ordinary twin flexible wires fixed to the walls, often without insulators, and these do not seem to give trouble. The pressure there is lower than is generally used in this country, but with good material and workmanship this system should be quite suitable. The cost of installing electric light is a very serious consideration to the small householder. That this is realised is shown by local authorities themselves wiring houses on what may be called easy payment terms. Whether this is advisable or not is a question that I will not deal with now, but I think that everyone will agree that it is better for the undertakers not to do it if the consumer will. By reducing the cost of installation work this end may be attained.

The present position of supply authorities as regards the power to enforce wiring regulations is vague and unsatisfactory. On account of the use of inferior material and of bad workmanship fires have occurred through electricity. This, in time, may shake the confidence of the public in the safety of electric light. In the Electric Lighting Acts, and also in most provisional orders, there are clauses which may be taken to give the undertakers the necessary powers to enforce good work. But as these are not so definite as might be desired, your council are now considering this matter with the view of asking the Board of Trade to sanction wiring regulations which will, as far as possible, ensure the safety of the public from the risk of fire.

The president last year referred to the testing of consumers' lamps. This has been taken up very energetically by Mr. Wilkinson in Harrogate, who has made arrangements so that consumers or contractors can have their lamps tested at a nominal charge. Although testing the lamp when new will not prevent the consumer from using it after its useful life is past, it will at any rate insure that the lamps when new are efficient. This seems a simple way to prevent the consumer buying low-priced inefficient lamps, simply because they are cheap at first. I think the majority of users of electric light will be very glad to buy lamps that have been tested and certified by the corporation. This matter is now being carefully considered by a committee of this council, and suitable rules and conditions are being drawn up which will be issued very shortly.

One of the aims of a municipal electrical undertaking is to utilise the machinery during the daytime as much as possible, and, therefore, electricity for power or heating purposes is sold at a low rate. But there is a weak point in this arrangement. The motors are used during the time of maximum lighting load during the winter months, and, therefore, additional machinery must be provided for them. If we can arrange for the motors to be switched off during the two or three hours of maximum load for lighting in the four winter months, extra machinery will not be required, and so a very low rate can be charged. This system is just now being adopted in Endinburgh, and is also in force in a few other cities. On analysing the consumption of electricity by motors, it is generally found that the load factor is extremely low. The following figures show the average number of hours a day during which the total power installed is used for different classes of work in Edinburgh.

| | Total H P. installed. | Full load. Hours per day. |
|---|---|---|
| Elevators | 610 | ·9 |
| Butchers and bakers | 180 | 1·27 |
| Printing works | 1,327 | 1·52 |
| Breweries | 247 | 1·13 |
| Joiners and builders | 1,057 | 1·85 |
| Engineering works | 981 | 2·08 |
| Laundries | 40 | 2·87 |
| Aerated water works and bottling stores | 88 | 3·27 |

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Unfortunately these figures refer to kilowatts installed, not to maximum kilowatts required, but they show that the whole plant would only be used for an exceedingly short time each day. From these figures it is quite certain that the total power used at any one time is not half the power installed, and so the hours per day can at least be doubled, but even then the load factor would not be good. As the cost of generating electricity will be in inverse proportion to the load factor of the motors, this should be considered when fixing the price of electricity for power purposes. The above figures are not of very much value, because they do not tell us how much of the motor load overlaps the lighting load. In connection with the large Power Bill now before Parliament a good deal has been said about the diversity factor, but is this not over-rated. As a rule, factories shut down at about the same hour, say, six o'clock in the evening, and probably the motors are in use more or less up to the time of stopping.

In conclusion, I would suggest that the members of this association would be collecting very valuable data if they could find out how the motors connected to their system are used during the hours of maximum lighting load in the winter months.

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Alderman ELVY ROBB, of Tunbridge Wells, proposed that a vote of thanks be given to Mr. Newington for his interesting address, which touched on a wide range of subjects in a most temperate and useful manner. The subjects were of interest to all, and the president's treatment was eminently fair.

Prof. A. B. W. KENNEDY had pleasure in seconding the vote of thanks, and congratulated the president on the sound common sense displayed in the treatment of the thorny points in the address. He thought that those present would, on the whole, agree with the conclusions come to.

The President then called on Councillor Sinclair, of Swansea, to read his paper on

## Load Factor—Its Effect upon an Electricity Station.

BY COUNCILLOR ALEX SINCLAIR, CHAIRMAN OF THE ELECTRIC LIGHTING AND TRAMWAYS COMMITTEE, SWANSEA.

In compiling this paper the author keeps in view the great importance which the load factor of a station has upon its commercial success, not that it is at all necessary to labour this point as far as engineers are concerned, for he feels sure everyone fully realises the immense possibilities to their stations if a high factor can be ensured; his object, however, is not so much to impress engineers, but to attempt to bring before the notice of the chairmen and their committees the necessity of improving their position in this respect. Although lighting was in the first instance the reason for establishing an electricity under-

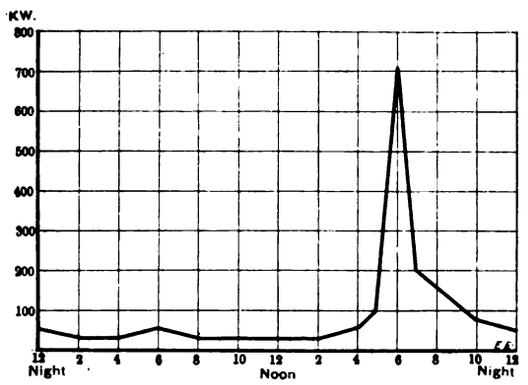


CHART NO. 1.

taking, it is generally conceded that this alone can only hope for a certain measure of success. Of course, very large stations with large outputs do not come within this category—and, successful as many have been, they cannot, on lighting alone, hope (no matter how they increase) to add much to their prosperity. By adding customers who will take energy either for power or other purposes during the hours of light load the load factor is improved, with a result that the cost of generation per unit becomes decreased. Among desirable customers to assist in attaining this end are public lighting, power and heat, and tramways, but there are also others of great importance, such as supply in bulk, small cottages, etc., but for the purpose of this paper it is the writer's intention to deal only with those enumerated. For simplicity he divides his remarks into two parts: the first dealing with the station itself, and the other with the commercial aspect.

A series of charts is submitted to illustrate graphically the effect attained by incorporating the classes of supply mentioned

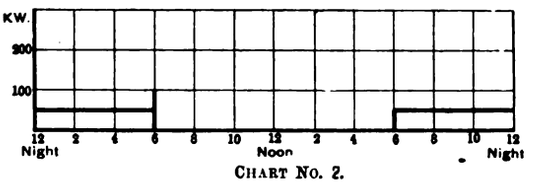


CHART NO. 2.

with the ordinary lighting. These charts are neither in any way typical of any station nor ideal, but simply form an illustration of what might be done in common practice in a town of 100,000 to 150,000 inhabitants and a station of 1,500 kw. to 2,000 kw. They do not interpret the load on any particular day of the year, but what might be termed the average loads of 365 days reduced to one, but with, in each case, the maximum kilowatts reached. Of course the usual irregularities of the

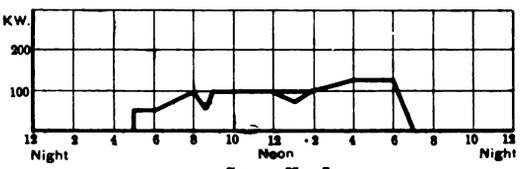


CHART NO. 3.

daily curves are left out, and the figures, like the charts, are merely illustrative. Chart No. 1 supposes an annual output of 613,200 units with a maximum load of 700 kw. for private lighting. The load factor on this supply would be

$$\frac{613{,}200 \times 100}{8{,}760 \times 700} = 10 \text{ per cent.}$$

It will be noticed that, notwithstanding this high maximum demand—the time of the demand is limited and the rest of the

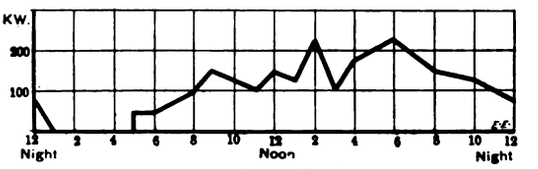


CHART NO. 4.

day the load is light—to supply a large number of customers with light during the early hours of darkness requires 10 times the machinery that would suffice to supply energy to the same amount during the 24 hours. Further, it will be seen that, adding to lighting customers only, will surely add to the height of the peak without materially filling in the rest of the diagram.

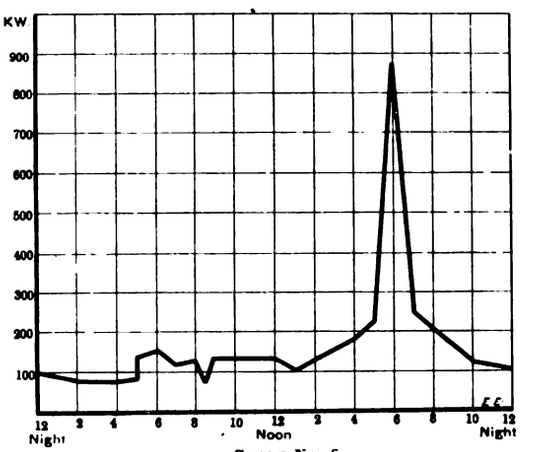


CHART NO. 5.

Chart No. 2 illustrates a public lighting supply giving an annual output of 219,000 units with a maximum demand of only 50 kw. This would give a load factor of

$$\frac{219{,}000 \times 100}{8{,}760 \times 50} = 50 \text{ per cent.}$$

It will be readily seen that with so small a plant capacity giving such a large output, the position of the station must improve. Charts 3 and 4 refer to power and traction, giving a supply of 459,000 units with a maximum of 125 kw. and 916,370 units with a maximum of 225 kw. respectively; their

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load factors are 42 per cent. and 47 per cent. These further illustrate the improvement to a station already related in the remarks *re* public lighting. Chart No. 5 shows the combination of lighting (private and public) and power, whilst No. 6 depicts the same with traction added. In the first example, with 1,281,200 units and a maximum demand of 875 kw., the load factor is increased to 16·71 per cent., whilst in the other, having 2,207,570 units at 1,100 kw., the load factor becomes 23·14 per cent.

The question now arises as to what is the commercial value of the foregoing, but before doing so fully it will be necessary to show what is the likely result of improved load factor on the cost sheets of the station. For this purpose, after much study

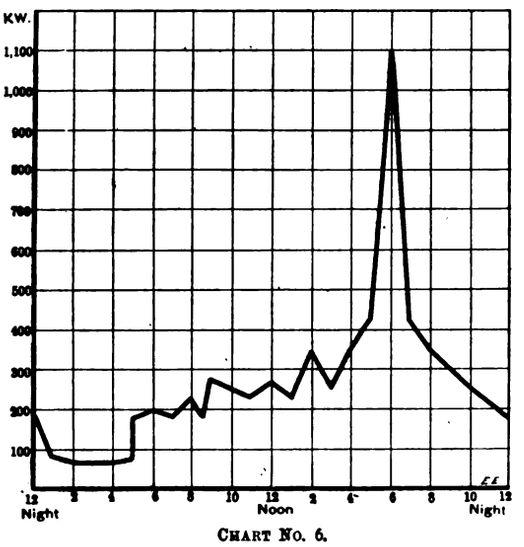
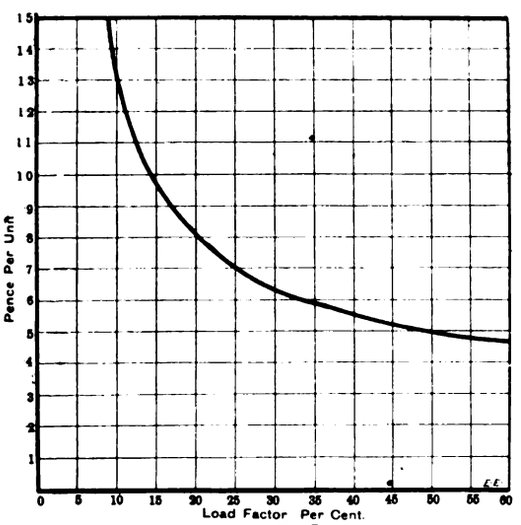



CHART No. 6.

and considerable experience, the author has compiled a series of curves showing cost per unit under varying load factors; these must not be taken as indicative of either the relatively good or the relatively bad, or to the very large or very small stations, nor of any particular one, but may be applied to all, correcting for variations due to locality or other cause. Curve No. 7 is intended to illustrate the works cost under different load factors; the cost per unit in pence can from this curve be readily ascertained for any factor from 8 to 60 per cent.; it is made up of station charges for coal, wages, repairs, oil, stores, etc., but as the figures are reasonably within ordinary results, it is not necessary to comment thereon. Curve No. 8 is an effort to depict the total charges—*i.e.*, works cost plus management, rent, rates, taxes, insurance, etc., in pence



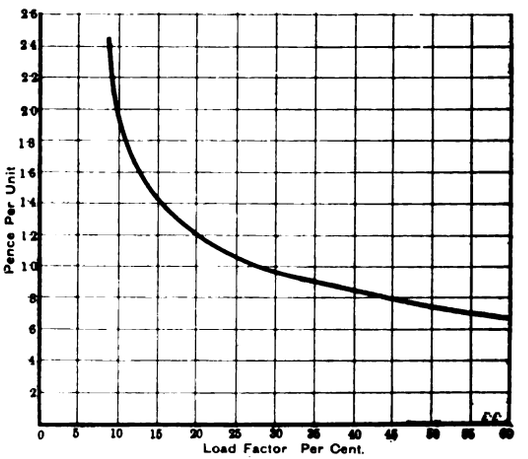

CURVE No. 7.

per unit for factors ranging from 8 to 60 per cent. In compiling Table A the author has not so much in mind the proof or otherwise of the correctness of his figures, nor to show how closely they approximate to average practice, but to impress more particularly the great improvement in cost due to increased load factor. In arriving at these figures he noticed considerable variations in the amounts charged by different stations for management, rent, etc., such variations differing from £610 in a 1,000-kw. to £2,000 in a 1,200-kw. station; these figures are taken at random from the *Electrical Times* to illustrate the great lack of uniformity in this direction; this variation is no doubt due to the policy of the particular place or district, but for the purpose of making strict comparisons greater uniformity might be arrived at; further, it is

Table "A" giving Cost with varying Capital Charges per Kilo-Watt of Maximum Demand.

| Load Factor. | Cost per Unit. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Works. | Management, Rent, etc. | Total. | Total plus Interest and Sinking Fund at 5¼% calculated on Cost per Kilo of Maximum Demand. | | | | | |
| | | | | £80. | £90. | £100. | £110. | £120. | £130. | £140. |
| % | d. | d. | d. | d. | d. | d. | d. | d. | d. | d. |
| 8 | 1·840 | 0·610 | 2·450 | 3·880 | 4·060 | 4·240 | 4·420 | 4·600 | 4·780 | 4·960 |
| 9 | 1·400 | ·573 | 2·073 | 3·350 | 3·510 | 3·670 | 3·830 | 3·990 | 4·150 | 4·310 |
| 10 | 1·325 | ·545 | 1·870 | 3·020 | 3·164 | 3·308 | 3·453 | 3·595 | 3·739 | 3·883 |
| 11 | 1·236 | ·524 | 1·760 | 2·798 | 2·928 | 3·057 | 3·187 | 3·316 | 3·446 | 3·575 |
| 12 | 1·156 | ·504 | 1·660 | 2·618 | 2·738 | 2·858 | 2·977 | 3·097 | 3·217 | 3·336 |
| 13 | 1·090 | ·485 | 1·575 | 2·455 | 2·565 | 2·675 | 2·785 | 2·895 | 3·005 | 3·115 |
| 14 | 1·027 | ·468 | 1·495 | 2·318 | 2·414 | 2·516 | 2·618 | 2·720 | 2·822 | 2·924 |
| 15 | ·983 | ·452 | 1·435 | 2·195 | 2·290 | 2·385 | 2·480 | 2·575 | 2·665 | 2·760 |
| 16 | ·953 | ·427 | 1·380 | 2·094 | 2·183 | 2·272 | 2·361 | 2·450 | 2·539 | 2·628 |
| 17 | ·916 | ·414 | 1·330 | 2·003 | 2·087 | 2·171 | 2·255 | 2·340 | 2·424 | 2·508 |
| 18 | ·867 | ·403 | 1·270 | 1·910 | 1·990 | 2·070 | 2·150 | 2·230 | 2·310 | 2·390 |
| 19 | ·827 | ·393 | 1·220 | 1·880 | 1·942 | 2·004 | 2·067 | 2·130 | 2·193 | 2·256 |
| 20 | ·795 | ·385 | 1·180 | 1·752 | 1·824 | 1·896 | 1·968 | 2·040 | 2·112 | 2·184 |
| 21 | ·773 | ·377 | 1·150 | 1·697 | 1·765 | 1·833 | 1·901 | 1·970 | 2·038 | 2·106 |
| 22 | ·756 | ·369 | 1·125 | 1·645 | 1·710 | 1·775 | 1·840 | 1·905 | 1·970 | 2·035 |
| 23 | ·738 | ·362 | 1·100 | 1·597 | 1·659 | 1·721 | 1·783 | 1·845 | 1·907 | 1·969 |
| 24 | ·715 | ·355 | 1·070 | 1·550 | 1·610 | 1·670 | 1·730 | 1·790 | 1·850 | 1·910 |
| 25 | ·702 | ·348 | 1·050 | 1·510 | 1·567 | 1·624 | 1·682 | 1·740 | 1·797 | 1·854 |
| 30 | ·638 | ·320 | ·958 | 1·330 | 1·387 | 1·435 | 1·483 | 1·530 | 1·578 | 1·626 |
| 40 | ·560 | ·270 | ·830 | 1·115 | 1·151 | 1·187 | 1·223 | 1·258 | 1·294 | 1·330 |
| 50 | ·505 | ·225 | ·730 | ·958 | ·987 | 1·015 | 1·044 | 1·072 | 1·100 | 1·128 |
| 60 | ·465 | ·135 | ·650 | ·819 | ·803 | ·887 | ·912 | ·937 | ·961 | ·995 |

the author's opinion that these charges should be properly allocated so as to approximate to the position a similar undertaking would hold were it owned by a private company, and so prevent criticism often levelled at municipal accounts. In Curve 9 will be found the cost per unit in pence under different load factors for total costs plus interest and sinking fund; for the purpose of this curve an average capital expenditure of £120 per kilowatt of maximum demand has been taken and the calculation worked out on the basis of 5¼ per cent. for interest and sinking fund. For




CURVE No. 8.

simplicity the author has tabulated in Table A the results obtained in Curve 9, but with capital charges rated at from £80 to £140 per kilowatt of maximum demand. In allocating to each unit, irrespective of its use, its due share of capital charges, he will, no doubt, be subject to severe criticism, but he is of opinion, after serious consideration, that such is only fair and proper. True, such a proposition contains a weakness which may be illustrated by the absurd example of 24 persons taking each one unit per day, but consecutively hour by hour, through the same day. In the one case collectively their load factor would be 100 per cent., but individually it would be only 4·7 per cent., whilst the one person would be the same as the 24 collectively. The financial result, however, would probably be 24 units at, say, 6d. and 24 units at, say, ¾d. for prac-

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Table "B." giving Actual Cost per Unit compared with those contained in Curves 7 and 8

| Place. | Units. | Load Factor | Actual. | | | Curves 7 and 8. | | |
|---|---|---|---|---|---|---|---|---|
| | | | Works. | Management, Rent, etc. | Total. | Works. | Management, Rent, etc. | Total. |
| | | % | d. | d. | d. | d. | d. | d. |
| Collwyn Bay - | 145'406 | 7·38 | 1·77 | 0·71 | 2·48 | 1·95 | 0·75 | 2·70 |
| Hereford - - | 108'851 | 8·45 | 1·39 | 0·81 | 2·20 | 1·61 | 0·59 | 2·20 |
| Llandudno - - | 336'936 | 8·41 | 1·47 | 0·69 | 2·16 | 1·61 | 0·59 | 2·20 |
| Leicester - - | 1'719'001 | 9·64 | 1·24 | 0·59 | 1·79 | 1·36 | 0·56 | 1·92 |
| Luton - - - | 160'844 | 9·90 | 1·12 | 0·74 | 1·86 | 1·33 | 0·55 | 1·88 |
| Longton - - | 61'747 | 10·19 | 1·45 | 0·38 | 1·83 | 1·31 | 0·54 | 1·85 |
| Lancaster - - | 604'948 | 10·20 | 1·30 | 0·51 | 1·81 | 1·31 | 0·54 | 1·85 |
| Darlington - - | 266'311 | 10·87 | 1·04 | 0·79 | 1·83 | 1·25 | 0·53 | 1·78 |
| Lincoln - - | 399'797 | 12·24 | 1·09 | 0·51 | 1·60 | 1·14 | 0·50 | 1·64 |
| Birmingham - | 4'367'164 | 12·25 | 1·33 | 0·51 | 1·74 | 1·14 | 0·50 | 1·64 |
| Birkenhead - | 661'171 | 13·30 | 1·13 | 0·46 | 1·59 | 1·07 | 0·48 | 1·55 |
| Derby - - | 1'490'611 | 13·58 | 1·11 | 0·35 | 1·45 | 1·06 | 0·47 | 1·53 |
| Burton - - | 678'020 | 14·42 | 1·15 | 0·38 | 1·53 | 1·01 | 0·46 | 1·47 |
| Cheltenham - - | 1'534'144 | 14·95 | 1·05 | 0·42 | 1·47 | 0·99 | 0·45 | 1·44 |
| Newport - - | 1'572'362 | 15·30 | 1·10 | 0·21 | 1·31 | 0·98 | 0·44 | 1·42 |
| Swansea - - | 871'555 | 15·81 | 0·98 | 0·38 | 1·36 | 0·96 | 0·43 | 1·39 |
| Cardiff - - | 2'385'472 | 15·85 | 1·11 | 0·30 | 1·41 | 0·96 | 0·43 | 1·39 |
| Leyton - - | 1'194'944 | 15·93 | 1·02 | 0·40 | 1·42 | 0·96 | 0·42 | 1·38 |
| Bury - - - | 671'911 | 16·26 | 0·92 | 0·38 | 1·30 | 0·94 | 0·42 | 1·36 |
| Govan - - | 894'702 | 17·03 | 1·02 | 0·42 | 1·44 | 0·92 | 0·41 | 1·33 |
| Sunderland - | 3'508'139 | 19·21 | 0·92 | 0·38 | 1·30 | 0·82 | 0·39 | 1·21 |
| Devonport - - | 1'349'645 | 20·46 | 0·87 | 0·22 | 1·09 | 0·78 | 0·38 | 1·16 |
| Greenock - - | 1'413'783 | 20·27 | 0·86 | 0·38 | 1·24 | 0·79 | 0·38 | 1·17 |
| Ayr - - - | 1'047'781 | 22·55 | 0·99 | 0·30 | 1·29 | 0·74 | 0·37 | 1·11 |
| Bootle - - | 1'785'486 | 24·97 | 0·72 | 0·18 | 0·90 | 0·70 | 0·35 | 1·05 |
| Motherwell - - | 724'279 | 27·06 | 0·64 | 0·24 | 0·88 | 0·68 | 0·34 | 1·02 |

tically one and the same thing. Such a condition of affairs can only be imagined, for in practice these things generally average up, and it is, indeed, the purpose of this paper to bring home the great advantage of accumulating customers for all times and purposes, so that the load factor may be improved. The figures above quoted, as already pointed out, are not symbolic of any particular station, but taken as a whole, they will be found to coincide fairly with modern practice, as is demonstrated in Table B.

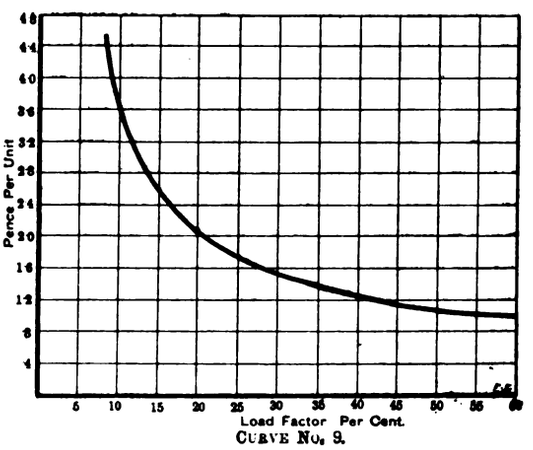
Now as to the commercial advantage likely to accrue from improved load factor, it is only necessary to take the earlier examples as shown in Charts 1, 2, 3, 4, 5, and 6 in combination with No. 9. It will be noticed that for private lighting alone each unit costs at 10 per cent. load factor, 3·595d.; public lighting alone with 50 per cent. load factor, 1·072d.; power alone with 42 per cent. load factor, 1·2d.; traction with load factor of 47 per cent., 1·1d.; whilst the four combined, with a load factor of 23·14 per cent., costs only 1·835d., or practically half the cost for private lighting alone. As to the reliability or otherwise of these figures, and assuming for the moment they represent the revenue per unit, they should give on the collective load factor a similar amount as on the individual load factor. For this purpose are again taken the figures of the earlier illustrations—viz. :

| | | | |
|---|---|---|---|
| Private lighting, | 613,200 units at | 3·595 | £9,185 |
| Public ,, | 219,000 ,, | 1·072 | 978 |
| Power | 415,000 ,, | 1·200 | 2,075 |
| Traction | 916,370 ,, | 1·100 | 4,200 |
| | | | £16,438 |

whilst collectively the result is

2,163,570 units at 1·835d. ..... £16,502

The author thinks it plain from his remarks that it is essential to the cheap generation of electricity to increase the load factor of a station by every possible means, and he has tried to prove that this can be done by pushing vigorously the different kinds of business enumerated. To sum up, he would advise, first, the increasing of the ordinary lighting load by systematic canvassing, thereby bringing before the notice of probable consumers in an attractive form, by booklet or otherwise, the great advantages of electric lighting over other forms of illumination ; lighting is mentioned because, although an increased lighting load does not materially decrease the cost per unit, still the larger the output the better it is for the general welfare of the undertaking. Secondly, public lighting should be extensively used, for by its use the financial position is so improved as to allow energy to be sold at cheaper prices ; Edinburgh and Glasgow may be cited as typical examples of the fruitfulness of this supply. He also is of opinion that this point does not always receive its due consideration by electric lighting committees, and where it is tried, more or less extensively, its progress is often throttled by the charge per unit being too high, thus affording adverse comparison with other forms of street illumination. It has been made clear in the course of this paper how cheaply energy can be generated when so valuable a load factor as that of street-lighting can be obtained, and the writer thinks that this matter should receive far more attention in the future than it has had in the past. Thirdly, and on this point he lays particular stress, that great hopes may be held out for the future of stations by dispensing power on a large scale to small users at cheap rates. There are many towns where there are small users of power, such as timber yards, printing establishments, machine shops, etc., at present using steam or gas driven plant, where electricity would prove more efficient and economical. Where powers are held for the hiring out of motors this class of consumer is making great headway, because many view with much apprehension the scrapping of their present plant and substituting electricity with what they think the possibility of failure, when they know that by hiring a motor their liability—should they wish it—ends with the year they are more prone to enter into a trial in what they consider to be more or less an experiment. The experience in this direction in Swansea has been to add very largely to the business, and to some extent to account for its successful running. In two years we have improved our load factor from 12 per cent. to nearly 18 per cent., and the author may here add that it is to this circumstance the title of his paper owes its origin. Lastly, with regard to traction, it is not many stations which are so fortunate as to have this valuable asset, but the experience of those having such a load is quite sufficient to demonstrate its help in producing excellent results. He



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refrains from expressing an opinion as to the wisdom or otherwise in having two distinct stations, the one for traction and the other for lighting, etc., as he does not think it comes within the scope of this paper, but it is evident from what he has brought before you that the addition of a traction load to its other functions is of immense advantage to the undertaking.

There is another feature the author has not yet touched upon, but the close study of this question has fully confirmed his belief that electricity cannot be purveyed like milk or sugar at so much per quart or pound ; in other words, an uniform price per unit cannot be fixed, but must depend on the nature of the supply—*i.e.*, quantity and load factor. The maximum demand system meets the requirements of the case, but unfortunately its explanation is so complicated to the ordinary individual that he either cannot or will not try to understand it. The author would like to throw out a suggestion which may or may not bear fruit. If a system simple in itself could be arrived at whereby a customer's load factor could be readily and easily ascertained, his charge per unit could then be regulated by a discount on its rated price. By some such means the ordinary customer, usually a man of business, would be appealed to because he would readily accept the situation if he is aware that his account is subject to a discount on the quantity (as gauged by his load factor) of energy he uses, whereas when confronted with the complex explanations of the maximum demand, he is amazed, always confused, and, if his bill be high, never satisfied.

In conclusion, the author once more wishes to impress the fact that his remarks are intended to place before the chairmen of committees in a concise form the obvious advantages which are sure to follow an improved load factor. Although he has brought forward nothing new, nor, he hopes, anything of a very controversial character, he is of opinion that the criticisms which will follow in discussion will be generally helpful to the carrying on of municipal electric undertakings. Before concluding, he would like to record how highly he appreciates the valuable information contained in the supply costs and records

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of the *Electrical Times*, and also his best thanks to those engineers who, at much trouble to themselves, accorded him great assistance.

Mr. J. F. C. SNELL, of Sunderland, opened the discussion on the paper, and commended the author for the concise way in which he had explained the advantages of improvement in load factor. It would help chairmen of committees to follow by means of the curves given the evolution of the load factor of a station supplying power, traction, and street-lighting from the curve for a station with private lighting only. He did not agree with the author on one or two points. Thus the power factor of public lighting he found to be from 20 to 24 per cent., instead of 50 per cent., as given in the paper. The author's power factor of 47 per cent. for a tramway load was abnormally high. He found 28 per cent. an outside figure. He would also question the accuracy of the £120 for the average cost per kilowatt of maximum demand, which he thought high. The average cost for plant installed was from £60 to £70 per kilowatt, and there was not a margin of 100 per cent. of spare plant. As regards the maximum demand system of charges, he did not think this would survive. With the extended use of electricity the importance of the diversity factor would not be so great, and he thought that flat rates for the various classes of consumers would be generally introduced instead. At Sunderland, where the price of gas was 1s. 5d. per 1,000, it was soon recognised that they must get other than lighting consumers on to the system if the undertaking was to extend. Their efforts to obtain large power consumers had been so successful that out of 11 shipyards and engine works within the area, eight were now being supplied, and two others had agreed to come on. They had sold 5,000,000 units last year, and expected to sell 7,000,000 next year. The consequent improvement in the power factor by the load from these large consumers had caused the coal consumption to drop from 8lb. to 9lb. per unit down to 4 8lb. At the present time the daily load factor was as high as 47 per cent., and they were able to reduce the lighting charges. He would point out the fact that the improvement in load factor caused by tramways was not permanent, as the tramway load did not increase in proportion to the lighting.

Bailie WILLOCK, of Glasgow, thought that, instead of abandoning the maximum demand system because the people could not understand it, they should educate the consumers to appreciate the system. The gas undertaking in Glasgow was extending its business on the same lines by offering special facilities to long-hour consumers. They had adopted a principle of favouring power consumers whose load did not overlap the lighting peak. With the exception of the hours from four to six during the three winter months supply for motors could be obtained at ¾d. per unit. He believed in having an active canvass made of the district in order to secure new consumers.

Mr. H. FARADAY PROCTOR complimented the author on the curves he had prepared to show the variation of costs with power factors. He asked for further information as to how these curves were obtained, so as to know if they were applicable to all undertakings. He agreed that the maximum demand system was not entirely satisfactory, as it regulated the charge to a consumer by his own demand irrespective of the total demand on the station, which really affected the cost of supply. As regards the intermittent supply in which the power could not be used during the lighting peak, he did not think this would find favour. In a factory the cost of power was small compared with the total cost, and it would not pay to shut down the factory during certain hours in order to save a small amount in the cost of power.

Mr. H. L. P. BOOT, of Tunbridge Wells, said that in spite of Mr. Snell's remarks they really charged on the maximum demand system in Sunderland, as they varied the cost of the unit according to the class of consumer and the number of hours he used the supply. He had found that the power factor of public lighting exceeded 20 per cent.

Councillor BUZZY, of Poplar, advocated the linking up of adjacent municipal electrical undertakings, so that current might be interchanged one with the other in the same way that the various water companies shared the demand for water when there was a likelihood of a water famine. He thought that this linking up of adjacent undertakings would improve the power factor, and enable the municipal undertakers to supply at lower rates. In view of the proposed competition from a big power company in London, this joint action should be promptly organised.

Councillor SINCLAIR, in reply, said that his paper was intended to be of the general character, and it was quite likely that Mr. Snell's figures were more accurate in detail. He did not think, however, that the average cost per kilowatt demanded of £120 was too high. He obtained this figure by dividing the total capital outlay for a large number of stations by the total maximum loads observed on the same. They did not want a flat rate, but rather a scale which varied the change with the load factor.

## Street-Lighting.

BY E E HOADLEY, CHIEF ELECTRICAL ENGINEER, MAIDSTONE.

The subject of street-lighting, although a well-worn one, and one about which several papers have previously been written, and read before this association, is, to the author's mind, a subject admitting of a great deal more discussion, and on which there is still a large amount of knowledge and experience to be gained, if anything like universally good and successful results are to be obtained. In this paper the author proposes to deal with the question from the point of view of a central-station engineer, and to confine himself more especially to those problems which occupy the attention of an engineer in a town of moderate size, say 50,000 people, leaving to others, more competent and with greater experience, the fight as to the best means of lighting the principal streets of the Metropolis and our other great towns. It is the hope of the author that these remarks will promote a healthy discussion and be found of interest to at least some of the members, and if the result is that a larger number of the streets in those towns having an electricity supply are in the future so lighted, this paper will not have been written in vain.

The three chief points to be borne in mind by an engineer who is trying to get this street-lighting business into his own hands are as follows: (1) that the light given shall be superior, or at least equal, to the existing lighting in the streets; (2) that the cost to the ratepayers shall be very little, if anything, in excess of that already paid; (3) that the business shall be done at a profit to the electricity works. To attain these three conditions simultaneously is by no means an easy matter in towns where, as in Maidstone, gas is exceedingly cheap and the gas company is pushful and enterprising; however, the problem is by no means insoluble.

Up till a few years ago, leaving the arc-lighted streets out of the question, it was a fight between the flat-flame gas-burner and the carbon-filament electric lamp, a fight in which the honours were pretty evenly divided, and provided suitable fittings and methods of deflection were used, the electric lamps had, if anything, the better of it. At this stage the incandescent gas mantle made its appearance, and having got over the troubles of infancy and grown strong enough to withstand the vibration caused by the street traffic and winds, became at once a serious and successful competitor of the carbon-filament electric lamp, and for some time bid fair to monopolise what is commonly known as side-street lighting. A good many men will differ from the author on this point, but a special study of side-street lighting and an experience extending over seven years has convinced him that he has failed to show the average man in the street that as good a light can be obtained from the carbon-filament lamp for the same price as from an incandescent gas mantle, and this in spite of all that illumination photometers will tell him. At this period of the fight the Nernst lamp made its appearance, and, after many initial trials and partial failures, has survived, and, while still imperfect, is, the author hopes to be able to show, able to compete successfully with the incandescent gas mantle for the lighting of our less important thoroughfares. Maidstone was, the author believes, practically the pioneer of street-lighting with Nernst lamps, and a good deal of trouble was taken in experimenting with the various types of lamps and fittings before anything like a standard was arrived at. As most of you know, the Nernst lamp, which is simply the principle of the gas mantle applied to electric lighting, is made up in several forms. Firstly, the lamp known as the "A" type, which is the one most generally used; this lamp has a vertical glower, or light-giving filament, and is made to take either half or one ampere at pressures varying from 100 to 250 volts. This half-ampere lamp at 230 volts, giving about 75 c.p., has so far proved by far the most satisfactory in use in Maidstone. Secondly, the "B" type lamp, which is a smaller form and fitting into an ordinary lamp-holder, and having a horizontal glower; this was the type the author originally hoped to use, as a lamp taking only quarter

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of an ampere at 230 volts will give from 32 c.p. to 35 c.p., and seemed to be just the lamp required at the time; this, however, had to be given up for reasons set out hereafter. Then we come to the rather newer forms of the Nernst lamp, the "C" type or "Luna" lamp, having a horizontal glower fixed close up to a white porcelain backplate; and, last of all, the "D" type, which is a "B" type lamp enlarged and improved and giving about 75 c.p. with an energy consumption of about 110 watts.

Experiments in street-lighting and tests have been made in Maldstone with examples of all these various types of lamps, with the following results: The tests were made to determine, firstly, the average life of the burners; secondly, the effect on the life of variation in voltage and of vibration; and so far as the results of these tests prove, both with the "A" and "B" types, very little difference in the life was observed either with a voltage rise of nearly 4 per cent. or in lamps exposed to a considerable amount of vibration. The first test consisted in taking batches of six "B" type Nernst lamps, the first six having a 210-volt burner and a 20-volt resistance, the second six having a 215-volt burner and a 20-volt resistance, and the third six having a 220-volt burner and a 20-volt resistance. These were all connected up on a nominal 230-volt circuit and switched on; they were then switched off once each day and allowed to get cold and then switched on again, so as to approximate as closely as possible to the usual working conditions. The following results were then obtained:

*230-Volt Lamps.*

1. Failed at 555 hours.
2. Failed at 1,494 hours.
3, 4, 5, and 6. Still burning at the end of 1,800 hours.

Average burning life, 1,543 hours. Assuming the burners to be useless at 1,800 hours.

*235-Volt Lamps.*

1. Failed at 1,675 hours.
2. Failed at 598 hours.
3, 4, 5, and 6. Still burning at the end of 1,800 hours.

Average burning hours, 1,580 hours.

*240-Volt Lamps.*

1. Still burning at end of 1,800 hours.
2. Failed at 707 hours.
3. Failed at 824 hours.
4. Still burning at the end of 1,800 hours.
5. Failed at 476 hours.
6. Failed at 411 hours.

Average life, 1,004 hours.

The lamps have been taken as burnt out at the end of 1,800 hours, as although the lamps were still intact, the candle-power had very considerably decreased. In the second test, 12 "B" type lamps, having a 220-volt burner and a 20-volt resistance, were taken, and six of them suspended from a fixed board and six rigidly mounted on a board, which was exposed to a constant periodic vibration and at intervals to jars of a harder nature. The actual figures of this test are not available at the present time, but the general results were quite as good from those lamps exposed to the vibration as from the fixed ones. The third test consisted in putting some of the "B" type lamps up in the streets, and measuring the illumination at various distances from the post with a "Trotter" illumination photometer. The average results obtained with a well-designed reflector were as follows:

| 10ft. | 15ft. | 20ft. | 30ft. | 40ft. |
|---|---|---|---|---|
| 0·048 c.p.f. | ·03 c.p.f. | ·017 c.p.f. | ·008 c.p.f. | ·004 c.p.f. |

On the above results a great many of these quarter-ampere "B" type lamps were put up in Maldstone, and for a short time the results were satisfactory, the general illumination competing very fairly with that obtained from a single gas mantle in average condition. After a short time, however, it was found that the candle-power of these small lamps fell away very considerably in some cases, and in others hardly at all, with the result that as soon as the burner began to deteriorate it could not hold its own with the gas mantle, and people began to grumble. These lamps have now all been replaced by the half-ampere "A" type lamps.

Similar tests to those carried out on the small lamps were made on batches of the half-ampere ones, and the general results went to prove that the burners were very little affected by ordinary vibration likely to be met with in the streets, certainly not enough to justify the author in putting in spring suspensions for the lamps; but in the case of the half-ampere lamps it was found that better results were obtained by using a 220-volt burner and a 20-volt resistance on a 230-volt circuit, and this result has been confirmed by several engineers in other towns who have been large users of these lamps, and also by the manufacturers themselves.

The author has some 350 posts at the present time, most of them having a half-ampere lamp rigidly fixed and suspended from a swan-neck at the top of the existing gas column, the burner being about 11ft. from the ground, each lamp being housed in by the upper part of a special reflector which is used to get a better distribution of the light; clear glass globes are used, the general public preferring brilliancy to good distribution, although a good many prism globes were used at first. There are also some 30 posts fitted with the new "D" type lamp, but these have been in use for so short a time that the author cannot speak with any certainty as to their performance.

The "A" type lamp, however, has been in use at Maidstone for about three years, and during this time the life of each individual burner has been kept very accurately, and from the results obtained from a good many hundreds, it is found that the average life is 676 hours, and this has somewhat improved lately. Very few resistances fail, but there has been at various times a good deal of trouble with the cut-out coils in the lamps burning out. This was pointed out to the makers, and evidently more attention has been given to this point, as lately very little trouble in this direction has been experienced. It is the author's general experience that wet weather exercises a deleterious effect on the burners, which have to be replaced much oftener during a spell of wet weather than during an equal period of fine weather. The author would like to hear whether this has been found to be the case elsewhere, and whether anyone can offer a reliable explanation. The average illumination results obtained from a half-ampere "A" type burner with a well-designed reflector are as follows:

| 10ft. | 15ft. | 20ft. | 30ft. | 40ft. |
|---|---|---|---|---|
| ·14 c.p.f. | ·06 c.p.f. | ·03 c.p.f. | ·014 c.p.f. | ·007 c.p.f. |

and these figures compare very favourably with many results taken by the author from a single gas mantle in good average condition throughout the town.

Experiments were also made with the "Luna" type of lamp, but owing to the position of the burner the distribution of light is not, in the author's opinion, at all satisfactory or suitable for street-lighting; no arrangement of reflectors that he has up to the present been able to devise has got over the fact that the larger proportion of the light is thrown vertically downwards.

To sum up the author's experience with Nernst lamps in a few words, the greatest fault he has to find with them is their want of uniformity. This is most apparent in the life of the burners, as, although the average life obtained in Maldstone is 676 hours, yet they have had many burners in use for over 1,000 hours, and several between 2,000 and 3,000, equally they have had many which have failed before they have reached 100 hours burning. This want of uniformity is also noticeable in the way in which the candle-power falls off; some burners do not appreciably drop for quite a long life, while others lose a great deal of their light-giving properties in a very short time, and will then last in this condition for a long while.

These remarks finish all the author has to say on Nernst lamps themselves, and he would like to now consider the three problems which confront the station engineer before he can get the street-lighting into his own hands. Firstly, to give a light at least equal to that given by the ordinary gas mantle. A half-ampere "A" type lamp at 230 volts will give a degree of illumination superior to that given by a gas mantle, both when measured by an illumination photometer in the streets and, what is far more important, when judged by the eye of the general public. This point having been settled, there remains the two more important ones—namely, that the cost shall not be greatly in excess of the cost of gas lighting, and that the electricity supply works shall get a profit out of the business. Firstly, as to the cost of lighting. As a result of a great many enquiries the author finds that the annual cost per post for a gas lamp having a single mantle varies from £3 to £4 as a general rule, which price is inclusive of trimming and maintenance charges; he thinks £3. 10s. per annum an average figure. These gas lamps are generally placed at distances apart varying from 40 yards to 50 yards, thus the cost of lighting a mile of street will vary from £122. 10s. to £154 accordingly. An equally illuminated street can be got by means of half-ampere Nernst lamps placed at a distance of 55 yards, although in Maidstone, as the existing gas columns are used, they average 50 yards, and the author hopes to be able to show that a half-ampere lamp can be kept alight from dusk till dawn for £3. 10s. per annum. The lamp having a 220-volt burner and a 20-volt resistance on a 230-volt circuit requires 390 Board of Trade units during the year, and has actually cost 9s. for renewals of burners, resistances, etc., 10s. for lighting and extinguishing and cleaning; interest and sinking fund charges calculated at 6 per cent. on £6 absorb 7s. 6d., repairs and maintenance of fuses, etc., have actually cost 2s. 6d. per annum, thus leaving £2. 1s. for the 390 units of electricity consumed, or 1·3d. per unit.

Before proceeding further it may be of interest to explain how the lamps are looked after and the details of converting a gas-lighted post to a Nernst lamp. Maidstone has about 350 posts to be maintained, spread over practically the whole of the town, and each post is supplied from the ordinary distributing mains, and has its own switch. There is a staff of four lads who do the whole of the repairs and renewals of burners, etc., clean-

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ing, lighting, and extinguishing; one lad acts as a sort of foreman, and his duties consist in lighting up one round of about 60 lamps each evening, and during the daytime seeing to all the necessary repairs and renewals. Two other lads switch on a round each, and take alternate weeks in being on scout duty during the evenings for the renewal of burners that fail after lighting-up time, and assisting in the daytime in the same work; these two also switch one-third each of the total number of lamps in the morning. The fourth lad switches on a round in the evening, thoroughly cleans 30 lamps, globes, and reflectors each day, and switches off one-third of the lamps in the morning. A few of the lamps round about the station are switched on by a joiner's mate, and are not included in the above. The lads walk for the rounds in the town and cycle over the longer ones. The switching on is done in from 50 to 55 minutes, and the switching off in just over the hour, which are the times specified by the Highways Committee. As stated above, the average cost of attendance comes out at 10s. per post per annum, and for this sum they are kept in first-class order.

Now, as to the exact method and cost of conversion of each post: As it was necessary to keep the capital cost down as low as possible, special permission was obtained from the Board of Trade for the use of a very small cable for the lamp service; after the gas supply is cut off a service is run in from the nearest distributing main, using a special small service box and a twin armoured cable of ·0042 cross-section, which cable is run right up to the top of the post without any joints whatever, where the ends are clamped to the terminals of the switchbox, which is an integral part of the swan-neck fitting. This latter is wired from the switch terminals to the lampholder with twin rubber-insulated lead-covered wire of No. 3/22 size. The top of the lampholder and both openings of the switchbox are then filled in solid with box compound, and this has resulted in a very great reduction in the number of faults other than those due to the Nernst lamp itself. The actual cost of conversion of a lamp, including the post purchased from the gas company for £1. 10s., the swan-neck and fitting £1. 19s., the Nernst lamp, globe, wiring, cable, excavation, making good, is about £6. These lamps, when converted and painted, and with a special fitting and reflector made to the author's own design, look exceedingly well in the streets.

Having shown that the light given by a half-ampere lamp is somewhat superior to that given by the ordinary single-mantle gas lamp using gas under the ordinary pressure, and that the cost to the ratepayers per post need not be more than that already paid for gaslighting, at which price energy is to be supplied at 1·3d. per unit, it remains for the author to give his reasons for stating that at this low price energy can be supplied at a small profit to the electricity department giving the supply. The author looks at the matter from the point of view that this street-lighting business is a very desirable one to obtain, for, first of all, it is a load that is absolutely constant for 10 hours out of the 24 averaged throughout the whole year; this means a 40 per cent. load factor on a perfectly steady load, which is a thing that is not picked up every day. Beyond this there is the fact that street-lighting, provided it is well done, is a good advertisement, and will lead to mains being laid in a great many streets where otherwise they would not be laid, at least until some time later. Having acknowledged these two facts, the question is whether by taking on this street-lighting at 1·3d. per unit we should gain or lose money. The author's calculations and experiments were made on a basis of 350 half-ampere lamps, or exactly 37 kw.; now the extra expense to the electricity works is made up of interest and sinking fund charges on the value of the 37 kw. of our undertaking, which in the case of Maidstone means £147. 12s. per annum, and the extra cost of generating the extra 135,050 units required per annum for these lamps.

Before deciding the matter the author made some very careful experiments, lasting over six weeks, to determine what was the actual cost of generating these extra units, bearing in mind the fact that stand-by and up-keep losses must occur whether they supplied the street-lighting or not; thus the author contends that for this purpose it is only necessary to take into consideration the cost of coal, oil, waste, stores, etc., and repairs. From his experiments this totalled up to ·6d. per unit generated, or allowing a 20 per cent. loss between the switchboard and the lamps it amounts to ·75d. per unit; this with the capital charges makes up 1d. per unit, leaving a profit even after allowing for office expenses, etc., which are exceedingly small as there is only one account to be made out and no trouble at all in collecting it. The author is aware that in looking at the matter from this point of view he will be considered wrong by a great many people, but he cannot help thinking that this street-lighting business is of such a nature as to warrant it being considered from this standpoint, and it is, in his opinion, worth while looking at it from the point of view that "Shall we, as the supply authority, actually gain or lose money by taking it on."

In conclusion, the author would like to say a word or two about the future of side-street lighting. With the Nernst lamp, the mercury vapour lamp, the osmium lamp, and, later still, the tantalum lamp, he has no fear but that central-station engineers will be able to keep the business in their own hands. It behoves them all in these days of strenuous competition to do all that they possibly can to promote economy at both ends of the line—that is, in the cost of the production of energy and the efficiency of the light-giver—by giving careful thought and trials to these new appliances as they come along, and not always waiting for the results of someone else's experiments. The introduction of these newer lamps seems to the author to be of the highest importance, as it means the same amount of light as with the carbon-filament lamps for less than half the same expenditure of energy, and it is at this end of the line, he feels sure, that the greatest advances will be made, advances which will have much more effect on the final result than at the power station end, as he would be a bold prophet who would state that within the next few years a reduction of 50 per cent. will be made in the cost of production of the unit. Personally, the author considers the Nernst lamp, although still far from perfect, to have been the saviour of the side-street lighting business for the electrical world. The chief improvements he would suggest in its manufacture are: that the burner should be made a more mechanical job, and that the actual filament when broken should be capable of easy replacement by the user at a cost of a few pence, instead of, as at the present time, the whole burner, including the heating coil and its support and connections, being thrown away, at a cost of nearly 2s. So far as his experience with the "D" type lamp goes, the author is inclined to think that this will be the most useful type for street-lighting, as up to the present, beyond burners going, he has not had a single failure due to resistance or cut-out troubles or from bad insulation in the lamp, and it is much more easily dismantled and put together than the larger and earlier "A" type, and is only half the price. The author cannot say anything about the other new lamps, as he has not yet been able to test them under street-lighting conditions. The mercury vapour lamp seems to have the germs of a very useful article in it, but, so far, the lamp he has had has not got out of the test-room. The ideal lamp for the lighting of the less important streets will, I think, be found eventually in a small-flame arc lamp taking about 100 watts, and having a magazine feed so that it will burn some 50 or more hours without attention. The manufacturers who first produce a reliable lamp of this description, or something of equal efficiency, will reap a rich harvest.

The author hopes that these few remarks he has been enabled to put before the association will lead to a good and profitable discussion, as there are many points on which he and others are anxious to gain information.

Mr. G. WILKINSON, of Harrogate, opened the discussion on Mr. Hoadley's paper, and said that the subject was a most interesting one to all at the present time. He was pleased to note that at Maidstone one-half of the lamps in the streets were electric. He thought that the success of the Nernst lamp was handicapped by the fact that their manufacture was a monopoly, and that the German firm who made them would not listen to the demand of engineers for improved details. He asked if Mr. Hoadley had included in his figures for the average light of Nernst lamps those which lasted 2,000 hours and over. He had found that after 1,000 hours the light given had fallen so low that the lamp should not be used. His average life for Nernst lamps was 580 hours. He thought it was a mistake to have an individual connection from the low-pressure main to each street lamp, as 80 per cent. of the faults on the low-pressure side of one system he knew of were due to connections for street-lighting. He advocated instead a completely separate system of mains from the station for the supply of the street-lighting. The lamps could then be switched on or off from the station, which resulted in a considerable saving in labour and power. Thus in the three nights before and after a full moon he had found it possible to save 7½ per cent. of the total energy required for street-lighting by judicious switching on and off. As regards the use of small flame arc lamps, he had experimented with one taking three amperes which was not so efficient as the Nernst lamp; the figures he found were 1·8 watts per candle for the arc lamp as against 1·2 for the Nernst.

Councillor STEVENSON, of Edinburgh, said that they had been experimenting on side-street lighting with Nernst lamps in Edinburgh. He believed in supplying street-lighting at cost price, as it was not right that one corporation department should make a profit out of another. They had used two quarter-ampere Nernst lamps in the same

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globe and switched one lamp off at midnight. Mr. Newington's estimate of cost for the supply of current to these lamps, their upkeep, and cleaning was £2. 0s. 5d. per year. The interest and sinking fund charges would be 4s. 8d., making a total cost of £2. 5s. 1d. The actual cost of installing the new lamps and lanterns on the top of the present pillars would be £1. 17s. 6d. each They were now supplying 1,000 10-ampere arc lamps at a cost of £10. 15s. per annum. They had given an offer recently to light 200 more of these arc lamps for £9. 10s. per annum, one half of the lamps being switched off at midnight. The competition of the gas undertaking was very keen, as they actually quoted 2s. per thousand for gas supply to incandescent lamps in the street, as against 2s 5d. for gas for the flat-flamed burner. He calculated that even then the electric light was able to hold its own.

Mr. T. P. WILMSHURST, of Derby, commented on the fact that the flame arc lamps were not long burning; thus, while they could get open-type lamps to burn 60 hours, 18 hours was the longest life he knew of for the carbons of a flame lamp. He also complained that these carbons were dear. He thought that the success of Mr. Hoadley was due to the good price he obtained of £3. 10s. per lamp in competition with the 4ft. incandescent gas lamp. In Derby the gas lamps were supplied for £1. 10s. per annum, which included everything except lighting and trimming. He thought the firm supplying the Nernst lamps were to blame for making extravagant claims as to what they would do. The lamps were badly made, and gave considerable trouble in various details. The heater was often placed so far away from the rod that the lamp would not light up. He had also noticed that as the life of the lamp increased, the time taken for the lamp to light after being switched on also increased. He did not agree with the use of spare plant for street-lighting.

Alderman S. SMITH, of Liverpool, was a strong advocate for gas lighting, and commented on the success of the gas lighting in Liverpool streets. He also questioned the estimate which Councillor Stevenson had given, as he had found considerable difference between estimates and performances.

Mr. HADYN T. HARRISON said they wanted one definite means of comparing street-lighting. Mr. Hoadley referred to two—*i.e.*, the man in the street and accurate measurements of candle-power. He thought they should stick to one or the other, as it was no good making accurate measurements of the light obtained if the judgment of the man in the street was afterwards to be taken. He noticed that the figures for candle-power feet from the gas lighting at Maidstone were not given in the paper, but he had seen them, and they were very favourable to the electric light. He deprecated the undue claims made for the candle-powers of rival illuminants. With incandescent gas burners he rarely found one-third of the candle-power stated. Electrical engineers were also to blame, as the 500-watt arc lamps would never give 2,000 c.p. in the street with the globes on. He recently had to test some large gas lamps supposed to give 800 c.p., and found that 300 c.p. was the light obtained. Again, a number of 40-c.p. Nernst lamps did not give more than 20 c.p.

Mr. S. E FEDDEN, of Sheffield, said they had no electric street-lighting in his town. He had tried the Nernst lamp of both the B and D type, and did not consider them a success. He thought people judged street-lighting by the glare in their eyes. Streets in Sheffield which seemed to be brilliantly lighted had a very poor light distribution, which did not enable print to be read in the middle of the road. He had recently tried to introduce flame lamps for street-lighting, but although they were cheaper than incandescent gas, light for light, they had not been successful. He had hopes that the tantalum lamp would help them in the competition, and he was using two of these lamps in series on the 220-volt circuits.

Alderman J. P. SMITH believed in the electricity department being actively managed by the engineer as a separate concern quite independent of the other undertakings of the municipality. It could be left for the committee or the council to check any undue competition between departments. He thought that the electric lighting of the Edinburgh streets would compare most favourably with the gas lighting at Liverpool, both as regards cost and the light obtained.

Mr. Hoadley reserved his reply, which will appear in due course in the *Transactions*.

During the afternoon visits were paid to the generating stations at Dewar-place and McDonald-road.

In the evening the Lord Provost, Magistrates, and Council of Edinburgh received the members and their ladies at the City Chambers.

## THE ELECTRICAL CONTRACTORS' ASSOCIATION.

The annual banquet of the Electrical Contractors' Association was duly held on Tuesday evening last at the Holborn Restaurant. As to the size of the gathering, it need but be said that the accommodation afforded by the King's Hall was almost fully taxed, thus indicating a flourishing state of the association. Mr. W. R. Rawlings presided.

The keynote of the after-dinner speeches was struck by Mr. E. L. BERRY, on whom it devolved to propose the toast of "The Councils and Municipalities." He gave credit for the many excellent services rendered by those bodies, praising, in particular, the sound work carried out in the provinces, but fell foul of their trading propensities, holding that municipal authorities had quite enough to do with legitimate undertakings without going out of their way to spoil contracting work. He referred to the case of Shoreditch, where failure had attended the attempts of the Council to establish a municipal wiring department.

Mr. G. L. GOMME (clerk of the London County Council), in reply, argued that extension of work by the municipalities was good for trade, and if trade were hurt in one direction there would be a corresponding development of industry in another. The work of the great authority which he served was not necessarily in conflict with trade interests. In Germany municipal work was supported by people in similar positions to which they held.

Mr. H. BUSBY BIRD (Mayor of Shoreditch), who also replied, frankly admitted that the electric wiring experiment referred to by Mr. Berry had been a practical failure. He had his own place wired by the department, and thanked the Lord he was alive to tell the tale. Now every facility was given to local contractors for the work, and the Council did not intend in future to meddle with wiring or fitting work, because they had had some.

The toast of "The Electrical Contractors' Association" was proposed by Mr. B. H. ROLFE, who pointed out the great benefit which had resulted to the trade as a whole from the activity of the association.

The PRESIDENT, in responding, said the funds of the association were used to promote the advancement of the electrical contractor, to protect him, and to bring about better trading between the contractor and manufacturers from whom he purchased goods. There were some men they did not admit into their association—for instance, the man who asked for a rule to measure megohms, and how many of the latter went to a foot; or the man who ran three wires to each point, because the installation was to be connected up to a three-wire system of distribution; or, again, the man who complained of the fuse wire which was always melting.

The "Casino Orchestra" performed during the banquet, and some excellent songs were interspersed with the speeches afterwards, while brilliance was imparted to the scene by orange rays from the "Excello" arc lamps, which have been substituted by the Union Electric Company, Limited, for arcs of older type previously in use. Nor was their radiance obscured by the tobacco fog which gathered.

## PERSONAL.

The Partick Town Council have increased the salary of Mr. J. Bryce, burgh engineer, from £450 to £500 per annum, and that of Mr. H. B. Maxwell, burgh electrical engineer, from £250 to £300 per annum.

Mr. Herbert Vickers, assistant tramways engineer to the Wolverhampton Corporation, was married last week to Miss Bertha Thornley, second daughter of the late Mr. James Thornley, of Bolton.

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### TO CORRESPONDENTS.

*All Rights Reserved.* *Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

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### RESPONSIBILITY AND REMUNERATION.

Summer meetings are in fashion. All classes of municipal officers have been hob-nobbing together, reading papers, passing opinions, visiting works, and generally getting rid of the high-pressure verbosity that has accumulated during the past twelve months. There is a topic simmering throughout the municipal world which to us seems wrongly considered. Agitation on all sides is being carried on for superannuation. In our view superannuation is a mistake, except in particular cases and under certain circumstances. What is required is a proper, perhaps a generous, salary for responsibility. A man should be paid, not partly paid, and should be trusted to make his own provision for old age. There is no shadow of a doubt from economical considerations that the paying of a pension means underpayment during years of work, and the using of the balance between what is and what ought to be paid as insurance premiums. While we are writing, municipal electrical engineers are in conference. They are meeting for the purposes above mentioned, and we take the opportunity of referring to their position as regards remuneration. On the whole, they are underpaid. It will be said that there exist a few prizes. That may be so, but does anyone doubt but if some of the men engaged in the work put the same brains and energy into business concerns the ultimate reward would be far and away superior to anything they are likely to get in the profession in which they are working. They are not likely as municipal electrical engineers to accumulate large fortunes—indeed, it is only the exceptionally placed among them who can contemplate with equanimity the expenditure necessary to keep them abreast of progress. Many are tempted to grow careless, to depend upon satirical and cynical notes or a lot of statistics for their information instead of reading and digesting the original papers. The curse of true knowledge is dependence upon a lot of abstracts good enough in their way, but which ought to be used for nothing more than an aid to memory. As we say, much of this casual glancing at the records of professional progress is due to inadequate pay. It is not the state of things calculated to ensure the best results. In these days of progress education should be continuous and thorough. New developments are of frequent occurrence in all branches of engineering, and unless the engineer entrusted with responsibility can keep abreast of the times it is unreasonable to expect he will be able to do the best for himself or for those who employ him. Every facility for acquiring the fuller knowledge should, therefore, be given him. It is in some quarters fashionable to scoff at the length and prosiness of German literature; while, on the other hand, we are continually dinned with the view that Germans and Americans are better equipped with knowledge and better trained in its use than their British competitors. Has it ever occurred to speakers and writers that many of the things they suggest are somewhat incompatible, and especially when we are told what we don't know and don't do. Might it not be possible that we do know and don't do just because we do know, and that the lack of action is due to the further knowledge that we can do better by following our own devices. Of course, it is impossible in this world to make responsibility and remuneration always exactly proportional. The responsibility of a man in charge of a small station with a moderate capital is often far greater in mental and bodily wear and tear than the responsibility of a man in charge of a large station with a commensurately large capital, yet the latter, in the natural order of things, gets the higher salary. The former partly lives on hope—hope

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to get to the higher-paid position. The desire for a pension seems to indicate incapacity to provide for the future—but here is the fun of the fair. The man is pronounced capable of bearing a greater responsibility, so that the implied inability to undertake a responsibility affecting himself is ludicrous.

## THE VERBAND DEUTSCHER ELEKTROTECHNIKER.

### Thirteenth Annual Meeting—Dortmund and Essen.

[FROM OUR SPECIAL CORRESPONDENT]

(*Continued from page 877.*)

Reverting to the first day's business proceedings in Dortmund, brief reference may be made to the reports of the various committees. It appeared from the report of the Safety Rules Committee that they had entrusted a sub-committee with the revision of the regulations for mines, and another sub-committee with the drafting of revised rules for theatre installations.

With regard to the Committee on Hysteresis, it seemed that the question of testing had again occupied their principal attention, with the result that all three methods hitherto perfected—namely, those of Epstein, Möllinger, and Richter respectively—are to be allowed. But to facilitate checking the rated loss, it is to be stated with which of these methods the check test shall be made. Moreover, this loss is to be that which obtains when the E.M.F. curve of the testing current is sinusoidal. As regards ageing, the committee had defined its coefficient as the percentage increase of loss after 600 hours' heating to 100deg. For the rest, they had refrained from dealing experimentally with the question of ageing, since the Reichsanstalt had offered to make the necessary investigations, and, indeed, to undertake a systematic research into the whole question of relationship between the magnetic properties and chemical composition of iron. The committee therefore regarded their mission as fulfilled, and asked to be dissolved, a request which was acceded to by the meeting.

It may be mentioned here that the council of the Verband have voted £250 towards the cost of the proposed research by the Reichsanstalt, which it is estimated will occupy from four to five years to complete. The reports by the other committees were for the most part merely a forecast of recommendations which will be submitted in elaborated form to the next annual meeting of the Verband for final approval.

The first paper was read by Dr. Norden, and reintroduced the question of "standards for arc lamps," the importance of which is urged by the Vereinigung der Elektricitätswerke, from whom he had received his brief. In the course of his somewhat lengthy contribution Dr. Norden pointed out the increasing need in practice for accurate data relative to the candle-power of arc lamps. For interior lighting, so long as the arc lamp had to compete only with the electric glow lamp its superiority in regard to economy and illuminating power was unchallenged, but since the introduction of the Nernst lamp and other current-saving lamps, it paid to consider which would best meet the requirements of the particular case in view. The same applied to outside lighting. A street, dock, or railway station lighting installation had nowadays to submit to comparison with one or other of the many modern systems of gas-lighting, almost before completion Then the classification of arc lamps according to their respective suitabilities for given requirements must be considered. If manufacturers of arc lamps could agree among themselves to adopt a uniform terminal voltage and size of carbon in regard to lamps of similar types for each ampere capacity, it would then devolve upon carbon manufacturers to give the necessary guarantees of candle-power, since there would be no longer any difference in the details of construction which could affect the illuminating power of the lamps. Unfortunately, however, there was little prospect of such an agreement being arrived at, not only because of the difficulty of converting so many minds to one view, but also by reason of the increasing demands on the lamps due to progress in the art of lighting, which would entail a constant revision of such standards. But assuming the guarantees continued to be given by the lamp manufacturers as heretofore, it was no less desirable that these guarantees should be made as intelligible as possible, and that competing firms should adopt a common basis upon which to establish them. Both manufacturer and consumer would benefit thereby.

The author went on to show that the lack of uniformity in current practice made reliable comparisons of the data furnished by different firms almost impossible. It was desirable that all calculations as to candle-power, watts consumed per candle-power, etc., should be based on common standards, also that standard apparatus and

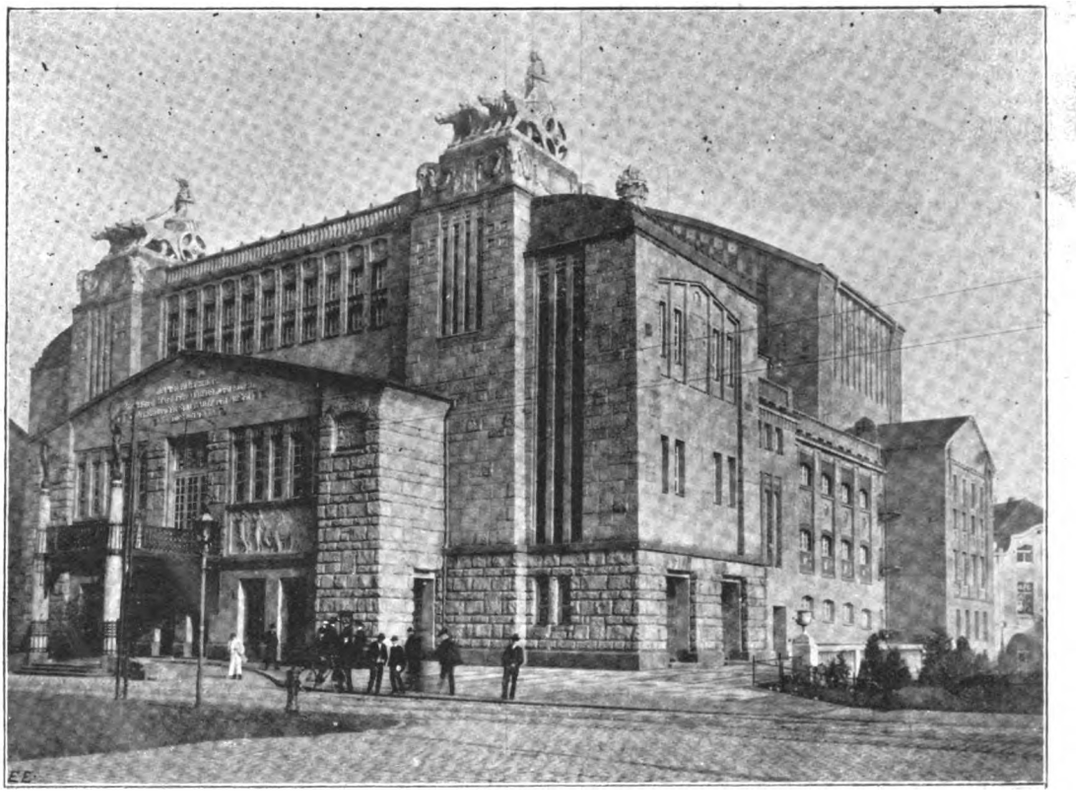

FIG. 2.—Stadttheater, Dortmund—Exterior View.

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methods of measurement should be employed. True, the problem of photometrically comparing different coloured lights remained unsolved, but the increasing use of flame arcs had rendered the matter urgent, and it would be well to obtain the assistance of the Reichsanstalt in establishing a standard method.

In concluding his remarks the author expressed a doubt as to the attitude which manufacturers would adopt towards the suggested standards, although it was clear they would serve to suppress a competition which was opposed alike to the true interests of the trade and consumers.

The outcome of this paper and the subsequent discussion thereon was the appointment by the meeting of a committee to deal with the question of standardising the candle-power of electric lamps generally. This committee will be assisted by the Vereinigung der Elektricitätswerke so far as arc lamps are concerned.

The accompanying illustrations (Figs. 2, 3, and 4) are from photographs of the Dortmund Stadttheater, wherein a special performance was given for the benefit of the Verband on the second evening of their meeting. It will be seen that the theatre is a handsome one and quite new

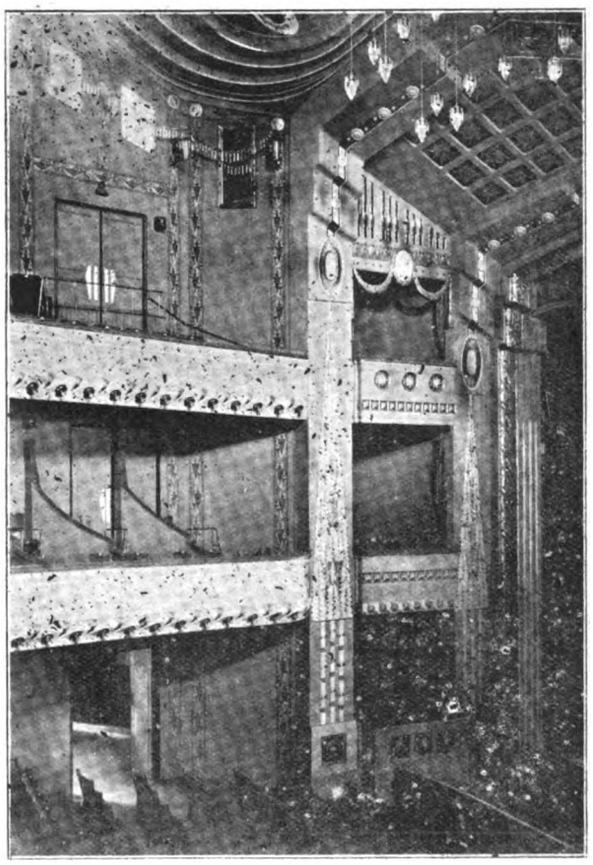

FIG. 3.—Stadttheater, Dortmund—Interior View, showing Pendant Lighting.

The single-lamp pendants (see Fig. 3) constitute an interesting feature of the lighting installation, being simple and quite in keeping with the new art style of general decoration. The entertainment provided was most enjoyable, and time was allowed between the two plays presented to hunt up old friends. It was during this interval that I heard of the honorary degree conferred upon friend Kapp, and had a chat about the latest thing in dynamos for train-lighting with Mr. Rosenberg, the inventor. This dynamo, it will be remembered, was fully described in the *Electrical Engineer* for April 28 last, pp. 600-602. It has attracted considerable attention throughout Germany—I might say the world—and arrangements have been made, I understood, for its manufacture in this country by Messrs. Mather and Platt, of Salford, Manchester. Among others, of whom their numerous English friends will be doubtless glad to hear, I also met Mr. Naglo, formerly with Messrs. Siemens Bros., at Woolwich, and the genial Heinrich who represents Weston instruments in Berlin. Notable absentees were Drs. Slaby and Aron, Prof. Georges, and Mr. Julius H. West, their places being filled by lesser lights.

*(To be continued.)*

## TRIPLE-EXPANSION ENGINE FOR MELBOURNE CORPORATION.

It is a matter of special interest to us to have to record the exportation of a large electrical plant to one of our colonies. The plant in question consists of a large 1,160-i.h.p. triple-expansion engine to run at 275 revolutions per minute, built by Messrs. W. H. Allen, Son, and Co., Limited, of Queen's Engineering Works, Bedford, coupled direct to a 750-kw. continuous-current dynamo built by Messrs. Crompton and Co., Limited, of Arc Works, Chelmsford. This set (of which we give an illustration) has been built to the order of the Corporation of Melbourne, Victoria, to form the main part of the generating equipment of their lighting installation.

The engine is of Messrs. Allen's standard three-cylinder, double-acting, triple-expansion, vertical enclosed type, the cylinders driving three cranks, set at angles of 120deg. It has been designed throughout with a view to obtaining

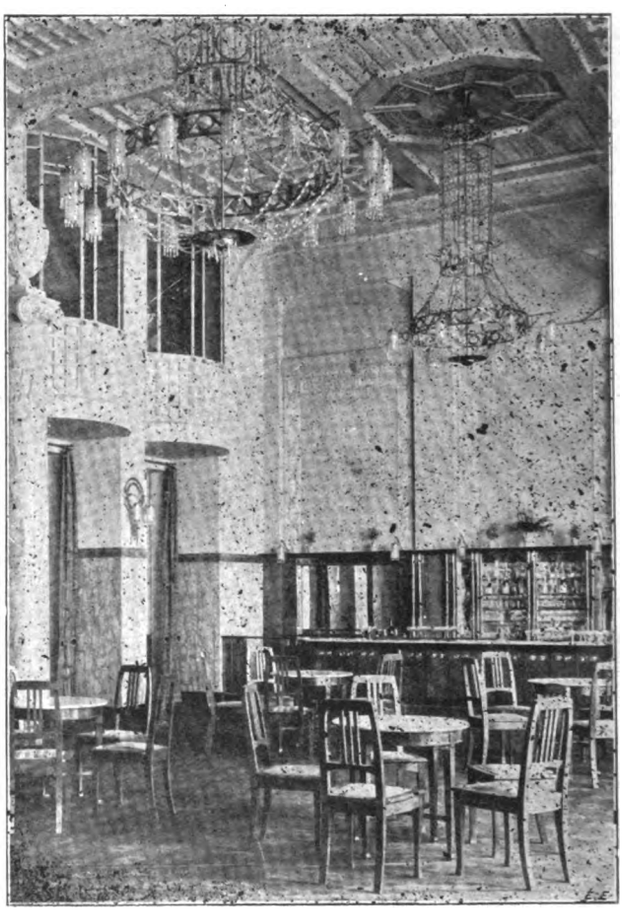

FIG. 4.—Stadttheater, Dortmund—another Interior View.

economical results over widely varying conditions of load when working with steam at 160lb. per square inch at the stop-valve with 150deg of superheat, and exhausting either into the atmosphere or into a condenser, capable of maintaining a maximum absolute pressure of 4in. of mercury; the full load when running non-condensing to be maintained by automatically by-passing high-pressure steam to the intermediate cylinder. The dimensions of the cylinders and the successive points of cut-off are so arranged as to produce as nearly as possible an equal distribution of power between the three cylinders, thereby ensuring an exceedingly even turning moment throughout the revolution of the engine. The weights of the reciprocating parts on each crank are also equalised in order to produce a good balance. With a view to still further reducing the vibration when running, cast-iron balance weights have been securely fixed to each of the cranks and arranged at such an angle with the crank as to reduce as far as possible the unbalanced couples due to the inertia of the valve gear, as well as those of the main reciprocating parts. The success of this system of balancing was a noticeable fact during the trials, the vibration being prac-

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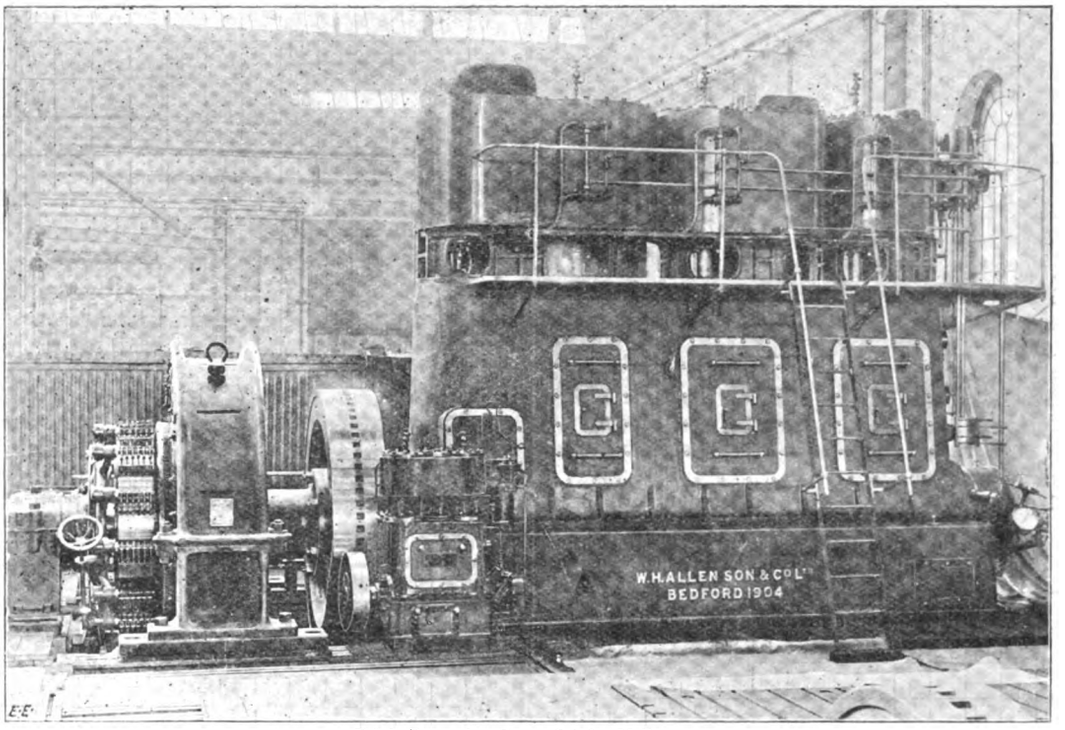
tically eliminated. The three cylinders are respectively 18in., 27in., and 44in. diameter, and have a stroke of 16in., and are made of a special mixture of hard, close, and tough-grained cast iron having a tensile strength of from 12 to 15 tons per square inch. They are also provided with the usual accessories in the way of drains and relief valves and provision for indicating. The intermediate and low-pressure pistons are of cast steel, and are fitted with Rowan's packing rings, and the high pressure piston is of cast iron of the solid block type, and is fitted with a solid packing ring of rectangular section, all three pistons being of equal weight for balancing purposes. The valves are all of the solid piston type, and take steam on the inside edges, thereby diminishing the pressure on the glands as compared with valves having steam on the outer edges.

The whole of the working parts of the engine are enclosed in a neatly designed and substantial cast-iron trunk, the walls of which carry the slides for the main cross-heads. Easy access to the interior of the trunk is provided for by three large doors arranged along the front of the engine, each door being furnished with a smaller hinged panel in its centre which permits of inspection of the working parts. The back of the trunk of the engine is also provided with smaller removable panels in order to facilitate inspection and adjustment of the main bearings. Each cylinder is cast in one with a flanged distance piece, by means of which it is securely bolted to the top of the trunk which has just been described, the cylinders being completely isolated from each other, this design having been adopted by the makers for all their standard types of engines, excepting the smaller two-cylinder types, as it ensures that there shall be no distortion of the frame of the engine under any conditions of varying temperature, with the result that the working parts are always correctly in line, and work freely. The whole of the trunk and cylinders complete are mounted upon a massive cast-iron bed-plate, which forms a reservoir into which the oil drains and from which the oil is supplied at a pressure of about 15lb. per square inch to all the working parts by means of a small valveless force pump driven from one of the eccentrics of the engine.

The crankshaft, piston rods, valve rods, connecting rods, and eccentric rods are all of Siemens-Martin open-hearth steel having an ultimate tensile strength of 28 to 32 tons per square inch, and giving under test an elongation of 28 per cent. in a length of 2in. The eccentrics are all of solid forged steel, the high-pressure valve eccentric being securely keyed on to the shaft, the remaining two eccentrics being forged solid in one piece with the shaft. The apertures through which the piston and valve rods enter the engine trunk are fitted with a bush of special construction without packing of any kind, which effectually prevents water from the cylinders from entering the crank chamber, and oil from the crank chamber from passing upwards to the cylinders. The main stuffing boxes are all fitted with metallic packings, that on the high-pressure rods being of the Spherical Metallic Packing Company's manufacture, and that on the intermediate and low-pressure rods being of a special fibrous material of Messrs. Allen's own manufacture. The whole of the bearings throughout, with the exception of the cross-head bearings, which are of gun-metal, are lined with white metal, and receive oil under pressure from the force pump described above.

The governor is of the company's standard crankshaft type, and can be regulated by hand whilst the engine is running to give a speed variation of at least 5 per cent. above and below the normal, and operates a compound double-beat throttle valve of special design placed between the main stop-valve and the engine, and so arranged that at overload steam is by-passed direct to the intermediate-pressure cylinder. On trial the governor showed a maximum momentary speed variation of 4·4 per cent., the steady variation from no load to full load being 2½ per cent. The flywheel is of the solid disc pattern, and is forced on to the end of the crankshaft and securely keyed. The dynamo side of the flywheel is accurately faced up to form the coupling for the armature. The cylinders, steam stop-valve, governor valve, and steam separator are all properly lagged with asbestos non-conducting composition, and are neatly covered with blue planished sheet steel, the whole presenting an exceedingly neat appearance.

All the hand levers, including those of the main stop-valve, drain cocks, by-pass valve, and speed regulation, are all operated from the floor level at the high-pressure end of the engine. In close proximity to these are the sight-feed oil impermeator, tachometer, and pressure gauges—an exceedingly convenient arrangement which permits of the entire regulation of the engine from one point.




Triple-Expansion Steam Set for Melbourne.

## THE ALTERNATING-CURRENT SERIES MOTOR.*

BY F. CREEDY, STUDENT.

*(Concluded from page 881.)*

The results of the three last-mentioned tests are shown in Figs. 20, 21, 22, 23, and 24.

In Fig. 21, Curve I. represents output plotted against

* Paper read before the Institution of Electrical Engineers.

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speed (here the output includes friction losses). In Curve II. the iron losses due to rotation have been added. In Curve III. the field losses proper have been added also. Curve IV. includes the losses in the coil short-circuited under the brush. Curve V. includes the $I^2R$ losses in the armature. Curve VI. includes the compensating coil losses. Curve VII. represents the input.

In Figs. 22 and 23 the losses are added to the output in the same order, except that Curve III. represents the field losses, *including* those in the coils short-circuited under the brush. Thus the curves are numbered differently, there being only six curves instead of seven. In Fig. 22 it may be seen that the $I^2R$ loss in the armature is the greatest (the motor being perhaps overloaded). This amounts at the working speed (2,000 revolutions per minute) to about 15·5 per cent. The field losses are nearly as great,

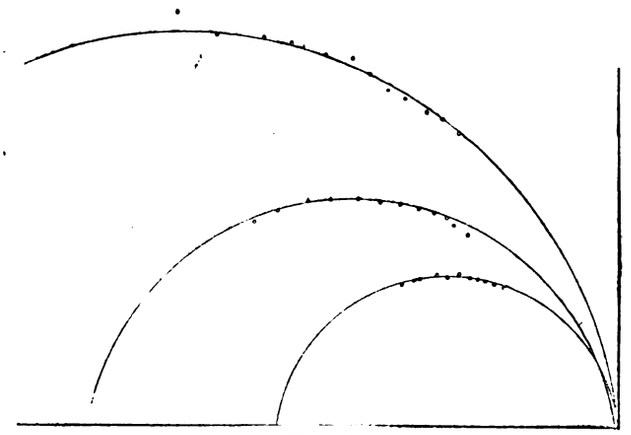

FIG. 20.

being 11·2 per cent. The losses in the compensating coil are 5·1 per cent., and the iron losses due to rotation 1·8 per cent. The losses in the coils short-circuited under the brush are quite insignificant. If we now turn to Fig. 23, giving the analysis of losses when we have 104 turns on the field, we see that the field losses are by far the largest, forming 17·9 per cent. of the input. The copper losses only form 7 1 per cent., the compensating coil losses 3 per cent., and the iron losses due to rotation 6 1 per cent. Fig. 22, giving the analysis of losses

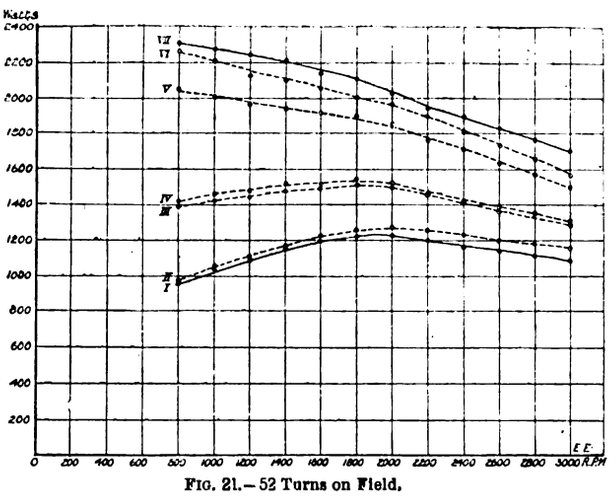


FIG. 21.—52 Turns on Field.

when we have 84 turns, forms an intermediate case. A comparison of these three figures is very instructive. It shows that the principal reason why the efficiency becomes constant at so low a value as 65 per cent., and cannot be raised by increasing the number of field turns, is because of the large iron losses. These are probably largely due to the fact that the machine has flat cast-iron end plates bolted direct on to the stampings, the field coils enclosing both stampings and end plates. This undesirable feature I was unable to alter. Fig. 21 in particular shows that the resistance of the machine is far too high. The resistance of the armature over the brushes is, in fact, 0 43 ohm. The other losses are not, I think, excessive, except perhaps the hysteresis due to rotation, which, in Fig. 22 especially, seems very high. In connection with this, it seems rather remarkable that in Fig. 21, when there were only 52 turns on the field, and consequently the flux was stronger than in the other two cases, the hysteresis, etc., due to rotation, is the smallest. It will also be noticed that the output + losses is considerably less than the input, and this suggests that the hysteresis due to rotation has been under-estimated. In Fig. 20 are given the three circles corresponding to the tests in Figs 21, 22, and 23. It should

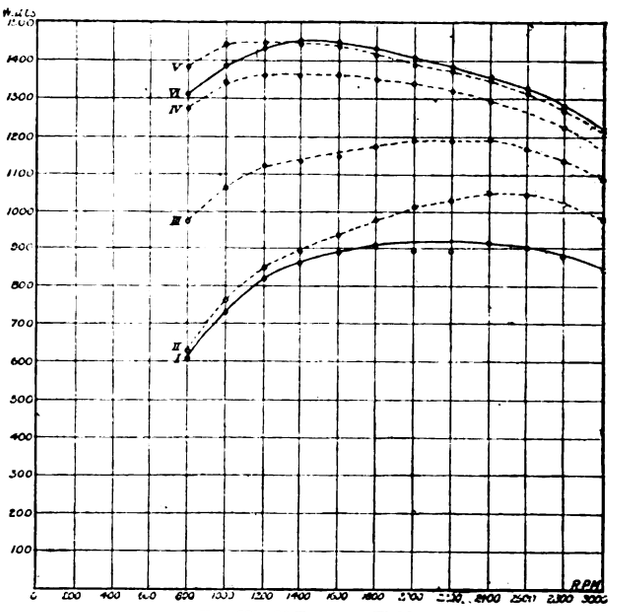


FIG. 22.—84 Turns on Field.

be mentioned, in this connection, that, since the compensating coil was put in, the centres of many of the circles observed have lain below the line of zero power factor. A possible explanation of this seems to be the following Unless the plane of the compensating coil is exactly perpendicular to the brush line (and this can only occur for one particular brush position), an E.M.F. will be produced by the rotation of the armature in the flue due to the compensating coil. This E.M.F. changes its direction as we move the brushes past the position of perpendicularity to the plane of the compensating coil. If it is in phase, instead

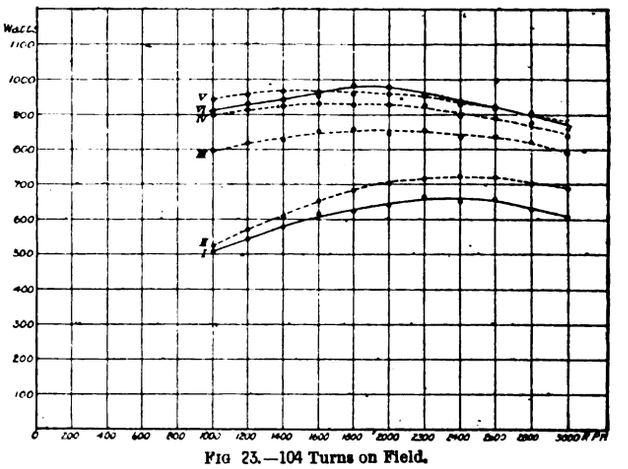


FIG 23.—104 Turns on Field.

of opposite in phase, to the current in the latter, it will tend to reduce the angle $\theta$ (Fig. 2), and may even make it negative, thus depressing the centre of the circle below the line of zero power factor.

In Fig. 24 are shown curves of output, power factor, and efficiency, plotted against speed. These were taken at 90 volts, 25 frequency, and with 52 turns on the field. They represent on the whole about the best performance of which the motor under test is capable. The output is excellent if we consider that the motor is about the size of an ordinary 1-h.p. direct-current machine. It weighs, in running condition, 169lb. At 100 volts the output would, of course, have been greater, certainly not less than 2 h.p. at 2,000 revolutions per minute. It was, however, found impossible

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to keep the voltage of the generator up to 100 with the heavy currents taken. The power factor, too, is very fair, but the efficiency is decidedly low. At 2,000 revolutions per minute we have output = 1,230 watts; power factor = 0 83; efficiency = 59 per cent. If we compare this with the specification given above, we see that, allowing for the effect of the compensating coil, they agree very fairly. The output is very much greater, as one would expect, since it is proportional to the square of the current passing through the motor, the power factor is better, which is also what one would expect, and the efficiency is lower, which is accounted for by the compensating coil losses and the iron losses due to rotation, which were not taken into account in the calculations. Thus we may be fairly sure that a motor designed by the methods described above will

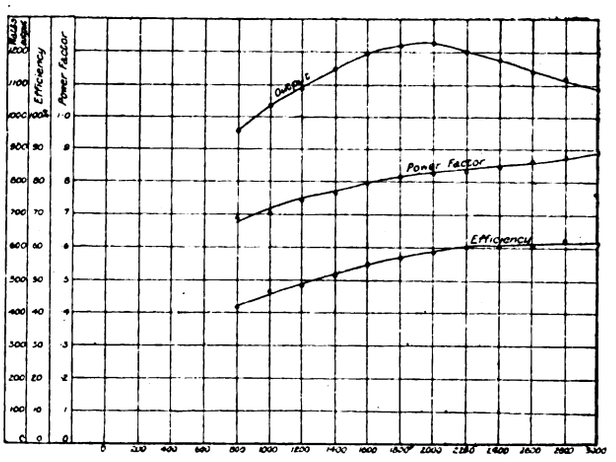


FIG. 24

fulfil its specification. The faults of the motor experimented on, and their remedy, are rendered quite clear by the above analyses of losses.

It is clear that in order to obtain a higher efficiency, a higher counter E.M.F.—that is, more turns on the armature—are needed. In order to decrease the armature $I^2R$ losses, a larger gauge wire is required. Thus the armature must be made considerably larger than in present direct-current practice. On account of the very small space occupied by the field winding a much more compact design

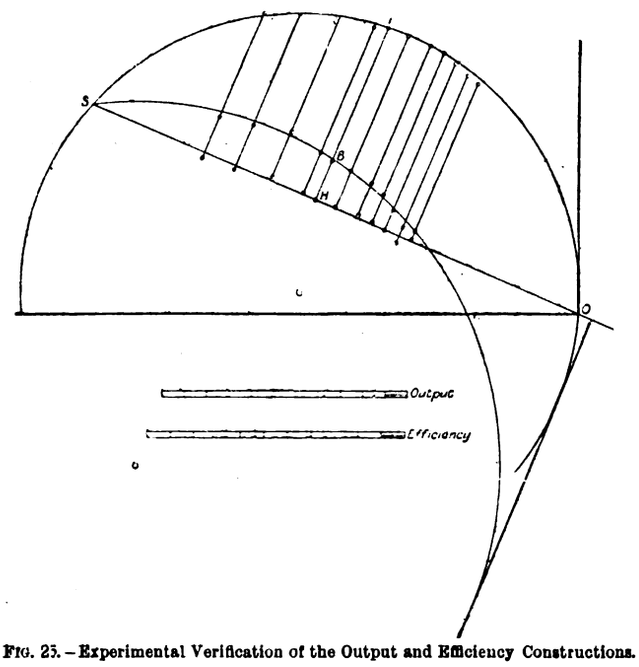


FIG. 25.—Experimental Verification of the Output and Efficiency Constructions.

of field magnet is possible, thus decreasing both the weight, the reluctance, and the iron losses. The iron, as mentioned above, should be distributed symmetrically about the axis of the main magnetic flux. A motor built in this manner would have good efficiency and high power factor, while the output per pound would probably be even higher than in the motor tested, which at full load gave nine watts per pound, 100 volts being applied. The reason why such good "weight efficiencies" are obtained with so small a motor is on account of the large number of armature turns employed. Though this method of design is adopted for quite other reasons, it is precisely the one recommended by Mr. Hobart in his book "Electric Motors," and elsewhere, as giving good "weight efficiency" in direct-current motors. In fact, when this experimental motor was tested with direct current, it gave about 3 h.p. at 1,400 revolutions per minute, with an efficiency of about 70 per cent, 100 volts being applied. The low efficiency is explained by the high $I^2R$ losses, as we have seen above. In this case we got 12·5 watts per pound, very nearly.

It has been shown experimentally above that in the alternating-current series motor the current moves on a circle as we vary the speed, and that the speed may be found by the construction given in Fig. 2. It is also clear that the torque is proportional to the square of the current. These two constructions being assumed, the constructions for output, efficiency, etc., follow mathematically, no further reference to the series motor being necessary. It was thought of interest, however, though not strictly necessary, to attempt a direct experimental verification of the two latter constructions, more especially as a verification of the efficiency construction would enable us to test whether the theoretical result that the efficiency is 100 per cent. at infinite speed, supplies us with a satisfactory efficiency scale. Fig. 25 gives us an experimental verification of the output and efficiency constructions given in Fig. 2.

A perpendicular I H was dropped from a point I on the current circle on to the standstill current, its length measured, the output corresponding to this point noted, and from these two observations the scale to which I H represents the output was found. Setting off the outputs corresponding to the other points on the current circle along lines through these points and perpendicular to O S, we get a series of points which, as Fig. 25 shows, lie very closely along O S, thereby verifying the output construction. The efficiency circle was next drawn, according to the rule given above, the length of I B and the (observed) efficiency corresponding to the point I noted, and from these the efficiency scale determined. Setting out the efficiencies corresponding to the other points on the current circle, from these points, in the same way as the outputs, a series of points is obtained, which, as may be seen, lie very closely along the efficiency circle. This verifies the efficiency construction. Comparing the efficiency scale as determined experimentally above with that deduced from the assumption that the efficiency is 100 per cent. at infinite speed, it was found, as had been suspected, that they did not agree, the latter scale giving efficiencies which were a good deal too high. Thus in practice it will be necessary to determine the efficiency scale experimentally.

Thus it will probably prove impossible to obtain a satisfactory test on the series motor by means of one or two observations taken at standstill, as may be done in the case of the induction motor. A brake test will always be necessary. It may be pointed out here that the Hopkinson test is perfectly applicable to the series motor, the power required by such a motor being supplied by another, exactly similar, coupled to it and acting as a brake. The wattless current taken by the machine, however, cannot be so supplied, and thus the generator must supply both the losses and the wattless currents required by both machines.

Throughout the series of experiments described above it has been found impossible to obtain satisfactory experimental values of the standstill current, on account of the fact that the contact resistance of the brushes is much higher at standstill than when running. This effect will probably occur in all commutator motors, though it may be less marked in large machines. It produces a slight decrease of the current and a considerable increase in its power factor on account of the enormous commutator losses. It was frequently found that the power factor of the motor when running at a slow speed, say 80 revolutions per minute, was *lower* than that at standstill, on account of the above effect. It was found impossible to keep the motor stationary for long with current flowing through it, as the brushes rapidly got red-hot.

I have usually been obliged to deduce the standstill

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current from the observations of current, etc., when the motor was running, by means of the speed construction. In verifying the speed construction itself, the following method was adopted: According to theory, as may easily be seen, if O S (Fig. 2) does not correspond to zero speed, but to some other speed, say $a$ revolutions per minute, then S P will be proportional, not to the actual speed, $s$, but to $s-a$. Thus, if we plot S P against the measured speed, we ought to obtain a straight line, whatever the position of O S. This was found to be the case, and this fact forms the real verification of the speed construction. For one, and only one, position of O S, the curve between S P and the measured speed was found to pass through the origin. This was taken as the correct position, and is used in the curves given in Fig. 7 above.

In conclusion, my thanks are due to Messrs. Nightingale, Chaffer, Nealor, Hodgkinson, King, and Herbert for their assistance in the experiments described in this appendix. I have also to thank Mr. Nightingale for his assistance in preparing some of the figures.

## JUNIOR INSTITUTION OF ENGINEERS.

On Tuesday a reception was held at the Royal United Service Institution, Whitehall, in celebration of the institution's "coming of age." The president (W. H. Lindley, M.I.C.E., F.G.S.) and the chairman (Samuel Cutler, Jun.M.I.Mech.E.) received the guests at the top of the main staircase, after which the secretary (Mr. Walter Dunn) was presented with a magnificent silver loving cup. The ceremony took place in the theatre of the institution, and the president, supported by Messrs. Cutler, Tennant, Marshall, and Taylor, referred in the highest terms of eulogy to the eminent services rendered to the institution by Mr. Dunn, and also by Mrs. Dunn, during the whole of its existence. In the museum opportunity was afforded to inspect the Nelson Centenary Exhibition, as well as the permanent collection of models, specimens, etc., relating to the navy, army, and auxiliary forces. An excellent programme of music was discoursed by the band of the 21st (Empress of India's) Lancers (by permission of Lieut.-Colonel J. Fowle and officers), under the conductorship of Mr. Edmund Hinton; and vocal selections, which were much appreciated, were rendered by Miss Carrie Tubb, Miss Ada Gaskill, Mr. Frederick W. Lake, and Mr. Edwin Evans, Mr. Richard Cooper, A.R.C.O., being the accompanist. Several models and a collection of photographs, etc., kindly lent by the president in illustration of his address on municipal engineering on the Continent, delivered at the commencement of the session, were also exhibited. During the course of the evening lecturettes were delivered in the theatre on "The Invention and Manufacture of Steel Pens," by James P. Maginnis, Esq., A.M.I.C.E., and on "Britain's First Line of Defence," by W. J. Harding, Esq., M.I.C.E. The latter was illustrated by slides lent by A. F. Yarrow, Esq., M.I.C.E.

## FORTHCOMING EVENTS.

**Junior Institution of Engineers**—Summer meeting commences June 30. For particulars see issue of June 16.

**Incorporated Municipal Electrical Association.**—Convention at Edinburgh. On July 1 a visit will be paid to the Aberdeen Electricity Works.

**Third International Electric Tramway and Railway Exhibition.**—Opening at the Agricultural Hall on July 3 by the Earl of Derby, at noon.

**Municipal Tramways Association.**—Conference at the Agricultural Hall on July 4, followed by a smoking concert at 8 p.m. On July 5 the conference will be continued, and at 8 p.m. there will be a conversazione. On July 6 there will be an excursion to Reading and Henley at 11 a.m.

**University of Liverpool.**—Opening of new electrotechnics laboratory by Sir J. Swan, July 8.

**Permanent-Way Institution.**—Summer convention begins on July 21, continuing till July 27, in the course of which a visit will be paid to Holland.

**University College, London, Union Society.**—Foundation oration, "The Academic Side of Technical Training," to be delivered by Dr. A. B. W. Kennedy on June 29, at 5.30 p.m.

**Commerce with Abyssinia.**—We hear from Messrs. W. P. Thompson and Co., patent agents, Liverpool, that the Abyssinian Government has agreed to allow the merchants of Khartoum to form a trading station at Itang and another at Gambela, both of which are situated on the River Baro. A regular steamship service is about to be organised. For some time to come this trade is likely to be conducted through Egyptian channels. This permission to establish trading houses has only just been granted, and it behoves English manufacturers to be first in the field, not forgetting to protect their trade marks in Egypt or the Soudan.

## PHYSICAL SOCIETY.

At a meeting of this society on June 16, Prof. J. H. Poynting, F.R.S., president, in the chair,

A paper "*On the Ratio between the Mean Spherical and the Mean Horizontal Candle Power of Incandescent Lamps*" was read by Prof. FLEMING. This paper contains a theoretical deduction from first principles of experimental results given by Mr. G. B. Dyke, B.Sc., in a paper read before the Physical Society on Nov. 11, 1904, respecting the ratio of the M.S.C.P. of incandescent electric lamps to the M.H.C.P. taken when the lamp was rotating round a vertical axis. In the case of nine different types of electric incandescent lamps, this ratio was found to be a number near 0·78. The author shows, by discussing the simple case of linear filament, that the ratio of the M.S.C.P. to the horizontal candle-power for this last case must be represented by the value $\pi/4=0\cdot785$, and, hence, that the constant ratio found experimentally by Mr. Dyke necessarily follows as a simple consequence of the fact that the light sent out in any direction from each unit of length of an incandescent filament varies as the cosine of the angle of inclination of the ray to the normal to the filament. In the paper it is shown also how a simple correcting factor may be obtained for reducing the actual horizontal candle-power of a linear filament of finite length to the candle-power in the same direction which would be found if the elements of the filament were concentrated on the axis of the photometer and all normal to it. If $\phi$ is the angle subtended by any linear filament at the photometer disc, then the expression $\frac{1}{2}\{\cos^2\phi+\phi\cot\phi\}$ is the correcting factor which must be applied to correct the candle-power of the filament in the sense indicated above. From this expression is derived a general expression for the ratio of the mean spherical to the mean horizontal candle-power of a filament of finite length when the measurements are made at such a distance that the length of the filament subtends a sensible angle at the photometer. The result of experiments are also described, justifying the assumption of the above cosine law of radiation.

Mr. G. B. DYKE briefly described the experiments which had been performed to justify the law.

Mr. L. GASTER thought that the subject discussed by Prof. Fleming deserved considerable attention at the hands of lamp manufacturers. Owing to the improvements made in recent years in the manufacture of incandescent lamps it is advisable, in comparing their relative merits, to consider the mean spherical candle-power given out, and to determine the total flux of light per watt consumed, thereby conveying an accurate meaning as to the efficiency of the lamp as an energy-transforming device.

Dr. CHREE pointed out that the quantity $\frac{1}{2}(\cos^2\phi+\phi\cot\phi)$ was based on a calculation which supposed the photometer disc exactly opposite an *end* of the filament and required modification when this was not the case. When $D/l$ was so large that $\phi$ was small, higher powers of $\phi$ being neglected, the quantity reduced to $1-\frac{2}{3}\phi^2$; but if the photometer disc were opposite the *centre* of the filament $\phi$ had to be replaced by $\phi/2$, and the departure of the quantity from unity was reduced to a quarter. He remarked that the quantity $\frac{1}{2}(\cos^2\phi+\phi\cot\phi)$ had to be applied as a *divisor* to the observed illumination to deduce what the result would be under the ideal conditions when $D/l$ was so large that $\phi$ was negligible; and he was doubtful whether the language employed, especially the description of the quantity as a "correcting factor," was sufficiently free from ambiguity.

Prof. J. A. FLEMING said he had tried to impress upon lamp users the advantage of expressing candle-power in terms of the total flux of light per watt consumed. Now that a simple relation had been established between M.S.C.P. and M.H.C.P., there was no excuse for expressing the candle-power of a lamp as *its maximum* horizontal candle-power.

Dr. H. A. WILSON read a paper on "*The Electrical Conductivity of Flames.*" The paper contains an account of a series of experiments on the conductivity of a coal-gas flame for electricity between platinum electrodes immersed in the flame. The variation of the current with the distance between the electrodes and the fall of potential along the flame are investigated by using a special burner producing a long narrow flame. The burner consists of a fused quartz tube with a series of small holes parallel to its diameter. The electrodes are two parallel discs of platinum, one fixed at one end of the flame, and the other capable of movement horizontally in the flame, so that it can be placed at any desired distance from the fixed electrode. The current through the flame was measured by a moving-coil galvanometer, and the potential difference between the electrodes by an electrostatic voltmeter. The quartz-tube burner being a good insulator enables a current to be passed from one end of the flame to the other without fear of any of it going through the tube instead of through the flame. It thus enables the effect of putting salts into different parts of the flame to be easily studied.

Dr J. A. FLEMING said that the paper was of practical interest, and described some experiments he had made to utilise the properties of flames rendered conducting by potassium salts in the construction of a sensitive telegraphic relay.

Mr. W. DUDDELL drew attention to the similarity of the phenomena described to those exhibited by electric arcs. He asked the author if he had considered the possibility of using a conducting flame as a high-voltage rectifier. Also, had the author tried sodium salts and what were their effects compared with those of potassium.

Dr. W. WATSON asked if the drop of potential at the negative electrode depended upon the temperature of the electrodes.

Dr. H. A. WILSON, in reply to Mr. Duddell, said that the salts of cæsium, rubidium, potassium, sodium, and lithium imparted conductivity to flames in the order named. This order was also the order of the atomic weights. He had found that a flame could be used as a rectifier when using alternations about 100~ per second, but was not

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sure whether it would rectify rapidly alternating currents. In reply to Dr. Watson, he said that the temperature of the electrodes exercised a great influence. An increase in the temperature of the electrode diminished the drop of potential at the electrode.

A paper on "*Contact with Dielectrics*" was read by Mr. ROLLO APPLEYARD. The object of the paper is to examine (1) whether tinfoil electrodes, pressed against a sheet of dielectric by indiarubber discs, enable accurate determinations of dielectric resistance to be made; (2) the effect upon dielectric resistance of change of load on such tinfoil electrodes in the case of presspahn; (3) the effect upon dielectric resistance of increase or decrease of voltage in the case presspahn between tinfoil electrodes; (4) the rate and direction of the change of deflection in direct-deflection tests on presspahn, and to determine in how far these changes result from surface conditions and in how far from internal stresses; (5) the effect of reversals of voltage upon dielectric resistance; (6) the effect of prolonged "electrification"; (7) to indicate the probable limits of accuracy with mercury electrodes; (8) to point out that Price's guard wire can be used in sheet tests to eliminate leakage over the sheet surface as well as over the instruments. Among the conclusions arrived at are the following: (*a*) Except in the case of homogeneous dielectrics, it is misleading to deduce specific values referred to unit cube of the material from the results of tests on sheets. (*b*) With tinfoil electrodes, the apparent resistance of presspahn diminishes as the load increases, and it attains a fairly constant value at a load of 400 grm. per cm.$^2$ (*c*) If, with tinfoil electrodes, the load is gradually diminished after a load of 543 grm. per cm.$^2$, the resistance gradually rises, but the rise is less rapid than the diminution in the former case (*b*). (*d*) When the full load with tinfoil electrodes is again restored the resistance falls to its minimum value. (*e*) For small loads, with tinfoil electrodes, the second-minute deflection is in general greater than the first-minute deflection. As the load increases, a point is reached at which these deflections become approximately equal. For loads greater than about 360 grm. per cm.$^2$, the first-minute deflection is in general greater than the second-minute deflection. (*f*) Increase of voltage, with tinfoil electrodes, especially with small loads, behaves like increase of load, apparently increasing the contact area and diminishing the observed dielectric resistance. Load, voltage, and the normal effect of "absorption" thus combine to determine the ratio of the first-minute deflection to the second-minute deflection. (*g*) When mercury electrodes are used, the dielectric resistance as measured at different voltages is sensibly the same, even for abrupt and great changes of voltage. (*h*) When mercury electrodes are used the second-minute deflection is in general never greater than the first-minute deflection. The inference is that when, with tinfoil electrodes, the converse is the case, it arises from imperfect contact, and not from the material itself. (*i*) When mercury electrodes are used the dielectric resistance as measured with a voltage applied in a given direction is sensibly the same as that measured with the voltage reversed, and this equality appears to become greater after a few reversals. (*j*) There is a critical load at which tinfoil electrodes yield fairly accurate results. With greater loads there is danger of crushing the material. With a less load the contact is faulty.

Mr. DAVID OWEN, in reference to the variation of apparent resistance with the volts applied in the case of the experiments made by the author where tinfoil electrodes were used, pointed out that an effect of the same kind takes place in the case of the leakage resistance of condensers of paraffined paper and tinfoil. If the insulation resistance be measured by observing the rate of leak of the condenser, the curve of volts and time drops more slowly than according to the exponential law. The same result is obtained if the current maintained by the application of a steady voltage across the condenser terminals is measured by a galvanometer in series. For such a condenser a recent test gave an apparent resistance of 100 megohms for a P.D. of four volts, but this value steadily dropped with rise of voltage, and was 41 megohms for 20 volts. Though the voltage here used was much less than those applied by the author, the effect in question is the same in kind and in degree.

Mr. A. CAMPBELL said Mr. Appleyard's paper was an interesting contribution to our knowledge of a difficult but practically important subject. He had established the advantages of mercury electrodes. Mr. Campbell remarked that he had used tinfoil and indiarubber electrodes for the last 15 years, and mentioned that before they were adopted at the National Physical Laboratory for Mr. Rayner's and other work they were put through a series of tests with varying weights, and from the observations a working pressure was chosen which gave tolerably accurate results. He had also tried guard wires with several kinds of sheets, and found that the surface leakage was negligible. In Mr. Rayner's experiments at high temperatures, the changes due to a fall of temperature of a few degrees were so enormous that any inaccuracy due to the clamps was of trifling importance. Mr. Campbell mentioned that when measuring the capacities of thin sheets, tinfoil electrodes gave results which in some cases varied with the applied pressure. For example, with dry paper as dielectric, increase of pressure gave considerable increase of capacity, and since in this case the contact does not matter, the effect must have been due to approach of the electrodes. If the paper be blackleaded the change of pressure has less effect. He therefore suggested that in cases where mercury was inconvenient the use of blacklead might be of advantage.

Dr. H. A. WILSON expressed the opinion that when using mercury electrodes the diminution in resistance might be due to compression of the dielectric caused by the pressure of the mercury, rather than to better contact between the mercury and the dielectric.

Mr. W. A. PRICE said that the question of insulation tests was an important and far-reaching one. Dr. Wilson had suggested that the pressure of the mercury might cause a change of form, but he did not think that pressures so small would produce any appreciable change. The author had shown that provided you obtained good contact between the electrodes and the dielectric, you could obtain constant values for the insulation resistance.

Prof. W. CASSIE suggested that the pressure might be applied to the tinfoil electrodes by placing a sheet of indiarubber over each of them, or by putting the plate of dielectric with its tinfoil electrodes in a flat indiarubber bag and pumping out the air under the indiarubber. Thus the pressure of the atmosphere would produce more uniform and effective contact of the tinfoil with the dielectric. The pressure obtainable in this way might have any desired value up to about a kilogramme per square centimetre.

Mr. R. APPLEYARD, in reply to Mr. Campbell's suggestion with regard to the use of blacklead, pointed out that it was necessary to guard against moisture. Spurious effects might be introduced by electrolytic action.

# LEGAL INTELLIGENCE.

## ACCIDENT.

At the Essex Assizes, before Mr. Justice Bucknill, an action was brought by Mr. Grant, hotel proprietor, to recover damages from Messrs. J. G. White and Co. for personal injuries sustained by plaintiff through alleged negligence on the part of the defendants in not properly protecting an excavation. Defendants denied negligence.

Plaintiff was driving in a dog cart in June of last year about 11 p.m. He had two lights on his cart, and was travelling at seven or eight miles an hour. When he reached Barrack-street he saw a red light in the middle of the road, and, continuing to drive on, on his near or proper side, the rear wheel of his cart tilted up over a heap of granite setts, with the result that the off wheel dropped into an excavation which was made in connection with the construction of the tramways. Plaintiff was thrown out, rendered unconscious, and so severely injured as to necessitate considerable medical attendance and care. It was stated on behalf of the plaintiff that the construction of the tramlines had led to the traffic being diverted to one side of the tramlines, leaving about 10ft. available for traffic. The plaintiff, who had not driven that way previously while the excavations were being carried on, did not notice that the traffic had been so diverted, as there was nothing to indicate it.

Counsel for the defendants argued that the lights put up by them should have been a sufficient warning.

HIS LORDSHIP, without calling upon counsel to reply for the plaintiff, decided that the defendants had been guilty of negligence. He found that there was no light in the middle of the road in such a position as to indicate to the plaintiff that it was dangerous for him to proceed down the road. The proper and usual course for defendants to have carried out would have been to have had a hanging lamp from a scaffold pole. He did not find that there was any contributory negligence on the part of the plaintiff. Judgment would be for the plaintiff with £200 damages and costs.

## MOTOR REPAIRS.

In the Lord Mayor's Court, before Mr. F. S. Jackson and a jury, the case of the Refuse Destructor Company, Limited (in liquidation) *v.* Toshinsky and Ruchkovitz was disposed of. The plaintiff company claimed £10. 10*s.* in respect of certain repairs to an electric motor machine, at the request of the defendants. The plaintiffs supplied the defendants with a 20 h.p. electric motor. The defendants requested the plaintiffs to see to the motor because it had got out of order. The plaintiffs sent their engineer, one Mr. Wiltshire, who found upon going to the sawmills that the motor had been subjected to negligent treatment. The repairs now sued for were in respect of a sum of 10*s.* for heated bearings, which were put right, and the sum of £10 for repairing a burnt-out armature. When the motor was fitted up by the plaintiffs the defendants were informed that it would be necessary to brush the machine from time to time, and not to allow hardwood dust and oil to accumulate. The motor, being used in a sawmills, could not be kept absolutely free from dust, but the defendants allowed an accumulation of wood-dust and oil to occur, and the result was to cause a "bridging" of parts of the motor that were insulated. This, acting as a conductor, broke down the insulation and caused the damage to the armature. The question for the jury was whether the damage to the armature was caused by defective workmanship or negligent treatment.

For the defence, Mr. EWARD KEIL, engineer, said that when first employed the motor was connected to a countershaft. The distance between the countershaft and the motor was about 9ft., and it was impossible to get the motor to work properly, and they could never get a 20-h.p. drive out of it. The effect of so short a drive was that the belting was required to be so tight that the bearings became heated immediately. He had altered the length of drive and connected the motor to the main shaft, and it was now working admirably.

Judgment for plaintiffs for amount claimed.

# COMPANIES' MEETINGS AND REPORTS.

## J. G. WHITE AND CO.

The sixth ordinary general meeting of this Company was held on Friday last under the presidency of Lord Arthur Butler.

The CHAIRMAN, in moving the adoption of the report, stated that the present position of the business was very satisfactory, as the Company had in hand work of very considerable magnitude—in fact, con-

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siderably more than it had ever before at any one time. The contract work actually in hand exceeds £1,750,000, some considerable portion of which is being carried out in foreign countries, where, it is anticipated, the profits will be considerably larger than on tramway contracts carried out in Great Britain. A number of contracts have been secured for the complete construction of tramways, which indicates that the scope of the business is widening. In addition, arrangements have been made for securing business in Brazil.

Mr. J. B. WHITE seconded the motion, which was carried unanimously.

The CHAIRMAN next moved: "That a dividend, free of tax, at the rate of 6 per cent. per annum, on the cumulative preference shares for the year to Feb. 28, 1905, be declared."

This was seconded by Mr. J. B. WHITE, and agreed to.

The CHAIRMAN also proposed: "That a dividend, free of tax, at the rate of 6 per cent. per annum, on the ordinary shares for the year to Feb. 28, 1905, be declared."

Mr. J. B. WHITE seconded the motion, which was unanimously agreed to.

The retiring directors, Mr. W. C. Burton and Lord Arthur Butler, were unanimously re-elected, on the motion of Mr. J. B. WHITE, seconded by Mr. A. N. CONNETT; and Messrs. Monkhouse, Stoneham, and Co. were reappointed auditors, on the motion of Mr. WOOLLETT, seconded by Mr. BURTON.

A vote of thanks to the chairman concluded the proceedings.

## EDMUNDSON'S ELECTRICITY CORPORATION.

The report for the year ended March 31 last, to be presented at the meeting on the 6th prox., states that, including £13,923 brought forward from last year, the net profit, after payment of debenture interest, amounts to £68,915. The directors recommend a final dividend on the ordinary shares at the rate of 9 per cent. per annum, making 7 per cent. for the year, and a dividend at the rate of 7 per cent. on the 10,000 ordinary shares issued in November, 1904, to be added to reserve fund £6,635, leaving to be carried forward £15,007. The trading profit for the first time shows a small decrease, but, on the other hand, the income derived from investments has considerably improved. It is on a continuance of this improvement that the progress of the Corporation will in future mainly depend. During the year 10,000 preference shares, 10,000 ordinary shares, and £37,804 debenture stock have been issued. The premiums received in respect of these issues, less expenses, amount to £13,364, and have been added to the reserve fund, which, with the contribution proposed to be made from revenue account, will be thereby increased to £90,000. The growth of the electric lighting and power stations in which the Corporation is interested continues to be satisfactory, the lamp connections having increased from 568,549 to 761,453 during the year. The central station at Newbury was completed and opened in January. Good progress has been made in connection with the central stations at Inverness and Ramsgate, both of which will be opened during the next few months. These will complete the whole of the central stations which the Company at present proposes to erect.

## UNITED RIVER PLATE TELEPHONE.

The directors, in their report, say that the gross receipts in sterling for the year in the River Plate were £151,084, as against £134,824 for last year. Deducting debenture interest, dividend on preference shares, and interim dividend on ordinary shares, and adding interest on investments and transfer fees there remains a profit of £41,662, to which must be added £3,428 brought forward from the previous year, leaving an available balance of £45,091. Owing to the renewal and improvement of some of the most important trunk lines and the general rise in wages consequent on the enhanced cost of living in Argentina, there has been an exceptional increase in the River Plate expenses. After putting aside £10,000 for renewal of plant and transferring the sum of £15,000 to the reserve fund, the directors recommend that a final dividend of 5 per cent. be paid upon the ordinary share capital of the Company, making, with the interim dividend paid Dec. 31 last, a return of 8 per cent. for the year, free of income tax, and that the balance of £2 591 be carried forward. The business of the Company continues steadily to increase, and, as anticipated, further capital is required. It is therefore intended to make an issue of £50,000 in ordinary shares, which will be offered to the ordinary shareholders at par.

## NEW COMPANIES REGISTERED.

**Electrical Distribution of Yorkshire, Limited.** — Capital, £10,000. Objects: To carry on in the West Riding of Yorkshire or elsewhere the business of suppliers of electricity and gas for light, heat, motive power or otherwise, electricians, electrical, chemical engineers, etc.

### Lien Discharged.

**British Tramways and General Construction Company, Limited, London, E.C.** — Discharge registered June 20 of lien registered April 22, 1904, for £120,000.

## APPOINTMENTS VACANT.

**Shift-Engineer Foreman.** Applications to Box S 92, *Electrical Engineer* Office. See advertisement in last issue.

**Electrical Engineer**, Handsworth Urban District Council. Salary, £350 per annum. Applications by June 30.

**Principal** of the Paddington Technical Institute, Saltram-crescent, W. Commencing salary, £500 a year. Applications to the London County Council by July 3. See advertisement in last issue.

**Electrical Draughtsman**, Metropolitan Asylums Board, London, E.C. Salary, £125 per annum. Applications to Mr. T. Duncombe Mann, clerk, by 10 a.m. on July 3.

**Tramway Manager**, Leyton Urban District Council. Salary, £300 per annum. Applications by 12 noon on July 1.

**Shift Engineer**, Bursalem electricity works. Applications by July 6. See advertisement.

**Various.**—Head of electrical engineering department; salary, £200 per annum. Head of civil and mechanical engineering department; salary, £200 per annum. Assistant for building construction, etc.; salary, £130 per annum. Halifax Education Committee. Applications by July 11. See advertisement.

## CONTRACTS FOR ELECTRICAL SUPPLIES.

**Fregenal (Spain).**—The Municipality require tenders for public electric lighting. Tenders by July 3.

**Mazarron (Spain).**—The Municipality require tenders for public electric lighting. Tenders by July 5.

**Liria (Spain).**—The Municipality require tenders for public and private electric lighting. No date fixed.

**La Rambla (Province of Cordoba, Spain).**—The Municipality require tenders for public electric lighting. Tenders by July 1.

**Cataquoxes (Spain).**—The Municipal Electric Light and Power Company require tenders for electric plant. Tenders by July 1.

**Gillingham.**—Tenders are invited for one water-tube boiler and superheater, for the Electricity Committee. Tenders by July 3.

**Leigh (Lancs.).**—Tenders are invited for the supply of one water-tube boiler for the electricity department. Tenders by July 1.

**Fulham.**—The Council invite tenders for extension of cables, feeders, etc. Tenders by noon on July 12. See advertisement in last issue.

**Ilford.**—The Urban District Council invite tenders for the supply of ·4in. and ·25in. concentric cable. Tenders by 4 p.m. on July 11. See advertisement.

**London.**—The London County Council invite tenders for two low-tension feeder switchboards. Tenders by 10 a.m. on July 11. See advertisement in last issue.

**Bradford.**—The Education Committee invite tenders for the lighting of block A of the Grange-road new Council schools by electricity. Tenders by 10 a.m. on July 3.

**Bradford.**—The Corporation invite tenders for electric lighting installation in connection with the alterations at the central public library, Darley-street. Tenders by 12 noon on July 3.

**Dewsbury.**—Tenders are invited for the wiring and fittings required for lighting the warehouse in Wellington-road belonging to the Dewsbury Pioneers' Industrial Society, Limited. Tenders by July 5.

**Burton-upon-Trent.**—The Corporation invite tenders for the electrical equipment on the overhead system of about 1¾ miles of tramway (Contract No. 10). Tenders by noon on July 7. See advertisement in last issue.

**Loughborough.**—Tenders are invited for the supply of materials and stores for the year ending July 31, 1906, for the electricity works. Tenders to the Borough Electrical Engineer by July 18. See advertisement.

**Brighton.**—The Town Council invite tenders for supply, erection and maintenance of a 260-cell storage battery, having a capacity of 1,000 ampere-hours, at their power station, Southwick. Tenders by 10 a.m. on July 3.

**Alicante (Spain).**—The Harbour Board (Junta des Obras del Puerto) require tenders for two electric cranes, capable of lifting 10,000 kc. and 1,500 ko. respectively. Tenders by Sept. 15. Estimate, 107,010·10 pesetas.

**Stalybridge.**—The Stalybridge, Hyde, Mossley, and Dukinfield Tramway and Electricity Board require tenders for the supply, delivery, and erection at the Stalybridge sub-station of a 400-kw. motor-generator, together with the necessary switchgear for same.

**Neath.**—The Rural District Council invite tenders for the supply, etc., of electric light and power mains, sub-stations, switchboards, feeding pillars, switch pillars, excavations, and other works in connection within their area. Tenders by July 17. See advertisement.

## RESULTS OF TENDERS.

**Port Elizabeth.**—The tender of Messrs. Wills and Davey has been accepted, at £8,985, for the electricity works.

**Bristol.**—The Docks Committee have accepted the tender of Messrs. Stothert and Pitt, Bath, for the construction, delivery, erecting in place, fitting, testing, and maintenance for 12 months after completion, of four two-ton movable electric jib cranes, and one three-ton movable electric jib crane to be erected on the adjoining wharf at Canons Marsh.

**Colliery Contracts.**—Messrs. Bruce Peebles and Co., 25, Victoria-street, report the following recent contracts for colliery plant: Lambton

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Collieries, Durham, 2 800 h.p. in hauling, pumping, and ventilating motors; average size, 150 h.p. Risca Collieries, South Wales, 1,800 h.p. in pumping and hauling; average size, 180 h.p. Darbishires Quarries, North Wales, 1,500 h.p. motors varying from 50 to 150 h.p. Bow Hill Collieries, 500 h.p. in pumping and hauling. The total horse-power aggregates over 6,000, and the value of the orders aggregates over £40,000.

**Hammersmith.**—The Borough Council have received the following tenders for the cable required for connecting up the new generating plant to the main switchboards:

| | | | |
|---|---|---|---|
| Henley's Telegraph Works Company | £294 | 0 | 0 |
| Western Electric Company (accepted) | 294 | 18 | 9 |
| St. Helens Cable Company | 300 | 0 | 0 |
| Siemens Bros. and Co. | 317 | 5 | 0 |
| British Insulated and Helsby Cables, Limited | 338 | 0 | 0 |
| Glover and Co. | 357 | 3 | 9 |

**St. Pancras.**—The Borough Council have received the following tenders for the supply of arc lamp carbons for 12 months:

| | | | |
|---|---|---|---|
| Campagnie Française | £385 | 5 | 8 |
| G. Braulik | 463 | 13 | 2 |
| Siemens Bros. and Co. | 466 | 0 | 11 |
| De Grelle and Houdret | 471 | 19 | 1 |
| Sloan Electrical Company (accepted) | 476 | 19 | 0 |
| Mayer and Co. | 464 | 5 | 5 |
| D. McNaughton (Henrion carbons) | 494 | 17 | 4 |
| Brush Electrical Company | 500 | 9 | 6 |
| Crompton and Co. | 492 | 18 | 3 |
| General Electric Company | 510 | 15 | 2 |
| Johnson and Phillips | 505 | 5 | 4 |
| Electrical Company | 544 | 0 | 8 |
| British Thomson-Houston Company | 544 | 17 | 0 |
| Veritys, Limited | 543 | 11 | 7 |
| International Electric Company | 585 | 14 | 5 |
| Henckel and Jordan | 709 | 16 | 1 |
| Rumney and Rumney | 1,629 | 13 | 9 |

# BUSINESS NOTES.

## TRACTION.

**Cardiff.**—The accounts for the year, over which there has been a good deal of speculation, are expected to be presented to the Finance Committee this week.

**South Shields.**—The Local Government Board has completed its enquiry into the application of the Corporation for sanction to a loan of £15,625 for additional tramway plant.

**Heywood.**—Sanction has been received to the borrowing by the Corporation of £37,200 for electrifying the tramways within the borough and the extension of the electricity works.

**Belfast.**—At a meeting of the inhabitants a resolution was passed expressing "dissent and strong disapproval" of the suggested 1d. stages, which, in regard to the Falls-road district, were characterised as "unjust and unfair."

**Erith.**—At the meeting of the Urban District Council, the Electric Lighting and Tramways Committee reported that they hoped at the next meeting to be able to state when the whole of the tramway works are likely to be completed.

**Leith.**—The Town Council have had an "instruction" car placed at the tramways depôt in order that the drivers of the present horse cars may gain a practical knowledge of the working of electric cars before the new system of tramways is installed.

**Private Bills in Parliament.**—In the House of Lords the following Bills have been read a third time: Central Electric Supply, County of London Electric Supply Company, London United Tramways (Extension of Time). In the Commons the following Bills have been read a third time: London County Council (Money), and Metropolitan Electric Tramways.

**Huddersfield.**—Some rather severe strictures were passed on the motormen at the meeting of the Corporation in connection with the recent accidents. In their defence a councillor stated that in the case of the Newsome-road accident the brakes were tested, and on the first test were found to be all right, but tested again they failed. The brake was again tried, and it then acted all right.

**Warrington.**—Colonel von Donop last week inspected on behalf of the Board of Trade the new Stockton Heath tramway extension. At present the cars only run to Stafford-road, whereas the centre of the village is Victoria-square, 250 yards away. The great difficulty in making the extension has been the swingbridge over the Ship Canal, but the engineers have successfully surmounted this. At the trial spin there was some delay owing to some dirt having affected the switch under the bridge, but the run over the bridge to the square was then accomplished without mishap. The extension has cost about £11,000.

**Oxford.**—We recorded last week that at a public meeting a resolution was carried in favour of deferring the acquisition of the company's undertaking until further information had been obtained in regard to methods of conveyance generally. A special meeting of the Corporation was held last week to consider the question of purchase in the light of this resolution, when, after considerable discussion, it was decided to acquire the company's undertaking, and the follow supplementary proposition was agreed to: "That the seal of the Corporation be affixed to an agreement to carry into effect the resolutions already adopted by the Council, and that it be referred to a special committee to settle the terms of the agreement, and to take all such necessary steps as may arise out of the transaction."

**The Underground.**—Electric trains, four to the hour, will commence running to-morrow between Ealing and Whitechapel. Simultaneously the Inner Circle service of the Metropolitan Railway will come into electrical operation. As announced earlier in the year, the preparations were entirely completed for this change, but owing to the delay in the delivery of the sister companies' rolling-stock the transformation has been delayed. It is expected that the District Railway circle service will be worked by electricity in its entirety shortly after the beginning of next month, but a definite announcement will be made in a few days.

**St. Helens Tramway Strike.**—Replying to a question at the meeting of the Liverpool Corporation, Sir Charles Petrie explained that they had no arrangement whatever with the St. Helens Tramways Company. The arrangement was with the South Lancashire Company, and not the St. Helens Company, as to the working of that portion of the line between Knotty Ash and Prescot. There was a strike in connection with the St. Helens Company, but the Liverpool Corporation had nothing to do with that, and took no sides in the matter. They simply undertook to work this particular length of line between Knotty Ash and Prescot for the benefit of the passengers, and had not interfered in any way. The matter was now at an end, as the South Lancashire Tramways Company had recommenced to work the line.

**Rating of Tramways.**—At the invitation of the town clerk of Wakefield a conference of representatives from the local authorities through whose areas the lines of the Wakefield and District Light Railway run, was held at the town hall last week. The town clerk asked for support in a proposal to contest the refusal of the company to pay in full the district rate levied by the Corporation, on the ground that they are entitled to be rated at one-fourth only. The Corporation, on the other hand, contend that the light railway is not a railway within the meaning of Section 211 of the Public Health Act, 1875, and that the company are not occupiers of land used only as a railway. The delegates were unanimously of opinion that the Wakefield Corporation should be supported in its action, and they promised to report to their respective authorities.

**Glasgow.**—The following figures in regard to the Corporation tramway accounts for the past year are supplementary to those we gave last week: Expenditure—traffic, £217,873; general, £75,119; repairs, £68,640; power, £25,535—total, £387,167. Adding amount set aside for renewal and depreciation (£153,334) the total is £540,501. Deducting this amount from the gross revenue there remains a balance of £227,403. From this the following items have also to be deducted: lease of Govan lines, £5,080; lease of Paisley District Tramways, £915; interest, £49,906; sinking fund, £46,920; income tax, £5,434; parliamentary expenses, £891; common good, £25,000—total, £134,146. This leaves a net surplus of £93 257, of which the committee propose to appropriate £68,500 for special depreciation, and to carry the balance to reserve fund.

**Bournemouth.**—Extension to Christchurch is being pushed forward as expeditiously as possible by Messrs. J. G. White and Co., the contractors, who have about 100 men busily engaged in preparing the track. The continuance of the fine weather will facilitate the work, and no delay is expected, as all the materials have been delivered and the contracts settled. The first section of the line will, it is confidently hoped, be open for use on August Bank Holiday. This will give a ride from Pokesdown to Tuckton Bridge. Onwards the work is of much greater magnitude, for it involves the reconstruction of Tuckton Bridge. The second section will probably be finished in October, and by November the contractors hope to have completed the undertaking. The construction of the line will necessitate other work, and the telephone and telegraph wires, instead of running overhead, will be carried underground.

**London United Tramways Co.**—The Highways Committee of the Kingston Town Council have resolved that the company shall be required to lay their tramways in the streets where tramways are now being laid at such levels as shall be consistent with the wood paving hereafter of such streets throughout their entire width. The Council have received from the company plans for the widening of the bridge in St. James's-road, for the widening in Clarence-street from Church-street to Fife-road, for the widening in Clarence-street from Fife-road to the King's Arms public-house, for the widening at the junction of Penrhyn-road and St. James's-road, and in respect of crossing places and levels at Surbiton-road. A reply has been received from the company stating that the matter of the construction of the length of tramway along Richmond-road from King's-road to the borough boundary would be considered by the directors.

**Brighton.**—Although there is a deficit on the past year's working of £320, the system showed a marked improvement over last year, when the deficit amounted to £4,778. The chief figures for the year ending March 31 last are: income, £250,339. 11s. 7d.; expenditure, £38,495. 13s. 9d.; leaving a gross balance of £11,843. 17s. 10d. Out of this interest charges absorb £8,084, and sinking fund charges £4,080. 16s. 10d., leaving a deficiency of £321. 11s. 11d. The principal items of expenditure for 1905 and 1904 respectively are; traffic expenses, £15,956. 15s. 3d. (£17,153. 12s. 9d.); power expenses, £11 350. 8s. 5d. (£11,093. 13s. 6d.); repairs and renewals, £6,476. 7s. 9d. (£8 487. 2s.); management and general expenses, £3,813. 19s 8d. (£3 260. 7s. 11d.); rents, rates, and taxes, £898, 2s. 8d. (£223. 13s. 4d.). The population served by the tramways is 126,250, and the car miles run during the past year total 1,152,828, the track mileage being 9 miles 3 furlongs 200 yards, of which 7 miles 5 furlongs 137 yards are double track, and 1 mile 6 furlongs 63 yards single track. The units of energy consumed were 1,816,067, the number per car mile being 1·57. During the past year the capital expenditure amounted to £30,402. 7s. 10d., the total expenditure to date being £274,070.

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**Kirkcaldy-to-Leven.**—At the monthly meeting of the Kirkcaldy District Committee of the County Council the clerk reported that he had received the opinion of Mr. Campbell, K.C., in connection with a proposal by Mr. Sellon, engineer of the Wemyss tramways, that at certain points where the tramways came on to the road the rails should be laid at the side of the road, the tramway track being about 6in. above the surface of the road. In a lengthy opinion counsel pointed out that the gross margin at the side of the road was under the control of the District Committee, but he thought it very doubtful if that fact made them occupiers of the land abutting on the road or adjoining the road within the meaning of Section 4 or Section 22. He further stated that the duty of the District Committee was to maintain the road in the interests of the public, and not to sanction encroachments on the carriageway or margin. If they agreed to Mr. Wemyss's proposals, they would be liable for any damages to members of the public resulting from the alterations which they had authorised. A letter was read from Mr. Sellon, in which he said he differed entirely from Mr. Campbell's opinion, and he had not the slightest doubt he could get it reversed 20 times over by counsel who knew anything at all about parliamentary work. They were aware, no doubt, that he did not require the consent of the County Council in this case, neither did he require the matter to be referred to eminent counsel, and he accordingly advised them formally that in three weeks he would order the rails for the purpose of constructing the tramway section necessary for the construction of the line down the centre of the Randolph-road, leaving it entirely for the County Council to consider within that time whether they would not prefer to suggest to him some course beneficial alike to all parties without the interference of outside parties. After some discussion, it was agreed to reply to Mr. Sellon that while the District Committee had been all along willing to meet Mr. Wemyss's views in connection with the tramways, they could not do otherwise than be guided by the opinion of counsel.

**Edinburgh-Queensferry.**—A special meeting in committee of the Edinburgh Town Council was held last week for the purpose of considering a report by the Lord Provost's Committee submitting draft agreement between the promoters of the Queensferry tramways and the Corporation. We gave the main points of the agreement last week. The town clerk, in explaining the agreement, pointed out that the effect of the Corporation's refusal, if they did refuse, to give consent in any form to this tramway proposal, although they had nothing to do with the consent of other people, would be to kill the proposal for the present. The Dean Bridge route was the one the company would want if they could get it, but that obviously raised the question of the widening of the Dean Bridge, and that would entail a great deal more money than the company could afford to pay. The committee had only refrained from saying no to the Bedford Bridge route, which obviously was only an alternative to the Dean Bridge route, in order to allow the Town Council time to say either yes or no to that route. The other line was to connect Comely Bank with Blackhall. The company would do it, and Comely Bank would then become another Pilrig. The committee recommended giving consent to the company to come in from Blackhall to Comely Bank, but reserved to the Town Council to consider, as they would have to do, whether they would themselves go to Blackhall or convert the route up to Frederick-street into electric traction. What the document did was to give the Corporation absolute power to take at reasonable terms the part within the city, and power to acquire on reasonable terms outside lines. Some discussion took place on the question of the conditions of purchase. The Corporation may, on six months' notice, require the company to sell the tramways at a price equivalent to the then structural value as determined by an arbitrator, but not exceeding the cost price minus 2½ per cent. written off for depreciation, and with a certain bonus added if purchased at various periods prior to the expiry of 21 years. Payment for wayleave, ½d. fares, season tickets, advertisements, a time limit, and other matters were all discussed, and then the draft agreement was approved. Meeting again as the Town Council, the agreement was confirmed after a lengthy discussion.

**Manchester.**—The Tramways Committee at their meeting on Tuesday had before them the report and abstract of accounts for the year ended March 31 last. The report states that at the date of the last report the routes open for traffic aggregated 137 miles 1 602 yards of single track. During the year just ended the following extensions have been made and opened for traffic: Middleton-road, 3 miles 718 yards; circular route extension, Hulme Hall-lane to Belle Vue-street, 4 miles 1,543 yards—total, 8 miles 501 yards. The aggregate length of single track open for traffic at March 31, 1905, was therefore 146 miles 343 yards. The revenue account shows total receipts of £631,955. 12s. 4d., against £611,881. 3s. 8d. for the preceding year. The working expenses were £411,497. 3s. 11d., against £391 853. 13s. 11d. The gross profit, with bank interest, totals £222,227. 17s. 6d. After allowing for interest (£52,120), redemption of debt (£35,379), and other charges, there remains a surplus of £101,277. 13s. 10d. Out of this the following sums have been voted: renewals and depreciation account, £70,907; contribution in aid of the rates, £46,000; street improvements round infirmary (interest, etc.), £4,043. 3s. 8d.—leaving a net profit of £120,950. 3s. 8d. The contribution in aid of the rates was increased by £5,000 being tranferred from a reserve fund accumulated in former years, making the total contribution in aid of the rates during the year the sum of £51,000. The total of the borrowing powers is £1,925,000. Powers have been exercised up to £1,515,168, and the gross capital expenditure is £1,587 930. During the year the number of passengers carried was 126 900,875, an increase of over 6,000,000 on the previous year, when the figures were 120,772,368. The car mileage shows an increase of considerably over 1,000,000 miles, the figures being 14,123,124 during last year and 13,617,448 during 1903-4. The percentage of passengers' fares show that 71·94 paid 1d. for the journey, 11·01 paid 1½d., 7·10 2d., and 5·40 ½d. Of the total number of passengers carried 91,281,804 paid 1d. fares. The electrical energy used during the year amounted to 18,854 240 units, against 16,815,764 in the previous year. The average traffic revenue per car mile was 10·68d., against 10·52d., and the average traffic revenue per mile of single track was £4,299, as against £4,468 in 1903 4. The average working expenses per car mile, including power cost, was 6·99d., against 6·78d. The renewals and depreciation fund now amounts to £185,085, against £119,844 in the previous year. The committee had before them a report by the general manager, Mr. M'Elroy, in reference to the application of the motormen, conductors, timekeepers, and inspectors employed on the tramways for an increase at the rate of time and a half for Sunday duty, Good Friday, and Christmas Day. The committee decided that they were unable to comply with the men's request. The report of the general manager states that the concessions already granted to the staff in the Corporation service, as compared with what was received by the men who worked under the old tramway company, amounted to an annual cost on the department of £50,000. If the further concession were granted it would mean an increase of £6,000 to this amount.

## LIGHTING AND GENERAL.

**Stafford.**—There has been an increase of 37 per cent. in the output of the electricity department during the last month.

**Elgin.**—The Duke of Richmond and Gordon proposes to lay cables for the supply of electricity to the village of Fochabers.

**Removal.**—The National Electric Construction Company, Limited, have removed to larger premises at Queen Anne's-chambers, Westminster, S.W.

**Eastern Extension Australasia and China Telegraph Co.**—The directors have declared an interim dividend for the quarter ended March 31 last of 2s. 6d. per share.

**Southwark.**—Councillor Attenborough proposes to move a resolution in favour of selling the electric light undertaking as a going concern "in view of the heavy burden it throws upon the rates."

**Hamilton.**—The Burgh of Hamilton Electricity Supply, for which Edmundson's Electricity Corporation are contractors, have held an exhibition of electrical appliances, extending over four days, in the hall of the Commercial Hotel, Hamilton.

**Wireless Communication with Lightships.**—The Board of Trade and the Trinity House have concluded a contract with Marconi's Wireless Telegraph Company, Limited, providing for the equipment of lightships with Marconi wireless telegraph installations.

**Buxton.**—The accounts of the electricity department for the year ending March, 1905, show a total revenue of £4 212 compared with £3,884 for the previous year, being an increase of £328. The total expenses were £2,727 compared with £2,443 for the previous year, being an increase of £184.

**Edmundson's Electricity Co.**—The directors recommend a final dividend on the ordinary shares of 9 per cent. per annum for the half-year ended March 31, making, with the interim dividend already paid, a dividend of 7 per cent. for the year. They also recommend a dividend at the rate of 7 per cent. per annum on the 10,000 new ordinary shares issued in November, 1904.

**Swansea.**—The *South Wales News* reports that while Mr. Alexander, electrical wire inspector under the Swansea Corporation, was engaged on a raised trolley repairing a wire at the hospital junction, one of the wires was carried away and struck Mr. Alexander, who was thrown to the ground, a fall of 20ft. He was picked up in a semi-conscious condition and conveyed to the hospital, where it was found he had sustained a severe wound on the forehead.

**Technical Education.**—A large variety of practical instances of the work executed by students of technical classes in Great Britain, Ireland, and the Colonies, and by candidates of the City and Guilds of London Institute's annual examination, 1905, is being shown at the North Gallery of the Imperial Institute. The show was opened on Wednesday by Lord Spencer, and will remain open until July 8. With the exhibits we will deal in a future issue.

**Stock Exchange.**—The Stock Exchange Committee have ordered the undermentioned securities to be quoted in the official list: Calcutta Tramways Company, Limited, 32,610 shares of £5 each (£1 paid), Nos. 105,001 to 137,610. Applications have been made to the committee to appoint a special settling day in and to grant a quotation to County of Durham Electrical Power Distribution Company, Limited, 50,000 ordinary shares of £5 each and 50,000 preference shares of £5 each (special application); Hastings and District Electric Tramways Company, Limited, £125,000 4½ per cent. debenture stock.

**Rochdale.**—The accounts of the electricity department for the year ended March 31 give a total revenue of £9,797 and a total expenditure of £4 975, which left £4,822 to be carried over to their revenue account. There was a balance of £622 from last year, and after paying £1,835 interest, £1,200 repayment of capital, £592 sinking fund, a balance of £1,818 remains to be carried forward. The units generated during the year amounted to 1,440,429, of which 1 160 593 were sold to private consumers by meter, 138,087 were used on the works, making a total of 1,298,680 accounted for. The total maximum supply amounted to 908·5 delivered.

**New Issue.**—In order to provide for the completion of the purchase of the undertaking of the Crystal Palace District Electric Supply Company, Limited, and to meet the continuous increase in the company's business, the South Metropolitan Electric Light and Power Company, Limited, are issuing a further £51,708 4½ per cent. first mortgage debenture stock at £105, and a further 16,300 ordinary shares of £1 each, and 32,600 7 per cent. cumulative preference shares of £1 each, at 21s. 6d. per share, payable as follows: on application, debenture stock 5 per cent., ordinary and preference shares 1s. per share; on allotment (including the premium), 25 per cent. and 5s.6d.; on Sept. 1, 1905, 25 per cent. and 5s.; on Jan. 1, 1906, 50 per cent. and 10s.

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**Norton.**—The Urban District Council are reminding the Northern Counties Electricity Supply Company, Limited, of the agreement the company undertook to establish works within a period of two years, and asking for the reason why the undertaking has not been carried out.

**Bray.**—The Electric Light Committee selected the following three candidates for the post of assistant electrical engineer in order of merit—viz.: (1) Mr. D. E. McDonnell, Macroom; (2) Mr. L. C. Redfern, Southport; (3) Mr. Warren Storey, Dublin—but no assistant is to be appointed.

**Rotary Pumps.**—Messrs. Federico Jarach and Co., Milan, whose foundry and engineering works are at Ghisa, have acquired from Positive Rotary Pumps, Limited, of 23, Northumberland-avenue, W.C., a concession for the manufacture and sale of pumps under their patents throughout the kingdom of Italy.

**Rawtenstall.**—With regard to the steps taken to bring the Town Council's electricity order into operation, it is reported that the Board of Trade have approved the scheme practically in the form submitted to them. The estimates and plans have been prepared for the Local Government Board, and an enquiry will shortly be held.

**Dublin.**—At a special meeting of the Corporation to-day the Electric Lighting Committee will submit a report referring to the delay which has arisen in connection with the extension of the electric lighting system. The committee recommend an application for sanction to a loan of £100,000 for extension of the undertaking.

**Pontypridd.**—The South Wales Electric Power Company are offering to supply electrical energy for domestic purposes in Pontypridd. It being questioned at the last Urban District Council meeting whether the company had a legal right to do so in view of the powers acquired by the Council, it was decided to take counsel's opinion on the matter.

**Bourne.**—Mr. W. E. Milns, of Stamford and Grantham Electricity Works, has prepared a scheme for the establishment of electricity works in Bourne, and this scheme was laid before a special meeting of the tradesmen's association on June 22. Further consideration is being given to the matter, and it is probable that enquiries will be made for firms willing to erect and run such an undertaking.

**Exeter.**—At the last City Council meeting Mr. Roberts, dealing with the electricity undertaking accounts, said that last year's trading not showing a profit was not to be wondered at, considering the changes made at the works and the fact that the price had been lowered to the consumer. He congratulated the committee that it was now putting the accounts in a proper state by facing facts and writing off depreciation, and by no longer carrying forward any unsanctioned loans.

**City of London.**—At last week's Court of Common Council the electrical engineer reported on the leakage of electricity from consumers' lines in cellars under the public ways, and the possible danger of shocks to the public therefrom. It was agreed that the attention of householders should be drawn to the necessity of fixing and maintaining their electric circuits and apparatus in such a manner and conditions as to prevent the possibility of the pavements from becoming charged with electricity.

**London Gazette.**—The first dividend of 1s. 6d. in the £ has been declared in the estate of William Henry Lloyd Watson and George Huntington, electricians, 83, Battersea-rise, London. The first meeting in the estate of Alexander Holmes and Alexander McCallum, electrical engineers, trading as Holmes and McCallum, at Crown Works, Darwen, will be held at 14, Chapel-street, Preston, on July 4, at 10.30 a.m. A first and final dividend of 2¾d. in the £ has been declared in the estate of Arthur Edgar Brooks, electrical engineer, 110, Cheapside, London.

**Battersea.**—The agreement with the London and South-Western Railway Company, relating to the supply of electrical energy for the purpose of their electrical installation, particularly for the lighting and supply of power at the Nine Elms goods yard, has now been completed by the company, and the Council have commenced the supply. A reverse-current circuit breaker is to be provided in connection with the new panel of the switchboard now on order at an estimated cost of £46. The figures for the half year show an increase of 37 consumers for lighting and 11 for power supply, with equivalent increases of 1,254 8-c.p. and 12 h.p. respectively.

**Houghton-le-Spring.**—Permission has been granted to the Durham Electric Power Distribution Company to carry overhead tension wires in the district where underground ones are impossible, subject to an undertaking to conform with the Board of Trade regulations as to the public safety, and an undertaking that wherever the footpaths or roads are damaged by the erection of the poles, the company will put the same into a proper state. The Lambton Collieries Company has been granted permission to carry certain electric light wires above the highways instead of underneath, subject to the company undertaking the public safety, and as far as they can legally do so.

**Agency.**—Messrs. Nalder Bros. and Thompson, Limited, desire us to notify that in future Mr. Ernest Roberts, 6, Holborn-place, who heretofore has had charge of their London district travelling, will not act in this capacity in future, owing to the large increase in his own business, but that any enquiries which he may receive will be attended to as heretofore. Messrs. Frampton, Paine, and Jackson, 29, Old Queen-street, Westminster, will in future represent them in London, and likewise in the Southern, Western, and Eastern Counties, and those districts where they are not at present represented, for ammeters, voltmeters, wattmeters, and circuit breakers and analogous apparatus.

**Aberystwyth.**—At the last meeting of the Town Council the following resolution, passed by a town's meeting, was read: "This meeting desires the Corporation to take into consideration the advisability of introducing electric lighting and a refuse destructor into the borough." The Mayor said that the town's affairs seemed to be reaching a crisis, and it was time for them to consider the question of the destruction of refuse and the desirability of stopping its discharge into the Severn. The refuse, he was told by experts, was suitable for burning in a destructor, and the power derived by the process could be utilised for generating electricity sufficient to provide 1,500 8-c.p. lamps. Mr. John Naylor, of Leighton Hall, was prepared to lease the building and turbines on the Severn-road at a low ground rent for a long term of years. It was decided to convene a special meeting of the Council to consider the question.

**Krupka and Jacoby.**—We are informed that Messrs. Krupka and Jacoby will from to-day cease to act as managers of Siemens Electric Appliances, Limited, and will continue to carry on business on their own account under the name of Krupka and Jacoby at 61 and 62, Watling street, Queen Victoria-street, E.C. They have made arrangements with Siemens Electric Appliances, Limited, under which they will continue to deal in all the electric appliances hitherto sold by them with the exception of fire alarms, the department for which will be transferred to the Woolwich works of Siemens Bros. and Co., Limited. The firm will also act as sole agents for Dr. Albert Lessing, Nuremberg, and as selling agents for Siemens electric lamps, for india-rubber electric light wires and cables manufactured by Siemens Bros. and Co., Limited, and for some of the products of Siemens-Schuckert Werke, of Berlin and Nuremberg, and Siemens and Halske, Berlin and Charlottenburg.

**Shildon.**—On Tuesday took place the formal opening of the electricity works and refuse destructor erected by Messrs. Heenan and Froude, Limited, for the Northern Counties Electricity Supply Company. There is a four-cell refuse destructor of the Heenan patent type worked in connection with two Babcock and Wilcox water-tube boilers, with a combined heating surface of 3,900 square feet, with a regenerator whereby the blast is heated by the waste gases *en route* to the chimney after they have passed through the boilers. The forced draught is promoted by means of a Heenan fan driven direct by a vertical enclosed quick-revolution engine. The furnaces are on the inter-communicating grate system. At the generating station are installed two 90-h.p. compound engines, by Messrs. Allen, Son, and Co., of Bedford. The dynamos are by the Westinghouse Company, and are capable of supplying current for 6,000 8-c.p. lamps. The switchboard, which has been constructed by Messrs. Dorman and Smith, of Manchester, is of the latest pattern. There is also a storage battery of 250 cells.

**Hull.**—An enquiry has been held into an application of the Town Council for sanction to borrow £36,000 for the purpose of increasing the electricity plant. The town clerk, Mr. E. Laverack, said the electric light undertaking had been successful from its inception in 1893, with the exception of the year 1901, when, owing to the high price of coal and other exceptional circumstances, no profit was made. Out of the profits they had paid interest on sinking fund, and the balance had gone to a reserve fund. Those profits had been made notwithstanding a gradual decrease in the charges from 7d. for light and 6d. for power to 4½d. for light and from 2l. to 1d. for power, the latter being governed by the quantities a consumer used. They had also made contributions out of revenue towards the depreciation of the plant which was originally installed, particularly meters. Mr. Bell, the electrical engineer, described the additional plant proposed, and which consists of boilers, dynamos, engines, transformers, cables, etc. He said that the maximum capacity of the existing plant would provide an increase of ½,000 kw. Last year the demand rose from 3,100 kw. to 3,500 kw., and he anticipated a greater demand next year, owing to some large power consumers which had recently been connected.

**St. Marylebone.**—A report of the Electric Supply Committee gives the following details of each consumer's account with the Metropolitan Company for 1904: total number of consumers supplied during the year, 5,801; total number of meters in circuit, 6,482; gross income from sale of current, £133,370. 16s. 9d.; income from meter rents, £4,469. 13s. 1d.; total Board of Trade units sold, 6 289,877; average price obtained per Board of Trade unit (excluding meter rents), 5·089d.; average price obtained per Board of Trade unit (including meter rents), 5·259d. The prices charged to consumers vary considerably. The charge for residential purposes is 6d. per unit; that for trade purposes 5d. per unit, if the consumption exceeds five units per 8-c.p. lamp installed per quarter; if the consumption falls below this, the price charged is 6d. per unit. For certain all-day basement lighting 3d. per unit is charged. In the case of blocks and flats where the supply is given in bulk, and the proprietor takes over all liability as to individual tenants, the company allow a rebate of 20 per cent. off the 6d. rate. For motive-power and heating purposes the indicator system has been introduced, the charges being 3d. per unit for the first two hours daily on maximum load, and 1½d. per unit for all in excess of this quantity. In addition to these standard rates, there appear to be many special agreements with large consumers, or consumers with a special class of supply, such as hospitals. In these cases the rates vary considerably, there being a few consumers at each of the following rates—viz.: 4½d., 4¼d., 4d., 3¾d., 3½d., 3¼d. (less 2½ per cent.), 2½d., 2d., 5½d., and 7d. per unit. The Board of Trade units sold at the various rates per quarter is given as follows: at 6½., 2,527,372; at 5d., 1,982,323; at 3d., 191 321; at 1½d., 59,523; at 4½d., 387,601; at 4¼d., 86 206; at 4d., 955,572; sundry, 99,959—making a grand total of 6,289,877 units. The table shows the total sales in Board of Trade units and money value and average price per quarter as follows: March quarter, 2,034,575 units, value £43,338. 13s. 5d., average price 5·11d.; June quarter, 1,018,298 units, value £21,731. 9s. 3d., average price 5·12d.; September quarter, 869,932 units, value £18,376. 1s. 2d., average price 5·07d.; December quarter, 2,357,072 units, value £49,924. 12s. 11d., average price 5·06d.—total for year, 6,289,877 units, value £133,370. 16s. 9d., average price 5·089d. The proportion of sales per quarter were: March quarter (*a*) sales in Board of Trade units 32·4 per cent., (*b*) income from consumers 32·5 per cent.; June quarter, 16·2 per cent. and 16·3 per cent.; September quarter, 13·8 per cent. and 13·8 per cent.;

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December quarter, 37·6 per cent. and 37·4 per cent. The ratio of sales at various rates to total was: at 6d., 2,527,372 units, 40·2 per cent. to total; at 5d., 1,982,323 units, 31·5 per cent.; at 3d., 191,321 units, 3·0 per cent.; at 1½d., 53,533 units, 0·9 per cent.; at 4½d., 387,601 units, 6·2 per cent.; at 4¼d., 86,206 units, 1·4 per cent.; at 4d., 955,572 units, 15·2 per cent.; sundry, 99 959 units, 1·6 per cent. The present rates of charge will continue until the end of the year, the Council reserving to themselves the right of altering the same before the expiration of that period.

**Hammersmith.**—Ground is to be purchased for an extra high-tension sub-station in the north of the borough, and a new high-tension cable laid at a cost of £2107. The premises of 22 additional consumers, representing a maximum of 567 8-c.p. lamps, have been connected to the mains, and 15 consumers have been disconnected, the present number of consumers taking current from the mains being 1,592. It has been decided to order six transformers of 100 kw. capacity each and six of 50 kw. capacity, the contract price with the British Electric Transformer Company being £120 and £87. 10s. respectively. When the revised charge for public lighting comes into operation, about 1,000 maximum demand indicators now fixed at consumers' premises will be rendered useless. An offer from the county borough of Hanley to purchase a number of these indicators at the following rates has been accepted—viz., 2½ and 5 amperes 15s. each, 10 to 25 amperes 17s. 6d. to 20s., larger sizes 30s. In continuation of the report noticed by us in March, 1905, with reference to the conversion of the arc lighting system from rectified to alternating current, the following report from the engineer has been submitted to the Council: "The trial circuit in Hammersmith-road is now in working order, and the result of this is in every way satisfactory. The cost of this conversion is £52. 2s. 8d., and this expenditure is justified for the following reasons: (*a*) The light is improved, being more equally distributed along the street instead of concentrated around the posts. (*b*) The lamps have been completely renovated, and are now quite as good as when purchased originally in 1896, and should stand another 10 years' use without any heavy expense for renewals. (*c*) The circuits consist of only 16 lamps, so the pressure on the cables is reduced, thus decreasing the risk of breakdowns, and also minimising the importance of breakdowns owing to the fewer lamps being affected. (*d*) The present system of running 50 rectified arcs on one circuit inflicts great strain upon the cables, and more especially upon the fittings in the posts, with the result that during stormy weather the fittings fail and cause a great deal of trouble and expense. For instance, during the recent bad weather we had trouble with all the rectified circuits, five lamps and one switch were burnt out, and the leads in the posts were damaged, the total cost of these faults amounting to about £25. This happens nearly every time bad weather is experienced, and is a very heavy charge on public lighting. The total cost of converting the whole of the rectified arcs to alternating (without taking credit for any apparatus which will be thrown out of use) will not exceed £500. The cost of upkeep of the present system amounted to £353. 17s. last year, and I anticipate that if the lamps are converted this item will almost disappear. I therefore recommend that the present system of street-lighting be changed from rectified to alternating, section by section until the whole has been completed, and that this work be placed in the hands of the Universal Electrical Company, who carried out the trial circuit alterations." The committee recommend that the work be carried out, and that the order for the same be placed in the hands of the company named.

## PROVISIONAL PATENTS, 1905.

JUNE 19.

12616. **Improvements in and connected with electric railways and tramways.** Alexander Swanson, Cathkin-avenue, Rutherglen, near Glasgow.

12618. **An apparatus for automatically recording the number of times a telephone is used.** Richard Richmond and George Ernest Clare, 74, Woodside, Wimbledon, London.

12645. **Improvements in means for regulating dynamos.** Henry Leitner, 4, South-street, Finsbury, London.

12682. **Improvements in telephone apparatus for use for diving and like purposes.** Alfred Graham and Robert Henry Davis, 4, South-street, Finsbury, London.

12690. **Improvements in intercommunication telephone systems.** Isidore Bernard Birnbaum and Herbert George White, 322, High Holborn, London. (Complete specification.)

JUNE 20.

12725. **Improvements in arc lamps.** Bernard Mervyn Drake, 66, Victoria-street, Westminster, London.

12778. **Improvements in electric unloaders for air-compressors.** Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (The Ingersoll-Sergeant Drill Company, United States.) (Complete specification.)

12791. **Improvements in electric locomotives.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

12792. **Improvements in and relating to dynamo-electric machines.** The Allgemeine Elektricitäts-Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Sept. 17, 1904, being date of application in Germany.) (Complete specification.)

JUNE 21.

12822. **An electric door-locking device.** Charles Peter, Zurich-Langnau, Switzerland. (Complete specification.)

12818. **An improved electric safety switch having or possessing a gas-tight sparking chamber.** Frederick Edward Oldfield and Owen George Cowper, 43, Trinity-street, Southwark, London.

12852. **Improvements in electro-plating.** Richard Bruno Roxby, 53, Chancery-lane, London.

12853. **Improvements in or connected with the electro-plating of aluminium.** Richard Bruno Roxby, 53 Chancery-lane, London.

12875. **Improvements in and relating to electric arc lamps.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.) (Complete specification.)

12876. **Improvements in and relating to alternating-current dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts Ges., Germany. (Complete specification.)

JUNE 22.

12880. **Improvements in electric conductors.** Anson Gardner Betts, Troy Rensselaer County, New York, United States.

12899. **Improvements in dynamo-electric generators and motors.** Leonard Knight Clark, 128, Colmore-row, Birmingham.

12914. **Improvements in telegraphic receiving apparatus.** Stephen Dudley Field, 65, Chancery-lane, London. (Complete specification.)

12945. **Improvements in dynamos for railway train lighting.** Henry Leitner and Richard Norman Lucas, 4, South-street, Finsbury.

12947. **Improvements in or relating to the storage of electrically-transmitted energy.** Henry Wilson Fox, 322, High Holborn, London.

12953. **Improvements relating to safety devices for electrical apparatus.** Lorenz Kottmair and Rudolf Zwack, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

12964. **Improvements in electric arc lamps.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

JUNE 23.

6987A. **Improvements in electric stop-motion mechanism for looms.** Joseph Botsford Whitney, 18, Fulham-place, Paddington, London. (Date applied for under Patents Rule 9, April 3, 1905.) (Complete specification.)

6987B. **Improvements in fallers for electric stop-motion mechanism for looms.** Joseph Botsford Whitney, 18, Fulham-place, Paddington, London. (Date applied for under Patents Rule 9, April 3, 1905. (Complete specification.)

12973. **An electrical timing apparatus for timing motorcars and for other analogous purposes.** James Martin Inglis, 37, West Nile-street, Glasgow.

12976. **Improvements in the methods of and means for the distribution of electricity to street lamps and the like.** George Wilkinson, Beech Mount, Harrogate.

12999. **Improvements in means for ensuring the continuity of movements derived from electric energy.** Arthur Booth Webber and the Standard Time Company, Limited, 22, Southampton-buildings, Chancery-lane, London.

13009. **Improvements in automatic signalling apparatus more especially for use in connection with electric traction systems.** Max Byng and William Charles Cloete Hawtayne, 71, Queen Victoria-street, London.

13025. **Improvements in electric arc lamps.** William Reginald Ridings, Westinghouse Patent Bureau, Westinghouse Building, Norfolk-street, Strand, London.

JUNE 24.

13062. **Improvements in or connected with insulators of electric railways, tramways, and the like.** Robert Naudin Tweedy, Toydene, Amblecote, Stourbridge, Worcestershire. (Complete specification.)

13063. **Improvements in or relating to electric clock and alarm systems.** Wilhelm Rausch and Hermann Gondolf, 30, Belvoir-street, Leicester. (Complete specification.)

13073. **Improvements in telephone and telegraph relays.** William Aitken, c/o The British Insulated Helsby Cables, Limited, Milton-road, Edge lane, Liverpool.

13084. **Improvements relating to controllers for single-phase induction motors.** Ray Philip Jackson, The Westinghouse Patent Bureau, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, June 30, 1904, being date of application in United States.) (Complete specification.)

13093. **Improvements in or relating to electric drills.** Alfred Julius Boult, 111, Hatton-garden, London. (William Obed Duntley, United States.) (Complete specification.)

13107. **Improvements in dynamo-electric machinery.** The Honourable Charles Algernon Parsons and Alfred Flint, 18, Southampton-buildings, Chancery-lane, London.

13108. **Improvements in dynamo-electric machinery.** The Honourable Charles Algernon Parsons, 18, Southampton-buildings, Chancery-lane, London.

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**13112. Improvements in and relating to dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.) (Complete specification.)

**13113. Improvements in holders for commutator brushes.** The Morgan Crucible Company, Limited, and Charles William Speirs, 4, South-street, Finsbury, London.

## COMPLETE SPECIFICATIONS ACCEPTED.

*To be published July 13.*

1904.

**6959. Filaments for electric incandescent lamps and method of manufacturing the same.** Levis. (General Electric Company.)

**16410. Electric measuring instruments.** British Thomson-Houston Company, Limited. (General Electric Company.)

**16619. Electric ignition apparatus for exploding gases in rotary or reciprocating engines.** Somerville.

**16853. Stopping-place indicators for electric tramcars and the like.** Wright.

**17000. Electromagnetic relays.** Tyer, Hollins, and Leake.

**17017. Electric motor-control systems.** British Thomson-Houston Company, Limited. (General Electric Company.)

**17021. Controllers for electric motors.** British Thomson-Houston Company, Limited. (General Electric Company.)

**17023. Electric switches.** British Thomson-Houston Company, Limited. (General Electric Company.)

**17024. Electric controllers for electric circuits.** British Thomson-Houston Company, Limited. (General Electric Company.)

**17632. Means for operating the points of electric tramways and the like, and also the overhead points or trolley switches and devices for actuating such operating means.** Norris.

**17705. Vaporisers.** British Thomson-Houston Company, Limited. (General Electric Company.)

**17803. Electrical measuring instruments.** Eversbed and Vignoles, Limited, and Eversbed.

**18054. Electric device for indicating the unauthorised opening of doors locks, window fastenings, and the like.** Levin.

**18173. Mercury and the like vapour electric apparatus.** Oarclan. (General Electric Company.)

**19061. Instruments for making calculations in regard to electric conductors and other problems.** Hincks.

**19917. Push buttons and the like for electric bells and similar services.** Harcourt.

**22647. Electrical resistances.** Moy and Bastie.

**23804. Insulators for high-veltage electric lines.** Soc. Ceramica Richard-Ginori. (Date applied for under International Convention, June 22, 1904.)

1905.

**410. Electrical hydro-pneumatic governor for marine engines.** Grasset.

**1552. Electric fans.** Fairweather. (Diehl Manufacturing Company.)

**1607. Alarm fuse for telephone exchanges.** Craft. (Date applied for under International Convention, Feb. 5, 1904.)

**2888. Electrical trolley heads with wire-finding apparatus attached.** Cherry and Olive.

**5232. Electric current circuit breakers.** Moy and Bastie.

**6066. Electric clocks.** Hope-Jones.

**7211. Electric clocks.** Campiche.

**7438. Method of securing the removable cover of a tumbler or like electrical switch.** Davies.

**8540. Electric induction meters.** Cie. anon. Continentale pour la Fabrication des compteurs à Gaz et autres Appareils. (Date applied for under International Convention, Feb. 16, 1905.)

**10853. Vapour electric apparatus.** Thomas. (Date applied for under International Convention, May 25, 1904.)

**10768. Receivers for wireless telegraphy.** Thompson. (Ges. für drahtlose Telegraphie m. b. H.)

## COMPANIES' STOCK AND SHARE LIST.

| Name. | Amount paid. | | Last price |
|---|---|---|---|
| **Commercial and Industrial.—** | £ | | £ |
| Alliance Elecurical Co., 5 per cent. Cum. Pref., Nos. 1-70,000 | 1 | – | ½-¾ |
| Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000 | 1 | – | 7/16-17/32 |
| British Insulated and Helsby Cables, Ord., 1-100,000 | 5 | – | 5¼-6 |
| —— 6 per cent. Cum. Pref., 1-100,000 | 5 | – | 5¼-6 |
| —— 4½ per cent. Mortgage Debentures | 100 | – | 103-106 |
| British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 100-102 |
| British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000 | 5 | – | 2 7/16-2 11/16 |
| —— 4 per cent. Mortgage Debenture Stock | 100 | – | 89-91 |
| Brush Electrical Engineering, Ordinary, Nos. 1-105,751 | 2 | – | ¼-¾ |
| —— Non. Cum., 6 per cent. Pref. | 2 | – | 1-1¼ |
| —— 4½ per cent. 1st Debenture Stock | 100 | – | 92-95 |
| —— 4½ per cent. 2nd Debenture Stock | 100 | – | 79-82 |
| Callender's Cable, Debentures | 100 | – | 106-108 xd |
| —— Ordinary | 5 | – | 10-11 |
| —— 5 per cent. Pref. | 5 | – | 5⅝-5¾ xd |
| Crompton and Co. | 5 | – | 1¼-2¼ |
| —— 5 per cent. Debentures | 100 | – | 98-100 p.c |
| Edison and Swan United, "A" Shares, 1-99,261 | 5 | – | 1¼-1¾ |
| —— "A" Shares, 01-017,139 | 5 | – | 2-2¼ |
| —— 5 per cent. Debentures | 100 | – | 89-94 |
| —— 4 per cent. Deb. Stock, Red. | 100 | – | 84-89 |
| Electric Construction, Limited, Nos. 1 to 112,100 | 2 | – | 1¼-1⅜ |
| —— 7 per cent. Cumulative Pref. | 2 | – | 2⅛-2¼ |
| —— 4 per cent. Perp. 1st Mort. Deb. | 100 | – | 95-98 |
| Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red. | 100 | – | 90-95 |
| General Electric Company (1900), 5 per cent. Cum. Pref. | 10 | – | 9⅜-10¼ |
| —— 4 per cent. 1st Mort. Deb. Stock | 100 | – | 97-101 |
| W. T. Henley's Telegraph Works, Ordinary | 5 | – | 11¼-12¼ |
| —— 4½ per cent. Preference | 5 | – | 5¼-5⅜ |
| —— 4½ per cent. Debentures | 100 | – | 109-111 |
| India Rubber, Gutta Percha, and Telegraph Works | 10 | – | 15¼-16¼ xd |
| —— 4 per cent. Debentures | 100 | – | 100-103 |
| Parker, Thos., Limited, Ordinary | 10 | – | 10-10¼ |
| Telegraph Construction and Maintenance | 12 | – | 32-34 |
| —— 5 per cent. Bonds | 100 | – | 103-105 |
| **Electric Lighting and Supply.—** | | | |
| Bournemouth and Poole, Ordinary | 10 | – | 11¾-12¼ |
| —— 4½ per cent. Cum. Pref., 7,501-15,000 | 10 | – | 10-10¼ |
| —— 5 per cent. Cum. Second Pref., 15,001-22,500 | 10 | – | 11¼-12¼ |
| —— 4½ per cent. Debenture Stock. Red. | 100 | – | 107-109 |
| Bromley (Kent) Electric Light and Power Co. | 5 | – | 5¼-5⅝ |
| —— 4½ per cent. 1st Debenture Stock, Red. | 100 | – | 103-106 |
| Brompton and Kensington, Ordinary | 5 | – | 9⅜-10¼ |
| —— 7 per cent. Preference | 5 | – | 9⅜-10¼ |
| Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000 | 5 | – | 9 9¼ |
| —— Nos. 60,001-80,000 | 5 | – | 8⅜ 9¼ |
| Cambridge Electric Supply Company, Ltd., £10 Ord. | 8 | – | 12¼-13¼ |
| Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock | 100 | – | 103-106 |
| Charing Cross and Strand, 70,001-80,000 | 5 | – | 7¼-8 |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5¼-5⅜ |
| —— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 | 5 | – | 5-5¼ |
| —— 40,001-80,000 | 5 | – | 5-5¼ |
| —— 4 per cent. Debenture Stock, Red. (Prov. Certs.) | 100 | – | 105-107 xd |
| Chelsea Electricity Supply | 5 | – | 6¼ 6⅜ |
| —— 4½ per cent. Debentures | 100 | – | 109-111 |
| City of London, Ordinary | 10 | – | 10¾-11¼ |
| —— 6 per cent. Cumulative Pref. | 10 | – | 13¾-14¼ |
| —— 5 per cent. Debenture Stock | 100 | – | 124-128 |
| —— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) | 100 | – | 104-106 |
| County of London Electric Supply, Ordinary | 10 | – | 8¼ 8⅜ |
| —— 6 per cent. Cum. Pref. | 10 | – | 12¼ 12⅝ |
| —— 4½ per cent. Debentures Prov. Certs. All pd. Rd. | 100 | – | 106-105 |
| —— 4½ per cent. 2nd Debentures Prov. Certs. | 100 | – | 113-116 |
| Edmundsons' Electricity Corporation, Ordinary, 1-50,000 | 5 | – | 5⅜-5¾ |
| —— 6 per cent. Cum. Pref. | 5 | – | 5-5¼ |
| —— 4½ per cent. First Mort. Deb. | 100 | – | 107-109 |
| Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000 | 5 | – | 2¼-3 |
| —— 5 per cent. Debenture Stock, Red. | 100 | – | 86-91 |
| Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000 | 5 | – | 5¼-5⅜ |
| —— 4½ per cent. First Deb. Stock, Red. | 100 | – | 101-104 |
| Havana Electricity, Limited, 1-15,000 | 10 | – | 9¼-10¼ |
| Hove Electric Lighting, Limited, Ord., 1-13,000 | 5 | – | 7⅜-8¼ |
| Isle of Wight Elec. Lt. and Pwr., Ld., 4½ p.c. Db. Stk. Red. | 100 | – | 100-103 |
| Kalgoorlie Electric Power and Lighting, Limited, 6 per cent. Cum. Pref., 1-150,000 | 1 | – | ¾-⅞ |
| Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000 | 5 | | 11¼-12¼ |
| Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red | 100 | – | 101-103 |
| Kidderminster and Dist. Elec. Lighting and Traction, Pref. | 10 | – | 9⅜-10¼ |
| London Electric, Ordinary | 5 | – | 2-2¼ |
| —— 6 per cent. Pref. | 5 | – | 5-5¼ |
| —— 4 per cent. 1st Mortgage Debenture Stock, Red. | 100 | – | 97-99 xd |
| Metropolitan Ordinary, 100,001-300,000 | 5 | – | 9¼-10¼ |
| —— 4½ per cent. First Mortgage Debenture Stock | 100 | – | 111-115 |
| —— 4½ per cent. Cum. Pref. | 5 | – | 5¼-5⅜ |
| —— 3½ per cent. Mortgage Debenture, Red. | 100 | – | 99-101 |
| Midland Electric Power Dis., Ld., 4½ p.c. 1st Mort. Deb. | 100 | – | 101-103 p.c. |
| Newcastle-upon-Tyne Electric Supply, Ordinary | 5 | – | 98-101 |
| —— Preference | 4 | – | 100-102 |
| Notting Hill Electric Lighting | 10 | – | 14¼-15¼ |
| —— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.) | 100 | – | 100-102 |
| Oxford Electric, Ordinary, 1-96 and 4[illegible]-14,310 | 5 | – | 6¼-7 |
| —— 4 per cent. Debenture Stock | 100 | – | 99¼-101¼ |
| Royal Electrical Company of Montreal 4½ per cent. First Shares Mortgage Debentures | 100 | – | 101-104 |
| Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 | 5 | – | 2¾-3¼ |
| —— 4 per cent. Debenture Stock | 100 | – | 79-83 |
| South London, Ordinary | | – | 3¼-4¼ |
| South Metropolitan Electric Light and Power Co., Ord. | 1 | – | ¾-⅞ |
| —— 7 per cent. Cum. Pref. | 1 | – | 1¼-1⅜ |
| —— 4½ per cent. 1st Mort. Deb. | 100 | – | 105-108 |
| —— Ditto, June, 1904 | | – | |
| St. James's and Pall Mall, Ordinary, 101-20,080 | 5 | – | 13¼-14¼ |
| —— 7 per cent. Pref. | 5 | – | 8¼-9 |
| —— 3½ per cent. Deb. | 100 | – | 98-100 |
| Urban Electric Supply Co., Ordinary, 8-30,007 | 5 | – | 4¾-5 |
| —— 5 per cent. Cumulative Preference, 50,001-80,000 | 5 | – | 5¼-5⅜ |
| Westminster, Ordinary | 5 | – | 12½-13 |
| —— 5 per cent. Cum. Pref., 110,101-158,251 | 5 | – | 6⅞-7⅛ |
| **Electric Tramways.—** | | | |
| Anglo-Argentine, 5 per cent. Cum. Pref., 1-260,007 | 5 | – | 6-6¼ |
| —— Ord. | 5 | – | 8⅜-8¾ |
| —— Permanent 6 per cent. Debenture Stock, 1888 | 100 | – | 140-143 xd |
| Auckland Elec. Trams., Ld., 5 p.c. 1st Mor. Deb. Stk., Red. | 100 | – | 106-108 |
| Barcelona Tramways, Limited, Ord., 1-20,000 | 10 | – | 12¼-13¼ |
| —— 5 per cent. Cum. Pref. Shares, 1-10,000 | 10 | – | 9¼-10¼ |
| —— 5 per cent. Deb., Red., 1-600 | 100 | – | 99-102 |
| —— 4½ per cent. Red. Deb. Stock | 100 | – | 96-100 |
| Bath Elec. Tramways., Ld., Pref. Ord. Shs., 75,001-150,606 | 1 | – | ¾-⅞ |
| —— 5 per cent. Cum. Pref. Shares, 1-59,394 | 1 | – | 15/16-1 1/16 |
| Belfast Street Tramways, Ord., 1-25,600 | 10 | – | 10¼-11¼ |
| Blackpool and Fleetwood Tramroad | 10 | – | 13⅜-13⅝ |
| Brisbane Tramway Invest., Lim., Ord., 1-75,000 | 5 | – | 1¼-1⅜ |
| —— 5 per cent. Cum. Pref., Nos. 1-75,000 | 5 | – | 3¾-4¼ |
| —— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. | 100 | – | 94-96 |
| British Columbia Electric Railway Co., Ord. Def. | 100 | – | 105-108 |
| —— Ord Pref. | 100 | – | 98-101 |
| —— 5 per cent. Cum. Perpetual Pref. Stock | 100 | – | 104-107 |
| —— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £240 each | 40 | – | 103-105 p c |
| —— 4½ per cent. Vancouver Power Deb. | 100 | – | 100-103 |
| British Electric Traction Ord. 1-300,000 & 60,001-90,000 | 10 | – | 9¼-9⅜ |
| —— 6 per cent. Cm. Pf., 30,001-60,000 | 10 | – | 11¼-11⅜ |
| —— 5 per cent. Perpetual Debenture Stock | 100 | – | 122-124 |
| —— 4½ per cent. 2nd Deb. Stock | 100 | – | 98-100 |

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| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | |
| Buenos Ayres and Belgrano Trams | 5 – | 3-3½ |
| —— 'A' 6 per cent. Cm. Pf., 1-40,000 | 5 – | 5½-5¾ |
| —— 'B' 6 per cent. Cm. Pf., 1-27,500 | 5 – | 5½-5¾ |
| —— 5 per cent. Deb. Stock, Red. | 100 – | 107-109 |
| —— Prov. Cert., all paid | 100 – | 103-106 |
| Buenos Ayres Electric Trams., Ld., 5 p.c. Deb. Stk., Red. | 100 – | 98-100 |
| Calcutta Tramways, Limited, 1-102,268 | 5 .. | 8 3/16-8 7/16 |
| —— 4½ per cent. 1st Deb. Stock, Red. | 100 .. | 107-109 |
| Cape Electric Tramways Nos. 1-480,000 | 1 – | 1¼-1½ |
| City of Birmingham Tramways, 5 per cent. Cum. Pref. | 5 – | 4¾-5¼ |
| —— ½ per cent. 1st Mortgage Deb., 1-3,000 (1917) | 10 p – | 99-102 |
| Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red. | 100 | 102 104 |
| Cork Electric Tramways and Lighting Co. Ordinary | 10 | 9½-10 |
| —— 5 per cent. Cum. Pref. | 10 – | 11-12 |
| —— 4 per cent. Debentures | 100 – | 101-102 |
| Dublin United Tramways (1896), Ord., Nos. 1-60,000 | 10 – | 13½-14¼ |
| —— ½ per cent. Pref., Nos. within 1-60,000 | 10 – | 15-16 |
| —— 5½ per cent. Mort. Debs., 1-3,000, Red. | 100 – | 94-97 |
| Imperial Tramways Ordinary | all – | 18-19 |
| —— ½ per cent. Cum. Pref. | all – | 14-14¼ |
| —— 4½ per cent. Deb Stock | 100 | 108-11 |
| Isle of Thanet Electric Tramways and Lighting, 5 per c. Cm. Pref., Nos. 30,001-60,000 | 5 | 2¾-3¼ |
| —— 4 per cent. Debenture Stock | 100 – | 85-90 |
| Kidderminster and District Lighting and Traction, Pref. 5 | – | 8-8½ |
| London United Tys. (1901), 5 per cent. Cum. Pref. | 10 – | 9¾-10¼ |
| —— ½ per cent. 1st Mt. Db. Stock, Red. | 100 – | 100-103 |
| Madras Elec. Trams (1904), Ld., 5 per cent. Deb. Stk., Red. | 100 .. | 101-103 |
| Metropolitan Elec. Trams., Ld., Defd., 1,000,001-1,314,016 | 1 .. | 9/32 11/32 |
| —— 5 per cent. Cum. Pref., 500,001-1,000,000 | 1 .. | 1-1 1/16 |
| —— 4½ per cent. Deb. Stock, Red. | 100 .. | 106-108 |
| Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8 000 | $1,000 .. | 106-110 |
| Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600 | 100 .. | 101-104 |
| —— Sterling 4½ per cent. Deb., 1922, 601-2,000 | 100 .. | 103-105 |
| New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,00 | 5 – | ¼-1½ |

| Name. | Amount paid. | Last price. |
|---|---|---|
| | £ | £ |
| Oldham, Ashton, and Hyde Tramway Ordinary | 10 | 12 |
| —— 6 per cent Cum. Pref. | 10 – | 9¾-9¾ |
| Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Sk | 100 – | 105-108 |
| Potteries Electric Traction, Ordinary 20,001-40,00 | 10 – | 8¾ 9¼ |
| —— 5 per cent. Cum. Pref., 1-20,000 | 10 – | 9¼ 9¾ |
| —— 4½ per cent. Debenture Stock | 100 – | 101-104 |
| South Lancashire Electric Traction and Power Company | | |
| —— £250,000 Ordinary | 1 | 1 |
| —— £101,132 6 per cent. Preference | 1 | 1 |
| —— £587,170 4½ per cent. Debenture Stock | 100 p.c. – | 100 p.c. |
| **Electric Railways.—** | | |
| Central London, Ordinary | 100 – | 91-93 |
| —— 4 per cent. Pref. | 100 – | 101-103 |
| —— ,, ,, deferred | 100 – | 78-81 |
| —— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) | 100 – | 111-113 |
| City and South London, Consolidated Ordinary | 100 – | 39-41 |
| —— 4 per cent. Debentura Stock | 100 – | 107-110 |
| —— 5 per cent. Pref. Stock '91 | 100 – | 120-123 |
| —— ,, ,, ,, '96 | 100 – | 119-122 |
| —— ,, ,, ,, '01 | 100 – | 115-118 |
| Liverpool Overhead, 5 per cent. Pref. | 10 – | 10-10¼ |
| —— Ordinary, 1-50,000 | 10 – | 3¾-4 – |
| —— 4 per cent. Mortgage Debentures, Red., 1-1,700 | – – | 99-101 |
| Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes | – – | 99-100 |
| Waterloo and City, Ordinary | 100 – | 90-92 |
| **Telephones.—** | | |
| National Telephone, Preferred | 100 .. | 111-112 |
| —— Deferred Stock | 100 – | 102-104 |
| —— 6 per cent. Cum. First Pref. | 10 – | 13-14 |
| —— 6 per cent. Cum. Second Pref. | 10 – | 12-13 |
| —— 5 per cent. Non. Cum. Third Pref. | 5 – | 5¼-5¾ |
| —— 3½ per cent. Deb. Stock, Red. | 100 – | 101-103 |
| —— 4 per cent. Deb. Stock, Red. | 100 – | 103½-105½ |
| —— 4 per cent. Prov. Cert. | – .. | 103½-105½ |
| Oriental Telephone and Electric Company | 1 – | 1¼-1¾ |
| —— 6 per cent. Cum. Pref. | 1 .. | 1 1/16-1 3/16 |

## TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

| Line. | Traffic Returns for week | | | Increase or decrease. | | Miles of single track open. | | Accounts for past year. | | | | Receipts per | | | Cost per car mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ending | 1905. | 1904. | Week. | Current year. | 1904. | 1903. | Ending | Total receipts | Passengers carried. | Car miles run. | Pas-s'nger | Car mile. | Mile of track. | |
| | | £ | £ | £ | £ | | | | £ | | | d. | d. | £ | d. |
| Aberdeen Corporation | June 24 | 1,571 | 1,560 | + 11 | – 1194 | 19¼ | 19¼ | May 31 | 37,931 | 9,099,715 | 794,641 | 0·98 | 13·02 | 1,970 | 6·14 |
| Ayr Corporation | ,, 17 | 225 | 336 | – 1 | — | 8 | 8 | ,, 15 | 14,160 | 3,201,586 | 336,049 | 1·03 | 10·11 | 1,770 | 5 0 |
| Barking Corporation | — | — | — | — | — | 1·33 | — | — | — | — | — | — | — | — | — |
| Birkenhead Corporation | ,, 25 | 1 129 | 1,060 | + 69 | – 165 | 23·53 | 23½ | March 31 | 56,073 | 11,327,932 | 1,349,701 | 1·158 | 9·98 | 2,385b | 6·1 |
| Birmingham Corporation | ,, 24 | 327 | 334 | – 7 | — | — | — | — | — | — | — | — | — | — | — |
| Birmingham Tramways Co. | — | — | — | — | — | 6¼ | 6¼ | — | — | — | — | — | — | — | — |
| Blackburn Corporation | ,, 21 | 818 | 920 | – 27 | + 5 9 | 24 | 23 | ,, 25 | 43,374 | 7,742,692 | 951,484 | — | 10 94 | — | 4·59 |
| Blackpool Corporation | ,, 22 | 2,013 | 857 | +1,156 | + 833 | 17½ | 17½ | ,, 31 | 211,168 | 6,169,121 | 784,443 | 1·52 | 10·8 | — | — |
| Blackpool-Fleetwood Trams. | ,, 21 | 913 | 690 | + 223 | – 357 | 16½ | 16½ | Dec. 31 | 32,021 | 2,258,984 | 600,757 | 3·34 | 12·75 | 2,001 | 7·05 |
| Bolton Corporation | ,, 25 | 2,276 | 1,855 | + 421 | + 916 | 38 | 38 | March 31 | 94,161 | 19,895,496 | 2,188,030 | 1·14 | 10·32 | 3,766 | 5·89 |
| Bournemouth Corporation | ,, 21 | 1,433 | 1,050 | + 383 | + 633 | 10·15 | 10½ | — | — | — | — | — | — | — | — |
| Bradford Corporation | ,, 24 | 4,352 | 4,506 | – 154 | — | 77 | 41 | — | — | — | — | — | — | — | — |
| Brighton Corporation | ,, 25 | 1,045 | 979 | + 66 | + 950h | 9 | 7½ | ,, 31 | — | 10,432,508 | 1,031,928 | 1·00 | 10·10 | — | — |
| Bristol Tramways Company | ,, 23 | 5,261 | 5,201 | + 60 | — | 51½ | 51½ | Dec. 31g | 253,150 | 44,391,439 | 6,036,528 | — | — | — | — |
| Burnley Corporation | ,, 24 | 1,079 | 936 | + 93 | — | 10·60 | 10 | — | — | — | — | — | — | — | — |
| Burton Corporation | ,, 25 | 322 | 341 | – 19 | – 250 | 8¼ | — | March 31i | 11,574 | 2,556,134 | 282,378 | 1·08 | 9·84 | 1,570 | 7·57 |
| Cardiff Corporation | ,, 24 | 2,195 | 2,095 | + 93 | — | — | — | — | — | — | — | — | — | — | — |
| Carlisle Tramways Company | ,, 26 | 218 | 201 | + 17 | – 351 | — | — | Dec. 31g | 9,937 | 2,805,277 | 334,393 | — | 7·17 | — | — |
| Central London Railway | ,, 24 | 6,401 | 6,620 | – 219 | + 1,622h | 6 | 6 | ,, 31 | 362,471 | 44,953,938 | 1,292,674a | 1·87 | 64·87 | 58,229 | 35·60 |
| City & South London Railway | ,, 25 | 2,269 | 2,552 | – 283 | – 3,84h | 6¼ | 6⅜ | ,, 31 | 165,003a | 19,069,319a | — | — | — | — | — |
| Colchester Corporation | ,, 21 | 209 | — | — | — | 7 | — | — | — | — | — | — | — | — | — |
| Cork E. T. and L. Company | ,, 22 | 561 | 535 | + 26 | + 535 | — | — | ,, 31g | 26,657 | 6,353,323 | 919,676 | 1·00 | 6·95 | — | 3·9 |
| Darwen Corporation | ,, 23 | 237 | 225 | + 12 | + 127 | 7·23 | 7·23 | March 31g | 12,341 | 2,360,735 | 254,279 | 1·25 | 11·65 | 1,707 | 9·36 |
| Dover Corporation | May 13 | 198 | 195 | + 3 | — | 4½ | 4½ | ,, 31 | 11,265 | 2,871,332 | 280,901 | 0 94 | 9·63 | 2,503 | — |
| Dublin & Lucan Electric Ry. | June 23 | 139 | 137 | + 2 | + 254 | 7 | 6⅔ | Dec. 31g | 6,234 | 388,905 | 107,164 | 3·88 | 14·09 | 932 | 7·39 |
| Dublin U. T., electric cars | ,, 23 | 4,389 | 4,274 | + 115 | } — | 47 | 46 | ,, 31g | 134,643 | — | 3,429,356 | — | — | — | — A |
| Dublin S. District, Electric | ,, 25 | 1,146 | 1,134 | + 12 | | | | | | | | | | | |
| Dundee City Tramways | ,, 21 | 856 | 851 | + 15 | — | 22 | 22 | May 15 | 35,874 | 9,084,522 | 752,814 | 0·93 | 11·276 | 1,630 | — |
| East Ham Corporation | ,, 24 | 837 | 781 | + 116 | + 737 | 10·77 | 10·75 | March 31 | 34,312 | 12,950,269 | 807,002 | 0·63 | 10·2 | — | — |
| Glasgow Corporation | ,, 24 | 16,121 | 14,279 | +1,842 | + 1,493h | 145 | 123 | May 31g | 656,572 | 177,179,549 | 14,008,750 | 0·88 | 11·25 | 5,489b | 7·40d |
| Gloucester Corporation | ,, 7 | 302 | — | — | — | 5½ | — | — | — | — | — | — | — | — | — |
| Halifax Corporation | ,, 14 | 2,576 | 1,393 | +1,033 | + 844 | 33 | 30½ | March 31 | 68,283 | 16,322,054 | 1,387,885 | 1·00 | 11·79 | 2,069 | 8·77 |
| Huddersfield Corporation | ,, 24 | 1,354 | 1,247 | + 107 | — | 35 | 35 | ,, 31 | 65,545 | 11,893,287 | 1,632,000 | 1·2 | 9·31 | 1,873 | — |
| Hull Corporation, E. S. | ,, 24 | 2,134 | 2,152 | – 13 | + 55 | 25 | 19 | ,, 31 | 87,707 | 21,065,999 | 2,218,696 | 1·00 | 9·49 | 5,004 | 5·0 |
| Ilford Corporation | — | — | — | — | — | 10½ | — | — | — | — | — | — | — | — | — |
| Ilkeston Corporation | ,, 21 | 119 | 143 | – 24 | — | — | — | — | — | — | — | — | — | — | — |
| Kirkcaldy Corporation | ,, 21 | 213 | 217 | – 4 | — | — | — | — | — | — | — | — | — | — | — |
| Leeds Corporation | ,, 24 | 5,937 | 5,781 | + 156 | + 3,110 | 89 | 81½ | ,, 25 | 280,562 | 60,739,234 | 6,215,799 | 1·10 | 10·84 | 3,407 | — |
| Leicester Corporation | — | — | — | — | — | 7¼ | — | — | — | — | — | — | — | — | — |
| Liverpool Corporation | ,, 17 | 12 289 | 10,857 | +1,432 | — | 103 | 103 | Dec. 31g | 531,484 | 113,057,234 | 11,734,838 | 1·11 | 10·73 | 5,160 | 6·98 |
| Liverpool Overhead Railway | ,, 25 | 1,602 | 1,721 | – 119 | – 1,767h | 6·57 | — | June 30 | 79,252 | 10,466,726 | 986,185a | 1·82 | 19·30a | 5,110 | — e |
| London County Council | ,, 17 | 15,885 | 12,488 | +3,397 | — | 46¼ | 40 | — | — | — | — | — | — | — | — |
| Lowestoft Corporation | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Maidstone Corporation | ,, 22 | 129 | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| Manchester Corporation | ,, 24 | 13,021 | 12,112 | + 909 | + 5,573 | 131½ | — | — | — | — | — | — | — | — | — |
| Nelson Corporation | ,, 24 | 145 | 116 | + 29 | — | 2⅔ | — | March 31 | 5,200 | 1,420,759 | 171,132 | 8·3 | 6·47 | — | — |
| Newcastle-on-Tyne Corptn. | ,, 24 | 3,719 | 4,995 | –1,277 | — | 45 | 38½ | ,, 25 | 185,027 | 39,715,120 | 4,059,907 | 1·1 | 10·94 | 4,111b | — |
| Newport (Mon.) Corporation | — | — | — | — | — | 15 | — | — | — | — | — | — | — | — | — |
| Oldham Corporation | ,, 25 | 1 728 | 1 137 | + 591 | — | 34¾ | — | — | — | — | — | — | — | — | — |
| Portsmouth Corporation | ,, 24 | 2,051 | 2,313 | – 262 | – 536 | 29 | 29 | ,, 31 | 91,448 | 18,204,426 | 1,828,193 | 1·16 | 12·39 | — | — |
| Reading Corporation | ,, 22 | 685 | 678 | + 7 | — | — | — | — | — | — | — | — | — | — | — |
| Rochdale Corporation | — | — | — | — | — | 4½ | 4½ | 31g | 5,416 | 925,281 | 127,456 | 1·38 | 10·27 | — | 7·66 |
| Rotherham Corporation | ,, 22 | 401 | 494 | – 93 | — | — | — | ,, 31 | 23,968 | 4,914,479 | 525,840 | 1·02 | 9·570 | 2,247 | 6·62 |
| Salford Corporation | ,, 26 | 4,555 | 4,060 | + 495 | + 3,054 | — | — | — | — | — | — | — | — | — | — |
| Scarborough Tramways Co. | ,, 24 | 172 | — | — | — | 7⅔ | — | — | — | — | — | — | — | — | — |
| Sheffield Corporation | ,, 25 | 4,977 | 4,659 | + 318 | + 1,813 | 34¼ | — | ,, 25g | 216,309 | 56,812,049 | 4,926,083 | 0·904 | 10·428 | 7,510 | 7·0 |
| Southampton Corporation | ,, 21 | 988 | 983 | + 14 | – 359 | 11 | 11 | ,, 31 | 35,874 | 9,084,522 | 752,814 | 0·946 | 11·436 | 3,760 | — |
| Southend-on-Sea Corporation | ,, 21 | 439 | 391 | + 47 | + 348 | 6¼ | — | — | — | — | — | — | — | — | — |
| Stockport Corporation | ,, 23 | 612 | 566 | + 46 | + 236 | 11½ | — | — | — | — | — | — | — | — | — |
| Sunderland Corporation | ,, 25 | 1,453 | 1,361 | + 92 | + 199 | 19·53 | 18·48 | ,, 31 | 62,506 | 14,848,968 | 1,433,463 | 1·01 | 10·46 | — | 6·02 |
| Swindon Corporation | ,, 21 | 195 | — | — | — | 3⅔ | — | — | — | — | — | — | — | — | — |
| Wallasey U.D.C. | ,, 24 | 818 | 766 | + 52 | + 515 | 10·5 | 10·5 | ,, 31 | 35,864 | 6,564,493 | 757,688 | 1·28 | 11·36 | 4,10 | 7·38 |
| Warrington Corporation | ,, 24 | 336 | 316 | + 20 | + 165 | 7½ | — | — | — | — | — | — | — | — | — |
| West Ham Corporation | ,, 22 | 1,647 | 1,132 | + 515 | + 7,619 | 8·62 | — | — | — | — | — | — | — | — | — |
| Wolverhampton Corporation | ,, 14 | 1,321 | 607 | + 713 | — | 7½ | — | ,, 31g | 20,878 | 4,263,066 | 417,335 | — | 12·006 | — | — |

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile. Per mile of single track. c Include rail and tram. d Including depreciation. f Including one section of horse traction. g 1905. h Half-year's figures. Only eight months—expenditure includes large special items incidental to starting new department.

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Supplement to "The Electrical Engineer,"
JANUARY 6, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

### QUESTIONS.

753. Discuss the rules for determining the most economical current density of a one square inch cable, one mile long, insulated in a satisfactory manner, working at a pressure of 1,000 volts direct current, the duration of the maximum load being on an average five hours per day, cost per unit delivered to conductor 1d., and interest and depreciation on cable taken at 10 per cent. State which rule you think gives the best result.—S. A. H.

754. It is well known that the indicated horse-power of a triple-expansion engine can be varied by altering the cut-off of the intermediate-pressure or low-pressure valve, the high-pressure cut-off meanwhile remaining the same. I am not referring to extreme variations, when the engine almost ceases to be triple-expansion, but to slight alterations in the cut-offs, when the engine is doing equal work in each cylinder. Can anyone explain why this should be so?—J. P.

### ANSWERS.

*Question No.* 745.—A direct-current generator of 500 volts, for use on a three-wire system, is fitted with an automatic balancing arrangement, consisting of a choking coil fed, *via* slip-rings, from two points on the armature windings, the middle point of the choking coil being connected to the neutral 'bus bar. Can you give the theory of its action in balancing the pressure of the two sides of the network?

*Answer to No.* 745 (*awarded 7s. 6d.*).—To simplify matters as far as possible, consider the case of a simple ring armature revolving in a two-pole field. Figs. 1 and 2 represent this, $B_1$ and $B_2$ being the diagrammatic representation of the two commutator brushes, and $s_1$ and $s_2$ the brushes on two slip-rings. These slip-rings are connected to two opposite points of the armature winding, and from them a single-phase alternating current can be collected, the virtual voltage being about four-fifths of the continuous-current voltage (with a pole arc of 50 per cent.). The maximum alternating-current voltage corresponds to the position in Fig. 1 when the instantaneous voltage between the slip-rings is

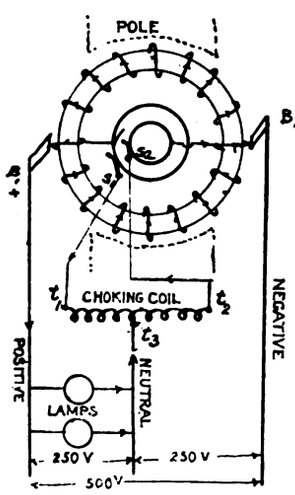

FIG. 1.

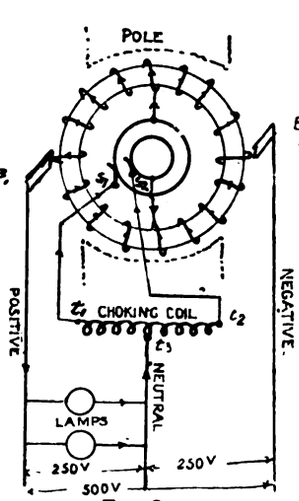

FIG. 2.

equal to the voltage between the continuous-current brushes, $B_1$ and $B_2$. In Fig. 2 the alternating pressure is now zero, corresponding to a quarter of a cycle's advance. One complete revolution of the armature corresponds to one complete cycle of the alternating current. If the two slip-rings are connected to a suitably designed choking coil, under normal conditions, an alternating magnetising current will flow in this coil. It is found, however, that if the centre point of the coil is connected to a terminal, $t_3$, a continuous current will flow between this terminal and either continuous-current brush, $B_1$ or $B_2$, and that the voltage will be half that between the continuous-current brushes, $B_1$ and $B_2$. The combination can thus be used to run a three-wire continuous-current distribution system, by connecting the neutral to the terminal, $t_3$, of the choking coil.

It was shown above that the voltage between the slip-rings varies from a maximum (in Fig. 1), when it is equal to the continuous-current voltage, to zero a quarter of a revolution later. A quarter of a revolution later still it will be at a negative maximum, and so on through the cycle. Now this voltage is what is applied to the choking-coil terminals, and it is obvious that the voltage between $t_3$ (the centre terminal) and $t_1$ or $t_2$ is always half that between $t_1$ and $t_2$; in other words, the potential of the point $t_3$ is always midway between the two potentials of the points $t_1$ and $t_2$—that is, midway between the potentials of the two slip-rings. At one moment (as in Fig. 1) the potential difference between $t_1$ and $t_2$ is equal to the potential difference between the continuous-current brushes—say 500 volts—and the point $t_3$ is at a potential halfway between these brushes. A little later (as in Fig. 2) the voltage at the terminals of the choking coil is zero, each end being connected to points on the winding situated at that instant symmetrically in the field. The point $t_3$ is at a potential midway between $t_1$ and $t_2$ (in this case the three potentials are all the same, and equal to zero), so that it is at a potential halfway between the brushes, $B_1$ and $B_2$. It can easily be seen that since the connections to the two slip-rings, $s_1$ and $s_2$, are symmetrically placed with regard to the armature and the continuous-current brushes, a point at a potential halfway between that of $s_1$ and $s_2$ is also halfway between that of $B_1$ and $B_2$ (the continuous-current brushes). The terminal, $t_3$, of the choking coil is such a point, and is, in fact, at all instants at what may be termed the electrical centre of the system. It is thus clear that the voltage between either continuous-current brush and $t_3$ is constant and equal to half that between the two continuous-current brushes.

It is interesting to follow out the course of the current. In Fig. 1, where two out-of-balance lamps are shown on one side of the three-wire system, the current comes out from the + brush through the lamps to the terminal $t_3$. Here it joins with the alternating magnetising current flowing, and goes *via* $t_2$ and $s_2$ to the armature, joining it just under the negative continuous-current brush. A reference to the diagram clearly shows that at this instant the voltage at the terminals of the lamps is half that of the brushes, $B_1$ and $B_2$. In Fig. 2 the current, after reaching $t_3$, will divide, part going *via* $t_1$ and $s_1$ and part *via* $t_2$ and $s_2$ to the armature, entering it at symmetrically placed points; and, again, it is obvious that the voltage at the lamp terminals is half that between the brushes, $B_1$ and $B_2$.

The above method of balancing can be used with three slip-rings connected to points 120deg. apart and giving three-phase current, and in practice this is the arrangement generally adopted. The choking coil has then three limbs star-connected, and the terminal $t_3$ is at the centre of the star. The coil has to be designed to stand the applied voltage, and large enough to carry the out-of-balance current expected without overheating. The arrangement has the advantage that no moving machinery save the main generator is required to balance the system, and in a properly-designed coil the losses are quite as small as those in a balancer.—W. W. W.

*Answer to No.* 745 (*awarded 7s. 6d.*).—This method of balancing has, I believe, only come up quite lately, and, that being so, it is not easy to hear results as to its working, but in one station I know where they have it they do not use it, but prefer the usual balancer.

The idea is this. Points are taken at 180deg. from each other round an armature, in which case it will readily be seen that there will be as many tappings as there are poles; these are taken down to two slip-rings, every alternate tapping being connected to the same slip-ring. Connections are then taken from brushes pressing on these slip-rings, through switches to the two opposite ends of the winding of a choking coil. The middle point of the winding of this coil is then connected through a switch to the neutral 'bus bar on the switchboard. The winding on the choker must be designed to be heavy enough to carry

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about the full out-of-balance current continuously when on load.

Fig. 1 is a diagram which should explain the above and make matters clear. In this N and S are two poles of a two-pole dynamo, between which the armature revolves; + and − are the two brushes on the commutator. A and B are the two conductors 180deg. apart, from which tappings are taken to the two slip-rings, from which it is collected by the brushes C and D. From C and D it passes through two switches, Sw, to the two terminals of the choking coil, F, from the middle point, E, on the winding of which there is a connection through a switch to the neutral 'bus bar. A little careful consideration of this diagram will reveal the fact that when the machine is running there will be an alternating current flowing between A and B by way of the slip-rings, brushes, and choking coil. This alternating current will have a frequency of P $n$ cycles per second, where P represents the number of pairs of poles and $n$ represents the number of revolutions of the armature per second. Now, in the case in point A and B are removed from the + and − brushes on the commutator by an equal distance, and, being similarly placed, the differences of potential between A and the − brush and B and the + brush will be equal; this is equivalent to having the same difference of potential between each end of the choking coil and the two outer 'bus bars. Now, as E is

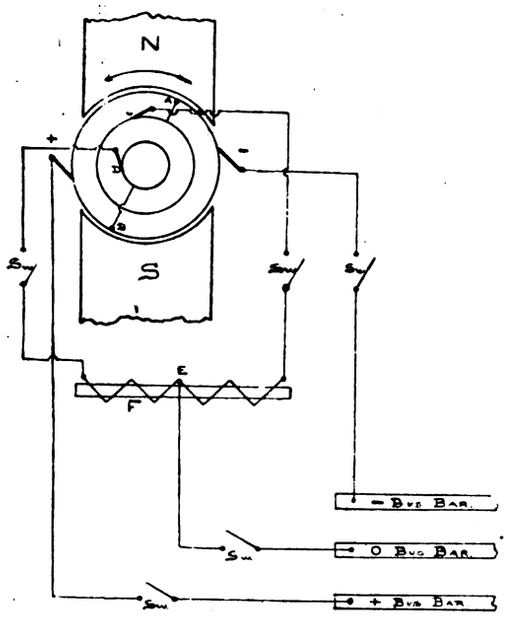


FIG. 1.

midway between the two ends of this choker, and these two halves are similar, the differences of potential between E and each end must be an equal amount, hence the voltage between E and each outer must be equal, and in this case that will be 250 volts, and this being connected to the neutral 'bus bar, we obtain the result of having 500 volts across the outers and 250 volts between the neutral and each outer. It will then be seen that for whatever position the wires, A and B, may be at any instant in a revolution of the armature, still there will be 250 volts difference of potential between the point E and the two outers, and this point E will always be 250 volts below the + 'bus bar and 250 volts above the − 'bus bar. The direction of the current in the choking coil will be determined by the position of the two wires, A and B, with reference to the + brush, as the current will always flow in the choker from the wire which is nearest to the + brush to the one which is nearest the − brush. Now, having shown that E will always be 250 volts negative to the + brush and 250 volts positive to the − brush, I will next proceed to explain the action of this choking coil when the machine is connected up to a three-wire network in which the load is not equally balanced on each side, but in which there is an out-of-balance current flowing in the middle wire. Let us assume a pure lighting load with 1,000 lamps on the + side and 1,200 lamps on the − side (all of the same candle-power and efficiency), and further let us assume that the resistance of a 16-c.p. lamp for use on this voltage is 1,000 ohms. Therefore, the total resistance of the + side will be $\frac{1,000}{1,000}$ = 1 ohm, neglecting resistance of the mains, etc. Likewise the resistance of the negative side will be $\frac{1,000}{1,200}$ = ·83 ohm. In the above I have neglected to take into account the fact that owing to the sides being out of balance there will be a higher voltage on the + side than the − side, and hence the resistance of the filaments on this high side will be greater than that on the low side, owing to the increase of resistance with the rise of temperature of the filament. Adding together these two resistances we obtain as a result 1 + ·83 = 1·83ohms resistance from outer to outer. Now, by Ohm's law we shall get a current of $\frac{500}{1·83}$ = 273·2 amperes flowing in our outers. Now, also by Ohm's law, it will be seen that it takes 273·2 × 1 = 273·2 volts to drive the 273·2 amperes through a resistance of 1 ohm—*i.e.*, the + side, and also it will take 273·2 × ·83 = 226·7 volts to drive 273·2 amperes through ·83 ohms—*i.e.*, the − side. The sum of these two voltages 273·2 and 226·7 gives us, of course, 500, which is the voltage across the outers of the supply. This means that, neglecting any balancing, with the load as indicated, the voltages on the two sides of supply will be respectively 273 volts on the positive side and 227 volts on the negative side, the result being that the lamps on the + side will burn very bright, and those on the − side will burn dim.

Now, let us next ascertain what would be the out-of-balance current in the neutral 'bus bar if, by some means or other, the voltages on each side were the same—*i.e.*, both 250 volts. By Ohm's law we now have a current of $\frac{250}{1}$ = 250 amperes on the + side, and a current of $\frac{250}{·83}$ = 300 amperes on the − side, so the result is that we have an out-of-balance current of 50 amperes flowing in the neutral. If we now look back over what we have done, we shall see that if the choking coil has its middle point connected to the neutral 'bus bar it will have a balancing effect, and will endeavour to keep the voltages on each side equal—*i.e.*, 250 volts—whereas, owing to the way the load is distributed, the voltage across the + and neutral 'bus bars will tend to be 273 volts, and that across the neutral and − 227 *volts*. Now, considering the − side, this is surely akin to paralleling 250 volts with 227, hence a considerable amount of the current for the negative side would come from the armature *viâ* the choking coil. This being so, it will not be necessary for the total current to flow through the + side, and so the voltage on that side will drop, and in the end we should obtain the required result of 250 volts either side with the out-of-balance current of 50 amperes being supplied by the choking coil arrangement. This may at first sight appear to be impossible, but, nevertheless, it is the case, and so I trust it will become plain that a choker connected thus can and does do the balancing. Of course, it will be understood that the less resistance in the winding of the choking coil the better, or else we should get a drop of potential in the choker itself due to it carrying the out-of-balance current. It will also be seen that as the armature revolves, the out-of-balance current will pass first through one half of the choker and then through the other, but always in the same direction with reference to the neutral 'bus bar according as to which side of the system is the heavier loaded, and the number of times it changes from one half to the other per second will be 2 P $n$, where P = the number of pairs of poles and $n$ = the number of revolutions per second. The object of making it a choking coil—*i.e.*, a coil possessing little resistance but considerable self-induction—is obviously to prevent a large wasteful current flowing from one slip-ring *viâ* the coil to the other, as this current would be alternating, and so the self-induction keeps this down, whereas it will let a continuous current flow through it, which is what we require for our out of balance, and even if the current does rise slowly in one half, when changing from one half to the other, still it will fall just as slowly in the other half, and the net result will be the same. At the times when the two wires from which the two tappings are taken are midway between the + and − brushes there will be no difference of potential between them, but still the middle point of the choking coil will be

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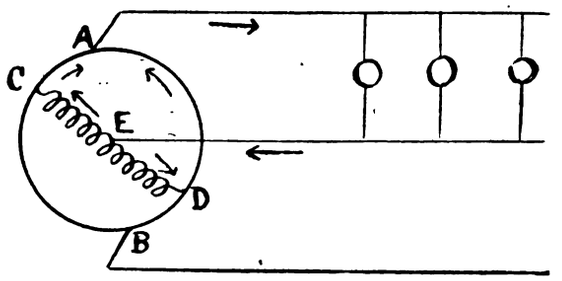
250 volts above and below the – and + 'bus-bar potentials respectively, and then, but for the lag of the currents in the two halves in growing and dying down, each half would take an equal share of the out-of-balance current. I believe this method of balancing has been tried by taking three points on the winding of an armature 120deg. apart, and then joining these to one common point through three similar choking coils (as in three-phase star connections), and so creating an artificial neutral and connecting this to the neutral 'bus bar through a switch.

I think from the above explanation it will be quite possible to understand this method of balancing, and a little thought will clearly indicate the directions the currents are flowing in the different wires under the various conditions, and so it is hardly necessary for me to do so now, as similar reasoning will show how an out-of-balance current on the positive side would be dealt with.—E. R. ALEXANDER.

*Answer to No.* 745 (*awarded* 5*s.*).—In the figure the arrangement described in the question is shown diagrammatically for a two-pole machine. The E M.F. between the brushes marked A and B remains constant at 500 volts. The E M.F. between the points C and D, which are connected by means of the slip-rings to the terminals of the choking coil, is an alternating one; it alternates with a frequency equal to the revolutions of the armature. This alternating E M.F. sends a small magnetising current through the choking coil which has a high self-induction. When C coincides with A and D with B, the E.M F. between C and D is, of course, 500 volts. In this position there are no armature coils between A and C, but between C and B there are half the total number of armature coils by each of the two paths; as C moves away from A and towards B, its potential changes in a corresponding manner,




so that the potential of C differs increasingly from the potential of A, and approaches the potential of B, until the point C coincides with the brush B, when, of course, B and C are at the same potential In the meantime the potential at D has been changing from the potential of B to the potential of A in an exactly similar manner, hence the potential between the terminals of the choking coil is not only an alternating one, but by the symmetry of the arrangement, the P.D. between A and C is at every instant equal to the P.D. between D and B. Now, the choking coil is really an auto-transformer, and the E M.F. of each turn being the same, since each has the same change of magnetic flux through it, therefore the middle point, E, is at a potential half-way between the potentials of C and D, and since the P.D. between A and C is equal to the P.D. between D and B, therefore the potential of E is always half-way between the potentials of the two brushes, and being connected to the neutral 'bus bar maintains the middle wire at the desired potential.

Consider an out of-balance current returning on the middle wire. As it is only the out-of-balance current that we are concerned with, we may neglect the balanced portion and regard the system as being loaded on one side only, as in sketch. The current we are considering all flows through one brush and returns by the middle wire to the point E. At E this current divides into two equal parts, one flowing through C and the other through D to A, where they again unite. The two equal currents in opposite directions in the two halves of the winding of the choking coil have no resultant magnetising effect on the iron core; their effects neutralise each other. Moreover, these currents are continuous, and hence they are not in any degree hindered by any choking action. The resistance of the two paths through the armature are in general not equal, and they are also varying continuously, but the armature resistance and the resistance of the choking coil, if properly designed, are both small, and the volts lost in ohmic drop will be negligible.

Perhaps another way of explaining the working of the arrangement would be to first of all suppose the choking coil replaced by a resistance, which would allow an alternating current to pass. This current would be in phase with the E.M.F. between C and D, and the middle point of the resistance would be at the correct potential for the middle wire, but if connected to it, the moment there was any out-of-balance current the available potential on the heavier-loaded side would decrease, on account of the ohmic drop. By the simple device of replacing the resistance with the choking coil, the resistance of whose winding may be very small indeed, the ohmic drop may be made negligible, while at the same time the energy wasted is also practically negligible, as there is only a small magnetising current flowing between C and D, and even this is largely wattless.—SUPERHEAT.

*Question No.* 746.—A 300-kw. Ferranti alternator (2,100 volts, 50 cycles, single-phase) is excited by a shunt-wound Elwell-Parker machine rated at 100 volts and 60 amperes, rope-driven from the main shaft. The exciting current varies from 40 to 60 amperes. Several times during the last 18 months this machine has dropped her exciting current under various load conditions, picking it up again after a short interval on one or two occasions. Careful examination for loose connections, slipping of the ropes, earths, or shorts on the exciter connections has failed to reveal any fault which would account for this behaviour. Moreover, the machine has invariably run satisfactorily on the next shift. The writer would be glad of an explanation of this phenomenon.

*Answer to No.* 746 (*awarded* 7*s.* 6*d.*).—The failure of the exciting current is most probably due to the resistance of the field winding of the direct-current machine being too near the critical value. For every shunt dynamo, at a definite speed, there is a certain critical value of the resistance of the field winding, which, if exceeded, will prevent the machine from exciting itself. This value can be determined as follows: Separately excite the field from cells, and for various values of the exciting current observe the E.M.F. at the brushes while the machine is running at the proper speed; plot the connection thus obtained on squared paper with field current for abscissæ and terminal volts for ordinates. The resulting curve is known as the magnetising characteristic. If the machine is delivering current the voltage at the brushes is less than the voltage on open circuit, by the ohmic drop in the armature, and also on account of a weakening of the field strength by armature reaction. If the voltage required to send the current through the field winding is less than the brush voltage, then the field current will be greater than necessary for this particular voltage, which will, therefore, rise until the required voltage and the available voltage are the same. If, on the other hand, the voltage necessary to maintain the field current is greater than that at the brushes, of course the field current is not maintained, and will decrease, with consequent drop of terminal volts, until either the available volts and required volts are equal once more, or the machine has lost all its volts. (This latter alternative is only another way of saying that the required and available volts are equal when each is equal to zero.)

The requisite value for the field voltage is got by simply multiplying the field current by the resistance of the winding. It is possible to represent it by a straight line on the same piece of paper as that on which the magnetising characteristic is drawn. Appended is a sketch in which are shown the sort of curves one may expect for a shunt dynamo running at a fixed speed, connecting brush voltage with field current when the machine is unloaded, and also when fully loaded. The straight line, undotted, gives the connection between required voltage and field current when the field winding is cold, say. The height of this curve is everywhere equal to the field current multiplied by the field resistance when cold. The points where this line cuts the first two curves gives the terminal voltage of the machine at no load and full load respectively for the particular speed at which it is running. Suppose that when the shunt has got warm by a long run, the connection between required voltage and current in the field can be represented by the dotted line in the sketch. As this line is everywhere higher than the brush voltage for the fully-loaded

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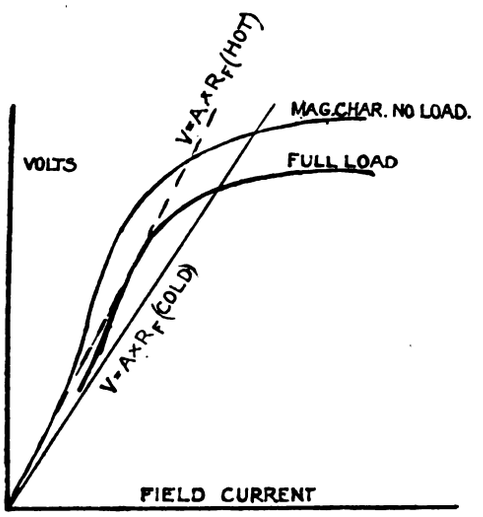
machine, whatever the strength of the field current, the excitation will disappear, although if the load be switched off the machine may re-excite, since then the brush voltage is up to a certain point higher than what is required to maintain the field current. This point where the two curves cross gives the value to which the volts will rise under these conditions. It is probably only when the machine has been running for a considerable time that its excitation fails. If this is so, it tends to confirm the explanation here given, and apparently a short rest allows the copper to cool sufficiently for re-excitation. Since the




excitation fails only occasionally, the resistance must be, as a rule, within the critical value, and a very slight movement of the brushes from the position of maximum E.M.F., or a very small amount of belt slipping, may account for the failure. Probably the best way of preventing the occurrence in future would be to so alter one of the pulleys that the speed of the dynamo will be increased.—SUPERHEAT.

*Answer to No.* 746 (*awarded* 7*s.* 6*d.*).—Assuming that the examination made by "W. H. H." for loose connections and faults has been thorough, we must look into the design of the exciter for an explanation of this phenomenon. Let us assume that the connections of exciter to alternator are as shown in Fig. 1, and also that as the exciter is a shunt-wound machine its characteristic curve would be as shown

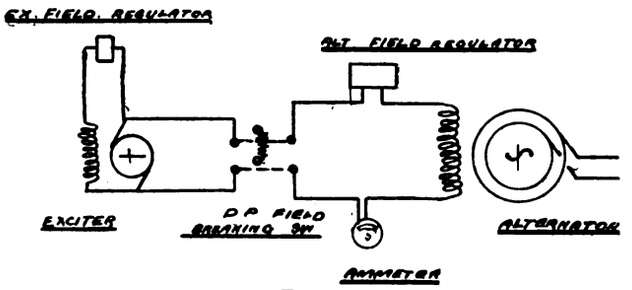



FIG. 1

in Fig. 2. It will be seen from this curve that if the current taken from the exciter is pushed too high, its volts will drop, and, therefore, its field will gradually get weaker, and it will cease to generate any current. With an exciter rated for 60 amperes this critical point should not be reached until there is a considerable overload, but the machine may be closely rated. Seeing, however, that we have a regulating resistance in both exciter field and alternator field, it would be possible, if the resistance in exciter field was high enough, to get the condition of affairs as set forth in the question at any load on the exciter. I think that if field of exciter was kept fully excited, regulating alternator field by resistance in its circuit, that the phenomenon would not occur.

The objection to this method is, of course, the waste of energy dissipated in the resistance. Suppose, for example, that all, or nearly all, the resistance was in exciter field, the exciter running, say, on about 40 amperes, there also being some resistance in alternator field. If there was now an increase of load on the alternator, resistance would most likely be cut out of its field to bring up its volts. Now, as the exciter is not working with its full field strength, the critical point on its curve would soon be reached, as this curve is only true for a case with no resistance in circuit, and would be different from the curve shown if resistance was in exciter field. This is very likely what happens. An

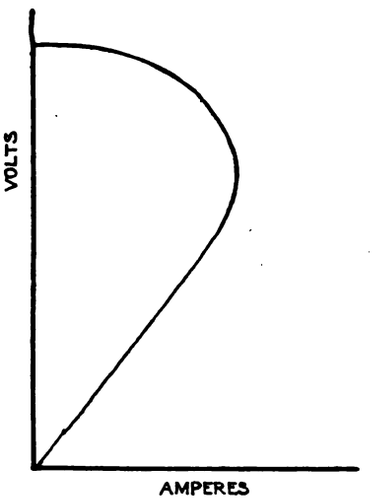



FIG. 2.

increase in load, which would bring down speed somewhat on engine, would assist in bringing about this state of affairs. The remedy is to either work on the resistance in alternator field, as suggested, or to put a few series turns on exciter field, thus compounding it.—J. H. THOMAS.

*Answer to No.* 746 (*awarded* 5*s.*).—The writer has found from his experience of Ferranti single-phase alternators that considerable margin in exciter voltage has been allowed for contingencies over and above what may be required to excite the alternator on its maximum load, which may be 25 per cent. or more overload. This margin, together with the difference in voltage required to send 40 amperes through the field on open circuit, as against 60 amperes on full load, may cause the exciter to be working at as low a voltage as 55 or 60 volts. It should be noticed that at this low voltage a current is drawn from the exciter approaching that equal to full load, whilst the exciter is considerably weakened. However stable the exciter field may be at its normal voltage of 100, it is far from being so at about 50 volts and a heavy armature current. The exciter is more than likely to be working well below the knee of the magnetisation curve. The brushes on exciters are very rarely moved whatever load is on the exciter unless sparking takes place. The brushes are consequently likely to be left in the position for top load, and therefore unfavourably placed for low load on the exciter, and thus assist greatly to demagnetise by additional back ampere-turns on the armature.

Under these conditions, therefore, it requires only a slight reduction in the speed of the engine due to a sudden increase in load (and before the governor has time to correct it) for the exciter to lose its field. The exciter would, under these circumstances, be able to pick up its field, which it would do more or less quickly, according to the conditions prevailing, on normal speed being resumed. Multipolar exciters which have the commutator bars moved round relative to the neutral position of the magnetic field have also given trouble, owing to the reduction in voltage caused by the faulty position of the brushes until their true position was ascertained. If attention were paid to the position of the brushes, and these moved to suit the load, some of the trouble might be eliminated.—W. W.

[Other replies to Question No. 746 will be given in our next issue.—ED. *E. E.*]

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Supplement to "The Electrical Engineer,"

JANUARY 13, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

755. An 80ft. brick chimney stack is obliged to be reduced in height by 20ft. To what extent could the loss in draught be remedied by taking the exhaust pipe up the inside of the chimney? At what height should the exhaust pipe enter, and at what distance from the top should it terminate to give the best results?—A.

756. A 160-h.p., 400-volt, shunt-wound motor, eight-pole type, is started up for the first time on no load, by means of a tramway-type controller having six contacts for the armature resistance. The motor runs well on the first and second contact, but when the controller is moved on to the third contact one of the top set of brushes commences to spark intermittently, and then suddenly there is a vivid electrical discharge between two neighbouring brushes, which are about 9in. apart, and the circuit breakers are thrown out. Various positions of the brushes are tried in close proximity to the sparkless position, but with the same result. Explain the cause and remedy of the above occurrence.—J. S. P.

### ANSWERS.

*Question No.* 746.—A 300-kw. Ferranti alternator (2,100 volts, 50 cycles, single-phase) is excited by a shunt-wound Elwell-Parker machine rated at 100 volts and 60 amperes, rope-driven from the main shaft. The exciting current varies from 40 to 60 amperes. Several times during the last 18 months this machine has dropped her exciting current under various load conditions, picking it up again after a short interval on one or two occasions. Careful examination for loose connections, slipping of the ropes, earths, or shorts on the exciter connections has failed to reveal any fault which would account for this behaviour. Moreover, the machine has invariably run satisfactorily on the next shift. The writer would be glad of an explanation of this phenomenon.

*Answer to No.* 746 (*awarded* 5*s.*).—Overload may cause a shunt dynamo to lose its field, but if, as per data in query, this occurs at various loads, we must seek for some other explanation. With regard to non-slipping of ropes, it would be advisable to take the revolutions of the dynamo by means of a counter; it may be just possible that the machine is running at about its critical speed. The adjustable resistance in the shunt winding should be carefully overhauled; there may be points where bad contacts are made; vibration from one or many causes may cause a break in the circuit. Look to the commutator and brushes. The writer some time ago had a somewhat similar trouble with a shunt dynamo fitted with carbon brushes. It was found necessary to frequently polish the commutator, and by means of emery cloth reface the carbon brushes where they bedded on the commutator. Unless this was done several volts were lost between commutator and carbons. The machine described in query may be excited so near the critical point on its characteristic that the loss of a few volts may make all the difference required to reach the position of instability. If, after careful examination for bad contacts, etc., the trouble should still continue, try copper brushes. As a last resource, alter the magnet winding so that the field is at a higher point of saturation. M. M.

*Question No.* 747.—How is it possible to predetermine, with anything like accuracy, the point at which a "synchronous" motor will drop out of step?

*Best Answer to No* 747 (*awarded* 10*s.*).—It is possible to determine graphically the maximum load of a synchronous motor, but although the machine will fall out of step when loaded to this amount, cases more generally arise where, because of what is known as phase swinging or the periodic variation of the speed just above and just below perfect synchronism, a motor will slow up long before the maximum has been applied. In fact, as this phase swing is more pronounced at light loads, the motion is often then more unstable than when the motor is normally loaded. The conditions which determine the degree of stability of a machine at ordinary loads are very complicated, and depend to a very large extent on what other machines, both generators and motors, are on the circuit, and also on the nature of its own load; but as the relation between the maximum load and the normal load is a good guide to the running qualities of any particular machine, the problem may be taken as satisfactorily solved if we develop a means for determining this maximum load It may here be remarked

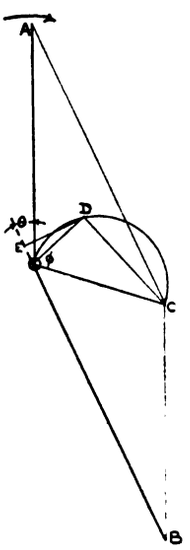


FIG. 1.

that the maximum load is different for different excitations, but the diagram to be given is applicable to all cases. In Fig. 1 we have the diagram as generally given for the synchronous motor. O A represents the applied E.M.F. of the motor and O B the generated E.M.F., which depends in value upon the excitation, and in general lags more than half a period by an angle $\theta$. Compounding O A and O B we get O C as the voltage, which is not balanced, and which, therefore, provides current to drive the machine. If the current lags by an angle $\phi$, O D will represent the current and therefore also the component of O C used in overcoming resistance, and D C corresponds to the drop in impedance which is determined in the usual way from the short-circuit characteristic. The output under these conditions is given by the rectangular component O E of the current O D upon the line of the generated voltage. To alter the value of the output O E, the angle $\theta$ varies, the excitation and therefore O B remaining constant, so that the rectangular component of the current becomes more or less as required. To proceed further with the problem it is advisable to alter the manner of the diagram as it is usually given in Fig. 1 to that as it is now given in Fig. 2. O A and O B are applied and generated E.M.F. as before, and with the given value of $\theta$, B C gives the unbalanced voltage. This, again, is split up into B D, the ohmic drop,

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and therefore also corresponding to the current and D C, the reactance drop. B E then corresponds to O E, the power component of the current.

If, now, another value of $\theta$ is taken, we have a new position of C at $C_1$. Going through the construction again, we obtain B $E_1$ as a new value of the output, larger than before. If we tried another point, $C_2$, further still round the circle, we could find another position for $E_2$ which would give a smaller power than B E. There is therefore

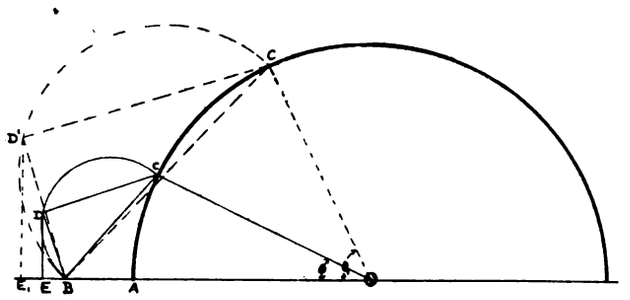


FIG. 2.

a position of C for which the power B E is a maximum—*i.e.*, the position of C which will give the corresponding point D its farthest position to the left. The construction for this is shown in Fig. 3. O, A, and B are as before. Now, consider the case of the maximum and minimum values of $\theta$—*i.e.*, 0deg. and 180deg. The circles, such as B, D, C in Fig. 2, for these values are B $D_0$, A, and B $D_{180}$ X respectively, and splitting up B A and B X in the same ratio as before, we have the points $D_0$ and $D_{180}$ correspond-

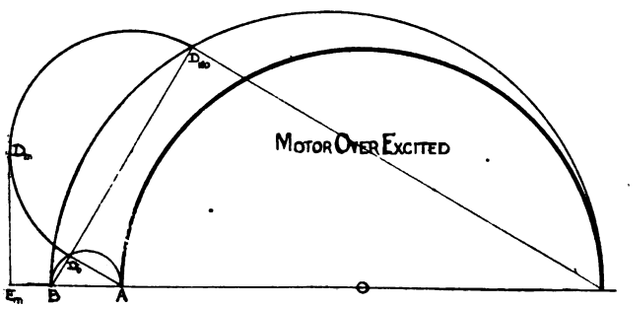


FIG. 3.

ing to these extreme conditions. The locus of D for all the intervening values of $\theta$ *is then given by the semicircle* $D_0$ $D_m$ $D_{180}$ *on* $D_0$ $D_{180}$. The point on this semicircle which is farthest to the left, is evidently that from which the tangent drawn is also perpendicular to O A B produced. B $E_m$ corresponds, therefore, to the largest output at this degree of over-excitation. The actual value of this output in watts is obtained by multiplying together O B and B E translated to volts, and then

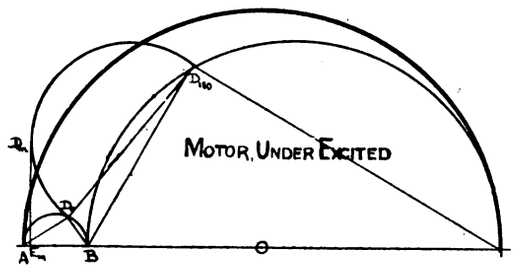


FIG. 4.

dividing by the resistance of the armature. The same construction holds for the cases of under excitation and normal excitation, that for the former being given in Fig. 4, where the letters mean the same as before. The case for normal excitation, and perhaps the most important, is shown in Fig. 5, the diagram becoming very much simplified owing to the points A, B, and $D_0$ coming into coincidence. It must be remarked that for the sake of simplicity the diagrams have been drawn somewhat out of proportion In an actual case, the synchronous impedance is many times greater than the resistance, and the triangle O D C in Fig. 1 becomes very acute at C. This makes the angle at X (Fig. 5) also acute, and in some cases it becomes impossible to draw the diagram with anything like accuracy, for A $D_{180}$ becomes so very small. In such a case it becomes very nearly perpendicular to X A, in which case the maximum output, B $E_m$, becomes equal in length to half A $D_{180}$. The maximum output can in such a case be calculated from the resulting simple expression,

$$\frac{E^2 \times n}{R \times I \times 2},$$

where E = the applied E.M.F.;
R = resistance per phase;
I = synchronous impedance; and
$n$ = number of phases.

As an example of this we may take the machine given by Mr. Eborall in his Howard lectures (see *Electrician*, xlviii., p. 275). The machine was three phase, 760 kw., 94 revolutions per minute, 50 ⁓, 2,200 volts. The resistance of armature per phase was given as 0·13 ohm, and the synchronous impedance calculated from the short-circuit test was about 3·0 for the higher currents.

The maximum capacity was, therefore,

$$\left(\frac{2{,}200}{1{\cdot}73}\right)^2 \times \frac{3}{3{\cdot}0 \times 0{\cdot}13 \times 2} \text{ watts}$$
$$= 6{,}100 \text{ kw.}$$

or nearly nine times the normal working value. It would, of course, be impossible to continuously load such a machine up to this amount; but in swing out of step from a normal load, this represents the maximum amount of power which

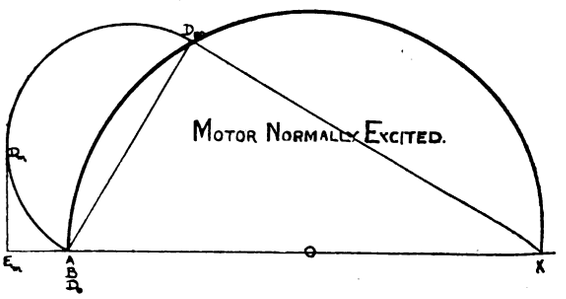


FIG. 5.

would be momentarily exerted to bring the machine back into step, and it is, therefore, not surprising that when swinging and only lightly loaded this large amount of power may do more harm than good in bringing the machine back to perfect synchronism.—H. W. T.

*Answer to No.* 747 (*awarded* 7*s.* 6*d.*).—The dropping out of step of a synchronous motor may be due to various causes. The first and simplest to deal with is the increase of load. It is well known that a synchronous motor can only absorb a determined amount of power. If the load, added to the losses in the machine, exceeds this power, the motor, instead of slowing down like a direct-current motor, refuses to do the work and fall out of step. But this maximum power which the motor can take from the mains must only be considered as a limit, which cannot be attained in practice for the following reason. When the load varies, the motor takes a certain time to adapt itself to the new conditions: it oscillates about the position of stable running, and if these oscillations are too great the motor will fall out of step. The amplitude of these oscillations depends on the difference of load put on the motor, and also on the suddenness of the change. Thus, if the motor is very lightly loaded and rapidly overloaded, it will fall out of step, although it would be able to bear a greater load if this was put on slowly. This shows us that it is not possible to tell exactly at what point the motor will fall out of step, except if the load was always altered in the same way. But there are other reasons more difficult to determine. A motor can fall out of step without any variation in the load. This may be due to irregularity of the supply current, very often caused by bad governing of the generating engines.

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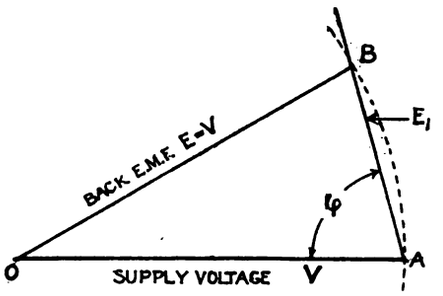
Particulars of the working of those engines would have to be known to tell what their influence on the synchronous motors is, and even then great accuracy could not be obtained. Disturbances are sometimes caused by the sticking of governors, and such cases would be impossible to determine. These oscillations, known as surging or hunting, can be considerably reduced by the use of damping coils (Leblanc amortisseurs).

Lastly, there is another reason for a motor to fall out of step; this is variation in the exciting current. By varying the excitation the driving torque is altered, and this gives rise to oscillations which may become dangerous. If we observe that the three causes mentioned—*i.e.*, increase of load, irregularity of supply current, variation in the exciting current—may act at the same time, this makes it still more difficult to determine the resulting effect due to their various combinations. To sum up, we may say that it is not possible to determine with exactitude the point at which a synchronous motor will fall out of step. All we can do is to determine the maximum power which the motor can take from the mains. This will give us the point at which the motor will fall out of step in the best conditions. This power can be obtained approximately in the following way: By varying the excitation, the current, C, flowing in the




armature can be brought into phase with the supply voltage, V. The power will then be a maximum, and the back E.M.F. of the motor, E, will practically be equal to V.

$$P = V C.$$

V is known, and C can be obtained as follows: Calling $E_1$ the resulting E M.F. produced by V and E, then

$$C = \frac{E_1}{\sqrt{R^2 + (2\pi n L)^2}}$$

R = armature resistance;
$n$ = cycles per second;
L = self-induction of armature.

$$P = \frac{V E_1}{\sqrt{R^2 + (2\pi n L)^2}} \quad . \quad . \quad . \quad . \quad (1)$$

The difference of phase between C and $E_1$ is given by

$$\cos \phi = \frac{R}{\sqrt{R^2 + (2\pi n L)^2}}.$$

Draw O A = V and A B, making an angle $\phi$ with O A. Cut A B with circle of radius E = V, and centre O. A B will then be equal to $E_1$, and P can be obtained from equation (1). ALTERNATOR.

*Question No.* 748.—Where several boilers are working together, is it common practice to fit isolating non-return valves instead of ordinary stop valves? State the advantages of doing so. Is there an automatic valve on the market which shuts off the steam supply when a pipe bursts? If so, describe it.

*Best Answer to No.* 748 (*awarded* 10*s*.).—It is now considered essential to safety to fit isolating valves, as well as stop valves, to each boiler in all cases where more than one boiler is working on the same steam main. Assuming several boilers feeding into one main and an accident occurring to one of the boilers—it may be a tube burst, a big leak in a seam, or the like—it is evident that considerable risk will attend any attempt to close the stop valve, especially if the fault be near the valve. The result may be that the other boilers working on the main discharge through the faulty boiler, and, so to speak, intensify the trouble. An isolating valve on each boiler localises the fault in and isolates the defective boiler, allowing the others to work without interruption. Where a boiler has been emptied for cleaning or inspection purposes, an isolating valve prevents the accidental turning on of steam from other boilers through the stop valve being opened or left open. An isolating valve also tends to the regulation of the equal firing of boilers, for if any one boiler falls below its proper pressure, the valve closes and the gauge shows the true boiler pressure. Of course, if only a stop valve be fitted, each gauge registers the steam-main's pressure. It is common practice to combine the stop and isolating valves, and many of the best valvemakers supply these. If, in addition to above, the valve is capable of closing automatically in either direction, so that in case of a steam-pipe bursting, or any other like accident happening outside the boilers, so to speak, the boilers are shut off from the mains, a further great safeguard is introduced.

There are several automatic valves on the market which shut off the steam supply when a pipe bursts, and one which gives excellent results is here described; it combines also the above features. Of course, it is an essential that the valve closes automatically in either direction, in case of a boiler accident shutting off steam from other boilers, and in case of steam main's accident shutting off the boiler steam supply. In Fig. 1 one type of the valve in question is

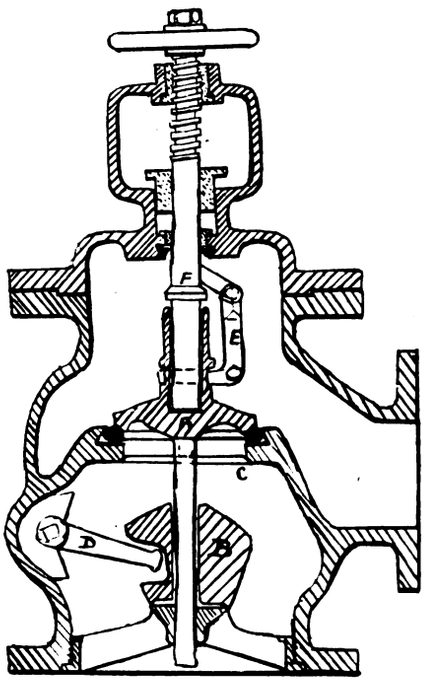



FIG. 1.

shown, and it will be seen that the valve is a combined stop and isolating valve. There are two valves, A and B, the upper and lower, both being loose on the spindle. When A is screwed down it acts as an ordinary stop valve, when the spindle is raised the valve is free, and the pressure on both sides being equal, is opened by the flow of steam from the boiler. In case of accident to the boiler, A, being loose on the spindle, acts as a non-return valve, and closes, preventing steam from other boilers passing. The lower valve, B, acts in the opposite direction, and under normal conditions is kept in position by its own weight and a certain pressure of steam caused by a partial vacuum formed by the flow of steam past the valve exerting a suctional action in the space between valve and spindle. If an accident occurs to a steam-pipe the velocity of the steam increases, and the valve B is closed against its seat, C, and is kept there until A is shut. When the valve A is closed as a stop valve, the flow ceases and the pressure on each side of B is equalised, steam passing to the upper part of the valve through the space between valve and spindle; B then returns to its normal position. An adjusting screw regulates the "difference in pressure" at which the valve closes. Levers D and E are connected by spindles to handwheels for testing purposes, and the valves operate independently until nearly closed, when the force of movement overcomes the friction of the gear. A valve facing F is formed on the spindle, which comes in contact with its

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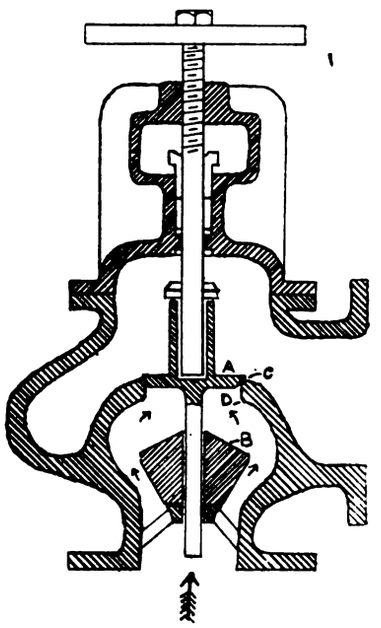
seating when A is fully open. This protects the stuffing box. Other types of this valve are made, but the main principles are the same. Other valves are manufactured and give good results; the one described has worked well and may be taken as typical.—S. E. D.

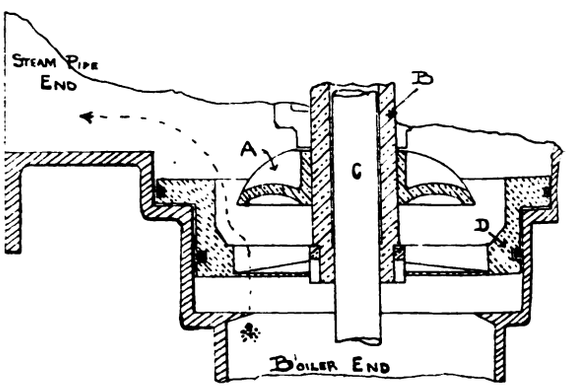
*Answer to No.* 748 (*awarded* 7*s.* 6*d.*).—It is certainly advisable to fit isolating valves to boilers working on one common main, and is now more often done than not; but in no case should isolating valves take the place of a stop valve, but each boiler should be fitted with both, for it is well known by those who have had experience with isolating valves that although they prove very useful in the case of accidents, it is often found that they do not shut off tight enough to enable a man to enter the drum. In addition to being of great service in the case of accidents, they also enable the boilers to be coupled and uncoupled automatically, and so prevent boilers being opened out with pressures higher than that of the main. The sketch shows a valve sold by T. Sugden, Limited, 180, Fleet-street, E.C., which has recently been fitted to two Babcock marine boilers in a station with which the writer is connected. This valve acts as a stop valve, and also closes automatically in both directions. A full description was given in *Engineering* on Jan. 1, 1904. The sketch as here shown is slightly different to that supplied




by the makers, several small details having been left out, but will serve to show its action. The valve is connected to the boiler in the vertical position, as shown, and the steam flows from the boiler in the direction of the arrows. There are two valves, A and B, both being loose on the spindle. The valve A may be screwed down by means of the spindle on to the seat, C. It then acts as an ordinary stop valve. On raising the spindle the valve A is then free to move up or down, according to which side is exposed to the most pressure, it being shut when the pressure of the boiler is less than that of the main. The lower valve, B, will only be lifted to the seat, D, when the pressure of the main is considerably below that of the boiler, caused, for instance, by a burst steam main. Under ordinary working conditions it is kept in the position shown by its own weight, and by a small presssure caused by a partial vacuum formed by the flow of steam. This lower valve can be adjusted to close with any desired difference of pressure by means of an adjusting screw, and after an accident has occurred it can be returned to its normal working position by closing the valve A. The valves A and B can each be separately controlled by wheels on the outside, the object being to keep them in working order, but for the sake of simplicity I have left this gear out in the sketch. The two boilers that we have fitted with this valve are always allowed to couple and shut themselves off automatically, and have always done so in a most perfect manner. So far, however, we have not had a steam main burst, and are therefore unable to give an account of the behaviour under these conditions, but, judging from the principle, there is every reason to believe what is claimed by the makers.—E Austin.

*Answer to No.* 748 (*awarded* 7*s.* 6*d.*).—When two or more boilers are connected up so as to feed into a common main steam-pipe, an isolating valve or non-return valve ought to be fitted in each boiler branch pipe, in addition to the ordinary boiler stop valve. The automatic isolating valve may be either combined with the boiler stop valve in the same casing (which appears to be the latest development of the apparatus), or it may be a separate and distinct valve fitted in the run of the boiler branch steam-pipe. As to whether it is common practice to fit these isolating valves, I am afraid the practice is not so common as it ought to be. There are, no doubt, numerous boiler plants (more especially those of recent construction) provided with isolating valves, but, on the other hand, there are a great many more plants which are not so provided.

The advantages gained by fixing isolating valves are briefly as follows: (1) in case of an accident to the boiler, or to anything on the boiler side of the isolating valve, steam is automatically cut off from the main steam-pipe, and the danger thus localised; (2) it prevents steam being accidentally turned into any empty or laid-off boiler, and is thus a safeguard to anyone working inside the boiler;




(3) in the case of the water getting low in any particular boiler, the safety valve of that boiler has only to discharge the steam generated in the boiler itself, the isolating valve cutting off the steam from the rest of the boilers until such time as it was possible to close the boiler stop valve.

Regarding the second part of the question—viz., "Is there an automatic valve on the market which shuts off the steam supply if a pipe bursts"—there is such a valve made by Messrs. Holden and Brooke, which is a modification of the ordinary type of isolating valve. The working parts are shown in Fig. 1, which shows the valve in the ordinary working position. The valve body, A, is free to slide up and down the sleeve, B; this sleeve in turn is free to slide on the spindle, C (when a stop valve is included with the valve it is fixed on to the lower end of this spindle). The valve seating, D, is fixed on to the sleeve, and is able to move up and down the casing; it is fitted with rings to prevent the passage of steam. A testing lever is fitted on the top end of the sleeve for trying the parts to see that none are sticking. In the case of a steam-pipe bursting, the rush of steam through the valve, and the consequent difference in pressure each side of it, would cause the seating, D, to rise until it jammed against the valve body, A, thus shutting off the steam. To prevent steam backing up into the boiler, in case of burst tubes, low water, etc., the steam pressure will act on the top of the valve body, A, and keep it down on the seat, and thus prevent the steam passing.—J. B. R.

[Other replies to Question No. 748 will be given in our next issue.—Ed. *E. E.*]

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Supplement to "The Electrical Engineer,"
JANUARY 20, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

### QUESTIONS.

757. A steam-driven set, shunt-wound and separately excited, is supplying about 400 arcs, eight in series. They are switched a few circuits at a time in the street. In the event of a breakdown, what is the best way to get on another similar set without sending out men to switch off all circuits?—SPONGY LEAD.

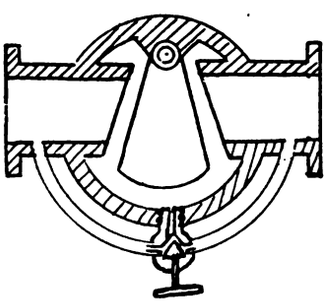
758. Give arguments *pro* and *con.* relating to fuses being fixed on neutral on consumer's main and branch circuits from the station, and fire and personal risk points of view.—M. A. C.

### ANSWERS.

*Question No.* 748.—Where several boilers are working together, is it common practice to fit isolating non-return valves instead of ordinary stop valves? State the advantages of doing so. Is there an automatic valve on the market which shuts off the steam supply when a pipe bursts? If so, describe it.

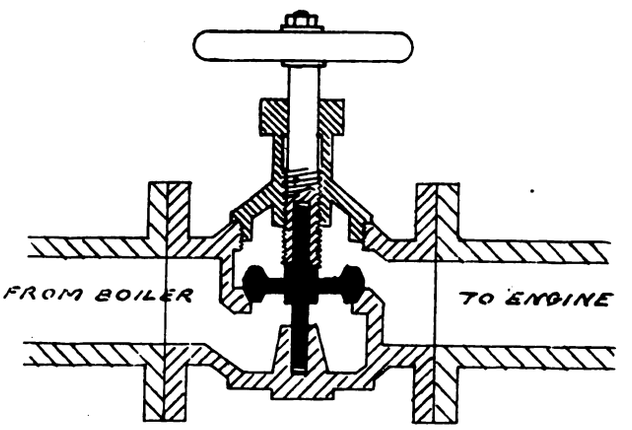
*Answer to No.* 748 (*awarded* 5*s.*).—It is not common practice to rely only upon the isolating valve when several boilers are working on the same range. There are certainly no advantages unless expensive stop valves are objected to on the score of economy. On the other hand, if you rely solely on the isolating valve, should at any time the valve be not properly seated, it would be impossible to clean out the particular boiler to which the valve was attached. Added to this you have no means of stopping priming in a boiler, as with an isolating valve only your valve will always be wide open or shut when using a stop valve. In addition, you have an easy means of slightly wiredrawing your steam, and so reducing your area to a minimum, so that in the event of priming your are safeguarded to a certain extent. The above remarks refer to boilers giving a supply of saturated steam. With superheated steam-boilers, where the superheater forms part of your boiler and is flooded from the boiler drum, it would be very risky, indeed, to dispense with a stop valve unless a thoroughly experienced man was always in charge of your boiler-house plant, as the ordinary stoker is liable to get up pressure, when the result would be disastrous to your engine-room plant and steam range in the event of the superheater not having been drained beforehand. It is usual in this class of boiler to have a notice fixed on the stop valve drawing the attention of the stoker to the necessity of doing so before opening up the boiler on the range. There are several forms of automatic valves on the market which shut off steam in the event of a pipe bursting.

The best example and simplest the writer has seen is a pendulum-pattern valve, as shown in the accompanying



sketch. The small branch pipe is closed when the valve is being used. This is for equalising the pressure on both sides of the valve after repairing the damage. This type of valve, it will be seen, would be more satisfactorily worked when used in conjunction with land or stationary boilers, and would not, I am inclined to think, work well when used aboard ship. Automatic valves are not much used, stop valves having the preference. The writer has never seen one used in practice, but has seen several tried experimentally.—W. F. S.

*Answer to No.* 748 (*awarded* 5*s.*).—The fitting of stop valves having a check valve, or non-return action, although sometimes done, cannot be termed general practice. There are several good forms of non return stop valve on the market. The figure is an illustration of one which not only has a check-valve action, but the valve is reversible.




The diagram will explain itself. There are distinct advantages claimed for a non-return stop valve. In the case of men working in a boiler which is "laid off," an ordinary stop valve may inadvertently be opened, and the men get severely scalded; with a non-return stop valve such an accident would be practically impossible. With boilers working together, one may have the pressure, as shown by its own gauge, supplied by the others; a non-return stop valve will give the engineer a rough idea, at any rate, as to the manner in which the boilers are being fired. Engineers, however, as a rule, prefer stop valves of such a construction that the valve is lifted off its seat by being connected to the spindle. They advance as an objection to the non-return type that the valves have a tendency to stick, and that they are generally unsatisfactory. When a boiler which is one of a number working together is "laid off," the handwheel of the stop valve should be securely fastened; this precaution is taken against its being accidentally opened. The writer is not aware of any automatic valve which shuts off steam supply in the event of a burst pipe. Automatic devices, although many good ones are in constant use, should be carefully examined before being fitted, and if fitted demand constant and skilled supervision that their action may be prompt when required. All such arrangements should be frequently tested, or the engineer may be lulled into a state of false security.—M. M.

*Question No.* 749.—A 200-h.p. three-cylinder gas-engine direct coupled to a dynamo is supplied with producer gas from a holder which is alternately filled and emptied. The engine will run steadily for hours at a time, but sometimes it will suddenly back-fire and pull up. The dynamo is cut out and the speed of the engine brought up again, and the dynamo is then put in again. The engine will then run steadily again. It has been noticed that the engine usually back-fires when the holder is commencing to fill. Give reasons for this.

*Best Answer to No.* 749 (*awarded* 10*s.*).—The name back-firing is sometimes applied to the case where the charge either fails to ignite in the cylinder and afterwards is exploded in the exhaust by the hot products of another explosion from the same or another cylinder, or the exhaust valve not closing properly part of the charge is merely pushed past it instead of being compressed, and the explosion then travels from cylinder to exhaust pipe. The name is also applied to the case where the ignition occurs prematurely, thus acting in the wrong direction on the crank and stopping the engine.

These different phenomena are easily detected in a single-cylinder engine, but they are not so apparent in the case of a three-cylinder engine, thus most likely giving three times

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as much work to get at the cause of failure. Now, one cylinder only or all three may be at fault, and it may be possible for a careful observer to tell, thus diminishing the labour. The former kind of back-firing is easily known by the violent noise in the exhaust, while the latter may be recognised by a nasty thump on the engine, so that no difficulty will be experienced in classing the behaviour of the engine under one or other of the above heads.

Most likely it will be found that the fault is of the former order, as it is by a long way the commonest. Should this be so, it will be necessary to take out the exhaust valves, or valve, if the faulty one can be located, and see that they are absolutely tight on their seats. A good plan is to make a number of chalk marks across the face of the valve, and drop it on its seat. The whole of the marks should be reproduced on the valve seat, and if they are not, the valve must be ground, or, if necessary, turned and ground until a reproduction of the marks is obtained. Next the spindle should be thoroughly cleaned and lubricated with cylinder oil, as a gritty spindle often causes the valve to stick up against the force of the spring. Care should be taken that the spring is strong enough and properly adjusted to pull the valve sharply to its seat, and that the spindle does not get too hot when the engine is running. If there is a water service to it, carefully see that it is all free and clear. Sometimes the explosions occur in the air-pipe, and, if so, the above treatment should be applied to the air-valve. Another course of exhaust explosions is wrong proportion of mixture; and it would be instructive to know if the engine is governed on a weakened explosion or hit-and-miss system, as if the former, the mixture may sometimes become so strong or so weak that the charge fails to ignite in the cylinder, and subsequently does so in the exhaust. This would be shown by the engine always back-firing at full or light load. Or, again, the cause may be failure of the ignition, due to dirty contact breakers of a magneto-energised spark plug, or defective insulation of the wires, etc., of any spark plug. The plug contacts should, therefore, be well cleaned, and care taken that the wires are well insulated. Or, again, as almost suggested in the question, the holder may be at fault by being too small for its work. But more information would be required before that could be determined. However, if none of the other reasons given meet the case, a new holder of larger capacity must be installed unless there is a defect in the present one. This would, of course, be determined by knowing whether the engine ever did run steadily on full load drawing from that holder.

Premature ignition is a rare occurrence, but if it does occur, it will probably be found that the producer gas is coming over too hot, and the heat generated by compression is sufficient to ignite the charge too early, as there is sure to be either electrical ignition or a timing valve, which cannot get out of time.

If the above points are carefully attended to, there is every likelihood of a satisfactory result, and, in conclusion, it should be again remarked that generally exhaust valves are the causes of failure, and their adjustment must be thoroughly and carefully carried out by a competent engineer.—D. R.

*Answer to No.* 749 (*awarded* 7*s.* 6*d.*).—*Re* your question No. 749 concerning gas-engine three-cylinder types, this class of engine I am fully familiar with. You state that this trouble only occurs when the gasholder is being refilled; there is no doubt but that it is caused by the gas. As you use producer gas, the reason of back-firing is due no doubt to excessive blowing of gas generators causing weakness of your gas, and also to the presence of air and water in same. This, on being admitted through gas-valve to mixing chamber, becomes mixed with the same amount of air that you have been using with good gas, the result being a slowing down of engine in first place due to weak explosion, and back-firing due to engines running slower, therefore, under their work as ignition taking place at same time as when you are running up to speed. It is now the practice on large gas-engines to make the firing slightly later on starting up; also later on larger loads than on light ones, the system used being a three-part commutator for three-cylinder engine. As you state that after your dynamo has been taken out of circuit your engine runs up to speed again, and does the load, this proves that the engine is mechanically perfect, and that there is nothing hot enough to cause pre-ignition, otherwise you would not be able to take up the load again until the engine had cooled down. I should advise you to take particular notice of your gasholder, and to also notice the quality of gas at your inspection burner (this should burn with a light-blue colour, with an orange colour tip at top of flame), and to see that the water is pumped out of gas-pipes every hour. When you notice your engine giving warning (this is easily detected on ammeter), go and reduce your air mixture—say if it is 1 of gas and 1½ air, reduce air to 1—and you will immediately notice engine pick up in speed, and after she has attained full speed gradually put mixture back to proper position. Do this without taking her out of circuit, but if you can ease load, slightly do so. In conclusion, gas-engines are subject at times to back-fires, also pre-ignition and dilatory ignition, which may be caused by many things—viz., improper setting of valves; valves not perfectly tight; dirt under inlet-valve cover face, in this class of engines allowing escape of explosion into mixing chamber, thereby contaminating all the mixtures to other cylinders; oil getting up to the top of the piston and becoming carbonised, and getting lighted by explosion causes mixture to be fired too early; piston and igniters getting too hot. The ignition is the most important factor, and great care and attention should be given to it. As it is found engines run well when gasholder is full, I should endeavour to keep it at one certain height.—S. H. Lee.

*Answer to No.* 749 (*awarded* 5*s.*).—There are two probable reasons of back-firing in a gas-engine: (1) owing to the charge taking fire due to high compression and a consequent high temperature, caused by the cylinder not being kept sufficiently cool; (2) by a piece of incandescent matter in the combustion chamber.

The first cause can be practically eliminated by taking care that there is a good circulation in the water-jacket, and not allowing the charge to be too rich in gas when working at full load. The second cause is also produced by the charge being too rich, and so forming a slight deposit of carbon in the combustion head. This does not necessarily at once cause back-firing, but in time a little of the deposit coats a certain projection in the combustion head, which may only attain a dull red during the compression stroke of the engine, but if a variation in the quality of the incoming charge takes place, it will vary the incandescence of this particle; if richer in air, it will brighten it up; if richer in gas, will deposit more carbon.

The reason of the firing of the three-cylinder gas-engine seems to point to the variation of the quality of the charge. This variation appears to take place during the emptying and charging of the holder, and no doubt just at this moment there is a slight decrease in the pressure of gas, which allows an intake of more air.—J. A.

*Answer to No.* 749 (*awarded* 5*s.*).—It has been the experience of the writer that the successful working of gas-engines depends more on the certainty of action of the igniting gear than on any other detail. Late ignition is one of the main causes of back-firing, as the maximum pressure is not reached until the later part of the stroke. The result is a great loss of power and a very high exhaust pressure, with the consequent strain on the exhaust valve gear, in addition to which there is the liability to overheat the exhaust valve, and to the slow burning of a portion of the gases throughout the exhaust stroke, which, on the opening of the air and gas valves for the admission of another charge, may ignite it, and cause the engine to back-fire.

To obtain the best results from blast-furnace gas of a low calorific value, the ignition tube requires to be kept at an exceedingly high temperature, and the area of the igniting surface should be adequate and well sustained. This can be obtained by using a Bunsen burner with an air-pipe leading from an air supply kept at 3lb. or 4lb. pressure, coupled to the gas-pipe of the burner. The air and gas being thus under pressure, almost any desired heat can be obtained on the ignition tube. It

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does not always follow that faulty ignition is due to the ignition gear proper. One of the most powerful causes of pre-ignition is the presence of water in the cylinder, due to leakage either through the metal, or to a bad joint in the combustion chamber, thus admitting the water from the jacket. Generally a large proportion of cases of pre-ignition are caused by some deposit in the cylinder, and this, becoming heated by the working of the engine, does not cool down during the exhaust stroke, and thus lights the next charge before the completion of the compression stroke. The deposit is usually traceable to either tar in the gas or to the carbonisation of the lubricating oil, through this latter having too low a flash-point for the temperature of the gas-engine cylinder. The richer the gas the greater is the probability of pre-ignition, this tendency varying directly as the hydrogen content of the gas. It sometimes happens that some foreign matter may get into the air-inlet pipe and be drawn into the cylinder, which, getting hot, will cause pre-ignition. Care should be taken that no portions of valves, etc., coming into the combustion chamber have projections likely to attain an igniting temperature, as, for instance, cotter-pins, stud ends on the end of piston, or any similar projections.

Back-firing is sometimes caused by the valves being wrongly set. The best way to discover this is to take an indicator card and study the diagram, but if this is out of the question, much can be done by turning the engine round by hand and noting the position of the valves. The inlet valve should open just at the beginning and close at the end or immediately after the end of the suction stroke. The exhaust valve should invariably close just as the exhaust stroke is completed. Both valves should be tight at all times, and if they should leak they should be reground to their seats with pumice-stone and oil, but at no time should emery be used.—G. E., JUN.

*Answer to No.* 749 (*awarded* 5*s.*).—The data are insufficient to give more than a few suggestions as to the cause of the back-fires. Whether back-fires are due to one cause or are the resultant of several causes acting together is often a most difficult matter to determine. Experience points to the ignition arrangements as being in nine cases out of ten the cause of the trouble. A dirty piston will sometimes give pre-explosions, thereby wasting a great part of the power as inefficient thrust at dead centre. This state of affairs will soon result in diminished speed. As the engine mentioned in the query generally fails when holder is being first filled, one would attribute the fault to the freshly-made gas not being of good quality. Is the steam pressure correct, and is the steam "dry?" In what condition is the fire in generator when commencing? A poor fire, with plenty of "frogs" in it, may pass on to the holder anything but a suitable gas. Is it possible that between generator and holder leaks may cause the connections to become filled with very dilute gas? Generally, it would appear that for some reason the first gas made is of poor quality. The data given by "R. A. H." do not enable one to point with any degree of confidence as to the cause, or causes, of the "miss-fires."—M. M.

*Answer to No.* 749 (*awarded* 5*s.*).—Back-firing is caused by the charge failing to explode at the proper time, and being discharged to exhaust, is fired by the hot gases of the following charge. Therefore, the problem is to find why the charge was not ignited at the proper time. This can occur when (1) there is not sufficient gas, (2) when air gets into the gasholder. When the gasholder is being filled it is quite possible for the engine to be short of gas for a few strokes, hence the explosive mixture would be too weak to ignite in the cylinder. To find out whether this is the cause or not, hold your hand on the gasbag when you expect back-firing; if the gasbag is not fully inflated after the suction stroke, the engine is short of gas. It is also possible for air to enter the gasholder with the gas or through any leakage when the gasholder is empty. In this case, when the gas is admitted to the holder, it would tend to throw the air to the bottom, near to the engine feed-pipe. Hence the engine would receive an inferior charge when the gasholder was being filled, and back-firing would occur. I think it would be advisable not to allow the gasholder to get emptied.—H. M.

*Question No.* 751.—What is the cause of shrinkage of active material in Faure type negative plates with subsequent loss of capacity? Can capacity be recovered; if so, by what means?

*Answer to No.* 751 (*awarded* 7*s.* 6*d.*).—Although the chemical theories of the accumulator advanced by different authorities are widely at variance, which shows that the accumulator is not properly understood, there is substantial evidence to show that the chemical action produces certain effects which enables the causes to be understood sufficiently well for practical purposes, and it is from this point of view that the following explanation is advanced. It is common knowledge that the temperature of a cell increases during charge and decreases during discharge; consequently this causes both the grid and active material to expand and contract, so that unless the expansion and contraction is equal in both cases, loosening of the paste or apparent shrinkage must follow. The trouble from this source, however, is small compared with the effect on the paste itself. During normal discharge rates sulphate is formed in small quantities, and the action is such as to cause an increase in volume of the active material; and if the cells are allowed to discharge too low, there is danger of breaking the grid or forcing off the active material. During charge the effect is reversed—that is to say, the active material contracts—so that it will be seen that in both cases there is always a tendency to break off particles of the paste or distort the grid if this expansion and contraction be too great The breaking away of the particles makes the actual shrinkage more apparent than real, although shrinkage or contraction really does take place. It will, therefore, be seen that the grid should be so constructed that it can change its volume as that of the active material changes. Inability of designers to meet this requirement causes most troubles in batteries. If, however, the rates of charge and discharge be moderate, the concentration of the acid in the pores of the active material and the chemical actions take place within moderate limits, thereby allowing the active material time to accommodate itself to the changing conditions.

Rapid charge rates are more harmful than rapid discharge rates, owing to the fact that the material in the former case contracts, and, if too rapid, pull loose from the grid. Loss of capacity due to reduction of active material occasioned by the above causes cannot be recovered, but loss of capacity is sometimes brought about by the following causes: (1) clogging of pores of the lead sponges with sulphate or impurities; (2) concentration of the pores; (3) formation of a layer of sulphate between the grid and active material; (4) loss of electrolyte.

In giving a remedy for these troubles I quote from "Storage Battery Engineering," by Lamar Lyndon, B.E., M.E.: "When the plate shows a decreased capacity and exhibits no signs of sulphation, nor loss of material, it will generally be found that the material has shrunken, or the pores are clogged with sulphate and impurities. The rejuvenation of these plates is accomplished by discharging the battery, removing the negative elements, placing them in a bath of 1·200 density sulphuric acid, and connecting them as anodes or in a reverse manner to that in which they are normally connected. As cathodes, "dummy" plates of plain sheet lead about $\frac{1}{16}$in. thick are used. On passing current through the plates, the sponge lead turns first into PbO, then $PbO_2$ as the action continues. When the sponge lead becomes completely peroxidised, the current is again reversed, the acid in the bath first being removed and fresh acid substituted, in order that the impurities may not be redeposited on the negative plates. When the elements are finally converted back into sponge lead and reassembled with the positions, it will be found that the capacity and activity of the battery are increased and brought up to nearly their original condition. Reversal of the complete battery, both positives and negatives, should be avoided if dummies can possibly be secured. If not, however, and the reversing be carefully done, possibly no harm will result to the positive plate. The rate of current flow on reversal, and the change back to sponge lead, should be about one-half of the eight-hour rate, say, as a general rule, ·025 ampere per square inch, or 3½ to 4 amperes per square foot of positive plate (= No. of + plates) × (length) × (width) × 2).

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The acid in which the change from sponge lead to peroxide takes place should not be used as electrolyte until the impurities discharged by the plates are removed. Loss of electrolyte by evaporation should be made up by proper additions of highly dilute acid—about 5 per cent. acid to 95 per cent. of water. If the liquid does not completely cover the plates, a smaller active mass is exposed, and the capacity proportionally decreased.—A. C.

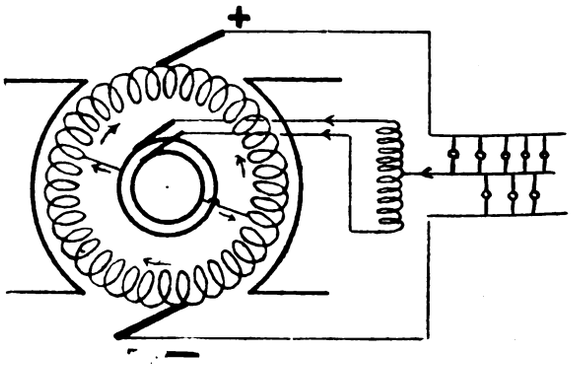
*Answer to No.* 751 (*awarded* 7*s.* 6*d.*).—Doubtless the real object of this question is to ascertain why some of the pellets of "active material" fall from the grids. There is no shrinkage or diminution in bulk in any part of the plates of a secondary leaden battery, but the reverse—viz., an increase in bulk. A short explanation of the chemical effect induced by the electrolytic action of the charging current will make this point clear. For simplicity, we will suppose two plates of lead partly immersed in dilute sulphuric acid, one being attached to the positive pole of the charging circuit, and the other to the negative. The first action of the current is to decompose the water of the liquid so that hydrogen goes in the direction of the current to the plate attached to the negative pole, and therefore called the negative plate of the battery, while oxygen goes to the plate attached to the positive pole. The result of this is to make a film of reduced or pure lead on the "negative" plate, and a film of peroxide of lead on the "positive" plate. While in this state, if we stop the charging current and make the discharging circuit complete, the sulphuric acid in the liquid can attack the reduced lead, but not the peroxide of lead, and therefore we have the conditions of an independent or primary electric battery, and the result of this chemical action, or, as we may call it, the attack of the acid on the reduced lead, is to make it into sulphate of lead. When the next charge occurs, this *used* acid is drawn out of the pores of the lead plate, and, as we know, the density of the electrolyte increases. If we could now examine the surface of the reduced lead under a microscope, we should find it rough and full of pores or dents. Of course, the surface of the lead plate is increased by this action. Now consider the case of a grid of metallic lead with its openings filled by compressed oxide of lead, which is the chemical name of red lead, or litharge. If all is in good order, and the charging and discharging of the "forming" process are properly conducted, a homogeneous plate is the result; but if, on the other hand, any impurity, such as grease or a film of some salt of lead, prevents the "active material" making good electrical contact with the grid, then the charging current would not act upon this partly insulated pellet to the same extent as the rest of the plate. This difference of state would cause local action—*i.e.*, a localised galvanic action—by which the reduced lead would be converted into sulphate, and in time this sulphating action would place a film of sulphate of lead between the pellet and the grid which should hold it. The charging current would draw the sulphuric acid out, and the action would be repeated until a crack might be seen by a microscope between the pellet and the grid, when, of course, the pellet might fall out at any time. These loose pellets must be thrown away, because they are sure to be badly sulphated, but the holes in the plate might be refilled by electrolytically-prepared reduced lead, which would have to be quite fresh, and would have to be pressed tightly into the hole of the plate immediately after charging. This operation would have to be done quickly, as lead freshly reduced gets very hot when in contact with the air, and, of course, heat would spoil the plate. Then the plate, with the new pellet in it, would have to be charged again for a little while before it could safely be discharged, or probably the new pellet would fall out before long. If the battery referred to in the question has sensibly lost capacity, I fear it shows that it has become badly sulphated. This may arise from allowing the battery to stand idle, from over-discharging, or from want of attention to the electrolyte. The best way to get rid of this trouble is to start charging at a fairly low rate and to examine every cell very carefully to see that no pellets or other articles have got lodged in between the plates, and, if so, to remove them at once by means of a lath. The density of each cell should be carefully noted at starting and at the finish. If any cells do not give off gas, look again for short-circuiting pellets, etc., between the plates and underneath them. Extra large bubbles rising during the charge are a sign of this short-circuiting caused by the fallen powder of the plates having mounted from the bottom of the cells to the bottom of the plates. When this happens the cell must be cleaned out. The sediment or dross may be put on one side and sold to the lead smelters who advertise in the *Electrical Engineer*, and the plates and acid solution may be replaced in the clean cell. An easy discharge—*i.e.*, at a rate not exceeding half the usual proper rate of the battery for a short time only—does the battery good, but it should be immediately recharged, and if after that the acid is not found to be up to full strength, a little more must be added, so that the density after a good charge, when plenty of gas is being given off, is 1,200deg. on the hydrometer, neither more nor less. It should be just mentioned here that cleaning out the cells removes or loses a considerable amount of sulphuric acid, partly from spilling and partly because a very large proportion of the dross is sulphate of lead, and, of course, all the dross is soaked with the acid solution. If every step of this process is carefully attended to, the battery will be restored to its original capacity in the course of a few days, but patience and intelligent care are absolutely necessary.—F. G. A.

[Other replies to Question No. 751 will be given in our next issue.—ED. *E. E.*]

## BALANCING CHOKING COIL.

SIR,—May I point out that of the five answers to Question No. 745, which you publish in your issues of Dec. 30 and Jan. 6, there is a certain mistake in no less than three of them, which shows that those who sent these answers did not fully understand the working of the arrangement they were explaining. The correct answers are by "X. Z. Y." and myself. The question reads as follows:

*Question No.* 745.—A direct-current generator of 500 volts, for use on a three-wire system, is fitted with an automatic balancing arrangement, consisting of a choking coil fed, *via* slip-rings, from two points on the armature windings, the middle point of the choking coil being connected to the neutral 'bus bar. Can you give the theory of its action in balancing the pressure of the two sides of the network?




The diagram is from the answer by "X. Z. Y." The current from the middle wire does not flow alternately first through one half and then through the other half of the choking coil, as the incorrect answers state. The inductive action effectually prevents anything of the sort. The out-of-balance current divides equally between the two halves of the choking-coil winding, and is continuous in each.

The total E.M.F. from the central point of the choker to the brush on the heavier loaded side must be the same by either of the two available paths. The only cause for inequality in the two parts of the current is the fact that the paths are always changing in resistance, one increasing while the other is decreasing; but the effect of this, which would alone make the current alternate in the two halves, is almost inappreciable in comparison with the inductive effect of the choking coil, which tends to maintain equality in the two parts of the current in any suitably-designed choker.—Yours, etc., SUPERHEAT.

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Supplement to "The Electrical Engineer,"
JANUARY 27, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

### QUESTIONS.

759. It is assumed that mains are about to be laid for supply to a small town on the three-wire continuous-current system, part of the scheme being the entire public lighting by ½-ampere Nernst lamps. What arrangements would you make for switching on all the street lamps from the generating station? The circuits of public lamps must be arranged to approximately balance one another, and precautions must be taken to prevent sudden "kicks" by switching on too many lamps at a time.

### ANSWERS.

*Question No.* 751.—What is the cause of shrinkage of active material in Faure type negative plates with subsequent loss of capacity? Can capacity be recovered; if so, by what means?

*Answer to No.* 751 (*awarded* 5*s.*).—In the two leading makes of batteries it is the practice nowadays to make the negative plates of the Faure type and the positive plates of the Planté type. Provided the positive plates escape buckling, they seem, as a rule, to retain their capacity longer than the negative plates. In a large Tudor battery that was under my care for some time, I noticed the negatives scaling badly at the bottom of the plates. This gradual transformation of the active material of the negative plates into scale, which was in time deposited in the bottom of the cell, was, of course, diminishing the amount of active material, and so reducing the capacity of the negatives. I fancy the cause of this was that the electrolyte at the bottom of the cells was denser than at the top, thus causing the bottom of the plates to be more heavily discharged than the top. When, therefore, the top portion of the plates was nearing the end of discharge, the bottom portion was over-discharged and liable to become sulphated. If a cell is heavily discharged or charged, there is an expansion and contraction of the plate, tending to loosen the plugs of paste. This would in turn affect the capacity, especially if some of the plugs became so loose as to fall out. I was some time ago overhauling a chloride battery that had been in use some years, and was astonished to find that the bottom part of the plates in many cases appeared to be altered in molecular structure. The metal was soft, and pieces of the plate could easily be broken away, and many of the plugs had fallen out. This seems to confirm the theory mentioned above, that the bottom portions of the plates do more work than the top portion.

As for recovering the capacity of the plates, that depends entirely on the condition they are now in. Go through the battery carefully, and notice if any plates have lost many plugs, or are badly buckled; remove these, and burn on new plates. Buckled negative plates are easily straightened between boards, but several makers put antimony into their positive plates, making them stiff and more liable to break if any attempt is made to bend them. If any negative plates are removed from the battery to straighten or scrape the scale off, do not expose them to the action of the air any more than can be helped, as they get hot, and when put back in the battery again they will be found to blister and scale badly. Lift them straight out of the electrolyte, and put them in water. After as much scale as possible has been removed, and any very bad plates renewed, a system of careful charging at a low rate must be started, the charging being kept on a little time after gassing has commenced. Discharge the battery a little below the maker's specified rate of discharge, and carefully note time the cells take to drop to 1·8 volts per cell. Whatever result is got assume in future that this is the capacity of the battery, and do not allow the battery to do more if possible.—W. A. T.

*Answer to No.* 751 (*awarded* 5*s.*).—The actual cause of the shrinkage of active material in Faure negative plates has not hitherto been satisfactorily determined. It is supposed to be due to a gradual filling up of the capillary spaces in the exposed surface of the active material (disintegrated lead) by lead deposited by a galvanic process which commences with the first use of the battery. Continuity of the whole plate is gradually interfered with, causing loss of capacity, both directly and also through the consequent formation of hard sulphate. As time goes on small ruptures may be observed in the plate, the paste becomes much disintegrated, and its union with the plate more insecure. This mechanical failing is increased by the shrinkage and expansion of the active material with each charge and discharge of the cell. Again, the rise in temperature of the acid during operation causes sulphating, accounting for a fairly uniform value for the density of the solution used, about 1·170 at 15deg. C. before charging. Should this value be increased, as is sometimes the case in working traction batteries, the formation of sulphate will be considerably increased, and the capacity reduced.

The deposition of lead referred to is so far without remedy, but it may be possible to improve the condition of the plates and prevent much deterioration by attention to the following details: (1) the electrolyte must be of proper density, and the plates will be protected against sulphating by the addition of ½oz. of sulphate of soda to each gallon of solution; (2) the cells must *never* be discharged below the specified voltage, generally 1·8 per cell; (3) avoid charging at *excessive* rates and *overcharging*.

All excessive working tends to buckling and destruction of the continuity of the plates through the loosening of the paste, with subsequent sulphating, which will also appear if the cells are neglected and run down.—A. M. L.

*Question No.* 752.—Describe what you consider the best method for cleaning the dust off boiler tubes of the Babcock and Wilcox type of boilers, especially where boilers are erected in a cramped position.

*Answer to No* 752 (*awarded* 10*s*).—The usual method of removing the flue dust and soot from the outside of the boiler tubes is by means of a flexible hose with iron end piece (shown in Fig. 1), and it is used very largely with the

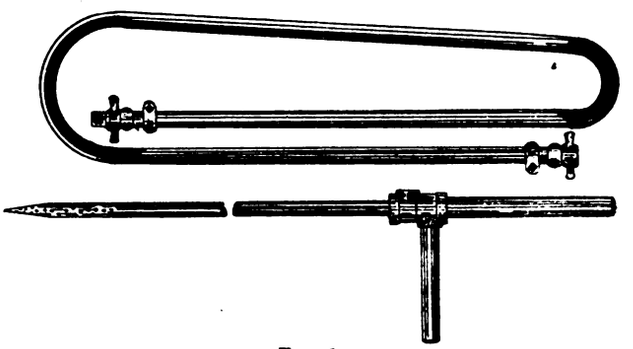

FIG. 1

Babcock and Wilcox boiler. The iron mouthpiece is introduced through side doors built in the brickwork. The standard length of hose for all boilers is 16ft. In cases, however, where the boilers are set in a continuous battery, and consequently the side passage, which is necessary for access to the side cleaning doors, is not available, and also when a method requiring the minimum of labour is desired, then the arrangement of fixed soot-cleaning jets shown in Fig. 2 is used. Upon a suitable attachment on the steam-drum a valve is fixed, to which is attached a three-way cock, an intervening drain-pocket being used to intercept any leakage past the valve. The down-comer pipes, A, to which small nozzles, B, with confined openings are fixed, are built into recesses in the brickwork setting, and the method of operating this form of soot cleaning is confined to opening the valve and turning the cock in the three directions, thus employing the force of the jets of steam through the nozzles for removing soot and dust. The frequency with which this apparatus should be used depends upon the nature of the fuel employed, but it can be used frequently without any difficulty, as the operation only involves opening a valve and turning a three-way cock. Where either of the above-mentioned soot-cleaning arrangements is used, it is advisable to run off any water which may have collected in pipes by blowing through to drain for a few seconds before blowing steam on to the tubes. The writer has found from experience that neglect of this precaution has resulted in the formation of a hard slag on the tops of the tubes, particularly at the

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front ends of boilers, and which required to be chipped off by hand.

Of the two methods, the writer much prefers the fixed steam-jet arrangement, even in the case of a single boiler. The flexible hose under ordinary working conditions soon becomes worn out, and flexible copper tubing does not make a very good substitute. The material of which the hose is made (largely rubber) soon disintegrates on the inside, and causes the perforations in the cleaning pipe to become choked up, and owing to the bending and twisting which the hose is subjected to when being used the hose and unions soon become leaky, and at the point of its connection to the union the hose gets rotted, and requires shortening and trimming very often.

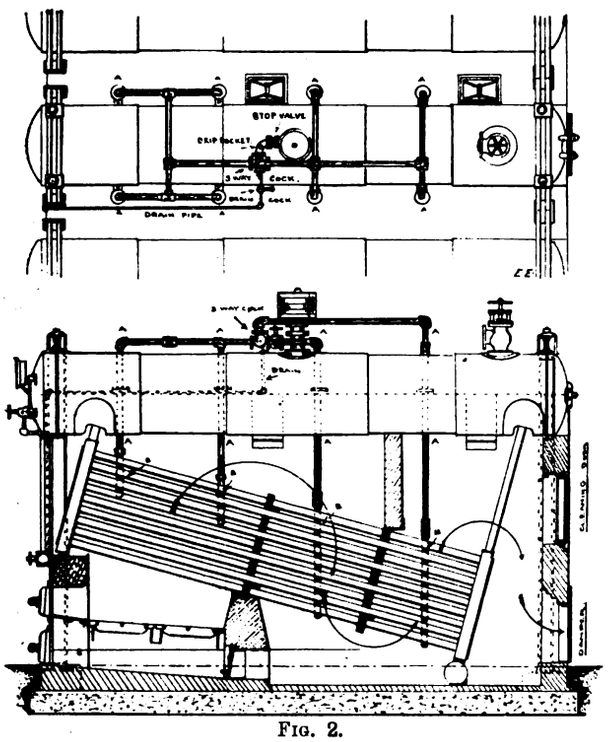


FIG. 2.

The writer has spent many a weary hour in the silent night watches in repairing a burst cleaning hose, the peaceful quiet of the boiler-room only being broken by the stoker with an occasional malediction on all pipes and steam apparatus in general what time he nurses the water blisters on his face and arms. It is not a pleasant experience by any means to be in a narrow passage (side passages between boilers are usually about 3ft. wide), using the hose arrangement, and when after having just inserted the cleaning pipe through one of the doors the hose bursts near to the union on handle of cleaning pipe. The action of the appliances used for cleaning off the soot during working should be assisted, when the boiler is laid off for cleaning, by means of brushes.—S. L.

*Answer to No.* 752 (*awarded* 7*s.* 6*d*).—There are two methods very commonly used for dusting the tubes in a Babcock and Wilcox boiler. (1) Fixed pipes running vertically down inside the brickwork of the boiler with nozzles screwed into them opposite each layer of boiler tubes. Fig. 1 illustrates a 172-h.p. boiler in which this method is adopted. (We have not reproduced this illustration as it is similar to Fig. 2 of the previous answer.—ED., *E. E.*) (2) Frames built into the brickwork at the sides of the boiler with small openings covered by flaps opposite each layer of tubes, through which a steam-pipe can be thrust and moved from side to side. Fig. 2 shows a boiler of the same size which has these frames. Both methods can be used for boilers erected in a cramped position, so it will be best to study the advantages and disadvantages of each.

1. As will be seen from the figure, steam is taken from the bottom of the safety valve, and after passing through a valve is conveyed into the four 2in. pipes on each side of the boiler. Nozzles are fixed in these pipes at proper intervals so that jets of steam are sent over the boiler tubes. The advantage of this method is that the stoker has only to go on top of the boiler and open the valve whenever the tubes want dusting. The disadvantages are (*a*) that the pipes carrying the nozzles have to be very accurately set, as if fixed too low the steam jets will soon blow holes in the sides of the tubes; (*b*) that as the vertical steam-pipes are fixed the steam jets only blow the dust off a portion of the nearest tubes, and widens its range of

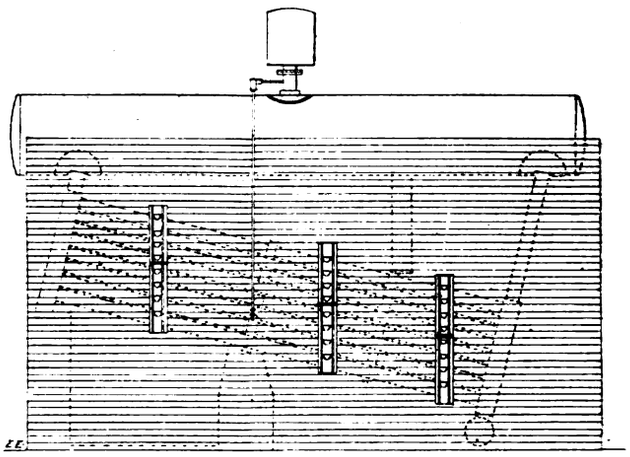

FIG. 2.

action the farther it gets away from the nozzle (this is illustrated in Fig. 3); (*c*) that the nozzles get burnt off with the heat from the flue gases.

2. This is generally considered the better method, and is used in the later boilers. Steam is taken from the top of

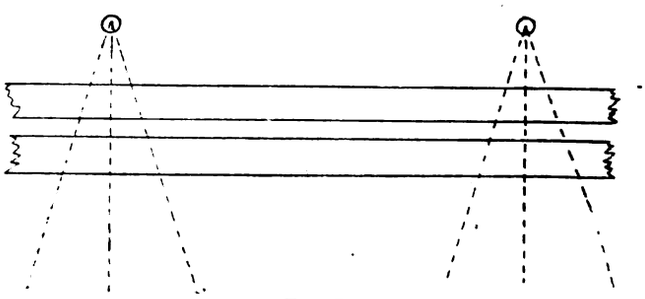

FIG. 3.

the boiler, as in (1), and runs through a ¾in. pipe down the outside of the brickwork. A valve is fixed on the bottom of this pipe, and on to this a rubber pipe is connected of sufficient length to reach to the farthest opening. Cast-iron frames are built into the side of the boilers, having holes in them so spaced that each comes opposite a layer of boiler tubes. One of these frames is shown in Fig. 4. The

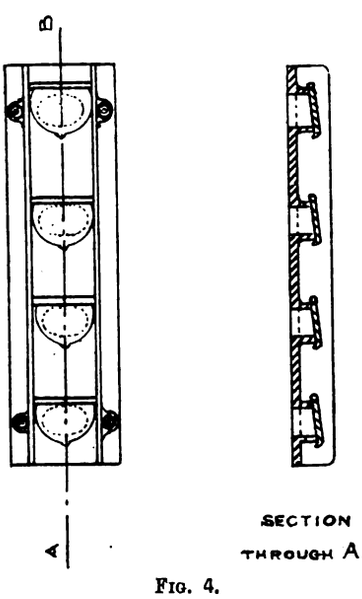


FIG. 4.

attendant puts the nozzle at the end of the rubber pipe through each of these openings in turn, and sweeps it from side to side, the steam jet thus cleaning the whole length of the tubes. The advantage of this way is that, as the nozzle is fixed to a flexible pipe, the steam cleans every

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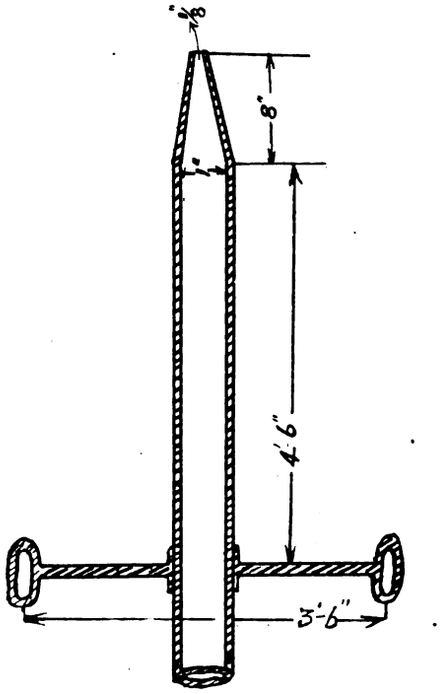
portion of the boiler tubes. The disadvantage is that the operation takes longer than in (1), and necessitates a boiler cleaner to do the work, as the stoker is not able to leave his fires for so long. When the boilers are erected in pairs, these frames are only able to be put up on one side of each boiler, but this is sufficient for keeping the tubes clean.—C. H. LYDALL.

*Answer to No.* 752 (*awarded* 5*s*).—The best method for cleaning the dust off boiler tubes of the Babcock and Wilcox type is to use a steam jet attached to a sufficient length of flexible steel steam tubing to allow any part of the boiler to be reached by the steam jet when the latter is inserted through the various inspection holes in the boiler casing. A form in use by the writer and used on boilers in very confined situations is shown in the sketch.




A length of steam-pipe is fitted at one end with a nozzle, and at the other with a pair of handles and a union for attaching the flexible steam hose. The dimensions shown will give a steam brush with which every part of the tubes can be reached, the nozzle end of the brush, of course, being inserted in the required inspection hole, and then the steam jet directed as desired by working the handles about as required. If the boiler tubes are well swept in this way just as the boiler is shut down, the whole of the dust will be found ready for removal at the bottom of the boiler. Owing to the careless and crude design of the furnace in the majority of water-tube boilers, the hot gases are cooled before they can complete combustion by coming into contact with the comparatively cold-water tubes. With some kinds of coal this leaves a very sticky, tarry deposit on the tubes, and if on examination it is found that the steam brush has not brought this deposit off the tubes, it should be brought off either with a scraper or by tapping the tubes a few times with a light sounding hammer, when the deposit will be loosened, and another application of the steam brush will clean the tubes thoroughly.—W. T. W.

*Answer to No.* 752 (*awarded* 5*s*.).—There are at least two methods in use of removing the dust from the tubes of Babcock and Wilcox boilers. In one a pipe is led down parallel to the boiler walls, with branches at right angles extending between the rows of tubes. These branches are perforated, and the steam issuing through the perforations carries the dust away. By the other method holes are provided in the boiler walls opposite the spaces between the horizontal rows of tubes. Through these holes a "lance," or tube with closed end, is passed, and the steam issuing through perforations made in the last few inches of its length blows the dust off the tubes. The lance is connected to the steam-pipe by means of a flexible hose, the flow of steam through the hose being regulated by means of a cock fixed within reach on the steam-pipe. The hose being flexible, the lance can be moved to and fro and backward and forward over the tubes. When room permits, a straight lance the width of the boiler is used; but when space will not allow of this, the lance can be cut into two or three parts, and a swivel joint, such as is used on a gas-bracket, fitted at the junction of the parts. The lance is kept straight when in use by means of a pin, the insertion of which prevents angular movement at the joints. I have tried replacing the swivel joint by an ordinary pipe union, and screwing and unscrewing the lengths into these when the lance is inserted and withdrawn. I found, however, that the swivel joint was to be preferred. The lance is effective in its work so far as it can reach. The utility of the method first described depends upon the distribution of the perforations along the horizontal branches. Should one or more of these branches get out of order, it may be a very difficult matter to get at them to effect repairs; and if the end should break off, so as to allow the steam to blow straight through instead of through the perforations, the utility of that particular branch would be considerably reduced. If the valve controlling the steam should not be tight, the leakage through it may cause external corrosion of the boiler tubes. But this first method is more convenient than the second to work, as all that is required is to turn on the steam Owing to the drawbacks mentioned, however, it has been superseded in some instances by the "lance" method.—H. J. W.

*Question No.* 753.—Discuss the rules for determining the most economical current density of a one square inch cable, one mile long, insulated in a satisfactory manner, working at a pressure of 1,000 volts direct current, the duration of the maximum load being on an average five hours per day, cost per unit delivered to conductor 1d., and interest and depreciation on cable taken at 10 per cent. State which rule you think gives the best result.

*Answer to No.* 753 (*awarded* 10*s*.).—This problem is the reverse of that generally set to engineers, it being usually necessary to determine the most economical cross-section of cable for a given load. As it is distinctly stated in the question that the load is a varying one, it follows that the current density will also be a varying one, and the problem set is really to find the mean value of the most economical current density. Now, in any cable there are two factors which have a great bearing on the most economical current density—viz.: (*a*) the cost of the energy wasted in the cable per annum; (*b*) the interest on the capital expenditure on the cable, and also the depreciation. It may be as well to state here that the interest and depreciation are usually grouped as one and taken as some percentage of the capital cost of the cable. This, it will be seen, is done in the question. Let us now consider the waste of energy in the cable. This, of course, is dissipated in heat. If at any instant in a cable of resistance R ohms we have a current, C, passing, it is well known that the waste of energy $= C^2 R$ watts, and the cost of waste of energy will be this quantity multiplied by some constant $a$, which we will determine afterwards—*i.e.*:

Cost of waste of energy per annum $= a C^2 R$ £ . . (1)

It will be seen that in practice, when we desire to calculate this cost of waste of energy with a varying current, it will not be correct to take the mean value of the current and square it and substitute in equation (1), but we must take the quantity $C^2$ as the mean value of the squares of the current.

Now let us consider the interest and depreciation of the cable. If the catalogues of all the cable manufacturers be consulted, it will be found that the cost of any cable is very nearly proportional to the weight of copper in the cable. Now, the weight of copper in a cable of given length is directly proportional to its cross-sectional area, which again is inversely proportional to its resistance, so that the cost of a cable may be expressed as $\frac{b}{R}$ £, where $b$ is a constant. Therefore the total cost of a cable and wasted energy per annum, $y$, is expressed as below:

$$y = a C^2 R + \frac{b}{R} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Now, given this equation (2), it is an easy matter to find for what value of R $y$ is a mimimum. Differentiate the equation with respect to R, and we get

$$\frac{dy}{dR} = a C^2 - \frac{b}{R^2} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

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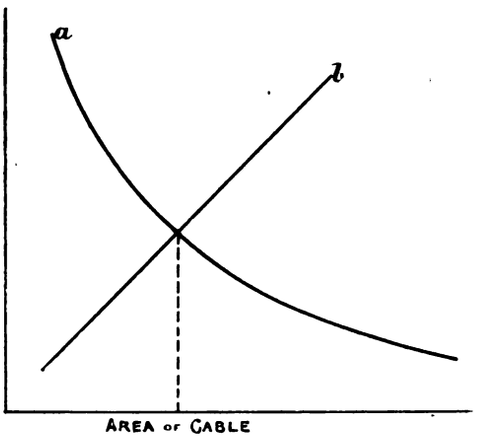
Now, $y$ is a minimum when $\frac{dy}{dR} = 0$—*i.e.*, when

$$a\,C^2 = \frac{b}{R^2}, \text{ or when } a\,C^2\,R = \frac{b}{R} \quad . \; . \quad (4)$$

or expressing this result in words we get what is known as Lord Kelvin's rule—*i.e.*, the total cost of a cable and wasted energy per annum is at a minimum when the cost of the waste of energy per annum is equal to the interest and depreciation on the outlay on the cable. This can be better explained by referring to the curves shown. The




point where the two curves cut gives the most economical conditions.

Let us first find the resistance of the cable by the well-known law $R = K\frac{L}{A}$, where L = length of cable in inches; A = area of cross-section of cable in square inches; K = specific resistance of copper. Taking K = ·66 microhm per cubic inch, $R = \frac{\cdot 66}{10^6} \times \frac{63{,}360}{1} = \cdot 0418$ ohm, L being one mile = 63,360in., and A = 1 square inch. ∴ waste of energy = ·0418 $C^2$ watts. One-watt-year = $\frac{24 \times 365}{1{,}000}$ units = 8·76 units. Now, cost of one unit = 1d. = £$\frac{1}{240}$. Cost of one watt-year = 8·76 × £$\frac{1}{240}$ = £·0364. The cost of waste of energy per year = A $C^2$ R = ·0364 × £·0418 $C^2$ = £·00154 $C^2$. The most economical current for the cable is therefore given by the equation below, taking $p$ as the capital cost of the cable in pounds, the interest and depreciation therefore being $\frac{p}{10}$.

$$C^2 \times \cdot 00154 = \frac{p}{10}, \text{ or } C^2 = \frac{p}{\cdot 0154} \quad . \; . \; . \quad (5)$$

Let us now get a close approximation to the capital cost of the cable. The volume of copper in the cable is proportional to its length and area of cross-section—*i.e.*, volume = A × L cubic inches. Now, A = 1 square inch. Take the weight of copper as ·32lb. per cubic inch = $\frac{\cdot 32}{2{,}240}$ tons per cubic inch. Weight of copper in cable = $63{,}360 \times \frac{\cdot 32}{2{,}240}$ tons = 9·05 tons. Take the price of copper as £75 per ton, value of copper in cable = £75 × 9·05 = £679 Let us therefore say that the cost of the cable will be about £1,000. Substituting this in our equation (5) we get

$$C^2 = \frac{p}{\cdot 0154} = \frac{1{,}000}{\cdot 0154} = 65{,}000,$$

or the root mean square (R.M.S.) of current density = 255 amperes per square inch; therefore, the load on the cable must be so proportioned for the most economical condition of working so that the R.M.S. of the current density is 255 amperes per square inch.

During the five hours of maximum load of course the current density will be great, so that it must be diminished during the times of lighter load.—ERNEST P. HOLLIS.

*Answer to No.* 753 (*awarded* 5*s.*).—A cable may be considered as a source of three different expenditures—viz.: (*a*) interest on capital expenditure; (*b*) cost of repairs and renewals; (*c*) energy wasted in the cable in transmission. (*a*) and (*b*) are covered by the 10 per cent. allowed for interest and depreciation per annum. Although the cross-section of a conductor may be determined by the maximum current it has to carry, the total annual loss of energy in the cable does not depend upon the maximum current unless the current is of constant value, which is never the case in practice. Energy will be wasted in the cable *at all loads*, the rate of loss at any instant being proportional to the square of the current. An assumption of the total loss per annum must be made from considerations of the most probable working conditions unless the actual amount be known. Let the loss per day be assumed equivalent to the loss that takes place during the flow of maximum current for $h$ hours. The most economical current density will be that which the cable will carry, under these conditions, with less expenditure than any other cable of different cross-section. That is, the expenditure, including interest on depreciation and cost of energy lost, will be less than that in any cable of greater, or of less, cross-section. Let $X_a$, $X_b$ $X_c$ be the capital cost per mile, including laying, etc., of three cables, the cross-section of the first cable being less than that of the second, and the second less than that of the third, these cross-sections to be of consecutive sizes. Let $r_a$, $r_b$, $r_c$ be their respective resistances per mile, and C the most economical current. Then the total annual cost in each case will be

$$(1) \qquad £\left\{\frac{X_a}{10} + \frac{C^2\,r_a\,h}{24 \times 10^4}\right\} = \left\{\frac{X_a}{10} + K_a\,C^2\right\}.$$

$$(2) \qquad £\left\{\frac{X_b}{10} + \frac{C^2\,r_b\,h}{24 \times 10^4}\right\} = \left\{\frac{X_b}{10} + K_b\,C^2\right\}.$$

$$(3) \qquad £\left\{\frac{X_c}{10} + \frac{C^2\,r_c\,h}{24 \times 10^4}\right\} = \left\{\frac{X_c}{10} + K_c\,C^2\right\}.$$

For (2) to be less than either (1) or (3), the following must hold good:

$$\frac{X_a}{10} + K_a\,C^2 > \frac{X_b}{10} + K_b\,C^2.$$

[A]—*i.e.*, $$C > \sqrt{\frac{X_b - X_a}{10\,(K_a - K_b)}}.$$

Also $$\frac{X_c}{10} + K_c\,C^2 > \frac{X_b}{10} + K_b\,C^2.$$

[B]—*i.e.*, $$C < \sqrt{\frac{X_c - X_b}{10\,(K_b - K_c)}}.$$

For example, let it be required to find the most economical current for cable (*b*), data referring to it and two other cables being as per table following:

| Cable. | Cross-section in sq. in. | Resistance per mile. | 10 per cent. [on cost of cable, £. |
|---|---|---|---|
| (*a*) | ·034 | 1·245 | 10 |
| (*b*) | ·046 | ·915 | 12·5 |
| (*c*) | ·060 | ·761 | 16·8 |

The total loss of energy per day is equivalent to that which would take place if the maximum current flowed for 2½ hours. Then we have

$$K_a = \frac{912{\cdot}5 \times 1\,245}{24 \times 10^4} = \cdot 0047.$$

$$K_b = \frac{912\,5 \times \cdot 915}{24 \times 10^4} = \cdot 0034.$$

$$K_c = \frac{912\,5 \times 761}{24 \times 10^4} = \cdot 0028.$$

By [A] we have $C^2 > \frac{12{\cdot}5 - 10}{\cdot 0047 - 0034}$

*i.e.*, $C > 43\,8$ amperes.

By [B] $C^2 < \frac{16\,8 - 12{\cdot}5}{\cdot 0034 - \cdot 0028}$

*i.e.*, $C < 84\,6$ amperes.

Thus the second cable of resistance 915 ohms per mile will be as economical as the first with a current of 43 8 amperes, and as economical as the third with a current of 84·6, and more economical than either for intermediate values. In practice the current must not be so high as to cause the maximum rise of temperature and pressure drop to exceed the maximum permissible in each case.—H. J. W.

[Other replies to Question No. 753 will be given in our next issue.—ED. *E. E.*]

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FEBRUARY 3, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

760. What is the method of calculating the repulsion effect of a magnet excited by single-phase alternating current. For instance, it is required to suspend in air a weight of about 4oz. at a distance of ½in. from the end of the magnet. Current available, 35 volts 28 amperes.—REGULUS.

761. In a certain hilly and moorland district, about four or five miles from one of the great towns, there are situated at distances of a quarter to three miles from one another about eight or a dozen ganister quarries and silica brick and firebrick works. At present each has its own separate steam plant for operating the necessary machinery, besides a heavy traction engine and several large wagons, used for taking the manufactures to the nearest railway and for bringing coal up again. What will be the best system to adopt in order to supply all these places from a common power station?—SILICA.

762. A three-wire feeder, ·25, ·125, ·25, which under ordinary circumstances carries 180 amperes, has developed a fault on the + side, and now takes only 80 amperes, the − side taking the same amount as before the fault occurred. The feeder is on the same 'bus bar as other feeders, and feeds into a network box 60 yards from switchboard. The fault is between network box and switchboard. Is there any means of locating same without breaking up the ground? as to do so would be very inconvenient, the feeder crossing a busy thoroughfare. The feeder is laid solid in iron troughing, and is free from earth faults.—W. H. R.

### ANSWERS.

*Question No.* 753.—Discuss the rules for determining the most economical current density of a one square inch cable, one mile long, insulated in a satisfactory manner, working at a pressure of 1,000 volts direct current, the duration of the maximum load being on an average five hours per day, cost per unit delivered to conductor 1d., and interest and depreciation on cable taken at 10 per cent. State which rule you think gives the best result.

*Answer to No.* 753 (*awarded* 10*s.*).—There are three rules by which the economical current density of a cable may be determined—viz: (1) when the total cost of the energy lost in the cable, together with the charges for interest and depreciation, is a minimum; (2) when the ratio of the income from the cable to the total cost of the energy delivered, together with the charges for interest and depreciation, is a maximum; (3) when the net revenue from the cable is a maximum—*i.e.*, when the income from the cable, less the total cost of the energy delivered, together with the charges for interest and depreciation, is a maximum.

These rules may be stated thus: (1) $e+I$ is a maximum; (2) $\frac{E}{G+I}$ is a maximum; (3) $E-(G+I)$ is a maximum, where $e$ = total cost of energy lost in cable or cables per annum; $I$ = charges for interest and depreciation per annum; $E$ = income from cable or cables per annum; $G$ = total cost of energy delivered to cable or cables per annum.

In the example given in the question, $e$ varies as the square of the current density of the cable or cables required to supply a given maximum load. I is 10 per cent. on the cost of cable or cables (laid complete), and varies inversely approximately as the current density for a given maximum load; a one square inch cable may be assumed to cost £3,000 per mile laid complete, and other cables a proportionate figure, for the purposes of these calculations. E varies approximately as the current density of the cable (where only one cable is considered), but for a given maximum load is constant. G varies approximately as the current density of the cable (where only one cable is considered), but for a given maximum load is the sum of a constant and a quantity which varies as $e$. To obtain values of $e$, I, E, and G it is, therefore, necessary to assume different values of current densities, and then by trial to ascertain which value conforms most nearly with the rules given above. Also for these examples we might assume that the price obtained is 3d. per unit, and that the maximum demand on the section under consideration is 1,000 amperes at 1,000 volts. A satisfactory result may be arrived at in a similar way by using any other figures—*e.g.*, the actual figures which obtain in the case for determination. Neglecting the energy delivered to the cable except during the period of maximum load, and assuming that the resistance of one mile (go and return) of table of one square inch section at its working temperature is 0·086 ohm, then the energy lost per annum will be $C^2\left(\frac{0{\cdot}086\times5\times365}{1{,}000}\right)$ units, or 0·157 $C^2$ units, for a one square inch cable, and proportional for extra cables.

The four following examples are given to show approximately how the economical current density may be obtained by using the three rules given above.

*Example* 1.—Assume current density is 1,000 amperes per square inch, then

$e = 0\ 157\ (1{,}000)^2$ units at 1d. per unit $= \frac{157{,}000}{240}$, or £654.

$I$ = £300—*i.e.*, 10 per cent. of £3,000.

$E = 1{,}000\times5\times365$ units at 3d. per unit $= 1{,}825{,}000\times\frac{3}{240}$ or £22,812.

$G = 1{,}825{,}000 + 157{,}000$ units at 1d. per unit $= \frac{1{,}982{,}000}{240}$, or £8,258.

Therefore (1) $e+I = 654+300 = 954$.

(2) $\frac{E}{G+I} = \frac{22{,}812}{8{,}258+300} = 2{\cdot}666$.

(3) $E-(G+I) = 22{,}812-(8{,}258+300) = 14{,}254$.

*Example* 2.—Assume current density is 500 amperes per square inch. Therefore, to supply 1,000 amperes another one square inch cable will be required, and we may, for the purpose of the calculation, assume its cost to be equal to the original one square inch cable. Then

$e = 0{\cdot}157\times(500)^2\times2$ units at 1d. $= \frac{78{,}500}{240}$, or £327.

$I = 300\times2$, or £600.

$E = 500\times2\times5\times365$ units at 3d. $= 1{,}825{,}000\times\frac{3}{240}$, or £22,812.

$G = 1{,}825{,}000 + 78{,}500$ units at 1d. $= \frac{1{,}903{,}500}{240}$, or £7,931.

Therefore (1) $e+I = 327+600 = 927$.

(2) $\frac{E}{G+I} = \frac{22{,}812}{7{,}931+600} = 2{\cdot}674$.

(3) $E-(G+I) = 22{,}812-(7{,}931+600) = 14{,}281$.

*Example* 3.—Assume current density is 750 amperes per square inch. Therefore, to supply 1,000 amperes another one-third square inch cable will be required, and we may, for the purpose of this calculation, assume its cost to be one-third of the cost of the original one square inch cable. Then

$e = 0{\cdot}157\times(750)^2\times1\frac{1}{3}$ units at 1d. $= \frac{117{,}750}{240}$, or £491.

$I = 300\times1\frac{1}{3}$, or £400.

$E = 750\times1\frac{1}{3}\times5\times365$ units at 3d. $= 1{,}825{,}000\times\frac{3}{240}$ or £22,812

$G = 1{,}825{,}000 + 117{,}750$ units at 1d. $= \frac{1{,}942{,}750}{240}$, or £8,095.

Therefore (1) $e+I = 491+400 = 891$.

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(2) $\frac{E}{G+1} = \frac{22,812}{8,095+400} = 2\,685.$

(3) $E-(G+I) = 22,812-(8,095+400) = 14,317.$

*Example* 4.—Assume current density is 667 ($\frac{2}{3}$ of 1,000) amperes per square inch. Therefore, to supply 1,000 amperes another one-half square inch cable will be required, and we may, for the purpose of this calculation, assume its cost to be one-half of the cost of the original one square inch cable. Then

$e = 0{\cdot}157 \times (\frac{2}{3} \times 1,000)^2 \times 1\frac{1}{2}$ units at 1d. $= \frac{104,667}{240}$, or £436

$I = 300 \times 1\frac{1}{2}$, or £450.

$E = \frac{2}{3} \times 1,000 \times 1\frac{1}{2} \times 5 \times 365$ units at 3d. $= 1,825,000 \times \frac{3}{240}$

or £22,812.

$G = 1,825,000 + 104,667$ units at 1d. $= \frac{1,929\,667}{240}$, or £8,040.

Therefore (1) $e+I = 436+450 = 886.$

(2) $\frac{E}{G+1} = \frac{22\,812}{8,040+450} = 2{\cdot}687.$

(3) $E-(G+I) = 22,812-(8,040+450) = 14,322.$

It will be seen that of the examples taken No. 4 satisfies the conditions, and is approximately correct—viz: (1) is a minimum, (2) is a maximum, (3) is a maximum. Therefore, under the conditions given and assumptions made, a current density of about 700 amperes per square inch would appear to be the most economical.

In most cases of supply cables, as in the present instance, the three rules will give approximately the same result, but in the author's opinion rule (3) is the best to use, as it is very simple and assures the net revenue from the cable being a maximum, which seems to him to be the end desired. The economy of a cable must, of course, be considered in conjunction with prevention of overheating and loss of pressure, and if the rule gives too great a current density the latter must be reduced until overheating is prevented and loss of pressure brought to the desired figure.—H. A. N.

*Question No.* 754.—It is well known that the indicated horse-power of a triple-expansion engine can be varied by altering the cut-off of the intermediate-pressure or low-pressure valve, the high-pressure cut-off meanwhile remaining the same. I am not referring to extreme variations, when the engine almost ceases to be triple-expansion, but to slight alterations in the cut-offs, when the engine is doing equal work in each cylinder. Can anyone explain why this should be so?

*Answer to No.* 754 (*awarded* 10*s.*).—Prof. Weighton, in a paper read before the North-East Coast Institution of Engineers (vol. 16), gives the results of several trials made to determine the most economical point of cut-off in the intermediate (I.P.) and low-pressure (L.P.) cylinders of multiple-expansion engines. It was found that, the cut-off in the H.P. being constant, there was a certain point of cut-off in each of the I.P. and L.P. cylinders at which the engine ran most economically, and this point is given as $\left(\cdot 15+\frac{1}{R}\right)$ stroke, where R is the ratio of the capacity of the cylinder in question to the capacity of the preceding cylinder. It was also found that the cut-off in the I.P. and L.P. cylinders affected the total horse-power developed, the H.P. cut-off being constant, and that in triples the cut-off for maximum power coincides with that for maximum economy in the L.P. cylinder, and is as given above, but that in the I.P. cylinder the maximum power cut-off is much later than the maximum economy.

Considering the I.P. cylinder, it was found that the later the cut-off up to a certain point the greater the horse-power developed by the engine, and that after that certain point the horse-power decreases. Considering the effect of the cut-off, the later the cut-off in the I.P. the lower is the first receiver pressure, and therefore the lower the temperature of the H.P. exhaust. It follows, then, that the temperature range of the H.P. cylinder would increase with the I.P. cut-off, and thus the mean temperature of the H.P. cylinder walls would decrease and the initial condensation increase. But another effect would be that the water initially condensed as above in the H.P. would re-evaporate to do work in the succeeding cylinders; also in the I.P. cylinder a late cut-off would reduce wire-drawing at admission, and reduce the temperature range of the I.P. Thus a larger card would be obtained. After a certain point, however, the receiver drop—H.P. to I.P.—at release in the H.P. would be excessive, and an increase in the I.P. cut-off would decrease the horse-power. Thus it will be seen that there is one point of cut-off in the I.P. cylinder—and on the same basis one point in the L.P. cylinder—which gives a maximum indicated horse-power. A later cut-off means excessive receiver drop, and hence loss in power; an earlier cut-off means excessive condensation in the cylinder or wire-drawing during admission, and a consequent loss in power.—S. E. T.

*Answer to No.* 754 (*awarded* 7*s.* 6*d*).—If the cut-off be kept constant in the H.P. cylinder of a triple-expansion engine and the initial pressure is not altered, the amount of steam admitted per stroke is always the same if we neglect the effect of the cylinder clearance. The total volume of the L.P. cylinder at release is the same whatever the cut-off in that cylinder may be, and, therefore, the number of times the steam has expanded, or the ratio of the volume of H.P. cylinder at cut-off to the volume of L.P. cylinder at release, is constant. Consequently the

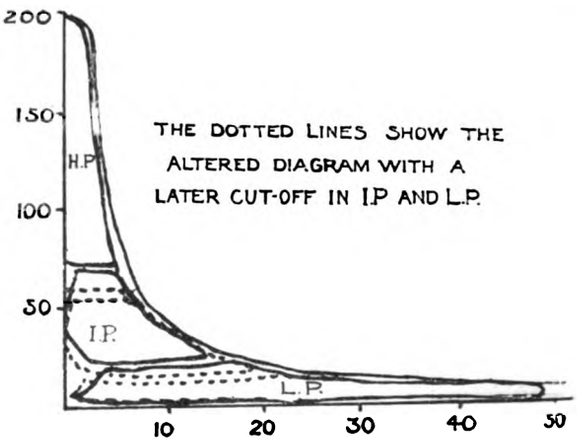


FIG 1.

release pressure of the steam, and the amount of work done by it in the three cylinders, is not affected by the position of the cut-off in the I.P. or L.P. cylinders. The above assumes that the loss by condensation, leakage, etc., is not altered by the alterations in the valve gear. For small variations this assumption is correct. It might be as well to state that if large alterations are made and all the work is thrown on one cylinder, the temperature range will be so large in that cylinder that condensation will be materially assisted. If this cylinder happens to be the H.P, the loss will be made up

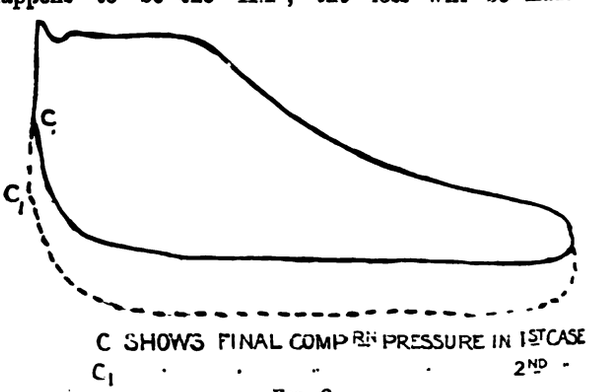


FIG. 2.

by more live steam; this steam will partially re-evaporate later on, and materially increase the total indicated horse-power of the engine. The combined diagram (Fig. 1) shows the redistribution of work between the cylinders if the cut-off is made later in the I.P. and L.P. cylinders. If the H.P. cylinder has a considerable clearance volume, and the back pressure of that cylinder is lowered by making the cut-off in the I.P. later, the compression pressure is reduced (Fig. 2), and thus more steam is required to fill it. This steam gives out work in

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the next two cylinders, and would thus increase slightly the total indicated horse-power. This effect can also be neglected if the clearance volume is small. The above, of course, only refers to the condition of things when the engine is running steadily. If the cut-off is altered while the engine is running, there will be a considerable momentary alteration of the indicated horse-power as the amount of steam present in the receivers alters, and it must have time to steady itself again.—E. J.

*Answer to No.* 754 (*awarded* 5*s.*).—It is a fact that the indicated horse-power of a triple-expansion engine can be varied by altering the points of cut-off of the I.P. or L.P. valves, though I hardly think it advisable to do this much unless it be to cut off earlier, as it will affect the cushioning at the end of the exhaust stroke of one side of the piston. I think to explain this it will be best to first take any theoretically good imaginary indicator diagram and then see exactly what this shows, afterwards endeavouring to arrive at a conclusion as to what will happen when the cut-offs are altered in either the I.P. or L.P. cylinders.

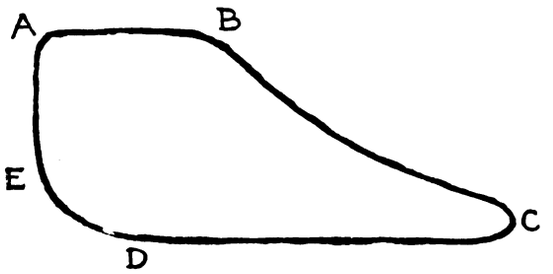


FIG. 1.

Let us take Fig. 1 as being this imaginary diagram. At A the piston has just got to the end of its backward stroke, and is just starting to move forwards again. Steam is behind it, tending to drive it forward, being at a pressure represented by the height of A above the atmospheric line and the inlet valve is still open. This steam pressure behind the piston forces it forwards till the point B is reached in the stroke, when cut-off takes place. At the instant the steam is cut off there is a certain volume and weight of steam behind the piston still at the same pressure as at A, which is practically the same as the boiler pressure, because the steam-inlet valve from the boiler has been open all the time now. From this moment of cut-off onwards to the end of this stroke the steam keeps on expanding, and its pressure correspondingly drops, almost following Boyle's law, which states that the pressure of a gas varies inversely with its volume. At the end of the stroke we have reached the point C, at which the exhaust valve is opened, and the pressure behind the piston immediately drops. The steam is exhausting from this side of the piston into the receiver during all the backward stroke until the point D is reached, at which point the exhaust valve closes. At this point the greater portion of the steam will have passed from the cylinder to the receiver, and only a comparatively small quantity will remain, which is, of course, at the same pressure as that in the receiver. After the exhaust valve has closed, as the piston still comes back, the steam in the cylinder gets compressed, and the pressure therein keeps on increasing till the point E is reached, when the admission valve once more opens. Immediately the pressure in this end of the cylinder rises up to the original pressure again, which is practically the full boiler pressure. We have now followed the action of the steam in the cylinder through one complete cycle or one revolution of our engine, and each succeeding revolution is similar. In the above I have considered more particularly the H.P. cylinder—of course, in either the I.P. or L.P. cylinders the steam cannot come from the boilers straight, but from the receiver, and so its pressure is about the pressure of the receiver.

We are now in a position to consider the action of varying the time of cut-off of the steam in either the I.P. or L.P. cylinders. First, let us suppose that the cut-off in one of these cylinders is made earlier, whilst that in the H.P. cylinder is kept constant. When the intermediate admission valve opens, steam is taken in from the receiver, and hence the pressure in this must drop somewhat, but as the cut-off is earlier, this drop will not be so great as before, and there will be a greater weight of steam also left in the receiver than would otherwise be the case, hence the immediate result as far as the receiver is concerned will be to leave a greater weight of steam at a higher pressure than before. Now, when next the H.P. cylinder exhausts into this receiver, owing to there being already a greater weight of steam at a higher pressure than before, not quite so much steam will exhaust into the receiver, and what is left in the cylinder after the exhaust valve has closed again will be greater by weight, and at a higher pressure than it would otherwise have been. Hence we may state that the immediate result of cutting off earlier in the I.P. cylinder will be to increase the back pressure or cushioning in the H.P. cylinder, and hence lower its indicated horse-power, and also to raise the pressure of the steam in the receiver. As to whether or not this will increase or decrease the indicated horse-power in the I.P. cylinder it is hard to say, as this will depend on how much the pressure in the receiver has risen and by how much the cut-off has been altered. It must also be borne in mind along with this that as the difference in pressures between the steam at admission and exhaust in the H.P. cylinder has been lessened, this will likewise lessen the difference between the temperatures at admission and exhaust; and, hence, as the range of temperature has been slightly lessened, the condensation in the cylinder will also be less, and so the efficiency should be improved.

If, now, the case of making the cut-off in the I.P. cylinder later be considered in a precisely similar manner, it will be found that this proceeding will enable this cylinder to take more steam from the receiver as the admission valve is now open to it longer, and on this valve closing the receiver will be left with a less weight of steam at a lower pressure than under normal conditions. This will have the effect of allowing more steam to exhaust into the receiver from the H.P. cylinder, which will lessen the back pressure and cushioning in this cylinder. Therefore, being less back pressure, the indicated horse-power in this cylinder will be increased. As to the I.P. cylinder itself, this will receive a slightly greater volume and weight of steam than before, but at a lower pressure. What effect this will have on the indicated horse-power of this cylinder it is also hard to say, as this will depend on how much later the cut-off has been made, and by how much the pressure of the steam in the receiver has been lowered, and in any case it will be seen that these two quantities tend to balance one another. Also it will be seen that the range of temperature in the H.P. cylinder will be greater now than normally, which by cooling down the cylinder walls at the end of each stroke will have a tendency to lower the efficiency. In either case, where the cut-off has been made earlier or later, the action of the steam in passing from the I.P. cylinder to the other receiver, and from there to the L.P. cylinder, and from thence either to the atmosphere or the condenser, will be much the same as under ordinary conditions with normal cut-off. Another thing to be borne in mind is the two receiver drops, which will be greater if the cut-off in the I.P. cylinder be later and less if it be earlier, which will tend to neutralise any benefits otherwise obtained by the later cut-off. I think from the foregoing few notes it will be seen that by altering the cut-off in the I.P. cylinder the indicated horse-power in the H.P. cylinder, with regards to pressure, will be altered in the manner pointed out, but as to whether this will actually alter the total indicated horse-power of the engine under consideration it is difficult to predetermine without some definite data, as there are so many things to take into consideration.—E. R. ALEXANDER.

*Answer to No.* 754 (*awarded* 5*s*).—The explanation sought by "J. P." is that by altering the point of cut-off in any engine its power may be either increased or decreased, and that the I.P. and L.P. lines in a triple-expansion engine are in themselves complete engines; consequently if the power be increased or decreased by lengthening or shortening the point of cut-off in either of these lines, the power produced by that line, and consequently the power produced by the triple engine, will be altered. To obtain the highest economy of steam used per horse-power hour, it is necessary to take full advantage of the expansive properties

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of the steam. This entails an early cut-off and a number of expansions, and if this were carried out in one cylinder excessive cylinder condensation would take place, and the cylinder and engine generally would have to be large and unwieldy for its power, on account of the great strains and the low mean effective pressure, so that no great economy can be looked for from a single-cylinder engine. If, however, two or more cylinders are used, and the cut-off in each cylinder be arranged so that the maximum advantage is obtained by using the steam expansively, but yet not so as to cause great initial condensation or an abnormally low mean effective pressure, and the subsequent cylinder or cylinders to the first be arranged to work with the steam rejected from the preceding cylinder, we obtain an engine giving economy of steam used per horse-power hour and a very even turning effort, provided that each line is adjusted to take an equal share of the load. "J. P." will thus be able to see that by, say, giving a longer cut-off to the intermediate valve of a triple-expansion engine, he will raise the mean effective pressure in the I.P. and L P. cylinders, and consequently will obtain more power from his engine, and *vice versâ*. Whether it is advisable to alter the cut-off in any of the cylinders is a matter which can only be decided by an examination of the engine in question. It has been found by experience that with modern compound and triple expansion engines the best results are obtained by expanding down to a final pressure of 8lb. absolute, with about 6lb. back pressure, the ratio of the cylinders one to another depending on the initial pressure used. The following table shows the cylinder ratios for triple-expansion engines generally adopted:

| Boiler pressure by gauge. | Ratio of cylinder areas. H.P. cylinder. | I.P. cylinder. | L.P. cylinder. |
|---|---|---|---|
| 130 | 1 | 2·25 | 5 |
| 140 | 1 | 2·4 | 5·85 |
| 150 | 1 | 2·55 | 7 |
| 160 | 1 | 2·7 | 7·25 |

—W. T. W.

*Question No.* 755.—An 80ft. brick chimney stack is obliged to be reduced in height by 20ft. To what extent could the loss in draught be remedied by taking the exhaust pipe up the inside of the chimney? At what height should the exhaust pipe enter, and at what distance from the top should it terminate to give the best results?

*Answer to No.* 755 (*awarded* 7*s.* 6*d.*).—As the intensity of the draught produced by a chimney is proportional to its height, reducing the height of the chimney from 80ft. to 60ft. will, other conditions remaining the same, reduce the intensity of the draught by 25 per cent. of its original amount. The draught produced by a chimney may be found approximately by the following formula:

$$D = \frac{7{\cdot}6\ H\ (T - t)}{T \times t},$$

where D = intensity of draught in inches of water pressure;
H = height of chimney in feet above grate surface;
T = absolute temperature of gases inside chimney;
$t$ = absolute temperature of air outside chimney.

Assuming the gases inside chimney to be 600deg. F., and the temperature of the external air 60deg. F., it will be found from the above formula that the intensity of draught produced by a chimney 80ft. high will be approximately equal to ·6in. water pressure, and the draught produced by one of 60ft. high approximately equal to ·45in. water pressure. The loss of draught due to lowering the chimney may therefore be expected to be, say, equal to ·15in. water pressure. This slight loss in intensity of draught can be more than counterbalanced by arranging the exhaust pipe to discharge in the chimney.

The exhaustive or ejective power of an exhaust pipe may be approximately found by using the following formula:

$$E = \frac{37\ d^{1\cdot662} \times p^{0\cdot8}}{D^2},$$

where E = exhaustive power in inches of water pressure;
$d$ = diameter of exhaust pipe in inches;
D = diameter of chimney in inches;
$p$ = pressure of steam at outlet of exhaust pipe.

As the respective diameters of chimney and exhaust pipe are not given in the question it is not possible to give the increased intensity of draught that will be obtained through exhausting in the chimney; but, unless the diameter of the chimney is exceedingly large in comparison with the diameter of the exhaust outlet, the loss of ·15in. in the draught occasioned by shortening the chimney will be more than counterbalanced by the new arrangement, as "A." will find out by making use of the above formulæ.

As regards the point of entry and the height up the chimney at which the exhaust pipe should terminate, providing the chimney is of ample area for the volume of gases it has to discharge, the best arrangement would be for the exhaust pipe to enter the chimney at its base (the bottom of the pipe being provided with a substantial footstep of ample area for supporting the weight of the vertical portion), and be carried up to within a distance from the top of chimney, equal to four or five times the diameter of the chimney; or, assuming the chimney to be 5ft. in diameter, the pipe could be carried up to within 20ft. from the top.—J. B. R.

*Answer to No.* 755 (*awarded* 5*s.*).—The effect of taking the exhaust pipe into the chimney in order to remedy the loss of draught is dependent on the pressure of the steam at the exhaust and the diameter of the chimney and exhaust pipe. This has been shown by Mr. Longridge, who, in the *Proceedings* of the Institution of Civil Engineers, vol. liii., has given the following formula for the exhaustive power of the steam, and which is found to agree very closely with practical results.

Let E = draught in inches of water caused by the exhausting steam;
$d$ = diameter of the exhaust pipe in inches;
D = diameter of the chimney in inches;
$p$ = pressure of the steam in pounds per square inch above the atmosphere.

$$E = \frac{37\ d^{1\cdot662}\ p^{0\cdot8}}{D^2}.$$

The pressure of the steam is dependent on the type and size of the engines. If the engines are triple-expansion it is obvious that the steam will be worked through a larger expansion ratio than if the engines were single-expansion. The diameter of the exhaust pipe will, of course, depend on the quantity of steam to be exhausted, which depends on the size of engine, since in a large engine there is a greater weight of steam passing through the cylinders than in a lesser power engine. The diameter of the chimney is dependent on the quantity of the products of combustion which have to be carried away. It must be remembered that if for any cause the boilers and engines should shut down, that when the fires have to be started again there will be no exhaust, and, therefore, the loss of draught cannot be remedied in any degree until the engines are started. The draught caused by a chimney is found by calculating the weight of the column of gases in the chimney at any moment and subtracting it from the weight of an equal column of air outside the chimney. As the draught of a chimney is usually spoken of in inches of water, the difference of weight found above has to be multiplied by 27·6 to bring it to inches of water, since 1lb. per square inch is equivalent to 27·6in. of water. An approximate rule for finding the draught is to multiply the height of the chimney in feet by ·0075, which gives the draught in inches of water. For the 80ft. chimney this is 80 × ·0075 = ·6in., and for the 60ft. chimney = 60 × ·0075 = ·45in., or the loss of draught is ·15in. of water. Given a good pressure of steam this loss ought to be easily remedied by the exhaust.

The exhaust pipe should be taken in the chimney as soon as possible, in order to minimise the loss of heat by radiation, which will, of course, reduce the pressure of the steam. The exhaust pipe should be placed centrally in the chimney, and should be so situated that the steam, as it spreads out, just misses the top of the entrance of the flue to the chimney, or the steam will attempt to pass down the flue.—Ernest P. Hollis.

[Other replies to Question No. 755 will be given in our next issue.—Ed. *E. E.*]

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Supplement to "The Electrical Engineer,"
FEBRUARY 10, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

### QUESTIONS.

763. What are the advantages of the Alberger or barometric type of condenser over other types commonly in use?—U. C.

764. Give a few simple yet reliable methods of testing cylinder and other lubricating oils, so that a poor consignment may at once be "spotted."—J. A. M.

### ANSWERS.

*Question No.* 755.—An 80ft. brick chimney stack is obliged to be reduced in height by 20ft. To what extent could the loss in draught be remedied by taking the exhaust pipe up the inside of the chimney? At what height should the exhaust pipe enter, and at what distance from the top should it terminate to give the best results?

*Answer to No.* 755 (*awarded* 7*s.* 6*d.*).—I expect the chimney referred to has been found rather unsteady on its foundations, perhaps rocking slightly in a storm, and it has been decided to take 20ft. off the top of the chimney, to do away with the risk of the whole thing collapsing. Naturally the draught of the chimney will be affected. A case very similar to that mentioned by "A." came under my notice some time ago. A chimney 100ft. high and 39in. in internal diameter had an evaporative capacity of 6,600lb. of water per hour. On reducing the height to 80ft., the evaporative capacity was reduced to 5,900lb. per hour. It was decided to take the exhaust pipe into the chimney, and so help the draught. Two or three years after this was done, the owner of the works decided to go in for electric driving, and I was engaged on the work. Amongst other things, it was decided to inspect the bottom of the chimney, to see whether the steam exhausting into the chimney had had any injurious effect. The chimney had been put into first-class condition when it had been shortened, but on examination it was then found that the mortar had disappeared from between the bricks at least one brick deep, thus seriously weakening the foundations. The spaces in between the bricks were filled up with cement, as this was the cheapest and easiest way out of the difficulty. This case shows that it is risky exhausting steam into a brick chimney, and if it can possibly be avoided I should advise "A." to do so. The foundations of the chimney are apparently already unsatisfactory, and the method proposed of increasing the draught would only make them more so. If, however, "A." is determined to risk it, take the exhaust pipe into the chimney about 10ft. from the base, with a short bend turning up into the chimney, but the flange of the bend inside the chimney off, so as to interfere as little as possible with the draught, and also to make it easier to insert the bend. As to what extent the exhausting of the steam into the chimney will affect the draught, that depends on the pressure of the steam in the exhaust pipe, and on wheter the engine is a high or low speed one. Fitting a condenser to the engine would secure better and more economical results than the method suggested.—W. A. T.

*Answer to No.* 755 (*awarded* 5*s.*).—"A." hardly gives enough particulars of his plant to enable a very definite answer to be given, but it will be assumed to be a plant working under average conditions. Turning the exhaust into the stack should certainly not only compensate for the loss incurred by shortening the stack, but should produce a far greater draught than under the original conditions the stack produced. The draught due to an 80ft. stack is ·592in. of water, and that due to a 60ft. stack ·444in. of water, giving a loss of ·148in. of water due to shortening the stack. The idea of turning the exhaust into the stack is that the velocity of the exhaust steam is greater than that of the hot gases within the chimney, and that the steam will impart its velocity to the hot gases, increasing their velocity, and also giving a better draught.

The following formula for finding the velocity of the hot gases in a chimney is based on several experiments which were made on a stack serving Lancashire boilers having well designed and constructed flues:

$$V = \frac{8\sqrt{H}\,(T-t)}{3{\cdot}3\,T},$$

where V = mean velocity of gases in the chimney in feet per second;
T = temperature in degrees F. of the hot gases within the chimney;
$t$ = temperature in degrees F. of the air outside the chimney;
H = height of chimney in feet above the fire-grate.

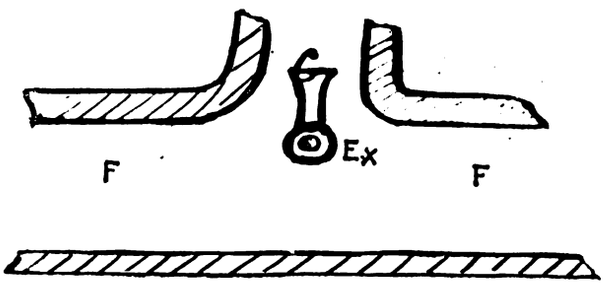
Assuming the following conditions—viz., temperature of gases within the chimney 600deg. F., and temperature of air outside chimney 62deg. F.—on applying the above formula we have:

$$V = \frac{8\sqrt{60}\,(600-62)}{3{\cdot}3\,(600)} = 16{\cdot}8\text{ft. per second.}$$

The velocity of the gases within the chimney being determined as 16·8ft. per second, it is now necessary to assume a value for the velocity of the exhaust gases when turned into the stack. Exhaust pipes are so designed as to permit an easy and free flow for the exhaust steam, the flow being kept, if possible, below 70ft. per second; in many cases 50ft. per second is obtained. To be on the safe side, let us take this lower figure, and then deduct 15ft. per second to allow for the lowering of the velocity of the exhaust steam when admitted to the stack. This gives us 35ft. per second as the velocity of the exhaust steam, and, consequently, the hot gases within the chimney. Again using the above formula, we have

$$35 = \frac{8\sqrt{H}\,(600-62)}{3\,3\,(600)} = 259\text{ft. high.}$$

The effect, then, of turning the exhaust into the stack is to give the draught equal to a chimney stack 259ft. high, and a chimney this height will give a draught equal to 1·91in. of water, so that not only have we been able to make up the loss caused by the shortening of the stack, but have also gained a draught equal to 1·32in. of water.




As to the position of entry of the exhaust pipe into the stack and the distance from the top it should terminate to give the best results, the best method is to bring the exhaust pipe into the bottom of the chimney, and let it run upwards to such a height that the exhaust steam is discharged into the stack about 3in. or 4in. above the level of the tops of the flues, the object being to get the means of producing the draught as near to the flues as possible. There is then less drop in the intensity of draught in the furnaces due to the fact that there is considerably less chance of air being drawn into the flues and chimney at undesirable places. Were the exhaust steam discharged well up the chimney, it can easily be seen that from the above cause alone its effect at the furnaces would be considerably reduced.

The accompanying sketch shows the idea described above. F F are the flues discharging into chimney C, and E X is the exhaust pipe.—W. T. W.

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*Question No.* 756.—A 160-h.p., 400-volt, shunt-wound motor, eight-pole type, is started up for the first time on no load, by means of a tramway-type controller having six contacts for the armature resistance. The motor runs well on the first and second contact, but when the controller is moved on to the third contact one of the top set of brushes commences to spark intermittently, and then suddenly there is a vivid electrical discharge between two neighbouring brushes, which are about 9in. apart, and the circuit breakers are thrown out. Various positions of the brushes are tried in close proximity to the sparkless position, but with the same result. Explain the cause and remedy of the above occurrence.

*Answer to No.* 756 (*awarded* 7*s.* 6*d.*).—The cause of the peculiar action mentioned by "J. S. P." may be found either in the motor or else in the controller. If the latter is at fault, there are two possible explanations—namely, either faulty design of resistance on the third step of the controller or else accidental short-circuit of the resistance by faulty workmanship or similar cause in the controller itself. The result of either of the above faults would be to cause a heavy rush of current immediately the controller arm reaches the fourth contact. Tests should be made of the resistance of each step to find out whether the steps are correctly designed. If the controller tests come out correctly, the fault undoubtedly is in the motor itself. In the first place, the shunt winding should be tested to see that the full field strength is on throughout; an ammeter in series with the shunt coils will immediately show a discrepancy in the direction. The armature winding is probably lap-wound, and unless the latter is equalised by means of equalising or "buck" rings, excessive currents will circulate in the armature winding. A complete explanation of the necessity of these "buck" rings was given in the *Electrical Engineer* of June 13, 1902. Of course, if a wave winding is used, these rings are not required. An open circuit or short circuit in any of the coils of the armature would account for the flashing at the commutator and the heavy current, and the writer would recommend "J. S. P." to take a drop test from bar to bar round the commutator. Any fault in the windings will be shown up under these conditions by a low reading on the milli-voltmeter between the bars to which the faulty coil is connected. If the above tests are made, "J. S. P." should have no difficulty in detecting where the present fault in his motor lies.—J.

*Answer to No.* 756 (*awarded* 7*s.* 6*d.*).—The occurrences described would seem to point to one or more of the armature coils being short-circuited. It may be assumed that the controller is properly arranged so as to fully excite the shunt before the armature is switched on. Whilst running at the low speeds corresponding to the first and second contacts, no appreciable effect might be produced by the short-circuited coil or coils, but as soon as the higher speed of the third contact is reached, the heavy current set up in the short-circuited coil might seriously affect the commutation of the neighbouring sections owing to mutual induction, and would cause intermittent sparking to take

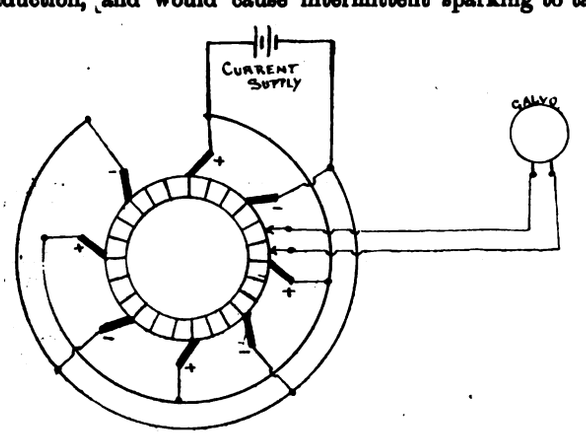


FIG. 1

place once every revolution at each set of brushes in turn (according to the question, such intermittent sparking was only noticed at the top brushes, but it probably also existed, though less obviously, at the other brushes). As the motor speeded up and reached the top speed corresponding to the third contact, the sparking would become sufficiently violent to allow a continuous arc to be drawn out from one brush to the next as the commutator rotated, and so cause a short-circuit of the supply mains and the opening of the circuit breakers. If this is the cause of the trouble, it should be possible by an inspection of the commutator face after the run to decide, by means of the blackening of certain of the commutator plates, as to which section is the short-circuited one. If this is not decisive enough, a simple drop of potential test should be made as follows: Whilst keeping the armature stationary pass a small steady current, say not less than about one quarter the normal full-load current of the machine, through the armature from brush to brush, and by means of any ordinary galvanometer (shunted, if necessary) or milli-voltmeter compare the drop in volts over the different sections of the armature by connecting the galvanometer terminals to neighbouring commutator plates in turn all round the commutator (Fig. 1). When the short-circuited section is reached it will betray itself by a very much reduced throw on the galvanometer, owing to the resistance of that section being reduced by the short-circuit. This coil must then be unsweatted and the necessary repairs carried out.—Q.

*Answer to No.* 756 (*awarded* 5*s.*).—This is by no means an unusual occurrence with new motors, and as a rule it is very easily remedied. In the first place, it would be advisable to thoroughly examine the set of brushes in question, and make sure that they are in good contact with the commutator. Try the tension on each brush and see how it compares with the tension on brushes in another set, and, above all, make quite sure that the spindle carrying the faulty set is perfectly rigid; for it may be that either there is insufficient tension or the spindle is loose, so that when the motor reaches a certain speed the brushes are intermittently thrown off the commutator, and so set up violent sparking, resulting in flashing over. This is a very frequent fault with new motors, and is not unknown with machines that have had considerable running, especially if the brushes do not receive their due amount of attention. The question that now arises is, how is it that the motor runs well on the first and second contact? This may be accounted for in several ways. The current taken by a motor on starting, of course, depends on the applied E.M.F., and this is controlled by the starter. $C = \frac{E - e}{R}$, where C is the current, E the applied E.M.F., and $e$ the back E.M.F. of the motor, and R the resistance in circuit plus the resistance of the armature, from which it is clear that any sudden decrease of R will cause a corresponding increase of C. It therefore might happen that this third contact allows much more current to flow than when on the first and second, so that any fault in brush setting will have a better opportunity of showing itself. This could, of course, be verified by connecting an ammeter in circuit and noting the current taken while changing to different contacts. Another reason for the satisfactory running on the first two contacts may be that the machine is running at lower speed, and loose brushes would be less liable to be thrown off the commutator by vibration. It often happens that machines vibrate much more at certain speeds, and this third contact might give the speed at which vibration is at its maximum. Thirdly, assuming the current to be greater while on this contact, armature reaction will also be greater, and so faulty brushes again have a better opportunity of sparking. Before going further, it will be well to thoroughly investigate these two first causes—namely, faulty brush contact and vibration—for since the sparking starts intermittently, it appears to me that these causes are jointly responsible. We will now give our attention to the field magnets. In new machines it is not altogether uncommon to find that one of the bobbins is partly or entirely short-circuited, which will cause bad sparking at one or more sets of brushes. The best method of testing this is to pass a current round the field magnets and measure the drop in volts across each bobbin. If it is found that the drop across one bobbin is much less than the others, it may be concluded that part of the turns are cut out of circuit, which will weaken the strength of this particular pole, and so set up sparking. This may also often be detected by holding a piece of steel so as to test the field strength, but the former method is most satisfactory. If it is found that any one of the bobbins are

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devoid of drop, it, of course, follows that it is entirely short-circuited. Bobbins connected so as to give two similar poles next to each other will also cause violent sparking, but will not be confined to one set of brushes. This can easily be detected by holding a compass needle in front of each pole; if it is found that the needle points in the same direction for any two poles side by side, one of the two bobbins must have their ends reversed so as to give opposite polarity. The poles of any motor should be alternately north and south, but, as already stated, if this is not so, it will cause sparking at more than one set of brushes. It is not necessary to give a remedy for each of the above faults, for once located the remedy is obvious.—E. AUSTIN.

*Answer to No.* 756 (*awarded* 5*s.*).—No doubt the phenomenon "J. S. P." records would seem rather remarkable, but I think that I shall be able to explain it, and I give the remedy which I should advise applying. Presumably this motor has never been started up before, as otherwise this faulty connection should have been discovered then and remedied. I think that, perhaps, it will be as well to just briefly describe what happens in running up a shunt-wound motor to speed, so as to make my explanation of this remarkable occurrence clearer. At starting there should be the total strength of current

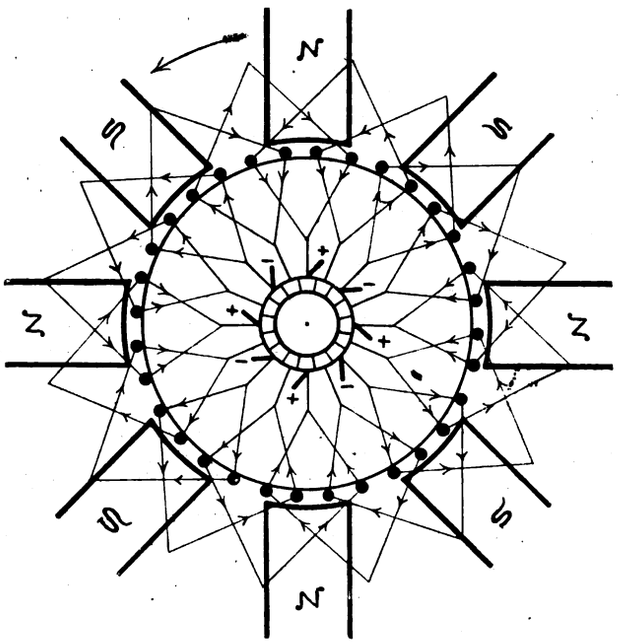

FIG. 1.

through the field coils so as to have the poles fully excited; then, also, the armature currents should pass through a resistance as the motor is at present standing, and this resistance is necessary so as to cut down the magnitude of these currents, as without any external resistance we should simply have in circuit the resistance of the armature, which will be equal to one-eighth of the resistance of the number of armature turns between one positive and an adjacent negative brush, and with only this small resistance in circuit we should, on switching on, have practically a short-circuit across the mains. Having now got the controller on the first contact, the armature will start to revolve with a torque which is proportional to the product of the magnetic flux and the current through the armature. The speed will rapidly accelerate, and the armature current will drop in value. This is because, as soon as the motor starts to revolve, it will generate a back E.M.F., owing to the armature conductors cutting the flux due to the field. This back E.M.F. opposes the impressed E.M.F., and so cuts down the value of the armature current; so that now we have $C_a = \frac{E - e}{R_a}$, where $C_a$ = armature current; E = impressed E.M.F. at terminals of motor; $e$ = back E.M.F. due to armature conductors cutting the field; $R_a$ = resistance of the armature.

When the current has dropped to about the normal value, the controller is switched over to the next notch, which cuts out some of the resistance in the armature circuit, and permits more current to pass through the armature. This increases its torque, which increases the speed, hence increasing the back E.M.F., which causes the current to once more decrease. This cycle of operations is continued till all the armature resistance is cut out and the motor is up to speed. I think the faulty construction or connection in the motor under consideration lies in the fact that one of the field coils is wrongly connected, resulting in either five north and three south poles, or *vice versâ*, instead of it possessing four north and four south poles.

Fig. 1. shows diagrammatically the end view of an eight-pole motor, with the various end connections of the armature conductors, the commutator segments, brushes, etc. The arrow heads indicate the directions of the induced voltages in the windings caused by the armature conductors revolving and cutting the magnetic lines due to the field flux—*i e*, these arrow heads indicate the direction of the back E.M.F. induced in each conductor. It will, of course, be noticed that the direction of the applied E.M.F. is opposite to the induced back E.M.F., which is, of course, as it should be, as the applied E.M.F. will drive current through the armature from the brushes marked + to those marked −, whereas the induced E.M.F. tends to drive current in the opposite direction. In the figure I have assumed that we are looking at the machine from the commutator end, and hence can see the various connections from the segments to the armature conductors. The connections at the back end of the armature I have shown projecting outwards, as otherwise they would not be very clear. All the connections and polarities of the poles are shown on this diagram exactly as they should be, and the arrows indicate the corresponding direction of rotation.

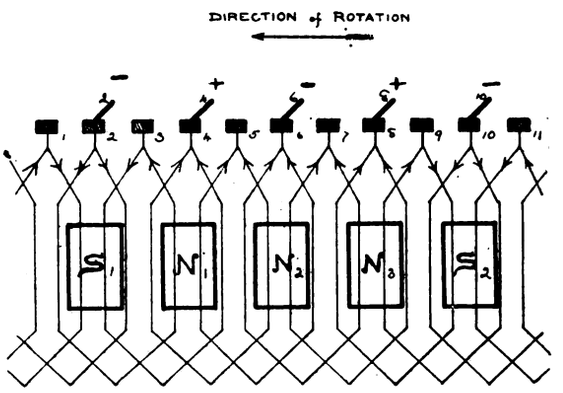


FIG. 2.

Now, in order to demonstrate my point, that if one of the field-magnet bobbins be connected up wrongly, it would give cause to the phenomenon "J. S. P." describes, I will now give another diagram (Fig. 2) showing this winding, etc, developed and laid out flat—*i e.*, as if we were in the centre of Fig. 1, and had a panoramic view of all the connections, poles, etc.—and will this time show it with one of the field coils connected wrongly, so as to make one pole a north instead of a south. The small arrows once again indicate the direction of the induced back E.M.F. in the armature, and the polarity of the brushes connected to the external supply is also shown. The small shaded rectangles at the top represent the commutator segments with the brushes on some of them. The thin lines connecting on to these segments are, of course, the armature conductors and end connections, the bottom of the diagram representing the back end of the armature. It will be noticed that the E.M.F.'s induced in the armature conductors between commutator segments 2 and 4, and also 8 and 10, all oppose the direction of the applied E.M.F.; this is quite as it should be. Now, if the directions of the induced E.M.F.'s in the armature wires between commutator segments 4 and 6 and also 6 and 8 be observed, it will be seen that some of them tend to oppose the applied E.M.F. and some of them tend to assist it. The net resultant of these induced E.M.F.'s will be zero. Hence there will be no back E.M.F. tending to oppose the E.M.F. applied between the brushes,

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and as the resistance of the armature conductors will be very small, there will be a very big current through these coils from the two + to the − brush between them. The only factor reducing this amount is the resistance in the controller. At first this external resistance, together with the resistance of these armature conductors, is quite sufficient on the first two controller contacts, but on the third, so much external resistance having been now cut out and there being no back E.M.F. to make up for this, there will be a very large current flowing through these brushes, which I will show causes the trouble.

To produce sparkless commutation on a motor, owing to the armature reaction, it is necessary to rock the brushes back a bit so as to have the conductors of the coil which is being commuted in a weak field of the polarity of the pole they are leaving. I have endeavoured to show this in my diagrams. This shifting of the brushes backward tends to demagnetise the poles by an amount which is directly proportional to the current through the coils, and also to the angle through which the brushes have been shifted backward. Consider this action with reference to Fig. 2. Firstly, owing to there being no back E.M.F. between segments 4 and 6 we shall get a large current flowing through the armature from brush 4 to brush 6. This will be greatly above the normal value, and hence its demagnetising effects will be greater than normal. This will weaken pole $N_1$, but $N_2$, which would have been weakened if it were a south pole, being wrongly connected, and hence a north pole, will be strengthened. Similarly, owing to the excessive current from brush 8 to brush 6, pole $N_3$ will be weakened and pole $N_2$ will be strengthened again. The result of this is that $N_1$ and $N_3$, which are of their correct polarity, will be weakened, and $N_2$, which is wrong, will be strengthened. Of course, if the poles are fairly saturated, this will not be so very much in the case of $N_2$. Now, the induced E.M.F.'s in the conductors under $N_2$ must under these conditions be greater than those induced under $N_1$ and $N_3$, and hence the net resultant E M F. induced in these parts of the winding will be in such a direction as to assist the applied E.M.F. instead of opposing it. Now, the current through these armature coils will be given by the formula

$$C_a = \frac{E + e}{R_a},$$

which will be very much above the normal, and this, together with the currents through the other brushes, would be sufficient to open the circuit breakers when the machine flashed over. It will, of course, be observed that this action of demagnetisation of $N_1$ and $N_3$, and the magnetisation of $N_2$, with the consequent result of increasing the induced E.M F. and the armature current, is an action which will keep on increasing. Incidentally, also, it might be mentioned that weakening $N_1$ and $N_3$ will slightly decrease the back E M.F. of the coils under them, and so the currents from brush 4 to brush 2, and also from brush 8 to brush 10, will be slightly greater, but not nearly so much as the other.

Now brush 4 and brush 8 have to carry considerably above the normal full load current, but brush 6 will have to carry more still, as it must carry the extra current passing through each, and hence this will be the brush which started to spark. This, as I said, will get worse and worse, owing to the armature current rising. In a motor of this size there will probably be a difference of potential of eight or ten volts between two adjacent commutator segments. The sparking at the brushes having got so bad, it will form an arc across the segments as they leave the brushes, and this arc will be kept up by the eight or ten volts after it has left the brushes. If this happens with every segment as it passes brush 6 we shall bridge across the commutator sections between brush 6 and brush 4 with a series of arcs, which is the effect mentioned in the question, and which, together with the large current passing through the armature, will bring out the circuit breakers.

I think all the above description should indicate clearly wherein lies the trouble; the remedy is fairly obvious. On consulting Fig. 2 it will be seen that the pole which is wrongly connected up is opposite the brush from which the arc starts, which should be an indication of which is the wrongly connected coil. If "J. S P." excites the field and then goes round trying the polarity of each pole with a small exploring compass, he should easily find out where the wrongly connected one is. If this be then reconnected in the proper manner, the machine should run satisfactorily.

Another possible cause of the trouble if it is not these field connections, might be that the machine and controller are so connected that the shunt current passes through the external starting resistance as well as the armature current. There will be a big drop in volts across this resistance, which will lessen the volts across the field coils and so weaken them. This will lessen the back E.M.F., and hence the armature current will increase, resulting in a bigger drop in the resistance, and so weaken field, etc. This big armature current will exert a considerable demagnetising effect on the field, which will still further weaken the poles and increase the armature current once more. This large current will cause the machine to spark at the brushes, and if one set are not exactly in their correct position—*i.e.*, unequally spaced with respect to the adjacent sets—that might be the set that was worst, and might cause the machine to arc from that set to the next as before. The obvious remedy for this would be to connect up the shunt in the correct manner, so that its current did not pass through the starting resistance. This fault would be shown by the motor racing.

Another cause for the trouble might be that if all the eight field coils were excited in parallel—which, however, I think is very unlikely—there might be a break in one of them. This would cause only half the proper amount of back E.M.F. to be induced in coils under it, and it would be something similar to a short-circuit through the armature and the machine might then arc across the brushes.

Whatever the cause may be, the reason the trouble does not occur till on the third contact of the controller is that until then the external resistance has been sufficient to cut down the current, but that on this contact the external resistance has been lessened to such an extent that the arc may occur.—E. R. ALEXANDER.

[N.B.—We have received another long answer on the same lines as the above from Mr. Alexander, but we think that the effects of a reversed pole would be so great as to prevent the motor from working satisfactorily on the first two contacts of the controller.—ED. *E. E.*]

*Question No.* 757.—A steam-driven set, shunt-wound and separately excited, is supplying about 400 arcs, eight in series. They are switched a few circuits at a time in the street. In the event of a breakdown, what is the best way to get on another similar set without sending out men to switch off all circuits?

*Answer to No.* 757 (*awarded* 7*s.* 6*d.*).—It is the practice in a large central station in which the writer had experience to switch on all the arc circuits, on a somewhat similar though larger installation to the one under discussion, and to run up the dynamo to speed and then switch on the field. In this case, however, there was no shunt field; the machines were separately excited from a 100-volt system. The arc circuits were all controlled from the station, and, as above stated, were switched in before starting up the dynamo. The dynamo was then run up to speed and the field switched on, the voltage then being regulated by the field rheostat. The system works satisfactorily, and no difficulty is experienced in the striking of the arcs or any consequent pumping in the circuits. It would seem that a solution of the question propounded might be found on the above lines, and that if a switch were inserted in the shunt field the above conditions could be reproduced. Suppose it impossible to parallel a new machine with the defective one, or that outside influences compelled a complete shut down, then start up the dynamo with main switches in and shunt field broken. When up to speed, close first the separately excited field and then quickly the shunt field switches, and it would seem that there is little fear that the arcs strike badly or that undue pumping results.—S. E. T.

[Other replies to Question No. 757 will be given in our next issue.—ED. *E. E.*]

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Supplement to "The Electrical Engineer,"
FEBRUARY 17, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

### QUESTIONS.

765. Explain some simple and effective system of recording on which side of a three-wire supply any new consumer must be connected, giving details as to how any probable out of balance may be quickly looked up for any particular district.—MAINS.

766. A central-station engineer of good experience and ability in running steam-driven stations is appointed to take charge of a plant driven by three-crank vertical high-speed gas-engines, direct coupled, and fed from gas producers. What are the chief points he should watch in order to run with the lowest possible amount of coal per unit generated, together with freedom from breakdowns and a light maintenance bill?—SILICA.

### ANSWERS.

*Question No.* 757.—A steam-driven set, shunt-wound and separately excited, is supplying about 400 arcs, eight in series. They are switched a few circuits at a time in the street. In the event of a breakdown, what is the best way to get on another similar set without sending out men to switch off all circuits?

*Answer to No.* 757 (*awarded* 7*s.* 6*d.*).—It is well known that an arc lamp, at the moment of switching on, takes an excessive current compared to its normal working current, and it is this objectionable feature which must be overcome in the circumstance postulated. It evidently would not do to run the machine up to normal voltage (say 400), and then throw it on the circuit. Any method to be successful must be of the following nature: A sufficient voltage must be put on the circuit to pass the normal working current. The arcs will then commence to "strike," and the current will drop. The voltage may then gradually be raised until the full E.M.F. is on the circuit. Two ways of doing this commend themselves:

1. As the machines are separately excited, the exciting current of the incoming machine must be reduced as low as practicable. The machine should next be switched on to the circuit *and then* started cautiously. As the machine is run up the ammeter will show the condition of the current. If the exciting current and the speed are then *slowly* increased, it will be found that the current will not exceed its normal working value, and that finally the voltage will be normal. The great point is to avoid putting excess pressure (and therefore excess current) upon the circuits until the carbons in the arcs have separated.

2. Another method that might be adopted in cases where the exciting current arrangements did not permit of much regulation, and where slow engine speeds could not be easily obtained, is as follows: Instead of switching the machine directly on to the circuit, it could be switched on through a resistance, and this resistance could be gradually cut out, the final voltage being equal to the normal voltage when eventually all the resistance was cut out. The ammeter in the main circuit would indicate the current, and serve to indicate to the attendant how fast he might cut the resistance out. The best resistance that could be used would probably be a water resistance, which could be quickly made in a wooden tub. Two lead plates of about one square foot area would easily suffice for the normal current (say about 500 amperes). A little acid would be needed in the water.

The machine should be run up to full speed, and one plate being in the liquid, the other should be gradually lowered in, the ammeter being watched closely. The plates should then be brought gradually closer. Finally, when the circuit voltmeter and ammeter showed promising readings the water resistance could be totally cut out by a short-circuiting switch. The water resistance would be best, since it is so easily adjustable and can take such large currents, but it would be an awful nuisance to have to rig up in series with the machine in case of a breakdown, and would only be resorted to in cases where the first method could not be employed. The object of any method that could be successfully employed would be based on considerations of avoiding the current in the main circuit exceeding its normal working value.—T. T.

*Answer to No.* 757 (*awarded* 7*s.* 6*d.*).—The arc lamps being eight in series will, of course, be of such a type that if through any cause one of them should fail to strike an arc, a resistance is inserted in circuit with the remaining seven, such that the drop of potential across the resistance will be equal to the drop of potential across the arc lamp, due to the resistance and back E.M.F. of the arc, if it were struck. If this were not so, it is obvious that the failure of one arc to strike would shut down the remaining seven in series, which would be a serious matter. Now, it is obvious that if the fresh set be run up to speed, and its voltage adjusted to 400 and the main switches put in, all the arcs will attempt to strike at once, the tremendous load being suddenly thrown on the engine will pull it up. Thus it will be seen that we must slowly increase the current in the circuit until all the arcs have struck. This would be a difficult matter if it were not for the resistances being in circuit as described above, as they will be with all the arcs out. This can be best done by using the method here described. First run the engine up to full speed, having the main and field switches out. Then put the regulating rheostat for the field in such a position that all the resistance is in the field circuit, and close the field switch and the main switches. Thus it will be seen that we have the whole system in series with the armature, but as yet there is little or no current flowing, owing to the field of the machine not yet being built up. If we now note the reading on the machine voltmeter, it will probably be zero. Now we must increase the current in the field winding of the generator by cutting out resistance in the field regulating rheostat. This will cause the field to build up, the voltage of the generator will slowly increase, as will the current flowing through the arc-lamp system. It is obvious that we are now applying the load slowly to the engine. Now, it will be seen that owing to the great current passing along the mains there will be a great drop in potential, and therefore there will be a greater difference of potential across the terminals of a set of eight arc lamps nearer the power-house than there will be at the far end of the feeder, so that as we gradually increase the current flowing in the mains, the arcs near the power-house will be the first to strike. It will therefore be seen that as we increase the current flowing through the field winding of the generator, we shall increase the voltage of the machine to such a point that a large enough current will flow through the arc lamps near the power-house, and they will strike, and, finally, the arcs at the far end of the feeder will strike. The voltage of the machine will be finally adjusted to 400 volts. I think this method is the best, because it needs no further resistances to be used other than the ordinary complement of the unit.

The same result could be obtained by inserting a resistance in circuit with the armature of the generator, and then, with the engine running at full speed and the voltage of the generator adjusted to 400 volts, cutting out this resistance slowly, at the same time regulating the field rheostat so as to keep the volts constant. This method, of course, labours under the disadvantage of having the extra resistance for the armature circuit. I have several times had occasion to use the method described, first on an ordinary incandescent lighting circuit, and I find that the time taken to get the fresh set on load is very small indeed.—ERNEST P. HOLLIS.

*Answer to No.* 757 (*awarded* 5*s.*).—From the way in which the question is stated, it appears that the street-lighting is supplied through two special feeders, from which distributors to each street are taken. The best method of getting in a fresh machine after a breakdown has happened is to get the machine turning at about quarter speed and then switch in, controlling the voltage by bringing up the speed and by adjusting the shunt rheostat and bringing up

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the volts gradually. If this precaution is not taken and the machine run up to speed, fully excited and then switched in, the result will be excessive sparking, and, perhaps, a flash over, a sudden drop in voltage, hunting, and also pumping at the arcs for some time, the reason being that the lamps being out at the time of switching in their carbons are together, and thus present a very easy path for the current; the resistance of this path being much lower than that through the arc, a very excessive current will flow, and will lead to the above results. If, however, the machine is run up and switched in as advised, the time taken from switching in to attaining a normal condition of things will not exceed two minutes, and although the arcs will pump until proper voltage is reached, the moment this is reached they will burn properly.—W. T. W.

*Question No.* 758.—Give arguments *pro* and *con.* relating to fuses being fixed on neutral on consumer's main and branch circuits from the station, and fire and personal risk points of view.

*Answer to No.* 758 (*awarded 7s. 6d.*).—It is evident that if the neutral wire of an installation was made continuous and connected to the earthed main of a three-wire system, there would be no danger of shocks being experienced from contact with the neutral wire or anything touching it. This danger, however, may exist in any badly-erected installation, whether for light or power, and whether neutral is continuous or not, and is due to the wiring being run in metal tubing which is not properly earthed, or to similar causes. This tubing or other object in contact with the wires is quite as likely to become alive from a fault on the supply mains as from a fault on a broken neutral, and the remedy for this danger is not a continuous neutral, but a continuous tubing connected to earth. As far as systems wired with insulated conductors throughout are concerned, the question of fuses or no fuses on the neutral seems to be of little importance. In an earthed concentric system the case is different. If a break is made in the neutral of an installation of this class, the current merely finds its way across the gap through an earth path, and, therefore, fuses are not only useless but dangerous from a fire point of view. Danger from shock in installations of the ordinary type is best prevented by efficiently earthing all parts of the installation which ought not to carry current, such as motor-starter frames, iron-clad switches, etc. Where this precaution is impossible, extra care should be taken in the selection and erection of fittings. Another source of danger is accidental contact with live metal parts, due to failure of the light when the neutral fuse blows. This is really a more serious danger, but may be partially counteracted in the manner suggested lower down, and wholly avoided by the system of covering all live parts with an earthed metal cover. The next point to be considered is the risk of fire from escaping currents, the fire being generally caused by the fusion of a gas-pipe, and the ignition of the escaping gas by a spark or by some exterior means.

The figure represents a house installation on the "distribution board" system, but the reasoning is applicable to any system where the circuits are in parallel. Suppose a fault to earth occurs on circuit 3 in the place shown, part of the return current from circuits 1, 2, and 3 will flow through the fault, and the remainder down the neutral wire, the currents in the two branches being inversely proportional to the resistances of the branches. If the fault is of sufficiently low resistance a considerable current may be shunted, and unless circuit 3 was fused on the neutral side, damage to the wires, and possibly fire, would result. The blowing of the fuse, and in certain cases the dimming of the lights, serves to indicate the faulty circuit; without this happening the only indication of anything unusual would be a deflection of the middle-wire ammeter at the station. The neutral fuse, therefore, should only open the circuit when there is a fault on the neutral wire; the supply fuse ought to deal with all other cases, as when a fuse on the latter side blows the circuit is dead, whereas if the neutral fuse blows the lights go out or become dim, leaving the circuit alive. This may cause accidents, as explained above. To meet this difficulty, the neutral fuses should be heavier than the supply fuses. So much, then, for branch circuits.

The question of fusing the neutral main is very similar. The supply authorities usually instal one set of fuses to protect their meters and wiring, and in series with these are the consumer's fuses, which protect the cables between main fuses and 'bus bars of distribution board. The latter fuses are lighter than the former, so that inconvenience may not be caused by the sealed fuses of the supply authorities blowing, unless there is a fault in their apparatus or wiring. Both neutral fuses should be heavier than supply fuses, for the reason that in the event of a fault occurring on the neutral cable between 'bus bar and street main, the current passing through the fault will be augmented by some of the return current from other installations on the system, just as the current through the fault in Fig. 1 consisted partly of return current from circuits 1 and 2.

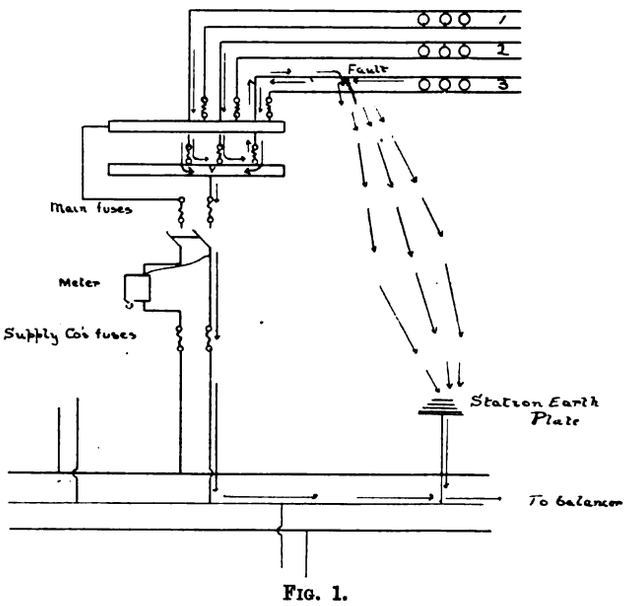


FIG. 1.

The question of expense is too small to be considered. To put the matter briefly: safety from shock is not greatly dependent on a continuous neutral, whereas safety from fire is greatly increased by the use of fuses on the neutral. The utility of a fuse as a fault indicator is also a fact which must not be overlooked. There is but one safe way of abolishing neutral fuses, and this to have a continuously earthed neutral over the whole network. This, however, is a wider subject altogether.—D. HUTCHISON.

*Answer to No.* 758 (*awarded 7s. 6d.*).—It is well known that a double-pole fuse is better protection in all cases than a single-pole, and as most installations connected to the supply mains are practically wired on two-wire system, it is certainly better to have fuses inserted in the leads connected to the neutral conductor of the three-wire system, both from the station and consumers' points of view. If we

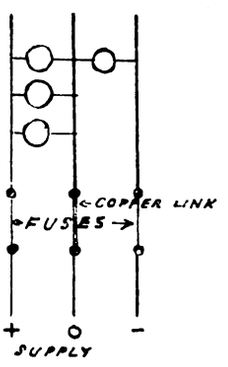


FIG. 1.

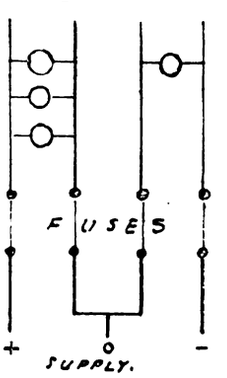


FIG. 2.

consider the following cases, which recently came before the writer's notice, we shall see that the *pros* predominate. For purposes of balancing, the wiring of large buildings is generally arranged so that approximately equal demands are made, at the same time on each side of the three-wire system, to prevent heavy currents flowing in the neutral conductor of the street mains; and in very large installations the three-wire system is maintained within the building (as in Fig. 1), instead of two separate two-wire systems

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(as shown in Fig. 2). In this case it is essential that the connection to the neutral conductor should be a solid one, as otherwise the blowing of this fuse, say, from overheating due to bad contact, or damage during insertion, would, if the load unbalanced, give excessive pressure on lightly loaded side and low pressure on heavily loaded one, with consequent damage to lamps and apparatus. If the wiring is arranged as in Fig. 2, it will be noticed that the blowing of a fuse, connecting either side to the neutral, will not in any way affect the other side, nor cause dangerous rise of pressure, and will give protection against risks mentioned later. Now, if we consider Fig. 3, and assume that consumer A is connected between negative and neutral and

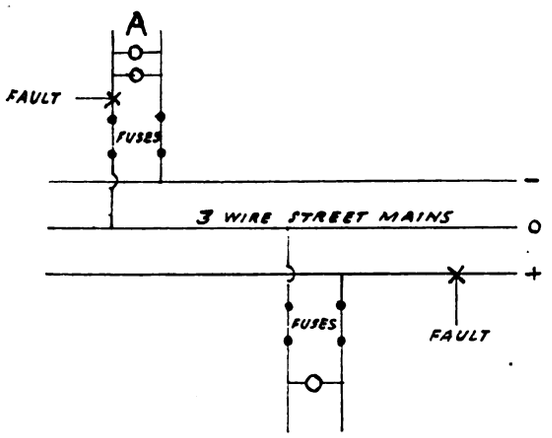
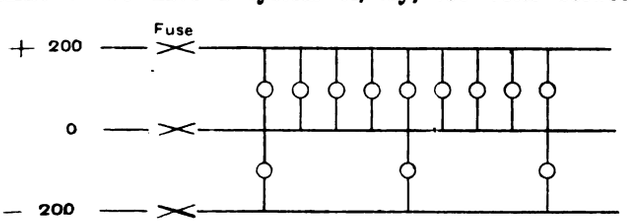



Fig 3.

has a metallic contact, say, between one of his main leads and a gas, water, or other earthed body, and that solid connection is made to neutral, it will be seen that a leakage from the positive of street mains or other installation will cause considerable arcing at this contact and probably ignite insulation, with disastrous results; but if we had a fuse inserted, this would be blown and installation isolated. It is also better from the station engineer's point of view to have fuses on neutral, as it is common practice, when slight "earth" exists on this conductor, to put pressure between it and earth and thus blow fuse connecting faulty installation to the mains.—A. T.

*Answer to No.* 758 (*awarded* 5*s*.).—I think that a fuse of any description in a neutral circuit is to be avoided. Let us consider under what conditions a neutral fuse will blow. It must be remembered that the current flowing in a neutral wire is the arithmetical difference between the currents flowing in the outers. Now, for this current in the neutral to be great, it is necessary for the currents in the outers to be greatly out of balance. Of course, if a consumer's main or a branch circuit is only on one side of the system—*i.e.*, the wires used are either positive and neutral or negative and neutral—a fuse in the neutral will perform the same duties as one in the positive (or negative), but even then the outer main is left alive, which is exceedingly undesirable. It must be remembered that if we have a system of, say, 400 volts between




the outers, as shown in the diagram, and through any reason whatever the fuse in the neutral circuit should blow, the neutral circuit only is broken and there is still a passage for the current through the lamps which form the system. Moreover, if the system is considerably out of balance, as will be very likely if the neutral fuse should blow, it will be seen that between the positive and neutral, say, there are a large number of lamps in parallel, and between the neutral and negative a small number of lamps in parallel. These two groups of lamps are therefore in series, and it will be easily seen that as the lesser number of lamps have the greatest combined resistance there will be a greater drop of potential across them than across the larger number, and it is therefore exceedingly probable that these lamps between the neutral and negative will be burnt out. I have had considerable experience with neutral fuses, and I have found that in nearly every case the fuse has blown, the lamps on one side of the system have been burnt out. It follows, of course, that the lamps on the other side of the system will have been extinguished, since the circuit is broken between them and the positive main. Now, if there had been no fuse in the neutral, and any serious trouble had occurred, the fuse in one of the outers would have blown, leaving the neutral and the outer intact, and thus only interfering with the lights on one side. As the cables are only intended to stand 200 volts, a serious breakdown may occur when a neutral fuse blows, since it is shown that it places one cable 400 volts above earth, and if the cable is in a house serious fire risks will be incurred. The element of personal risk is also great, since it is quite conceivable that a switch which will be quite safe with 200 volts will break down under the stress of 400 volts, and serious personal injury may be done to anyone who may touch it. On the other hand, a neutral fuse would be of great use if by any chance a fuse in the outer should arc over instead of blowing completely. This, however, is exceedingly improbable with a properly designed type of modern fuse. I think it is obvious that a fuse in the neutral is a weak point in any system, and that any trouble that may occur should be fully dealt with by the fuses in the outers.—Ernest P. Hollis.

*Answer to No.* 758 (*awarded* 5*s*.).—Taking the question first as to the advisability of placing fuses on the middle wire of a consumer's service mains, such an arrangement would be decidedly disadvantageous to the consumer. In the event of the fuse on middle wire blowing, the two sets of lamps would be in series across the outers, and although the current flowing might not cause the fuses on the outers to go, yet the excess current flowing through that side on which were the fewer lamps might result in dangerously heating the conductors. Such heating might easily cause

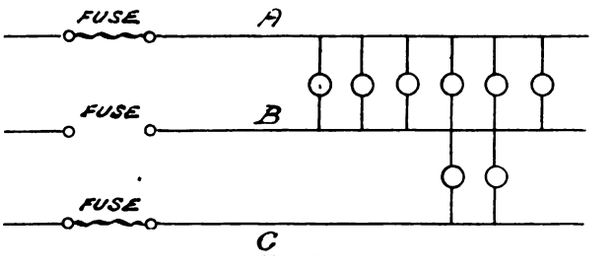



Fig 1.

a fire; besides, there is very considerable danger of spoiling the lamps through their being over-run. Fig. 1 will explain such a condition of affairs. Owing to the unequal loads, there will be a greater drop of potential between B and C than between A and B; the lamps between B and C may therefore be over-run, while those between A and B are insufficiently lighted. There may then be an abnormally large current flowing through the two lamps, such current being enough to burn out lamps or connections, while not enough to blow the fuses on the outers. Suppose, however, that the consumer has his service mains brought to a switchboard (Fig. 2), then local circuits, as D and E, may conveniently be provided with double-pole switches and fuses. The service mains should be fused on outers only, the middle wire being connected by means of a metallic link. This infusible link may be removed, if necessary, for purposes of testing, etc. Should a fault occur in either of the circuits D or E, the blowing of the fuses will only affect that particular circuit on which are the fuses. An advantage with such an arrangement of local circuits is that they may be immediately isolated from the supply mains. It is considered the best practice, when switches or fuses are fitted on the middle wire, to so arrange matters that in the case of fuses the fuse on the neutral wire is the last to go, and in the case of switches that the switch on neutral opens *after* and closes *before* those on the outers. General practice now is to earth the middle wire at the station through a resistance, and to keep the middle wire itself continuous

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throughout. At feeding points, and where junctions have to be made, instead of fuses infusible metallic links are employed, these links being readily removed if found necessary. A fuse in the neutral is rather a snare than a protection, and except under such conditions as have been specified is unnecessary.—M. M.

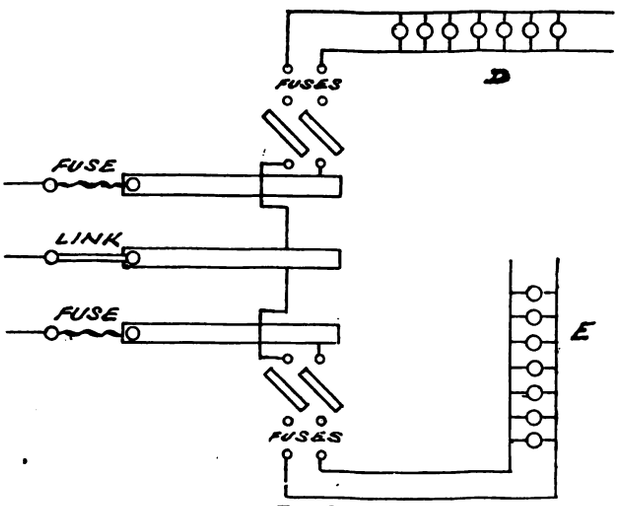


FIG. 2.

*Question No.* 759.—It is assumed that mains are to be laid for supply to a small town on the three-wire continuous-current system, part of the scheme being the entire public lighting by ½-ampere Nernst lamps. What arrangements would you make for switching on all the street lamps from the generating station? The circuits of public lamps must be arranged to approximately balance one another, and precautions must be taken to prevent sudden "kicks" by switching on too many lamps at a time.

*Answer to No.* 759 (*awarded* 7*s.* 6*d.*).—Nernst lamps are getting increasingly popular for street-lighting on account of their low current consumption, good light-giving properties, and of their not wanting much attention. Their chief disadvantage is the uncertainty as to how long they will last. Mr. R. Hammond, in a discussion on Nernst lamps before the Institution of Electrical Engineers in 1903, mentioned that he was trying a mile of street-lighting, using these lamps, and found that the average life of the lamps was 300 hours. They varied from 15 hours to over 1,000 hours. Just recently, in a case I know of, where two miles of street-lighting with Nernst lamps was tried, eight lamps out of 70 gave out the first week. In six cases out of the eight the filament had broken, and in the other two the heating coil had given out. The vibration due to heavy tramway traffic had most likely something to do with the numerous breakages of the filaments. In choosing the type of lamp to use, one should be chosen in which the burner is easily replaceable.

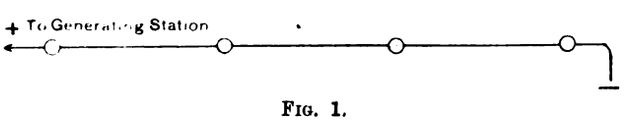


FIG. 1.

As to the method of wiring and balancing the lights there are several alternatives, each with its own advantages. In Fig. 1, 110-volt one-ampere Nernst lamps are wired four in series across the outers at 440 volts. Each set of four lamps is connected to the negative main in the street and to the positive street-lighting main going to the generating station. In this system there is a minimum of jointing and also of cable; also the feeders going to the station only carry half the current that they would do if arranged as in the following two systems. The only disadvantage is that if one lamp goes out, the other three in series do so also. Of course, with this system there is a perfect balance.

Fig. 2 shows the same size lamps, only connected up two in series, and connected to the middle wire. The advantages are that, if one lamp goes out, only one other lamp is affected, and also the attendant at the station can put all the lamps on the positive side of the system, the negative side, or half the lamps on each side. This last is a great convenience in a three-wire station, as it often happens that, however carefully the three-wire system is balanced, sometimes there will be a bigger out-of-balance than the balancers can manage. The attendant could then, by means of a street-lighting switchboard, put all the street

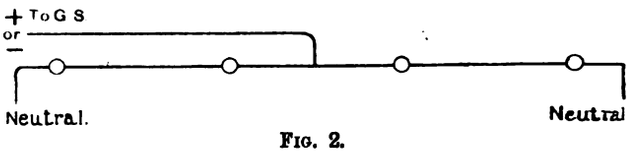


FIG. 2.

Fig. 3 shows 220-volt ½-ampere lamps connected between either of the outers and the neutral main. A broken filament in this case would only affect the lamp itself. The lights on the lightly-loaded side of the system and restore the balance.

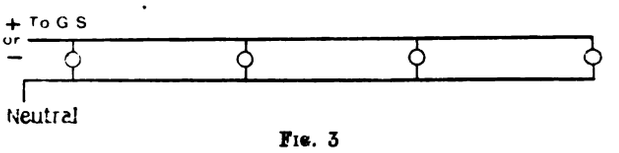


FIG. 3

greatest length of cable would be needed, and the largest number of joints. Under ordinary working conditions the current should always be kept flowing through the lamp in the same direction, otherwise the lamps seem to have a shorter life from some obscure cause.

For ordinary street-lighting have the lamps about 40 yards apart. Well-designed reflectors and globes have a good deal to do with efficient street-lighting. One so often sees the ground at the base of the pole brilliantly

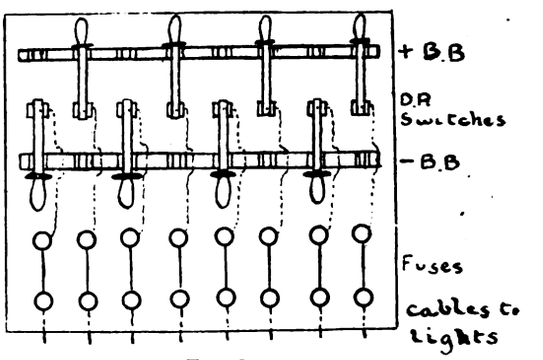


FIG. 4.

illuminated while halfway between the poles dense darkness reigns. Arrange the number of street-lighting cables coming to the switchboard in the generating station so that they average about 20 amperes each. This will avoid any trouble due to out-of-balance, and also if one of these cables break down it will not cause a great number of lights to be put out.—W. A. T.

[Other replies to Question No. 757 will be given in our next issue.—ED. *E. E.*]

## REVIEWS.

**Magnetism and Electricity for the Second-Step Examination of the Board of Education.** By R. WALLACE STEWART, D.Sc.(Lond.). Second edition. Rewritten and enlarged. London: W. B. Clive, University Tutorial Press.

The syllabus of an examination determines the scope and largely the arrangement of any book written primarily for those who desire to pass that examination. This book, however, is far better than the usual examination text-books, and, indeed, forms an exceedingly good book whereby young students can obtain a satisfactory introduction into the subject on which it treats. We have long inclined to the opinion that in teaching the subject we should prefer to reverse the arrangement adopted, and start with "current electricity," leaving "electrostatics" to wind up with. But these views may not be generally held, and even if they are militate nothing against the value of this book, which commences with electrostatics and ends with current electricity.

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Supplement to "The Electrical Engineer,"
FEBRUARY 24, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

767. An isolated three-wire network is fed from a sub-station by means of 100-kw. continuous-current transformers transforming from 2,500 to 440 volts. Two transformers are running at nearly full load, supplying the load and charging a battery at its normal rate—viz., 120 amperes a side—by means of a balancer booster fitted with shunt and series windings on the balancer fields. The motor and generator windings of the transformers are superposed, the high-tension winding being on the outside. These machines are self-exciting, shunt wound, there being also a high-tension series field for starting up, which is cut out automatically when the low-tension field is sufficiently strong. All machines and the battery are fused at about 200 per cent. overload. Under these conditions, if one of the transformer armatures breaks down from high tension to low tension, what will be the effect inside and outside the sub-station, and what approximately will be the extent of the damage?—H. JOSEPH.

### ANSWERS.

*Question No.* 759.—It is assumed that mains are to be laid for supply to a small town on the three-wire continuous-current system, part of the scheme being the entire public lighting by ½-ampere Nernst lamps. What arrangements would you make for switching on all the street lamps from the generating station? The circuits of public lamps must be arranged to approximately balance one another, and precautions must be taken to prevent sudden "kicks" by switching on too many lamps at a time.

*Answer to No.* 759 (*awarded 7s. 6d*).—From the question it is impossible to ascertain whether it is intended to run special mains, through switches and fuses in the generating station, out through the streets, or whether the current for the lamps is to be taken from the ordinary supply mains for the town consumers. This, it will be seen, divides the question into two separate cases, and it will be necessary to attain the end in view in either case by a different method.

Let us first consider the case of where separate cables are laid from the station out under the streets to various feeding points for the lamps. Being a three-wire system, these Nernst lamps will, of course, have been balanced, half having been arranged to be lit from one side and half from the other. The street-lighting mains will enter a sort of feeder pillar which will contain fuses for the lights in each street, and if the three cables—the positive, neutral, and negative—all enter this box the balancing of the load will have been arranged here. Assume that there are several such street-lighting feeders from the station running in different directions, and that they are in no way inter-connected, then, obviously, it would be possible to switch on one feeder at a time at the station, and so minimise the trouble of kicks in the voltage. As a Nernst lamp does not light up instantly, but takes nearly half a minute to warm up before it really lights, this will leave time for the switchboard attendant to adjust his voltage, after first switching on, before the glowers light up. Also, it is improbable that all the lamps switched on will light up at the same instant, but it may take five seconds, say, before they are all on after the first one. If the voltmeters be watched very attentively now, the voltage may be kept pretty steady by means of the shunt rheostat. After a minute or so it will be possible to switch on the next feeder and so on. By this means all the street-lighting may be switched on without having much of a kick on the voltmeter. Another way of doing this occurs to me, and it is this. At the time the street lamps have to go on, the main town supply lighting load will also be coming on. This will, in all probability, necessitate running up another generator, and paralleling it with the one, or ones, at present on load. If the switchboard contains more than one set of 'bus bars, and means are provided for paralleling these sets, it would be possible to run up the new generator, plugging it on to a second set of 'bus bars. Now, if the street-lighting be plugged also on to this separate set, the Nernst lamps can be lit up off this set of 'bus bars. Not so much attention now need be paid to the voltage regulation on these, as, of course, it cannot affect the network. Too high a voltage is very bad for this type of lamp, but too low a voltage will only affect the candle-power for the time being, and will not affect the length of life of the lamps. Now the two sets of 'bus bars can be paralleled, and if it be desired the new generator and the lighting feeders can be plugged on to the main bars. The result is that two operations have been performed in one—*i.e.*, the lamps have been lit up without affecting the voltage on the network, and also a new machine has been paralleled in with the others for the evening load. Exactly similar operations, only in the reverse direction, could be performed when it was time to put out the lamps, care having been taken to work over an amount of the total load equivalent to that taken by the Nernst lamps before separating the two sets of bars. This will prevent any sudden rises in the voltage on the network. It is quite possible that at this time it would not be desired to shut down a generator, in which case the lamps would be switched off a feeder at a time, and the voltage adjusted each time before switching off.

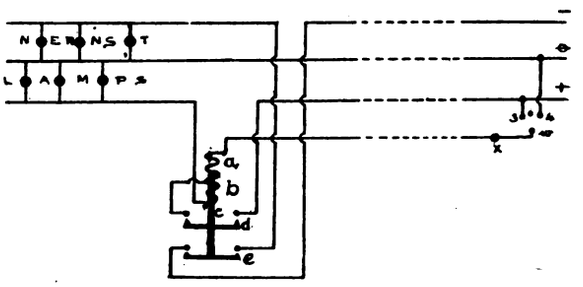


FIG. 1

We will now refer to the method to be employed in the case where the Nernst lamps are lit up off the main feeders for the network. These feeders from the station go out straight to feeder pillars in different parts of the town. Here they go through fuses on to a small set of 'bus bars, and from thence through fuses the distributors go in all directions to supply the current to the different consumers. For the street-lighting there would be separate circuits run from this feeder pillar, also through fuses. The question distinctly states that these are to be controlled from the generating station, so some sort of switching apparatus must be also put in this feeder pillar. This will be best to be electrically operated, and I would refer the querist to an article in the *Electrical Engineer* for Aug. 19 and 26, 1904, in which descriptions are given of several kinds of switches for this kind of work. The following description shows the style of arrangement I mean, and it seems to be about as good as any. It is described as a magnetically-locked switch. Fig. 1 is a diagram of the connections, and is similar to Fig. 6 in the *Electrical Engineer*, but this has been added to to allow for three-wire working. The exciting coil, *a b*, consists of two windings—a thin one, actuating the switching in and out, and a thick one (main coil), which serves to hold the switch in the "on" position. In order to light the lamps, the switch, *w*, is put on to contact 3. A current then flows from the positive pole through the switch, lamp *x*, the two windings in series, and the lamps back to the negative or neutral. The core, *c*, is attracted, and the brushes, *d* and *e*, close the circuits. Both ends of *a* are thus connected to the same pole, and *a* carries no

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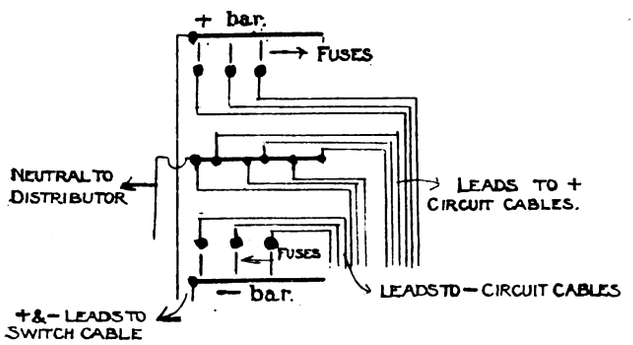
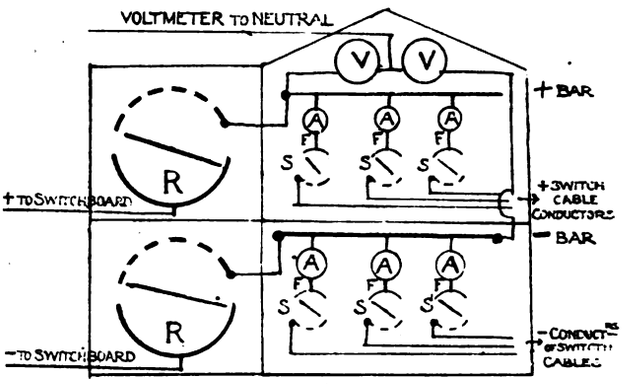
current, whilst the supply flows through *b* in the same direction as on first switching on, and so keeps the switch closed. If the switch, *w*, be moved to contact 4, *a* will receive a current in the opposite direction, and will oppose *b*, so that *c* falls and opens the main contacts. In order to see whether the switch is operating satisfactorily, a lamp has been inserted in the lead connecting the switch, *w*, with the coil *a* in the station. This will only light up whilst switching in or out. If it burns continuously it is a proof that the apparatus is not working correctly. The switches can, of course, be arranged to control as many lamps as is thought advisable, but as far as possible there should be an equal number on each side of the system so as not to upset the existing balance of the network. The smaller the number of lamps controlled per switch the less chance of kicks in the voltage on the network if the lamps be switched on one section at a time, but, of course, the capital cost and the particular features of the situation will determine how many lamps each switch shall control. For the switch wire from the station for controlling the switch a similar wire to the pilot wires for the voltmeter will be very suitable, as there is not much current for it to carry, and that is only momentary at the time of switching on and off. These few notes I think make clear what I should advise doing, and with discretion a reliable system should be the result.—E. R. ALEXANDER.

*Answer to No.* 759 (*awarded* 5*s.*).—In laying down a system of public street-lighting controlled from the generating station, it is necessary to bear in mind that the system must be both simple and reliable, and cheap in first cost, as a heavy capital outlay is a serious barrier to the success of a small lighting station. Assuming that the generating sets are of 50 kw. to 100 kw. capacity, it will be advisable that no more than 10 lamps be switched directly on to the mains, otherwise variations of pressure and "kicks" in the light will be unavoidable. On the other hand, to run switch cables back to the station for every 10 lamps would involve a multiplicity of cables and an unnecessary outlay, and an arrangement, therefore, similar to the following becomes necessary. The town is divided into several sections according to its size and the location of the streets, and in the most central position of each section a switch pillar is placed, from which all the lighting circuits for that section radiate, each circuit being arranged alternately on the positive or negative, so as to balance one against the other as far as possible. The section or switch pillar contains positive, negative, and neutral bars, each circuit cable being coupled, one conductor to the positive or negative 'bus bar through a removable fuse fitting, and the other conductor direct to the neutral bar. By this means each circuit can easily be cut off for testing or repairs, and the renewal of a fuse is a simple matter. The two conductors of the switch cable from the




Arrangement of Switch Pillar.

works are connected direct to the positive and negative bars, and the neutral bar is coupled to the neutral of the nearest distributor. Each section pillar, being balanced in itself, is to all intents and purposes taking a high-voltage supply, thus effecting a saving in copper and main losses, while the out-of-balance current returns direct to the distributor network. The arrangement for supplying the two-wire switch cables from the station is as follows. From the positive and negative 'bus bars of the main switchboard two leads are run to the two bars on the public lighting board through two series resistance, each of which can be adjusted to maintain a constant and steady pressure. (This is a very important point, as on the steadiness of the pressure the success or failure of Nernst lighting depends, and where lamps are directly connected to the distributor steadiness of pressure can seldom be obtained.) The positive and negative conductors of each switch cable are connected to the positive and negative bars through an ammeter, fuse, and resistance switch having two or three contacts, so graduated that the initial current on closing the circuit shall not exceed five or six amperes. By this arrangement the amount of switch cable is reduced to a minimum. There




Arrangement of Lighting Board at Station.

is a high-voltage supply from the station to the section pillar, and the whole of the circuits are easily got at from three or four central positions in the town, whilst the switching on and off and the regulation of the pressure are under the direct control of the switchboard attendant.—B. S.

*Answer to No.* 759 (*awarded* 5*s.*).—There are two methods by which public street lamps can be lighted from the generating station—first, by means of special feeders, and, secondly, by means of distance-control switches.

Considering the case of special feeders for the lamps, the conditions of the question require that switching on too many lamps at a time must be avoided to prevent sudden "kicks." For this reason the public lighting network must be divided up into a number of sections, the number of sections depending on the number of lamps. Say it required 240 lamps to light the town, these could be divided into four sections of 60 lamps. Each section would require 15 amperes on each side of the three-wire system. Each section is supplied by a feeder from the station, the feeders being only on the outers, as there is no necessity for middle-wire feeders; the middle-wire cables could all be connected together, and connected on to the public supply network where available. With the second method—viz., distance-controlled switches—the town is divided up into sections, as in the case of feeders being used, but at each feeding point the public lighting network is connected with the distributing mains through an electromagnetic distance-controlled switch. These switches are made in numerous varieties, although they all work on the same principle. A switch is fixed to the core of an electromagnet in such a way that when a current is passing round the coils in one direction the core is sucked in and the switch closed, and held closed until the current is either interrupted or reversed. Some forms of this type of switch have a few coils, in series with the switch, which carry the main current, and serve to hold the switch on, saving the waste of keeping the shunt coils constantly energised. Each section would require two of these switches, one on the positive side and one on the negative side. From the shunt coils of each switch two small wires are connected, one to the distributing main side of the switch, and the other is laid to the generating station, where it is connected to the middle wire 'bus bar through a small switch (as in the sketch). When this switch is closed it will cause a current to pass round the coils of the electromagnetic switch, closing the switch and lighting the lamps. When the small switch is opened the coils

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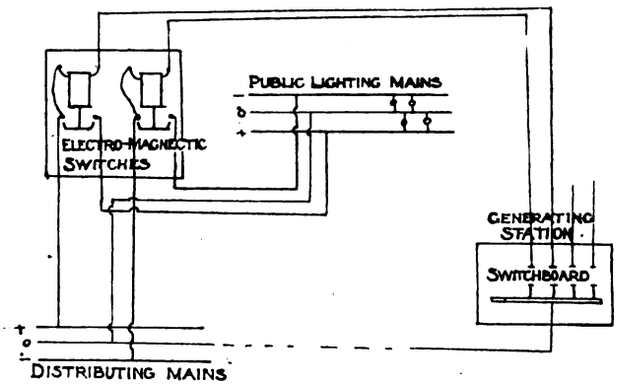
release the switch-blade, and the lamps are put out. Some switches depend on the current being reversed in the coils before they will open; in this case it is necessary to run both wires to the station, and connect them through a two-way switch on to the 'bus bars.

As regards balancing, there need be no difficulty in getting the lamps to balance well. Each section should be arranged to be approximately balanced independently. It is not economical to lay a three-wire cable down every street, so it will not be possible to arrange alternate lamps on opposite sides of the three-wire system. Three-wire cables should be laid down the principal streets, and the lamps in one side street arranged to balance with the lamps in the next side street. If the number of lamps in the side streets on one side of the principal street are about equal in number to the lamps in the side streets on the other side, the lamps in the streets on one side of the main street could all be on the positive side, and the lamps in the streets on the other side all on the negative side of the system.




The decision as to which system is to be used will depend on the size and shape of the town, and also on the amount of capital which can be spent. It is generally found cheaper to instal distance-controlled switches than special feeders; in a compact, small town, which is rarely met with, it might be as cheap in the long run to lay feeders. With the distance-controlled switches the distributing mains have to be of a larger size to carry the public lighting supply; the switches themselves are sometimes apt to stick, and necessitate a journey round to set things right. They should be fitted in pillars as free from dampness as possible, and should be kept clean.—J. B. R.

*Question No.* 760.—What is the method of calculating the repulsion effect of a magnet excited by single-phase alternating current. For instance, it is required to suspend in air a weight of about 4oz. at a distance of ½in. from the end of the magnet. Current available, 35 volts 28 amperes.

*Answer to No.* 760 (*awarded* 7*s.* 6*d.*).—If a conductor be situated in an alternating magnetic field, and at any instant the strength of the field be B lines per square centimetre, the force, F, tending to repel the conductor in a direction parallel to the direction of the field is given by the equation

$$F = \frac{B^2 \mu}{8\pi} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where $\mu$ is the magnetic permeability of the conductor. I shall not prove this equation (1), because, in the first place, the method of proving it is very long and intricate, involving higher calculus; and, in the second place, it is of little interest to practical engineers. However, if any reader requires the proof, it can be found in J. J. Thomson's "Elements of Electricity and Magnetism," Chapter XI. We will, however, suppose that our conductor is not one of the magnetic elements, and, therefore, has a permeability of 1, so that $\mu$ disappears from the expression. Equation (1) gives the repulsion at any instant, but since here B is proportional to cos $(p\,t + \phi)$ the mean value of $B^2$ is $\frac{H^2}{2}$, where H is the maximum value of B. Therefore, the mean value of the repulsion is given by the equation

$$F = \frac{H^2}{16\pi} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Now "Regulus" wants an electromagnet designed which will exert a repelling force of 4oz. We must, therefore, first convert the ounces to dynes: 1oz = 28·35 grm. and 1 grm. = 981 dynes. ∴ 4oz. = 4 × 981 × 28·35 dynes = 111,250 dynes = F. We have now to find the flux which will bring about this repulsive force.

$$\frac{H^2}{16\pi} = 111{,}250. \quad \text{Taking } \pi = \frac{22}{7} \quad H = \sqrt{\frac{111{,}250 \times 16 \times 22}{7}}$$

$$= 2{,}100 \text{ lines.}$$

This gives us the maximum value of the flux, and as we generally make our calculations in mean value, we will convert it to such.

Mean ordinate of sine curve = $\frac{2}{\pi}$ maximum ordinate,

mean value of flux = ·636 × 2,100 = 1,336 lines.

We must remember that the flux density we have obtained is the actual flux cutting the conductor. Now, in this question the conductor is situated ½in. away from the magnet, and we shall, therefore, have to introduce a sort of leakage coefficient, because it will be seen that all the lines of force generated by the electromagnet do not cut the conductor. This is illustrated by Fig. 1. We have

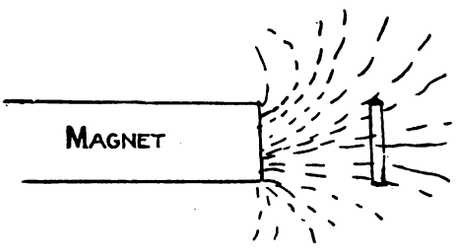



FIG 1.

now to decide the value of this "leakage coefficient," which is

$$\frac{\text{Number of lines generated by magnet}}{\text{Number of lines passing through conductor}}.$$

It will be very large indeed. It will depend on the length of the magnet, as with a long magnet the lines will spread out more in the air in order to return to the other pole of the magnet. It will also depend upon the flux density. I do not know of any definite data on the subject, but I suggest taking it with a fairly long magnet as 10. I do not think this is by any means too large. We therefore have to generate a flux of 1,670 × 10 = 16,700 lines.

Now, the intensity of the magnetic field down the middle of a solenoid of length $l$, having S spirals, carrying C amperes, with an iron core, and the permeability of the iron at this stage of magnetisation is $\mu$, will be given by

$$B = \frac{4\pi}{10} \frac{SC}{l} \mu.$$

Now, as we want a flux of about 16,700 lines, we obtain by referring to permeability curves that for this flux $\mu$ is 320 with soft annealed iron.

$$16{,}700 = \frac{4\pi}{10} \frac{SC}{l} \times 320 \qquad \frac{SC}{l} = 42 \text{ (taking } l \text{ as 20cm.)}$$

$$SC = 840 \text{ ampere-turns.}$$

Therefore, if we construct a solenoid having 100 turns and carrying 8·4 amperes, we shall obtain a flux density of 16,700 lines per square centimetre, and this, as shown above, will exert a repelling force on a conductor placed at a distance of ½in. away from the end of the magnet, of 4oz. per square centimetre.—ELECTRON.

*Answer to No.* 760 (*awarded* 5*s.*).—The formula given for the pull on a mass of iron in a magnetic field is—

$$\text{Pull in dynes} = \frac{B^2 A}{8\pi} \text{ dynes,}$$

where B = lines per square centimetre entering iron, A = area of iron affected. If, however, we are given the induction in lines per square inch and the area in square inches,

$$\text{Pull in lbs.} = \frac{B_l{}^2 A_l}{10^6} \times \cdot 014.$$

The method of designing an electromagnet to comply with the given conditions is as follows: A weight of about 4oz. is to be suspended. We may take it that one cubic

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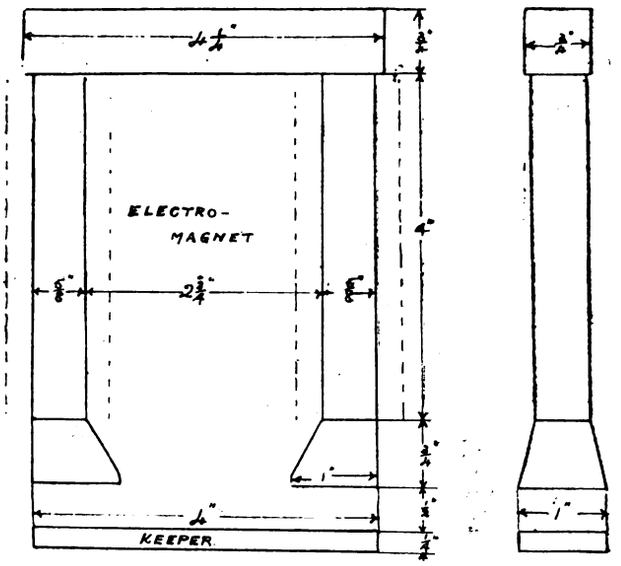
inch of wrought iron weighs ¼lb. Therefore, our weight must be of a volume equal to one cubic inch. As shown in the sketch, it is tentatively made 1in. × 4in. × ¼in. It is




now proposed to make the weight itself—that is, the piece of wrought iron—be the keeper of the electromagnet which is to be excited by the single-phase current. As a preliminary the sizes given are taken, and a design based on them is run through. Should the result be unsatisfactory, the design would have to be modified to remedy objectionable features.

1. *Calculation of Number of Lines entering Keeper.*—

$$\text{Pull on keeper (lbs.)} = \frac{2\,B^2\,A}{10^6} \times \cdot 014.$$

(Note there are two air-gaps)—*i.e.*,

$$\frac{1}{4} = \frac{2\,B^2 \times 1}{10^6} \times \cdot 014.$$

Whence $B^2 = 8{,}900{,}000$, $B = 3{,}000$ lines per square inch, say.

Take a leakage coefficient of 1·5. Then flux through electromagnet = 1·5 × 3,000 = 4,500. This, of course, is the average flux passing through the magnetic circuit. It is assumed that the flux follows a sine law (in the same way as the E.M.F. current). The average flux $= \frac{2}{\pi}$ maximum flux = ·636 maximum flux. Obviously, therefore, the maximum flux may be calculated by multiplying the average flux by $\frac{1}{\cdot 636}$ (= 1·57). Then we get for the magnetic circuit—

| — | Flux (total). | | Average density of flux lines per square inch. | | Length of circuit. | | Max. flux density. |
|---|---|---|---|---|---|---|---|
| Armature ... | 3,000 | ... | 12,000 | ... | 3½in. | ... | 18,840 |
| Two air-gaps | 3,000 (each) | ... | 3,000 (each) | ... | 1in. | ... | 4,710 |
| Magnets..... | 4,500 | ... | 15,000 | ... | 14in. | ... | 23,550 |

2. *Calculation of Ampere-Turns.*—Now the ampere-turns per 1in. of length in magnets and armature may be taken to be equal to 4 (from curves). Also ampere-turns for two air-gaps: ·3133 B $l$. (B = induction in and $l$ = length of air-gap) = ·3133 × 4,710 + ½ × 2 = 1,476. ∴ total ampere-turns = 4 × (14 + 3½) + 1,476 = 1,546. These are what might be termed the (maximum ampere) turns. If we take the virtual value of the current to be $= \frac{1}{\sqrt{2}}$ maximum value, we have for (virtual ampere) turns $\frac{1{,}546}{\sqrt{2}} = 1{,}100$ say.

*Adjustment of Coils.*—It is supposed that the magnet is to be made to take up about 30 volts (that is to act as a choking coil to a certain extent), and as it will form an inductive load, the number of turns necessary to give a back E.M.F. of 30 volts must be calculated. Now the inductive E.M.F. of the magnet will be $= \frac{4\cdot 44\, n\,.\, f\, N_m}{10^8}$ where $n$ = number of turns, $f$ = frequency of alternating current, $N_m$ = maximum flux through magnet. As no value for $f$ is given, a periodicity of 50 is assumed, and therefore

$$30 = \frac{4\cdot 44\, n \times 50 \times 23{,}550}{10^8}. \quad \therefore n = 573.$$

The number of turns are taken at 600, and a current of two amperes is assumed. (Thus ample allowance for regulation will be obtained.)

For the magnet winding a No. 18 S.W.G. wire is used of cross-section = ·001809 square inch, of diameter (over double cotton covering) = ·059in., and having a resistance of ·00034613 ohm per inch. Hence about 4½ layers are needed on each limb of the magnet, 300 turns being wound on each. The resistance of the wire comes out at ·6716 ohm. Hence E M.F. to overcome ohmic resistance = C × R = 2 × ·6716 = 1·343 (The back E.M.F. voltage has been increased in the ratio $\frac{600}{573}$, but there is still sufficient margin below 350 for regulation purposes).

Power wasted by $C^2$ R loss in coils = $2^2$ × ·6716 = 2·68 watts. Assuming 1·75 watts lost in hysteresis and eddy currents, we have total waste = 4·43.

The coil area comes out at 30·5 square inches. ∴ watts to be dissipated per square inch $= \frac{4\cdot 43}{30\cdot 5} = \cdot 15$. This is well within the limit. If an excessive value had been obtained, a new design would have had to be made, altered in some way from the original in order to reduce the amount by increased surface.

As a practical check, it will be noticed that the current density in the coils is 1,100 amperes per square inch; a very fair value.—T. T.

[Other replies to Question No. 760 will be given in our next issue.—Ed. *E. E.*]

## *RE* QUESTION 755.

Sir,—Kindly express my best thanks to "B. W. X." for his friendly criticism and correction. The mistake was due to careless wording; the sentence should have read: "Allowing for all losses, this gives us 35ft. per second as the velocity of the steam and hot gases inside the chimney." Had more data as to the plant been available, I should have also considered the plan of gradually reducing the area of the exhaust pipe from the base of the chimney to its discharge. This in itself would have increased the draught, but as no data was given in the question as to size of pipe, quantity of steam, or back pressure, I deemed it advisable to show the exhaust pipe with a free discharge.—Yours, etc., W. T. W.

## REVIEWS.

**Experimentelle Elektrizitatslehre mit Besonderer Berucksichtigung der Neueren Anschauungen und Ergebnisse.** By Dr. Hermann Starke, Privatdozent au der Universitat, Berlin. B. G. Teubner, Leipzig.

Besides describing the more important experiments conducted in the electrical laboratory and lecture-room, this book introduces the modern theory of electrical science. In a work of this kind it is impossible to be entirely original. Much ground has of necessity to be covered which has been traversed before, and the main points of difference are style and relative clearness of exposition. As regards the latter point, we have no fault to find with the book before us. The author has succeeded in writing down to the level of his audience, a task which some writers with similar ends in view have found beyond them. He uses none but elementary mathematics, and his methods of illustrating well-known phenomena bear the resemblance of originality at times. The book possesses the further advantage of being up-to-date. Thus sections are devoted respectively to wireless telegraphy, Röntgen, Becquerel, radium, and polonium rays, etc. No doubt the work will be found a welcome addition to the text-books intended for German students, especially as it is from the pen of one so able to impart his knowledge to others.

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Supplement to "The Electrical Engineer,"
MARCH 10, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

769. In a variable-speed motor the speed variation, say from 1 to 3½, is effected by varying shunt excitation by resistance in circuit. Auxiliary coils are placed between shunt coils and are in series with armature. In other respects the machine is connected as a long shunt motor. The machine is sparkless from no load to full load at all speeds, and at all speeds on reversal, with fixed brushes, the output remaining constant. Explain theory of sparkless commutation and influence of auxiliary poles on same. At certain low excitations, if the brushes were shifted 1mm. in the backward direction the motor ran away (hunted), and got up an abnormal speed in a second's notice. Explain this peculiarity.—AUXILIARY.

770. In installing boiler feed pumps in generating stations the present-day practice seems to be either a direct-acting steam pump, giving a slow-speed highly efficient pump but a wasteful system of driving, or an electrically-driven three-throw high-speed pump, giving an economical method of driving but a wasteful type of pump, generally driven through two reduction gears. How is it that a combination as described under is not used—viz.: slow-speed electric motor coupled by worm gearing to a slow-speed (2-10 double strokes per minute) three-throw pump, thus giving economy of driving and economy in pumping, worm gears at present obtainable being of high efficiency and large ratio?—W. T. W.

### ANSWERS.

*Question No.* 762.—A three-wire feeder, ·25, ·125, ·25, which under ordinary circumstances carries 180 amperes, has developed a fault on the + side, and now takes only 80 amperes, the − side taking the same amount as before the fault occurred. The feeder is on the same 'bus bar as other feeders, and feeds into a network box 60 yards from switchboard. The fault is between network box and switchboard. Is there any means of locating same without breaking up the ground? as to do so would be very inconvenient, the feeder crossing a busy thoroughfare. The feeder is laid solid in iron troughing, and is free from earth faults.

*Answer to No.* 762 (*awarded* 10*s.*).—The question does not state whether the cable is concentric, three-core, or three single cables, but probably the latter is the case. The feeder being only 60 yards long, it is unlikely that the fault, the nature of which is an increase by about 100 per cent. of the resistance of the positive cable, is in a joint due to bad sweating, or the use of a corrosive flux, but it is probably due to corrosion having set up owing to some foreign substance in the insulation of the cable, or the surrounding bitumen. The corrosion is evidently not due to moisture, as there is no earth fault, but it is extremely probable that the insulation resistance to earth is rather low at this point.

Now if the only fault is an increase of resistance, it is impossible in its present state to find where this extra resistance has crept in; therefore, the best plan appears to be to break down the insulation, which will no doubt happen at the fault. To do this, earth one side of a generator, and couple the other end to the faulty length of main through a light fuse, and run up the machine until it attains its maximum voltage. If this does not break it down, an attempt should be made to disturb the fault by the passage of a heavy current. This is best done by short-circuiting all three cables at the far end (see Fig. 1) and coupling the positive to one pole of the dynamo through an ammeter, A, and the negative and neutral to the other. The station end of the negative and neutral is also earthed through a low-reading ammeter, *a*, and a light fuse, F. The generator is now separately excited and run up dead slow (possibly a water resistance may be necessary to keep the current within reasonable limits) until the current reaches about 500 to 1,000 amperes. After a time the fault will probably burn out, and in doing so earth itself, in which case a reading will show on ammeter *a*, or the fuse will blow.

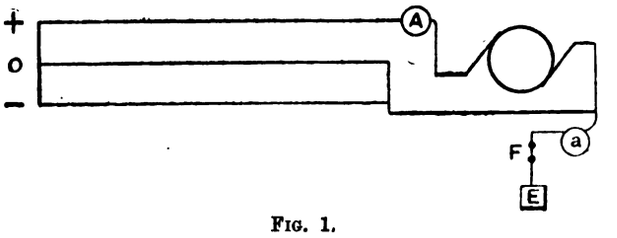


FIG. 1.

In the case of three single cables laid solid in iron troughing, this will probably result in the positive main earthing itself on to the troughing without contaminating the other cores, in which case the ordinary loop test is applicable, and as this has been frequently described in these columns of late I need not detail it again. If the resultant fault is a short, with or without an earth, the following test is probably the simplest. (See Fig. 2.) A battery of

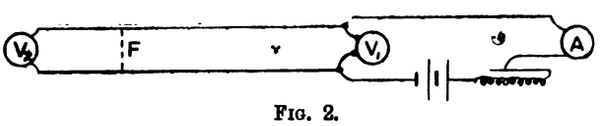


FIG. 2.

two storage cells in series with a regulating resistance and an accurate ammeter reading up to 15 or 20 amperes is coupled across the two short-circuited cables, and two accurate low-reading ammeters, such, for instance, as are used for taking the voltage of individual cells of a battery, are coupled across either end. The current is adjusted to give suitable readings on the voltmeters, and at a given signal simultaneous readings of A, $V_1$, and $V_2$ are taken. Then resistance of cable + fault $= \frac{V_1}{C}$ and resistance of fault $= \frac{V_2}{C}$. $\therefore$ Resistance of length of cable up to fault $= \frac{V_1}{C} - \frac{V_2}{C}$, whence the distance of the fault can be calculated by knowing the resistance per yard of the cable. This should be checked by taking readings from the other end.

If the attempt to disturb the fault has resulted in burning the cable asunder, the above test may still be applied with the following variation. Take readings $C_1$ and $V_1$ with battery, ammeter, and voltmeter at one end, and then $C_2$ and $V_2$ from the other end. Let $R_1$ and $R_2$ be the respective resistances (unknown) of the cable from either end to the fault, and $R_F$ resistance of fault.

Then
$$\frac{V_1}{C_1} = R_1 + R_F \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and
$$\frac{V_2}{C_2} = R_2 + R_F \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$\therefore \frac{V_1}{C_1} + \frac{V_2}{C_2} = R_1 + R_2 + 2R_F \quad . \quad . \quad . \quad (3)$$

$R_1 + R_2$ is the resistance of $60 \times 2$ yards of ·25 cable, and hence the value of $R_F$ can be found from equation (3); and by substituting this value in (1) and (2) we can find $R_1$ and $R_2$, and hence the position of the fault.—H. J.

*Answer to No.* 762 (*awarded* 7*s.* 6*d.*).—When a fault of the type suggested in the question develops, one of two things may be wrong with the cable—*i.e.*: (1) a bad joint has been made, and the exposed metal has afterwards

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corroded, thus increasing the resistance of the cable; (2) the cable has been laid in such a manner that some part of it has been in a state of stress—this has caused the copper to crack, and thus a *partial* break in the cable has resulted.

The first thing to do is to make a close examination of all the joints in the cable, and if any corrosion or other defect found it must be immediately remedied and the subsequent effect on the working of the feeder noted. Failing any defect in the joint, the fault in the feeder must be due to a partial break. Now, I think it is obvious that it is impossible, in the existing state of affairs, to directly locate the fault, as no matter where it is situated in the cable, the capacity resistance, etc., of the cable will still remain unaltered. The only way to locate is to pass a large current through the cable and thus burn out the fault. This, of course, will burn through the insulation to earth, and then ordinary methods of locating the fault can be used. First disconnect the cable, preferably, of course, during time of light load, so that the other feeders feeding on to the network can easily supply the demand without a great drop in pressure. Now earth the end of the cable at the junction box, making a good connection. Then plug the other end of the cable on to a spare set of 'bus bars, and make a good earth connection from the neutral bar. Now plug a standing shunt-wound generating set on to the same set of 'bus bars, as shown in Fig. 1, with all the resistance in the field circuit. Then run the set slowly up to speed.

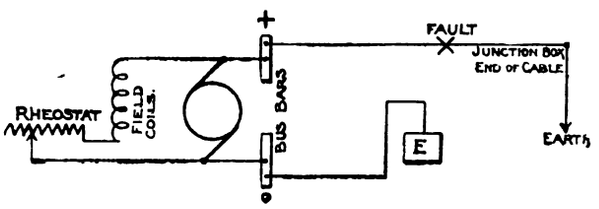



FIG. 1.

If the resistance in the field circuit be large, little voltage will be generated, but in any case watch the feeder ammeter closely until about 80 amperes are passing through it, then slowly increase the voltage generated by reducing the resistance in the field circuit. If there is a circuit breaker in the generator circuit, it will be as well to set it as near as possible to the point at which it is expected the cable will break down—say, 150 or 200 amperes. Then, of course, the current will reach such dimensions that the fault will burn out to earth. The circuit breakers on the machine will come out, or, if there is not a circuit breaker, owing to the exceedingly small voltage being generated—say, 20 or 30 volts—the field of the machine will die down, and it can be shut down. Now, if we have an earth fault developed on the cable it is comparatively an easy matter to locate it. Disconnect the cable from all the previous connections.

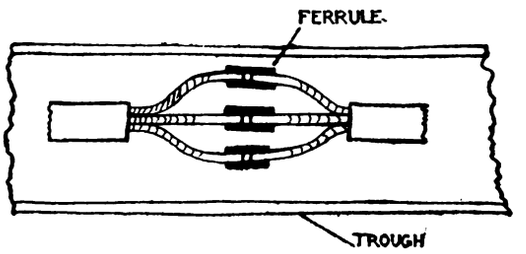
The best method of localisation of the fault is the induction method. An alternating or interrupted current is passed through the faulty cable, the circuit being completed through earth. A coil, in circuit with which is a telephone receiver, is taken over the route of the faulty cable, starting from the point at which the testing current is applied. In a successful test the receiver beats steadily until the point of the fault is reached, when the beating dies away owing to the testing current going to earth.

I will refer the reader to the paper on "Localisation of Faults" by Mr. W. E. Groves, read before the Institution of Electrical Engineers, Birmingham Local Section, Jan. 16, 1904, where a full description of this test and the apparatus is given. There are, of course, many other tests, such as the "loop" test, which may be used, but this one is generally found very successful indeed.—ERNEST P. HOLLIS.

*Answer to No.* 762 (*awarded* 7*s.* 6*d.*).—As this fault is a very curious one, it would be best to prove that the short length of positive cable mentioned is the cause of the trouble. This can easily be done by disconnecting the positive and negative ends of the cable at the switchboards and at the network box mentioned, and cross connecting them. The negative cable, which is of the same section as the positive, would now be taking the place of the supposed faulty section of positive cable. If the original load of 180 amperes is now shown on the positive feeder ammeter, while the negative only shows 80 amperes, then this 60 yards of cable in question is faulty. If, however, only 80 amperes is shown on the positive meter, then some change in the outside load is responsible for it.

Supposing that the fault is proved, it remains to find out what kind of a fault it is, so that some method may be used of locating it. Test the insulation resistances between the positive cable (60 yards in question only) and the neutral wire, positive cable and negative wire, positive and earth; preferably the iron troughing the cable is laid in. If the cable has had an earth or short-circuit on it, the fault will have burnt itself clear. It is possible that somewhere in this 60-yard length of cable the original fault, having burnt itself clear, has reduced the section of the cable and thus affected its resistance. Let us suppose the network is supplied by two sets of feeders and that the resistance of the positive cable in one set is increased. Then the positive cable of the other set would supply a larger share of current to the network, and relieve the first-mentioned positive cable of part of its load. To find out whether this is so, disconnect the set of feeders in question, bridge across from the neutral to the negative cable in the street box, and test the resistance of the two cables from the switchboard. Then, using the same clamp, connect the neutral to the positive cable and test the resistance of these two cables. As the positive cable is of the same area as the negative, and the neutral cable and connections were included in both tests, the resistances should be the same in each case if the positive cable is unaffected by the fault. When the above tests have been made, something definite will be known about the cable. If the cable has a fault to earth, neutral, or negative cable, it can be easily and accurately determined by means of a loop test. A good, practical method of taking this test was described recently in this paper in reply to Question No. 735. If the cable has been injured by a fault which has burnt itself quite clear, then the only thing to do is to dig the cable up.—W. A. T.

*Answer to No.* 762 (*awarded* 5*s.*).—The fault in the cable mentioned is not of the kind most commonly met with—viz., faulty insulation. The fact that less current flows with the same drop of potential along the positive conductor shows that its resistance has increased, owing, probably, to a reduction of its cross-section in one or more places. Two cases similar to the above came under my notice a short time ago. In one case, one of the outers of the feeder, nearly a mile long, was first found to carry about half the current it used to, the remainder being distributed among the corresponding outers of the other feeders in parallel with it. On the following days the current gradually fell off, and ultimately dropped to zero. On testing the affected outer of the cable, the conductor was found to be discontinuous, the cable being otherwise satisfactory. The fault was found to exist at one of the joints, which was of the kind shown in the sketch.




A gap of about $\frac{1}{4}$in. was left between the ends of the cores, and a ferrule slipped over them, the spaces between the cores and the ferrule being made solid by running in solder. This kind of connection may be very unsatisfactory. If the ferrule be too large, and either core not projecting a sufficient distance inside the ferrule, and due care not exercised to fill up properly with solder, the resistance of the joint may be high enough to cause heating, resulting in the solder running out of the ferrule. If the joints be buried in bitumen untaped, as was done in the above instance, the bitumen may flow into the space

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originally occupied by the solder. Thus, in time, the two cores may become insulated from each other.

The cable referred to by the querist, being a short one, may be in one length, in which case one may be justified in suspecting the joints at the street-box or switchboard end. On the other hand, if a joint exist along the length of cable, and is of the kind mentioned above, I should expect, as the result of my experience, to find the fault there, after making sure of the connections at each end.—H. J. W.

*Question No.* 763.—What are the advantages of the Alberger or barometric type of condenser over other types commonly in use?

*Answer to No.* 763 (*awarded* 10s.).—In order to compare the barometric type of condenser with the various other types in use, it will be necessary to just briefly glance at the main types found in practice. Condensers may be divided into two main classes, in which (*a*) the condensing water and the steam intermingle and (*b*) the condensing water and the steam are kept entirely separate. The first class may be sub-divided into (1) parallel-current jet condensers; (2) counter-current jet condensers; (3) barometric condensers; (4) ejector condensers; and the second class may be sub-divided into (2) surface condensers; (3) evaporative condensers.

*Parallel-Current Jet Condensers.*—In this condenser, shown diagrammatically in Fig. 1, the steam and cooling water flow

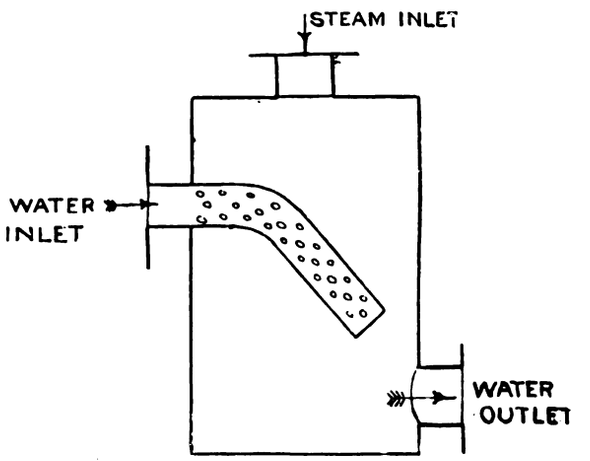


FIG. 1

into the upper end of the condenser, and are, generally speaking, withdrawn by one wet-air pump from the lower end. This type will be recognised as the one largely adopted in slow-speed stationary engine practice. This type of condenser has for several reasons been preferred to the surface condenser for land service; simplicity of construction and comparative smallness of first cost largely account for this. Further, other conditions being suitable, the jet condenser is more efficient than the surface condenser, and gives feed water for the boilers at a higher temperature in the hot-well.

*Counter-Current Jet Condensers.*—In this condenser, shown diagrammatically in Fig. 2, the water and steam inlets are separated as far as possible, the water being withdrawn by a separate water-pump and the air by a dry-air pump. This type, although foreshadowed by Watt, has only been developed commercially during the last few years, notwithstanding that it possesses advantages in economy, in construction, and motive power, as well as in efficiency. As has already been said, the dry-air pump in this type of plant draws its charge from the top of the condensing chamber at a point adjacent to the cooling water inlet, whilst the exhaust steam enters the chamber low down and near to the outlet of the cooling water. Baffle plates are arranged in the interior of the condenser to ensure the complete mixing of the steam and water; air and uncondensed vapour as they rise meet water increasing in coldness, until at the point of exit they are at the temperature of the incoming water. At this point, also, the air pressure is highest, the air denser, and therefore the air is greatly reduced in volume. The saving in volumetric capacity of the air-pumps due to this arrangement, as compared with those required to produce equal results in the ordinary parallel-current jet condenser, is as much as 40 per cent. As the duty of these pumps is simply to compress air, the expenditure of power will also be reduced in the same ratio. Hence with this system, using pumps of equal volumetric capacity, a higher vacuum may be obtained, or for a given vacuum smaller pumps may be employed.

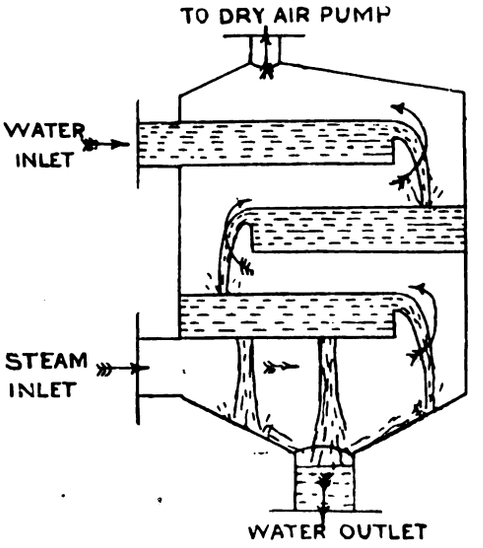


FIG. 2.

*Barometric Condensers.*—The use of the barometric condenser, in which the cooling water mixed with the air and uncondensed vapour is discharged through a column 33ft. to 34ft. in height, is common in connection with industrial installations where boiling and evaporating *in vacuo* are effected under low temperatures. It is not often that a simple barometric condenser is used in connection with a large power plant. Fig. 3 shows one of the simple barometric condensers installed at one of the Manchester electric lighting stations. The exhaust steam enters

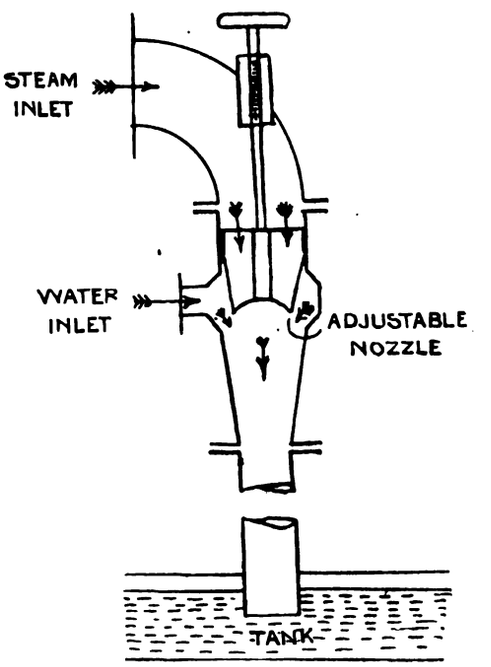


FIG. 3

at the top and passes through a taper nozzle which is adjustable vertically. The injection water enters at the side and passes through an annular space which can be varied in size by moving the nozzle, thus regulating the water supply to the quantity necessary to produce the best vacuum. It will at once be noted that no air-pump is used, and that if the water can be obtained with a head of about 15ft. above the inlet, no pump of any sort is required. But usually the water has to be raised some distance, and to overcome the friction in the pipes and the difference in pressure between the condenser and atmosphere, a centrifugal pump is inserted in the injection pipe. This pump has only to deal with cold water, whereas with

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counter-current jet condensers the water-pump has to withdraw the hot water from a space which is already highly exhausted. Great care is needed in designing these pumps to prevent lodgment of air in either suction or delivery passages. The water being hot and under such low pressures gives out much air, which must be completely expelled at every stroke, or the pump becomes inoperative. With the simple barometric condenser a vacuum of 26½in. to 27in. can be obtained. Much better results may be obtained with the arrangement sketched in Fig. 4, which shows a counter-current barometric condenser in combination with a dry-air pump. This arrangement combines the advantages of the barometric and counter-current jet condensers without their defects and limitations. At Neasden power-house barometric condensers are employed in conjunction with two-stage dry-air pumps—*i.e.*, pumps in which one pump is used to exhaust the clearance space of the first—and centrifugal pumps on the injection pipes, and should give exceptional results.

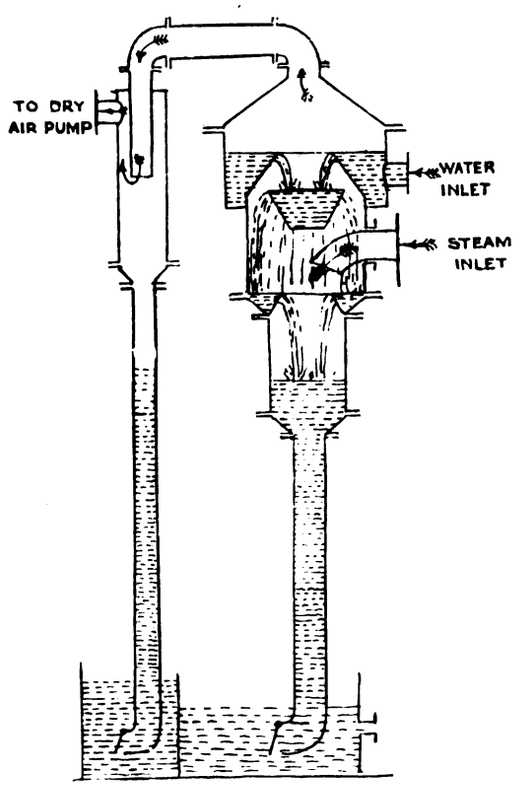


FIG. 4

*Ejector Condensers.* — The endeavour to obtain the simplicity and cheapness in first cost and working of the barometric condenser without its limitations, has produced the ejector condenser in its various forms. In this type of condenser the atmospheric pressure is overcome by the great velocity attained by the cooling water due to a certain pressure head and contraction in area of the supply pipe. The air, vapour, and water of condensation are withdrawn by a stream of water operating as a simple water-jet pump. Fig. 5 shows diagrammatically Korting's ejector condenser. The velocity of the outflowing water prevents the ingress of air from outside, and so a short discharge leg and a water seal alone are required on the outlet side. As water passages are fairly large, very impure water can be used without detriment. The vacuum is, however, rather low—about 25in.

*Surface Condensers.*—In the ordinary form of surface condenser the steam is led into a closed chamber containing a large number of tubes through which cooling water is passed (Fig 6). The tubular condenser in its simple form is rather inefficient, owing to the want of intimate contact between the water and steam, a large quantity of the water flowing placidly through the tubes, absorbing scarcely any heat. On board ship, where the necessity of providing water for feed purposes of a different quality to that available for cooling water is an important factor, the surface condenser must be employed. Much ingenuity has been expended on devices for increasing the efficiency of surface condensers, which are far too numerous to mention here.

*Evaporative Condensers.*—Generally these consist of stacks of cast-iron pipes with conducting fins throughout their length, erected in the open, and having the cooling water distributed in a thin stream over the whole surface. The heat of the exhaust steam is expended in evaporating this film of water, and when the conditions are favourable a satisfactory

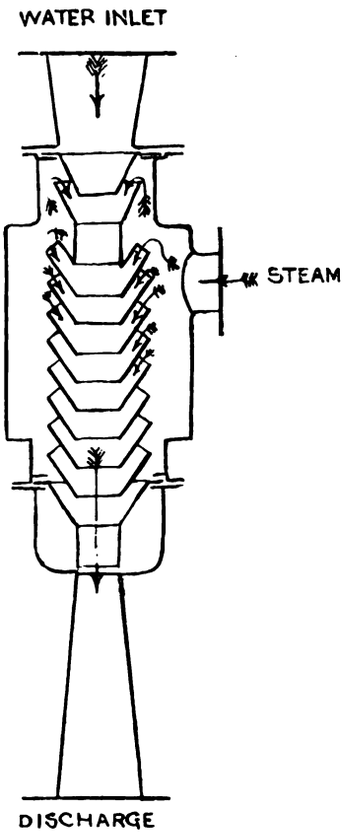


FIG. 5.

vacuum is obtained with the use of a quantity of cooling water even less than that of the steam condensed. Two conditions are essential to success: (*a*) that the numerous pipe joints subject to atmospheric pressure are kept tight; (*b*) that the cooling water, on being evaporated, leaves behind it no incrustation which will act as a non-conductor. The latter is the more serious difficulty in plant of this kind,

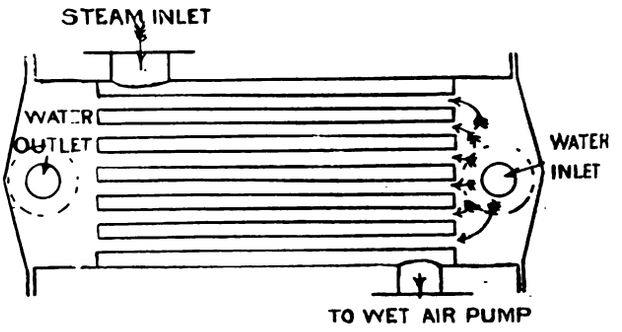


FIG. 6.

and really stands in the way of its more extensive development; otherwise it has much to recommend it. The first cost is not high. The fact that it can most effectually be placed on the roof gives the advantage of a barometric discharge for the water of condensation; hence only a dry vacuum pump is needed to maintain the vacuum in the condenser, and the quantity of cooling water required is so small that, even if it has to be raised a considerable height, the power expended is very small.—H. E. H.

[Other replies to Question No. 763 will be given in our next issue.—ED. *E. E.*]

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Supplement to "The Electrical Engineer,"
MARCH 17, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

### QUESTIONS.

771. What is the cause of the difficulties experienced in regulating voltage on a two-phase alternating system supplied through three-core cables, and having a partly inductive load? Are these entirely absent on a four-core or double-concentric system?—THREE-CORE.

### ANSWERS.

*Question No.* 763.—What are the advantages of the Alberger or barometric type of condenser over other types commonly in use?

*Answer to No.* 763 (*awarded* 10*s.*). — Before discussing the peculiar advantages of the barometric condenser

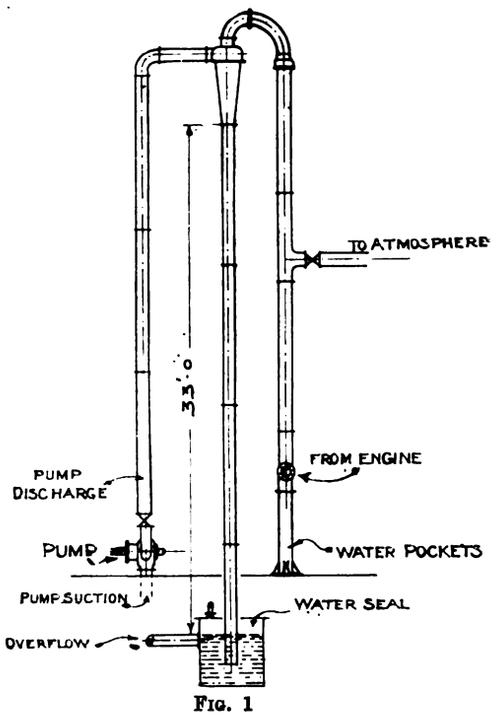


FIG. 1

it would, perhaps, be as well to briefly consider the principles of its working. The whole arrangement is very simple, and is shown in Fig. 1, which nearly explains itself. The exhaust steam from engines is carried up to the top of the condenser head, where it is condensed by jets of water; the whole mixture then falls down the barometric column into a water-tank, where it is taken away by an overflow pipe. Fig. 2 shows a section through a very simple type of condenser head, but which, nevertheless, has proved itself efficient even on a large scale, being quite capable of maintaining a vacuum of 26in., and using 28lb. of condensing water per pound of steam. The jets of water are inclined at an angle of 60deg. to the horizontal, and the water enters at rather a high velocity, thus effectually sucking all the air in the steam with it down the barometric column. If a higher vacuum is required, a small dry-air pump is fitted to suck the air out of the space above the jets. A centrifugal pump is used to lift the condensing water into the condenser. It has to be made large enough to be able to deliver full bore of water if there is no vacuum at the top, but, of course, much less power is required when the plant is running and there is a vacuum. It will be seen from the foregoing description that the great advantage of a barometric condenser is its simplicity, there being no troublesome air-pump with its initial cost and upkeep expenses. Of course where suitable feed water cannot be obtained cheaply, a surface condenser must be put in, but where a form of jet condenser can be used the barometric type will generally be worth consideration. Now a word on the disadvantages of the barometric plant. Special means must be provided for draining the exhaust pipe. Water cannot run down into the condenser as in the ordinary jet, which is generally placed low down, and, of course, the water cannot be drained away direct without first destroying the vacuum. One method used to overcome this difficulty is to fit a water pocket at the bottom of the exhaust pipe. From this pocket a drain pipe is taken to a closed reservoir, the top end of which is connected through a small pipe and cock to the vacuum space. The condensed water then drains down to this reservoir. When full it is cut off completely from the exhaust range, its top end opened to atmosphere, and the water allowed to drain away. Apparatus is made to do all this automatically. Accidents have occurred through water getting from the condenser into the engine. The most frequent cause of this is the water seal at the bottom of the down comer getting broken by the water level falling through some cause or other. Large bubbles of air then rush up the pipe and

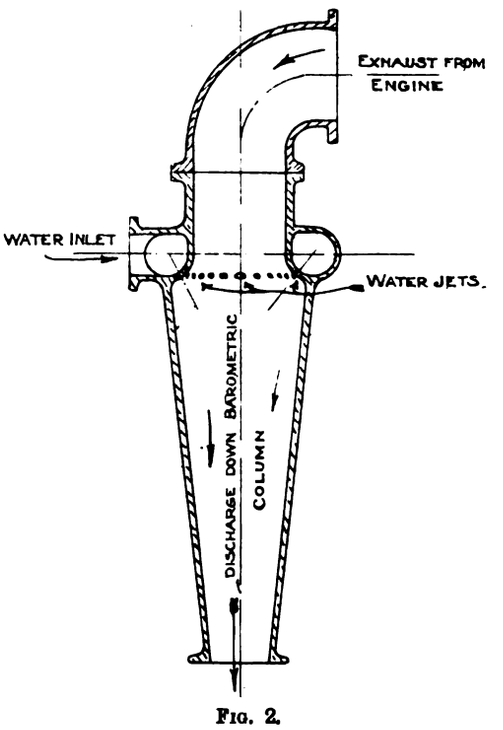


FIG. 2.

drive some of the water in it over the bend. Mishaps of this or a similar nature have prejudiced some engineers against the barometric condenser, but, in the writer's opinion, when carefully designed, the plant, under suitable conditions, is most satisfactory, being cheap and reliable.—E. J.

*Answer to No.* 763 (*awarded* 7*s.* 6*d.*).—The accompanying sketch shows a well-known form of barometric condenser; an examination of its properties will bring out its points of advantage. The exhaust steam from the engines passes up the vertical pipe, E, round the bend, B, into the vertical down-pipe, in which the condenser, K, is placed. The injection water enters a cone, C, at the top of the condenser, and has imparted to it a rotatory motion. The exhaust steam entering the top of the condenser comes into contact with the water and is condensed, the resulting water falling with the injection water down the discharge pipe to the hot-well. This discharge—or barometric—pipe is of length sufficient to support the water column by the atmospheric pressure, and is at least 30ft. from hot-well overflow to condenser.

The figure shows a practically automatic type of condenser, in which the injection water is siphoned from a tank, and this can be done if the water-supply level is not

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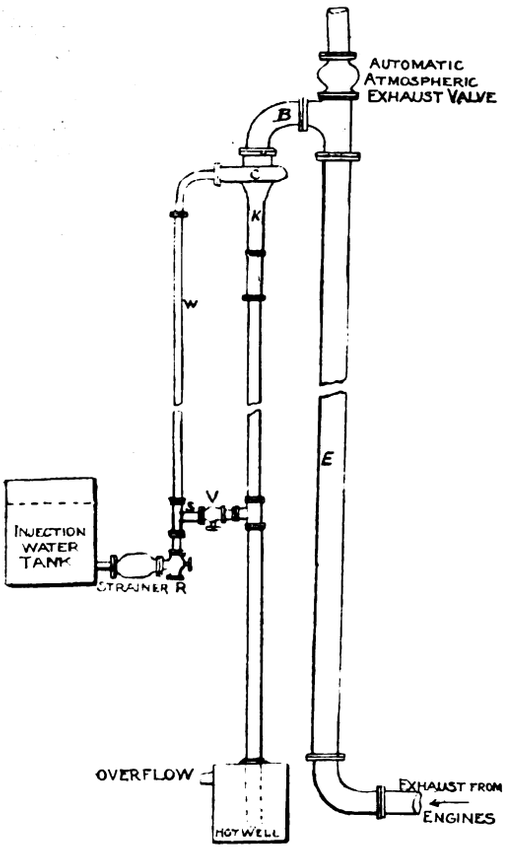
less than 10ft. above the hot-well overflow. To start the condenser, a cross pipe, S, is provided, and the starting valve, V, opened until the vacuum is sufficient to draw the water up the pipe, W, and maintain the siphon. The valve, V, is then shut, and the injection supply regulated by the valve, R. If the head of water is less than 10ft. above the hot-well overflow, a pump must be provided to lift the injection water. Once started, this type maintains a steady and high vacuum with less water than the ordinary type of injection condenser. It is reliable in its action, easily started, simple, has no wearing parts. It is easily erected and requires no special foundations; it may be placed outside a building, and thus requires but little space. Its upkeep is practically nil, and cleaning is a small item. It requires no attention when once started.

In comparing the qualities of different types of condensers, the question of boiler feed necessarily enters, but if it be merely a matter of condensation and apart from the ultimate use of the condensed steam, the comparison is straightforward. Surface condensers entail the use of air and water pumps, and the consequent maintenance and attention. The tubes require frequent cleaning, and an

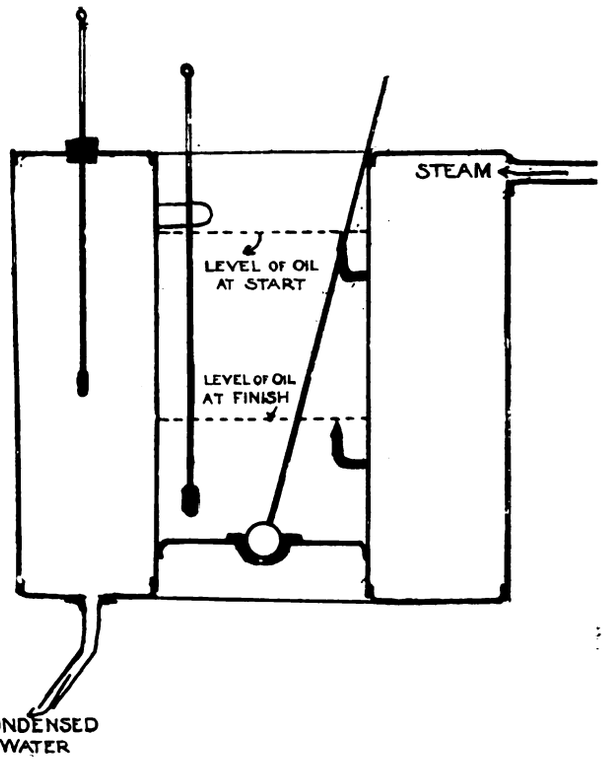



accident to air or water pump means that the plant is out of action. The floor space is considerable, the pumps at least having to be, so to speak, housed. Injector condensers of the ordinary type require an air-pump, and consequently, but to a lesser degree, the remarks made under the heading of surface condensers apply. Ejector condensers cannot be termed economical. They do not produce high vacuums—except under very special conditions with excessive water supply—and are not steady in their action. The above remarks would seem to claim that the barometric condenser is economical, simple, durable, and practically self-acting.—S E. T.

*Question No.* 764.—Give a few simple yet reliable methods of testing cylinder and other lubricating oils, so that a poor consignment may at once be "spotted."

*Answer to No.* 764 (*awarded* 10*s*).—Oils may be classified under the following headings: (*a*) mineral oils, and (*b*) animal and vegetable oils. The former belong mainly to a series of chemical bodies which contain only hydrogen and carbon. These are chemically inactive, and are therefore very suitable for lubricating purposes, as they do not attack the metal with which they must come in contact, and are not acted upon by air or steam. The most elementary member of this series of chemical compounds to which the mineral oil belongs is a gas, namely—ordinary marsh gas. The more complicated members of the series are more or less volatile liquids, comprising naphtha, petrol, kerosine, and paraffin. The higher members are the thick oils used for lubricating purposes, and the very highest are solids such as vaseline and paraffin wax. Many different degrees of oils are contained in the crude mineral form, so that by suitable refining oils of a prescribed consistency may be separated out. The animal and vegetable oils belong to a different class of chemical compounds, known as *glycerides*, and are in general of complicated constitution, and contain oxygen in various proportions and methods of combination. They have the undesirable properties that they absorb oxygen to form gummy viscous fluids, and attack metals to form soaps,* which last process is facilitated by the presence of steam.

The following heads are suggested on which lubricating oils should be tested: (1) viscosity at the temperature at which they are to be used; (2) uniformity of chemical composition; (3) either the flashing point or the volatility; (4) oxidising tendencies due to percentage of vegetable and animal oils; (5) tendency to act on metals owing to similar causes as in (4); (6) presence of mineral matter. Under some of these heads some simple tests can be suggested, but these, as a rule, should not be considered final, but only




as giving indications for further careful investigation, for inasmuch as the adulteration of oils is a specialised scientific process, it requires scientific knowledge and manipulation to detect such adulteration. We will deal with the heads in order.

1 *Viscosity.*—A rough indication of this may, of course, be obtained by shaking the oil in a bottle. A better way is to gauge how long a certain quantity takes to run out of a vessel through a small opening (a pipette would do very well), or again observing the time taken for bubbles to rise in a narrow tube containing the oil. If the same piece of apparatus is always used, a sample sent by the refiners may be taken as a standard, and later consignments should then come up to the same degree of perfection. The viscosity in the case of cylinder oils should be tested at a fairly high temperature, while for bearing lubricants the test should be made at the ordinary temperatures, and then again at about 50deg. C., and there should be no great difference of viscosity in the two cases. The accompanying sketch shows the form of apparatus supplied by several well-known firms for carrying out standard viscometry

* Ordinary hard soap is produced essentially by the interaction of caustic soda and some vegetable oil. In soft soap the metal potassium takes the place of the sodium.

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tests. The hole at the bottom of the vessel is made through a cup of agate, into which a ball fits to stop the flow of the liquid.

2 The second test is to determine whether the viscosity of the oil has been artificially raised by the addition of solid paraffin, which does not combine, but only dissolves in the oil, and may, under the action of heat, become reduced to a lower member of the series, and thus lower the resulting viscosity of the mixture. Any such alteration of viscosity may have been noticed in (1), but another way is to place a test tube of the oil in a freezing mixture, when the dissolved matter tends to come out of solution. Very thick oils are sometimes adulterated with lighter oils, such as kerosine, and this may, with familiarity with the clear red or yellow tinge of good oil, be detected by the opalescent greenish hue assumed by the oil under these circumstances.

3. *The flashing point* is practically defined by Act of Parliament, and the apparatus for the test has been standardised by the Board of Trade. For our purpose, however, a more satisfactory test may be made by finding the loss in the oil occasioned by free exposure to the air at a fairly high temperature, this, of course, giving an indication of the total volatility of the oil.

4. An oil which is readily oxidised will on exposure to the air form a skin on the surface. As, however, it would be a very bad lubricant with which this tendency was present to any appreciable extent, a more delicate test is necessary. This is to observe any rise in temperature which may take place when moderately dilute sulphuric acid is added to the oil.

5. This is essentially a chemical test. One method of procedure is to place a piece of copper in the oil and leave it for some time. The liquid is then transferred to a separator and shaken up with ether and dilute sulphuric acid. The latter mixture is then drained off, and if any of the copper had been taken by the oil its presence will be shown by the ether becoming blue when ammonia is added. In connection with this test it is a curious thing that animal and vegetable oils, when present in fairly small quantities as adulterations in mineral oils, attack metal more readily than in the pure state.

6. In this test the oil is allowed to burn in a small porcelain crucible, and mineral matter will be left as a residue when all the oil has burned.

In conclusion, it may be pointed out that as no oil is perfect the passing of oils for various purposes becomes, therefore, a question of carefully weighing advantages and disadvantages, and as such requires some little experience.—X Y. Z

*Answer to No.* 764 (*awarded* 7*s.* 6*d.*).—I have bought oils very successfully for many years for my machinery, and have selected from a great many samples. The chief tests I apply are simple and quick, but a little knowledge is more than advisable on the subject. To begin with, let us suppose a cylinder oil is to be submitted. Only samples should be admitted which are suitable for the pressure used in the steam cylinders. If a pressure of, say, 100lb. per square inch of steam is used, then an oil of high flash-point, such as about 600deg. F., should be sought; but with pressures of 50lb. and under a cheaper oil can be used. I prefer a black oil, but some people prefer an oil with a dark-green tinge. For high-pressure steam a pure mineral oil must be chosen, quite free from vegetable or animal or fish oil, as these would be decomposed by the steam. The first thing I do is to take a very little of the oil between my finger and thumb and start rubbing them together. If the oil is good it will work easier as it gets warm, but will not lose its body or consistence, and consequently my finger and thumb will not touch each other. If the oil gets thin and watery, I reject it. I now get a chemical test tube at a cost of 1d., and put oil into it to a depth of 1½in. to 2in., and heat it considerably over a flame. A good oil gets thin and mobile with the heat, but on cooling resumes its former consistency, and is none the worse for the experiment, but a bad oil will crackle and spit as it warms in an alarming way—at all events, at first. Then on cooling it will often show brown lumps, and will even refuse to run out of the tube when it is considerably tilted. Such a bad oil blocks the lubricators, and is apt to be a nuisance. I suppose the brown lumps are more or less adulteration. A good oil will smell the same before and after this experiment, but a bad one will change its odour, and will froth long before it begins to boil. I have given up taking the specific gravity, but I have had good oil at a gravity of 897 and bad oil at ·878. I also have a special bearing which I know is apt to be troublesome, and I put the sample of oil on this, noting how many drops a minute are required to keep it cool, and I find this a very excellent means of comparison.

For an oil to lubricate machine bearings I employ exactly the same tests and ignore the specific gravities, but I have never known any of them turn brown and lumpy by heating. Their chief fault seems to be loss of consistency by rubbing between finger and thumb, and another thing to look out for is a hard watery feeling. Oils with these defects are useless on heavy fast-running machine bearings. The best test, by far, is to put them into a sight-feed lubricator and try them on the special bearing above mentioned, and to note the number of drops used per minute to keep the bearing cool. These oils are generally of a brown or yellow colour, and are apt to be adulterated with paraffin oil to make them thin and cheap, but this "oil" is useless on bearings as a lubricant, and it may be detected by its peculiar blue tinge known as its "bloom," which can be easily seen when the sample is put into the test tube. These oils are also apt to contain vegetable oil, which may be considered a disadvantage, because then they are gummy, and make the bearings, etc., sticky and dirty. Gumminess may be detected by letting the oil flow very slowly down a slightly inclined plane of glass or bright metal in a warm atmosphere, or it may be allowed to siphon over its containing vessel by means of a single strand of worsted, which will become sticky in a day or so if much gumminess is present.

The only other test necessary is to put a bright piece of steel into the sample of oil and leave it there. If the oil is acid, the steel will rust in a few days, and, of course, the oil which rusts the steel will also rust the bearings of the journals, piston rods, cylinders, etc., but it would have to be a very bad sample of mineral oil to behave in this way. As mineral oils have now almost entirely superseded vegetable and animal oils for lubricating heavy machinery, and are cheaper and better, nothing further than that already said above need be mentioned about them. These oils turn rancid and gummy, and should then be refused, because they are acid when rancid, and are dirty and unsatisfactory when gummy.

Any reader wishing to pursue the subject further will find interesting information in the "Questions and Answers" columns of the *Electrical Engineer* for Feb. 28, 1902.—F. G. A.

*Answer to No.* 764 (*awarded* 7*s.* 6*d.*).—Although many ingenious pieces of apparatus have been invented for the purpose of testing oils, they require some considerable experience to get reliable results. The majority of practical engineers either rely on a cursory examination, or, if instruments are employed, they are for the most part of a very simple character. To explain what is meant by a cursory examination, the writer often tastes a sample of oil, by which a fair guess as to its composition and acidity can be obtained. To get an approximate idea as to its "body," take a pinch between finger and thumb and rub together. After a short time oil that is deficient in body will not only lose a great part of its greasy feeling, but may even give a rasping sensation. In order to perform a more satisfactory series of tests, the following are suggested:

*Specific Gravity.*—This very useful test may be taken by pouring some of the oil in a test tube and using a hydrometer. The hydrometer for the purpose should read from ·7 to 1. For very thick oils a specific gravity bottle is sometimes employed. The specific gravity bottle has a glass stopper, through which is a very fine hole; the bottle when filled with distilled water and then carefully wiped weighs a known amount. By filling with any other liquid and weighing, we are therefore enabled to obtain the specific gravity of that liquid. A suitable cylinder oil should have a specific gravity of about ·895, while castor oil is about ·966. Specific gravities of oils are usually taken at 15deg. C.

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*Viscosity*.—This is sometimes of very great importance. For instance, many otherwise good lubricating oils are so thick that when used on bearings having rotating ring oilers they prevent the rings from turning, thus putting a stop to the flow of oil. A good piece of apparatus with which to obtain the relative viscosity of oils is a glass tube having a small hole at the bottom. The oil drops through this hole, and the time is noted during which the surface of the oil in the tube falls through a certain distance. Another and quicker method is to place some oil in a test tube, and in this place a smaller tube loaded at the bottom. The time taken by the small tube to fall to the bottom of the larger one is then noted, and from this the viscosity is deduced. The temperature must be carefully taken, as oils do not by any means change in viscosity equally with the same alteration in temperature.

*Acidity*.—This is generally found by means of blue litmus paper, but some prefer to note effects when the oil is placed in shallow copper saucers. The latter method will show acidity, if present, by the formation of salts of copper; it will also enable an opinion to be formed of the tendency of the oil to "gum."

*Gumming*.—One method is to measure the distance a drop of the oil will trickle down an inclined clean glass plate in a given time. Another is to place a small weighed quantity in a watch glass, and after, say, 24 hours, weigh again and obtain the loss by evaporation. The tackiness and any tendency of the oil to gum must be carefully noted.

*Flashing Point*.—The temperature at which an oil gives off inflammable vapour is another test. A good cylinder oil should have a flashing point of at least 200deg. C. For delicate tests elaborate apparatus is necessary, but the following will usually satisfy an engineer. Half fill a porcelain crucible with the oil and place over a Bunsen burner, place a thermometer in the oil and note the temperature when the vapour given off by the oil may be ignited by a match. This is, roughly, the flashing point. In order to test the lubricating properties of an oil for journals, etc., some form of testing machine is necessary. One satisfactory contrivance has two discs which may be brought together as desired with an adjustable known pressure. By this means one is enabled to obtain the coefficient of friction of the oil.

As the testing of oils is really a series of comparative measurements, great experience is necessary in order to form correct conclusions, also it must be remembered that an oil unsuitable for one purpose may be particularly satisfactory under other conditions.—M. M.

*Answer to No.* 764 (*awarded* 5*s*.).—Oils used for lubricating purposes may be tested for acidity, viscosity, and solidification.

*Acidity*.—A simple test for this is to take a piece of sheet copper and carefully clean it with fine white sand until a perfectly bright, clean surface is obtained. Now smear the oil to be tested over one-half of the surface of the copper. After a short time wipe off the oil with a clean rag, and note the difference in brightness of the two halves of the copper surface. In order to compare different oils, streaks of oil may be placed side by side on the same piece of copper.

*Viscosity*.—A rough idea of the "body" of an oil may be got by dipping a finger in the sample and "feeling," by rubbing finger and thumb together. The viscosity of an oil may be tested in the following way. Procure a circular vessel, as shown in Fig. 1, about 3in. diameter and 5in. or 6in. deep, fitted with stop-cock, as shown. Suspend across the mouth of the vessel a point gauge having two pairs of points, $a$ $b$, and $a_1$ $b_1$. These points are directed upwards, as shown in the figure. The method of using it is as follows. The cock being closed, and the point gauge in position, a sufficient quantity of the oil to be tested is poured into the vessel to cover the point $a$. The cock is now opened, and the level of the oil falls, thus discovering the points $a$, $b$, $a_1$, $b_1$ in succession. The points will show quite definitely when the oil has fallen to their level. The time, in seconds, is noted between the points $b$ and $b_1$. The points $a$ and $a_1$ are only intended to act as warning points to $b$ and $b_1$ respectively. The test should be repeated a few times and the mean taken. The vessel should now be cleaned out with paraffin oil, and the test repeated, using water as the liquid. The viscosity of the oil compared with that of water will be directly proportional to the time taken in the two cases. Lamansky, in "Dingler's Polytechnische Zeitschrift," gives the following viscosities relative to water:

| Oil tested. | Viscosity (relative) (Water = 1 at 20deg. C). |
|---|---|
| Cylinder oil | 191 |
| Machine oil | 102 |
| Olive oil | 22 |

The Lahmeyer Company make an apparatus for testing the frictional coefficient of different grades of oil at various temperatures.

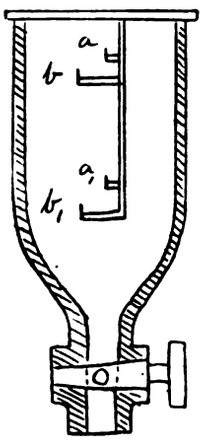


FIG. 1.

*Solidification*.—Take two polished iron plates and lay them together, with a little oil between. Should the oil be liable to solidify it will be found, after a short time, that it is difficult to move the iron plates against one another. If, however, it is found that the oil easily withstands this test, especially after being in stock a few weeks, it will be fairly safe to order the oil wanted.—L. S.

**Electromagnets in the Surgery**.—A writer in the *Scientific American* describes a large electromagnet constructed by him for uses which, save in respect of optical work, appears to be novel. It occurred to Dr. F. M. Wilson, of the Bridgeport Hospital, Conn, that the practice of oculists in using magnets for extracting particles of steel or iron from the eyes might be greatly extended. At his request the author of the article in question designed an electromagnet with a core 4ft. long and 6in. in diameter, insulated with special cartridge paper. A current of 30 amperes at 110 volts has in general been found the most suitable. One end of the magnet is placed in proximity to the part of the body affected, when, as the author naïvely expresses it, "the presence of the piece of steel or iron will be immediately felt by the patient, because of the magnet's attraction." Some remarkable instances of treatment by this method are given, amongst which may be noted a case in which a piece of a hammer-head had been driven into the muscles of the upper arm, and another in which a piece of a chisel had become embedded in the forearm. The surgeons advised no operation, trusting that the pieces would work out of themselves; but, instead of this, the wounds festered, so the magnet was tried. The result was completely successful, the pieces immediately appearing on the magnet. Similar success attended the extraction of a chip of steel that had been embedded in the palm of a man's hand for 1½ years, another piece of steel that had been in the back of the hand for seven years, and a broken sewing needle that had caused much pain. In all these cases the particles appear to have made their exit through the channel by which they entered, and without any surgical operation. The physician has often been aided by electrotherapeutics, and it looks as though magnetism is coming to the assistance of the surgeon. Especially in military hospitals should the new method be of value, in order to remove pieces of shell and steel bullets.

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## QUESTIONS AND ANSWERS.

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Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

772. In testing a short length of triple-concentric, lead-sheathed cable with a Silvertown set battery, volts 200, no deflections were obtained on the galvanometer unshunted, ·23deg with 100 shunt through 50,000 ohms. On testing the same cable with an Evershed ohmmeter set, the following readings were obtained: + to −, 40 megohms; + to ⌒⌣, ∞; + to lead, ∞; − to ⌒⌣, 5 megohms; − to lead, 50 megohms; ⌒⌣ to lead, 5 megohms. What is the reason for the differences?—E. H. H.

773. A quantity of lighting cable (200 volts, say) is suspected of being largely composed of reclaimed rubber instead of pure. Is it possible to decide the point, naturally without referring to the makers, and what would be the effect on the cable were such found to be the case?—R. R. R.

### ANSWERS.

*Question No.* 765.—Explain some simple and effective system of recording on which side of a three-wire supply any new consumer must be connected, giving details as to how any probable out of balance may be quickly looked up for any particular district.

*Answer to No.* 765 (*awarded 7s. 6d.*).—The answer to this question resolves itself into the best ways of balancing consumers one against another on a three-wire system, and therefore the methods by which the out-of-balance current flowing into the neutral main can be found at any time on any particular part of the distributing system, with a minimum of time and trouble. In the writer's opinion it is advisable to have at each feeding point a feeder pillar standing above ground, with 'bus bars inside, off which are tapped the various distributors through switch fuses of the Bates type, the middle wires of the various distributors being brought on to the neutral 'bus bar through links. In this pillar, on the back of the marble panel, can be placed a maximum demand current indicator, or a recording ammeter with a plug which can be connected in series with any one middle wire of any distributor in place of its disconnecting link, and thus the out-of-balance current will be registered continuously. The instrument can also be connected in series with any + or − outer of any distributor, and in this way it is easy to find the amount of out-of-balance current on any side of any length of distributor main, and so arrange consumers to the best advantage (see Fig. 1).

There is another way of finding the out-of-balance current, and that is by substituting for the ordinary middle-wire link (and for the outer links if thought desirable) in the distributor disconnecting boxes a special link with a known resistance. This link has at either end small holes, into which are plugged a special portable direct-reading ammeter, so calibrated in regard to the link (which is practically a shunt to the instrument) that it reads direct in amperes the current flowing through the link. The so-called ammeter is, of course, in reality, a milli-voltmeter, as it records the drop across the link at varying currents, but it is calibrated to read the amperes flowing upon which the drop depends. This instrument can readily be used at any disconnecting box, and gives the out-of-balance current flowing at the time. I believe this idea is patented by Mr. Cooper, of the Reading electricity works (see Fig. 2).

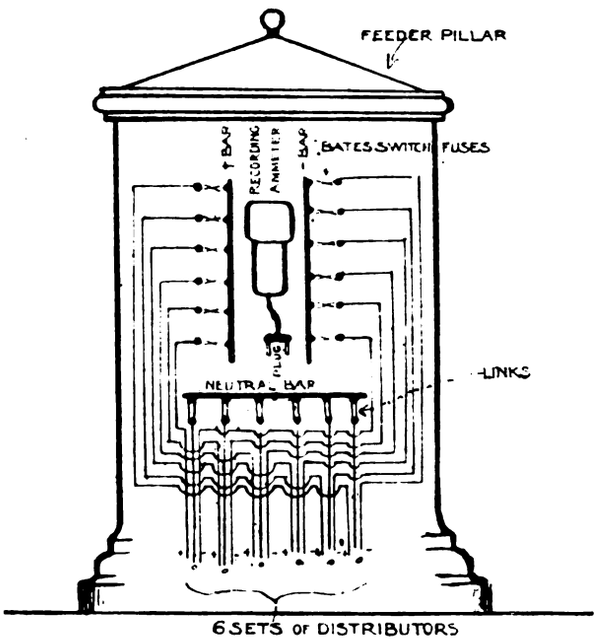


FIG. 1.—The Recording Ammeter can be plugged into any circuit (pos., neg., or neutral) in place of a switch fuse or link.

It is useful to keep at the station a large plan of the whole of the district (fixed on the wall for easy inspection), and have each consumer marked on same with the number of 8-c.p. lamps installed, those consumers on the positive side marked in red and those on the negative side blue.

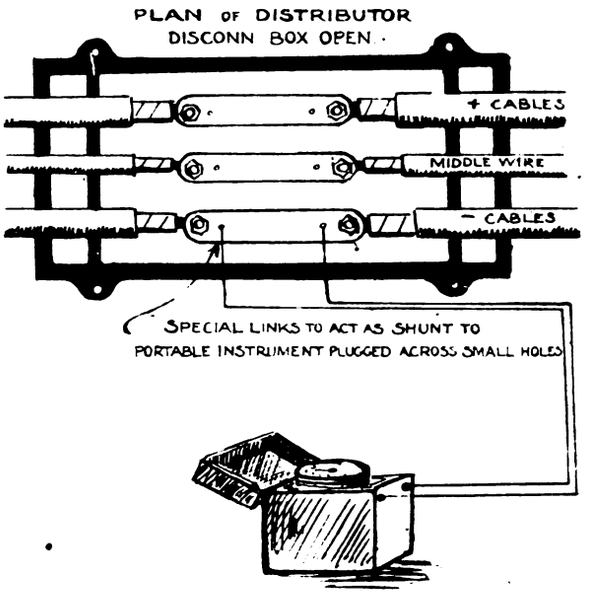


FIG. 2.

It is then easy to see how many lamps are connected on each side of the system on any particular distributor, and gives an indication of the side to connect future consumers.—DUPLICATOR.

*Answer to No.* 765 (*awarded 7s. 6d.*).—In connecting consumers to a three-wire system, it is necessary to give careful attention to the local balance in each street, otherwise there might be large local out-of-balance currents, causing bad regulation, when the balance recorded at the generating station is very good. To obtain good results, it is necessary to balance against each other those consumers having the same class of business. It would be very inferior practice to balance hotels against shops, or churches against

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street-lighting. To keep a check on the local balance, the writer recommends a system of diagrams, which enable the mains superintendent to see at a glance the probable local conditions in any street and the side of system to which any new consumer should be connected. The local balance diagram book is ruled as shown in Fig. 1. It has a page for each street and for each side of streets where mains run along both sides. Each page of this book has diagrams for different classes of consumers, as shown. It may be divided into as many classes as the user finds convenient. The thick lines denote perfect balance in each class; out of balance to the positive side is set off above, and to negative side below them. As all consumers are liable to overlap on winter evenings, a diagram showing the effect when all are on together is drawn at the foot of page for each street.

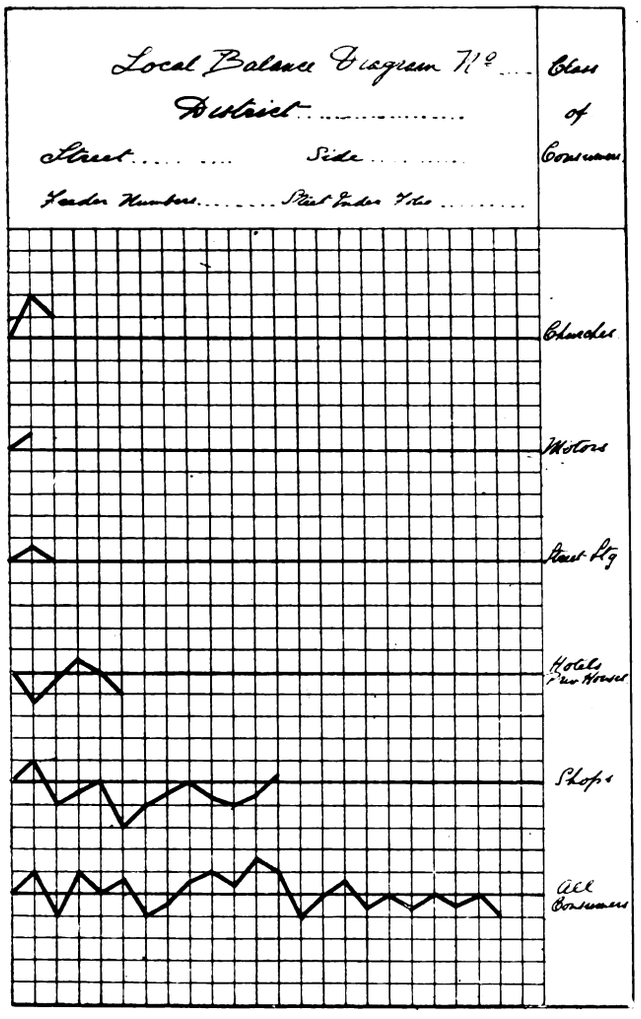



FIG. 1.

To keep the balance on the whole system good, another set of diagrams for each class of consumers should be kept, with every consumer in the area of supply entered thereon, and one showing the effect when all consumers in the area are on at the same time. The object in view when following these diagrams is to keep the out of balance for each class of consumer, both locally and over the whole system, as small as possible, and to so arrange it that when the loads overlap the out-of-balance currents due to different classes of consumers neutralise each other. The method of working is as follows: When a new consumer—say a shop—is to be connected, the mains man turns up the diagram for the street in which the connection is to be made, and looking at the diagram for shops, at once sees whether the out of balance is to positive or negative side. The new consumer is connected on the side that will improve the balance, and a line drawn on the chart for shops, showing the effect. At the same time a line is also drawn on the chart showing the balancing of shops over the whole area, and on the charts showing local out of balance, and total out of balance when all consumers' loads overlap.

To put the diagrams in use for the first time, it is advisable to make out lists of all the connections in each street for each class of consumer, and calculate the probable out of balance for each class. The diagrams are then started from these particulars, a mark being made on each chart. A little intelligent study of the switchboard log will show whether the different classes of consumers are using their lamps in the same proportion to numbers installed on each side of system, and if this is not the case the balance can be altered accordingly.

CONSUMERS' STREET INDEX. No.....

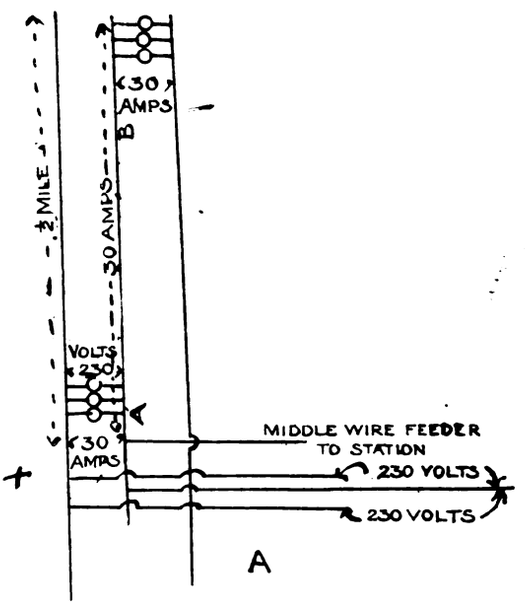
*Street*..... *Side*.....

| No. of application | Date of application. | Date connected. | Name and address. | Business. | Lamps connected. + | Lamps connected. − | Lamps disconnected. + | Lamps disconnected. − |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

FIG. 2.

In addition to the above diagrams, a book should be kept recording the connections in every street, ruled after the manner of Fig. 2. Apparatus consuming current from the outers should be shown in both positive and negative columns of this book.—T. R.

*Answer to No.* 765 (*awarded 7s. 6d.*).—No hard-and-fast rule can be laid down for equal balancing of consumers on a three-wire supply system, owing to the difference in consumption a consumer is likely to make even if the same class of trade be taken as an example. Your middle-wire ammeter is the best guide to good balancing; by this I do not mean your middle-wire ammeter which is fixed on your station switchboard. By observing this and this alone, you are liable to make serious errors owing to local out of balance, which would not show on this meter provided the sum total was equal on both sides of your system; of course, this would be less marked were you able to plug your ammeter on any individual middle-wire feeder. Let us take, for example, an instance where you are out of balance to the extent of 30 amperes on + side of your network, and 30 amperes out of balance on your − side half a mile lower down. Referring to sketch A, it will be




seen that the feeder being on the station side of your network and your pilots as well, no indication of anything wrong would show at the switchboard. The actual state of things would be this: on the + side you would have 230 volts and on your − side 230 volts less the drop in your middle-wire distributor between the point A and B. Sketch B shows a more extensive application of what the writer means.

It is the custom when balancing consumers to have a

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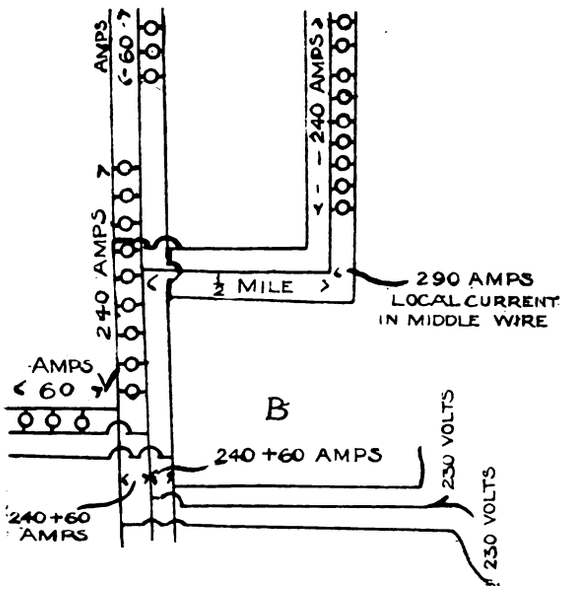
balancing book which gives you the side any consumer is connected to, which is handy for ready reference, as it is most essential that each street or district should be as nearly as possible balanced on itself. The writer has found it a good plan to put three-wire services in consumers' premises in all districts where a big demand is made. These precautions do not cost much, as I find it little more expensive to put in a three than a two wire service,




and an advantage which far outweighs the convenience, as this comes in not only in the balancing of consumers, but in case of a fault on either outer developing consumers can be changed over till such times as it is convenient to locate the fault.—W. F. S.

*Answer to No.* 765 (*awarded* 5*s.*).—Obviously the best way, or at any rate the simplest method, of ascertaining on which side of a three-wire supply system it is best to connect up a new customer, so as to improve the balance in that neighbourhood, would be to refer to the log book in the station on the switchboard. In this it is usual at stated intervals to jot down the machine currents and also the currents on each side of each outgoing feeder, the out-of-balance amperes on each feeder, the resultant out-of-balance current, various voltages, etc. A little judicious consideration of the position on the network of the new consumer and the out-of-balance currents on the nearest feeder or feeders, will indicate on which side of the system in that neighbourhood is the heavier load, and then naturally the new consumer will be connected on the lightly loaded side. I am well aware that such a thing has been known as the log to be cooked up, but still, even then, the attendant on the switchboard would in all probability have cooked it up, making the general idea as to the load on each side approximately correct.

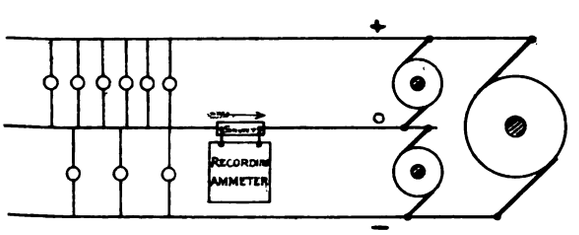



FIG. 1

Another method which could be adopted would be to instal recording ammeters in the neutral wire to show the out-of-balance current. According to how this is connected up, and which side of the central zero the curve usually lies, will be the indication as to which side is taking the bigger current, and then the new consumer should be put on the other side. Fig. 1 will explain the connection of this instrument, and the explanation is this. Suppose the positive side to be taking the bigger current, then the direction of the current in the middle wire will be that shown by the arrow. This current will cause the pen to deflect to one side of the central zero line. If the negative side had been taking the greater current, the direction of the current in the neutral would have been opposite to that indicated by the arrow, and hence the deflection of the recorder pen would have been to the other side.

A third method I should suggest would be to instal recording voltmeters in various parts of the network. These can be had wound differentially with two coils with a central zero, and if connected up correctly the pen will be on the zero line when the voltage is the same on each side of the system. If the pen is not on the zero line, but one side of it, it indicates that on that side of the system there is a greater difference of potential between the outer and the neutral than on the other side. Now, by Ohm's law it can be shown that the side with the fewer lamps on, and therefore the greater resistance, will have the greater voltage across, and hence the new consumer must be connected on the side that has the greater voltage across the outer and the neutral. This matter of the voltage on each side of a three-wire system has been discussed several times lately in these columns, that I think I hardly need go into it once again, but refer "Mains" to my answer to Question No. 745 published in the *Electrical Engineer* for Jan. 6, 1905, wherein I have discussed it fully. Instead of the expense of permanently installing several of these instruments on different parts of the network, no doubt a portable instrument wound and connected in this manner could be obtained. Readings of the voltages at different parts of the network could be taken by a man with one of these instruments at times of the peak load, and these records could be kept for reference, and would be useful at such a time as we are considering. The readings, however, should be taken at points remote from the feeding points, so as to obtain the maximum out-of-balance effects. Readings such as the above might be taken, say, once a month, which I think should be quite often enough.

With reference now to which of the above four methods I think best, I think the last is the best. The first method costs nothing, but only a rough idea can be obtained. The second method, with the neutral-wire ammeter, will also only give a rough idea very similar to the first. The recording voltmeter way is much better, and if enough of them are installed in different parts of the network remote from the feeding points a very definite conclusion can be arrived at. Against this, however, must be put first cost, and the bother of rewinding, inking, etc., of the instruments every day or so, and therefore I should recommend the adoption of the last method indicated with the portable "out-of-balance" voltmeter as being the cheaper and giving the best results.

If it be desired to come to a decision as to which side the consumer is to be put on without the use of any instruments, the best way will be to refer to the large scale map there will probably be in the station showing the positions of all the mains and the consumers. If this be kept well up to date, it may be possible to roughly judge which side is the heavier loaded in any locality, and then the consumer can be connected on the other side.—E. R. ALEXANDER

*Answer to No.* 765 (*awarded* 5*s.*).—The careful recording of particulars about consumers supplied from three-wire systems is most necessary if satisfactory lighting is desired. If the system be not well balanced there will be constant complaints of bad lighting, and consequently the use of electricity will not increase rapidly in the district. Out of

Date.....

| Name of feeder. | 12.30 | | 1.0 a.m. | | 1.30 | | 2.0 a.m. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | + | − | + | − | + | − | + | − | | | | |
| | | | | | | | | | | | | |

FIG. 1.

balance may exist which never shows on the feeder ammeters in the station It is advisable at certain periods for the switchboard attendant to take half-hourly readings of the feeder ammeters for a week and lay the results

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before the mains engineer. He will be able to see in what district and at what time any out of balance comes on, and by referring to the consumer's street index will be easily able to locate the cause of this out of balance, and make a note that the next new customer in a certain class of business must be added to one side of network. A suggested sheet for taking ammeter readings on is shown in Fig. 1, and the consumers' street index kept by the mains department in Fig. 2.

Name and side of street.....

| Date of application. | No. of application. | Name and address. | Business. | Demand in amperes on application. | | Yearly maximum demands. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | + | − | 1905 | 1906 | | |
| | | | | | | | | | |

FIG. 2.

The business of the consumer is a very important point to consider. Small workshops require the lights in the early morning, while public-houses, restaurants, and places of amusement late in the evening. Banks and offices only require light during the daytime, and shops until a certain hour in the evening. It would be absurd to connect a public-house to one side of a system and a workshop on the other and expect them to balance each other, supposing them to both require the same current. Each class of consumer should, if possible, be balanced with a consumer of the same class. Of course, premises requiring a large amount of current cause no trouble, for they are internally balanced, being supplied from both sides of the system. Any consumer requiring above 20 amperes should be supplied from both sides of system. It will not be so difficult to arrange consumers in the manner described as appears, for a certain class of consumer is generally found together. In one street there will be only private house lighting, while in another it will be chiefly shops, and so on. If the consumers' street index consists of sheets alphabetically arranged on a file they can be easily referred to, and in the case of much alteration in the arrangements in a certain district new sheets can be prepared to take the place of the old and inaccurate ones.—RESEARCH.

*Question No.* 766.—A central-station engineer of good experience and ability in running steam-driven stations is appointed to take charge of a plant driven by three-crank vertical high-speed gas-engines, direct coupled, and fed from gas producers. What are the chief points he should watch in order to run with the lowest possible amount of coal per unit generated, together with freedom from breakdowns and a light maintenance bill?

*Answer to No.* 766 (*awarded* 7*s.* 6*d.*).—Having held a similar position with same class of engines and gas producers, I mention a few things that it is important to watch.

1. See that your gas producers are kept clean, that they are fired regularly so as to keep the burden at a uniform height, that the peas used are perfectly dry, and that the generators are not blown excessively. Your sawdust in purifying boxes is well if changed once a month, and also clean grids at top of scrubbers weekly; this will enable you to make good *gas*, which, if so, will burn a light-blue colour with slight orange tip at top of flame.

2. Now, *re* your engines, you will be fortunate if you do not at times experience trouble. This may be classed as (1) back-firing, (2) pre-ignition, (3) mis-firing.

Back-firing may be caused by the charge having failed to ignite in the cylinder, and afterwards is exploded in the exhaust by the hot products of another explosion from another cylinder; or that the exhaust valve is not blowing properly, causing part of charge to be pushed by it instead of being compressed, and the explosion then travels from cylinder to exhaust pipe. The remedy for this is attention to ignition to ensure gas charge being properly burnt and attention to valves.

By pre-ignition is meant that the charge is by some means becoming ignited earlier than it is timed to do. This may be caused by the presence of carbon on top of piston block (a common occurrence in this class of engine). This becomes hot due to explosions, and, of course, fires charge too early sometimes. When the charge is entering by way of inlet valve, and often when compression is taking place, you will observe the latter by putting your ear to cylinder and observing a whistling noise, together with a lurch of your engine. The remedy is a clean piston head. Another cause of pre-ignition, and a very important one in this class of engine, is the leakage that often takes place under the seat of cover of inlet valve. When replacing this cover, you must be extra careful to see that the seat is perfectly clean, otherwise you will have considerable trouble, as this explosion takes place in mixing chamber, and at times it contaminates the mixture to the other cylinders, thereby causing a shut-down.

Mis-firing is often caused by failure of supply current. This is best obtained, if possible, from a set of accumulators. Then, of course, the igniters are likely at times to become grounded. This will at once shut your engine down; also the igniter stems require to be kept well ground in to prevent leakage, as if this takes place the stems become hot, causing them to stick. Keep points in good condition. Also, another point to be fully observed when running is the temperature of your engines. This is best at about 100deg. F., as if engine is run too cold sweating takes place, causing various troubles.

With regard to obtaining best results with your charges, this is obtained by firing your engines exactly at the proper time. This is best ascertained by means of indicator and diagrams; at the same time you may judge also the best mixture to use when running under load. The usual time of firing is between 20deg. to 30deg. in advance of crank, and the mixture to use is about 1 of gas to 1·5 of air; this I have found gives good results. *Re* all mechanical work, similar to steam-driven sets in repairs, etc.

In conclusion, I may say if you pay attention to the few points I have mentioned, you will be able to run your station well and reliable and also obtain good results. You will have a freedom from breakdowns and not a very large maintenance bill. As you admit your experience in gas-engines has been rather limited, I would advise you to proceed cautiously *re* making any alterations, and to read up at once any good work dealing with combustion engines in general.—S. H. L.

*Answer to No.* 766 (*awarded* 5*s.*).—In reply to "Silica," the following hints may be useful. First, with regard to the engines. The sparking plugs should be examined daily, and, if necessary, cleaned, as these are liable to get dirty and cause miss-fires. It will also be found that a certain amount of coke dust will be blown through with the gas, which collects on the mixing valve, inlet valves, and on top of the pistons. This should be cleared away about once a week and the inlet valves ground in, or pre-ignitions and back-fires will be caused. Oil in the crank chamber should be kept at a fixed height (the height being fixed by the makers) or it is liable to be sucked into the cylinders, where it gets carbonised and causes pre-ignitions. This oil will probably require filtering about once every three months. The settings of the valves should occasionally be examined, as they are liable to alter, and much trouble has been occasioned by one inlet valve not closing at the proper moment. Of course, there must be a plentiful supply of water to keep the cylinders cool.

With regard to the generators, if clinker is formed, it should be removed daily. The best gas is obtained when a level fire is kept with no holes in it, so that the stoker should bar down about every half-hour. The fire should also be kept as near as possible to one fixed height. With these precautions the writer has obtained as low a value as 1·8lb. of coal per unit generated. The best proportions for the gas are: $CO_2$, 6·8 per cent.; CO, 19·22 per cent; H, 19·24 per cent; O, a mere trace.

If these hints are followed out, "Silica" should obtain good results, with low maintenance and coal bills and few breakdowns.—R.

[Other replies to Question No. 766 will be given in our next issue.—ED. *E. E.*]

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Supplement to "The Electrical Engineer,"
MARCH 31, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

774. In a description of the electrification of a railway in France some weeks ago, rotary converters were mentioned as running compounded with the series windings opposing the shunt. Explain how such machines work, and give any advantages which they possess over ordinary compound rotaries.—G. J. R.

### ANSWERS.

*Question No.* 766.—A central-station engineer of good experience and ability in running steam-driven stations is appointed to take charge of a plant driven by three-crank vertical high-speed gas-engines, direct coupled, and fed from gas producers. What are the chief points he should watch in order to run with the lowest possible amount of coal per unit generated, together with freedom from breakdowns and a light maintenance bill?

*Answer to No.* 766 (*awarded* 7*s.* 6*d*).—It may be assumed that the plant in charge of the engineer is modern, and that the question refers simply to actual running charges apart from any alterations or additions to the existing plant. Considering first the engines, the first point requiring particular attention is the relative volumes of gas and air. If too much air is supplied, the gas drawn in is necessarily too little, and the engine capacity is lowered; if too little air, there is an excess of gas, and thus a surplus unconsumed each cycle, and a consequent loss of economy. It is therefore incumbent that the air supply be so adjusted that the proper proportions of gas and air are mixed in the chambers, and if the gas varies in quality, the proportion of air must also be varied.

Compression and the clearance between cylinder head and piston is the next important point, and the higher the compression, and consequently the smaller the clearance, the more economic is the engine. The most economic compression consistent with safety from spontaneous combustion being arrived at by careful testing, the engineer must see that his clearance is maintained unaltered.

Premature ignition must be avoided, and the igniter must be watched. If electric, a reversal of current periodically reduces the wear on the terminals, and of course, if possible, spare breakers should be installed. The ignition time must be kept correct and constant at the point just when the piston is about to begin its stroke after compression. The exhaust valves must be adjusted to clear the cylinder and close promptly. Naturally, the wear on the main bearings is great and the alignment of the engine and machine bearings should be periodically tested and adjusted. The water supply must be carefully watched and an adequate amount allowed, the cylinder jackets must be efficient. To advise a competent engineer that periodic indication of the engines and analyses of the gas are necessary is superfluous.

The producer plant requires more care than is generally given it—the method of stoking, cleaning out of ashes, and blast being matters of paramount importance. The coal costs depend primarily on the quality and cost of the coal. A free-burning rough slack of only slight caking qualities—not a coking coal—is to be sought, one with 5 per cent. of hydrogen to 60 or 70 per cent. carbon would be good. Ash and moisture to 25 per cent.—if the coal be cheap—is not detrimental, for good gas can be obtained from such a coal. The gas should be clean as delivered to the engines, and care must be taken in such cleaning. Tar must not be delivered to the engines, and the gas should be carefully washed and filtered. Washing must not be done until the gas be cooled—this is done partly by a regenerator and finally in a cooler; coolers and filters must be kept clean. By-products may be worth recovery, and the residues are ofttimes readily saleable. Works costs from three gas-power stations averaging 446,000 units each per annum, and from six steam-power plants averaging 350,000 units, are given below, and it will be seen that while coal and maintenance are nearly equal in the two systems, oil, etc., and wages are higher for gas than steam. Theoretically, coal and wages should be lower for gas than steam, and an up-to-date plant will probably give a reversal of the figures given.

| | Coal. | Oil, etc. | Wages. | Repairs. |
|---|---|---|---|---|
| Gas | ·62*d*. | ·18 | ·46 | ·22 |
| Steam | ·59d. | ·07 | ·38 | ·24 |

—S. E. T.

*Answer to No.* 766 (*awarded* 5*s.*).—It is but a few years ago since engineers, as a rule, only considered the gas-engine as a makeshift for the more familiar and better understood steam-engine; at present, however, the gas-engine is better appreciated. Electrical plants are now run satisfactorily by means of gas-engines, although undoubtedly more care and attention is necessary than when steam-engines are employed. The writer, when first placed in charge of a gas-driven plant, felt very diffident as to the behaviour of the engines, but careful study of their idiosyncrasies changed that diffidence into confidence. Perhaps the recounting of a few of the difficulties that cropped up may be of service to the querist. Without exaggeration, I can say that at least three-fourths of these troubles were caused by faulty ignition. Having had experience with both hot tube and electric ignition, the latter method has proved the most reliable. Taking the hot tube first, in the case of miss-fires it will often be found on examination that the tube is insufficiently heated. The Bunsen burner should be turned up or down as may be required—the flame must be at just the right height in order to secure the maximum heating effect. Another cause of a poor heat is when the tube is not equally surrounded with the flame; this can easily be remedied. Ignition tubes are generally placed inside an iron case, the iron case being lined with asbestos millboard. This asbestos liner must be in good condition or it will be found difficult, if not impossible, to keep the ignition tube at the proper heat. The asbestos must be cut to fit, well soaked in water, and placed while wet inside the iron case; when dry it will be found to keep in its position perfectly. The care spent over fitting a new asbestos liner will be well repaid. When metal ignition tubes are employed, at the slightest sign of fracture a new tube should be fitted or the result may be a stop when under load. If porcelain tubes are fitted, the spare tube must always be kept in good condition. With electric ignition by batteries and induction coil all the parts must be kept in thorough order, and sparking points frequently cleaned. If a magneto is used, see that contact at sparking pin is good, and that the circuit is broken at the proper time, giving a good spark. With both these forms of electric ignition every care should be taken that the insulated wire is in good condition. A point that requires more care with gas than with steam engines, is the lubrication of the cylinders; a good mineral oil, and plenty of it, should be used. Oils that give an appreciable deposit should be discarded. Use fresh oil for the cylinders, afterwards filtering for use at bearings, etc., where the lubrication is not such an important matter as is the case with the cylinder. Such an arrangement will enable the engine attendant to use plenty of oil without making it come abnormally expensive. With some plants, the circulation of water round the cylinder is not all that might be desired; this must be watched, and the pipes kept free from any obstruction. Gas-engines

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do not generally stand an overload so well as steam-engines; it is, therefore, good policy not to exceed the limit oftener than possible. It will be found better practice to run four units at three-quarter load than three units at full load. There will be little more difficulty in running machines in parallel than if steam-engines were employed, but, of course, more flywheel power is necessary. Gas-engines are sometimes a cause of annoyance by reason of the explosions, but good silencers will reduce this to a minimum. When using town gas precaution must be taken to ensure a good supply; pressure gauges may readily be fitted on each engine. With producer gas the case is more in the hands of the engineer himself, and, given suitable fuel, ordinary care should leave little fear of a "shut down."

With regard to the station cost per unit, gas-engines have several advantages over steam-engines. The stand-by charges are lower, and they show a greater thermal efficiency than steam-engines. Gas-engines, however, unless carefully looked after, are likely to run up a heavy repairs bill, but this again is a point where the ability, or inability, of the engineer-in-charge will assert itself. Generally, the writer is strongly of opinion that where the performance of gas-engines is unsatisfactory, much is to be attributed to the want of skill of those in command. These engines demand greater and more skilful attention than steam-engines, but if that is accorded them, they will do, and do well, all that may reasonably be expected.—M. M.

*Question No.* 767.—An isolated three-wire network is fed from a sub-station by means of 100-kw. continuous-current transformers transforming from 2,500 to 440 volts. Two transformers are running at nearly full load, supplying the load and charging a battery at its normal rate—viz., 120 amperes a side—by means of a balancer booster fitted with shunt and series windings on the balancer fields. The motor and generator windings of the transformers are superposed, the high-tension winding being on the outside. These machines are self-exciting, shunt wound, there being also a high-tension series field for starting up, which is cut out automatically when the low-tension field is sufficiently strong. All machines and the battery are fused at about 200 per cent. overload. Under these conditions, if one of the transformer armatures breaks down from high tension to low tension, what will be the effect inside and outside the sub-station, and what approximately will be the extent of the damage?

*Answer to No.* 767 (*awarded* 10*s*).—The conditions given may be represented diagrammatically as in Fig. 1. It may be assumed that the middle wire of the three-wire network is permanently earthed, and then three principal cases can be distinguished.

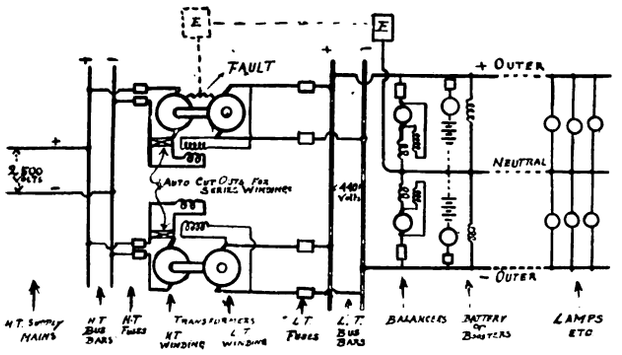


FIG. 1.

1. Should the fault in the transformer armature simply connect the high-tension and low-tension windings without putting them to earth, and should the high-tension supply mains both be thoroughly insulated from earth, no damage whatever need result, although the + and − low-tension outers would be subjected to a strain of $\frac{2,500}{2} = 1,250$ volts to earth (assuming that both high-tension supply mains have equal insulation resistances to earth) in place of their normal voltage of 220 to earth.

2. If the fault not only connects the high-tension and low-tension transformer windings, but also, as would most probably be the case, connects both of them to the armature core and so to earth, an intermittent short-circuit would occur, first on one side and then on the other side of the low-tension three-wire network. Every time the fault came under a low-tension + brush on the transformer the full 440 volts would occur between the middle wire and the negative outer, and at the same time the + outer and the middle wire would be short-circuited together, so that the + half of the battery would pass an excessive current to earth through the fault (see dotted lines in Fig. 1). In this way all the lamps on the negative side, and also the negative battery and balancer, would be subjected to 440 volts in place of 220 volts, and the + battery fuse and the + fuse on the low-tension side of the faulty transformer, as well as the balancer fuses, would be subjected to enormous currents. These effects would only occur intermittently, however, for when the fault arrived at a point midway between + and − low-tension brushes the normal state would again be reached, and, finally, when the fault reached the − low-tension brush the full 440 volts would occur across the + side of the network, whilst the negative outer and the middle wire would be short-circuited. This periodic action would repeat itself every time the fault passed from a brush of one sign to one of the opposite sign. In spite of the rapidly fluctuating nature of this voltage rise and overload, they would very soon lead to the burning out of all the lamps on the system, and the blowing of one or more of the fuses on the battery, balancers, and the low-tension side of the faulty transformer. So far the occurrences are only those which would occur on any ordinary low-tension three-wire supply if one of the main generators developed a fault to earth.

3. If, however, one of the high-tension supply mains (say the negative) is more or less earthed, and the transformer armature fault puts both high-tension and low-tension windings to earth as in (2), every time the armature fault reaches a + brush of the high-tension side of the faulty transformer, the high-tension mains will be more or less short-circuited (according to the quality of the earths on the negative and at the fault), and the high-tension fuses would very soon blow, though possibly not before the excessive current passing through the faulty high-tension winding had caused a flash over from + to − brush, and damaged the commutator and brush gear of that machine more or less. The excessive current passing through the earth on the armature would be sure to necessitate partial or complete rewinding of the armature. So long as the high-tension fuses did not blow, the occurrences described in (2) would also take place on the low-tension side.

In the rather unlikely event of the earthing of the high-tension and low-tension windings at the fault being imperfect, more or less of the full 2,500 volts would occur between the + low-tension outer and earth each time the fault reached a high-tension + brush, and this would probably cause serious damage to the insulation of the low-tension mains, and of the positive balancer and positive booster before the high-tension fuse had time to blow.—Q.

*Answer to No.* 767 (*awarded* 7*s.* 6*d.*).—Fig. 1 is a diagram showing the general arrangement of the connections on the high and low tension circuits, showing one complete transformer circuit, with balancer booster, etc. Under ordinary working conditions a current of about 40 amperes will flow along the high-tension cables, and one of 230 amperes along the low-tension of each transformer. In the event of a transformer armature breaking down from high tension to low tension, this means that the high-tension current has now a circuit of very low resistance to flow in. Consequently we have a very big rush of current taking place caused by this fault. Now, in the case of a fault occurring on a high-tension transformer circuit, it is necessary that the switch controlling that circuit should open automatically. Since the machines are set to 200 per cent. overload, this means that the switch will be carrying over three times its working current, and we shall have the contacts very badly burnt and require renewing. As regards the pressure on this high-tension transformer circuit it will not require to be considered, as since the transformer is running the switch will open the circuit, the pressure across the contacts being the difference between the high-tension 'bus bars and the back E.M.F. of the transformer. If the high-tension generators are working at nearly full load, we may have the extra high-tension current produced, causing the maximum cut-outs on the machines to act,

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thus cutting out the machine from full load to no load, and probably breaking down the armature owing to the high pressure developed, as well as doing damage to the switch and brush gear. These dangers can to a great extent be overcome by using switchgear of the Ferranti type (Fig. 2), where instead of the circuit being broken on the switch, it is broken by the copper contact, C, on the horns, the arc travelling upwards and gradually dying away.

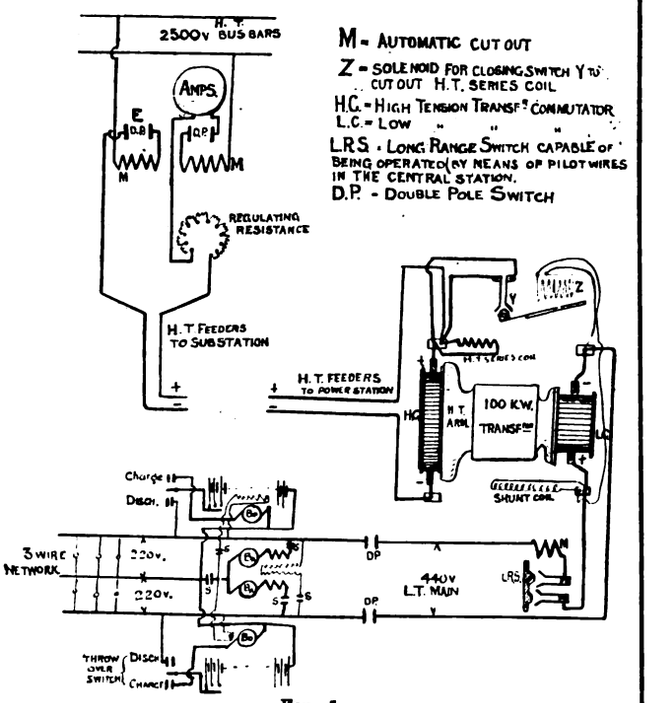



FIG. 1.

Turning to the sub-station, we find that the brushes and commutator on the high-tension transformer are very badly burnt owing to the excessive current (and the armature will require stripping and repairing), and that the pressure on the low-tension armature being practically six times the original (since the high-tension is now connected to low-tension), this without the heavy current may be sufficient to completely break down the insulation and earth it. This may probably be prevented by the maximum cut-out on the "long-range switch" picking up and breaking the circuit, and when this occurs it generally means that new

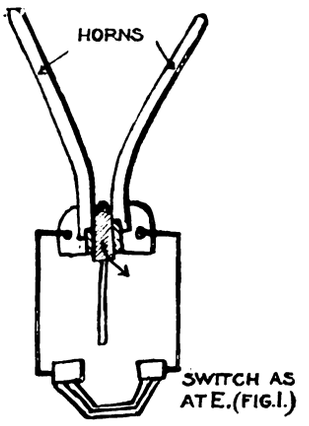
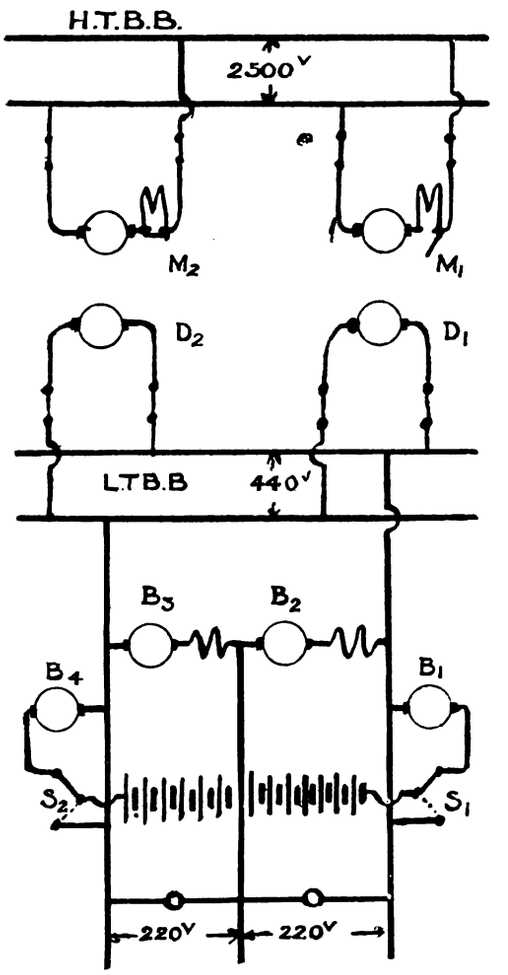



FIG. 2.

jaws, etc., are required on the switch; meanwhile we have the supply either cut off on the low-tension side (if the other transformer has cut out) or we have the pressure considerably dropped owing to the overloading of the other transformer, and the battery will discharge heavily through the boosters, and probably damage the plates or melt the connecting wires off. A lot depends upon the arrangement of the circuit breakers, as by these being properly set a lot of damage may be prevented, as the writer has known of cases where damage has been done which would not have occurred on later types of switchgear.—L. H.

*Answer to No. 767 (awarded 7s. 6d).*—To enable us to understand fully what is likely to happen under the circumstances mentioned, let us examine the sketch below. $M_1$ and $M_2$ are the high-tension commutators and series windings. The series windings are used in starting-up the transformer from the high-tension side, and when $D_1$ and $D_2$, the generators for the low-tension network, have started generating they are self-exciting, and supply the shunt current which passes through a solenoid, automatically short-circuiting the high-tension series windings. The compound balancers, $B_2$ and $B_3$, besides balancing the network drive the two battery boosters, $B_1$ and $B_4$, which are in circuit at the time, charging the two halves of the battery.

Suppose that the high-tension breaks down to the low-tension winding on No. 1 machine. The high-tension fuses of No. 1 machine would blow. They might blow before any further damage was done to the armature, but the chances are that the arc formed would earth the low-tension windings to the armature core. In the first case




No. 1 machine would probably simply run as a motor from the low-tension mains in the same direction as before. If, however, the low-tension windings were earthed, No. 2 machine and the battery combined would try at all events to blow the fuses of No. 1 machine on the low-tension side. We see that No. 1 machine would now either be running as a motor from low-tension side and giving no trouble, or all its fuses blown, making it completely dead. If the latter, the armature would be a complete wreck, owing to the large current that would flow before the large fuses would blow.

The two battery boosters, $B_1$ and $B_4$, are, or should be, fitted with automatic switches, $S_1$ and $S_2$, so that in case of an accident of any kind calling upon the batteries to discharge, the switch would automatically switch the booster off and drop into the bottom contacts, putting the battery straight on the line. If there is no device of this kind, the current will be flowing in the reverse direction through the battery booster armature, and as the shunt winding will remain the same, the booster will tend to run as motor in reverse direction, whilst the balancers

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are striving to run in the ordinary direction, with bad results for the battery booster. Besides this, the battery discharge may be so heavy as to seriously heat up the booster armature, which is only designed for a definite charging current. The result of the accident would be that No. 2 machine would be doing all the load, which would only consist of the outside load, as the battery would no longer be on charge, as the booster armature would probably be cut out when the accident happened, leaving the battery straight across the bars ready to help No. 2 machine if the line volts fall low enough.—RESEARCH.

*Answer to No.* 767 (*awarded* 5*s.*).—There is but very little chance of any damage being done by the high tension breaking down to the low, for it is practically impossible for the high pressure to find its way to the low-tension mains—that is to say, the P.D. between the low-pressure mains will always be dependent on $\frac{N n Z}{10^8}$, no matter whether the two windings are in contact or not—where N is the flux passing through the armature, $n$ the speed in revolutions per second, and Z the number of armature conductors in series on the thick wire winding. Imagine one of the high-tension conductors in contact with one of the low, then the whole of the low-tension winding will be raised to the potential of this particular conductor, and the high P.D. will exist, not between the two low-tension mains, but between the high and low. Suppose that two of the high-tension conductors break down to the low in different parts of the armature—a condition that is not at all likely to occur—then it is fairly clear that the high pressure will urge a current round the thick wire winding which will either blow the fuse or burn out the armature, but the pressure on the low-tension side cannot be raised to a dangerous value on account of the low-resistance circuit formed by the thick wire winding. The whole arrangement appears to be good, and there is no cause for anxiety with regard to the high tension breaking down to the low, but it is, of course, advisable to take frequent insulation tests, for the blowing of high-tension fuses and machines burning out are not things that are desired in connection with an electric lighting supply. Also, it should be remembered that if a conductor on the high tension comes in contact with one on the low, the consumer's fittings will have a high P.D. between the high-tension mains, and should there happen to be an earth on the high-tension side, anyone handling the fittings is likely to receive a 2,500-volt shock. A voltmeter or a batch of lamps connected between earth and the low-tension side would indicate when such a condition exists.—E. AUSTEN.

*Answer to No.* 767 (*awarded* 5*s*).—Very little data in connection with the type of switchgear used is given in this question, and therefore only an approximate idea can be given as to the extent of the damage done by the breaking down of high-tension to low-tension windings. We will, however, assume that maximum cut-outs are fitted on the high-tension switches, and long-range switches at the sub-station fitted with maximum and reverse current cut-outs on the low tension. The chances of a high-tension continuous-current transformer (with superposed windings) breaking down to low tension are very small, since so much attention is paid to the insulation between the two windings. I have, however, known one case where this happened, and the result was that the fact of breaking down had burnt the insulation of the low-tension winding, due to the shorting of the adjacent conductors, to such an extent that the low-tension winding broke down to earth. A case of this kind necessitates the rewinding of the armature, unless the fault be at the end of the core, and then may, perhaps, be rectified by splicing, but in any case the steel bands would have to be taken off the armature.

The most frequent trouble with transformers of this system is the low-tension winding shorting or breaking down to earth. One of the worst troubles in connection with the running of these transformers is the sparking and commutation troubles. Now, if only two machines are feeding an isolated network on full load, and one breaks down, it is almost a certainty the other one will suffer when it is called upon to do 100 per cent. overload, and probably do considerable damage to the brush gear, and in some cases have been the cause of breaking other machines down to the earth. This, however, can be greatly eliminated by having automatic devices on the switchgear. Fuses are not to be recommended for any work when this system obtains, as they are the means of fires in many cases, although at the time of the breakdown the balance booster would be charging; the latter is no doubt fitted to operate in such a case, and the battery would take the load from the network. The battery would not, however, last long, and unless some means obtain to connect up to another network, the sooner more plant was got up the better.—G. S.

*Question No.* 768.—It is required to establish telephonic intercommunication between eight huts on the banks of a canal. The huts are a half-mile apart. It is desirable to use as few wires as possible, any reasonable system of signalling being permissible. Can this be accomplished with two or three wires, nine being entirely out of the question?

*Answer to No.* 768 (*awarded* 5*s.*).—I notice that "J. H." asks in this question whether certain telephonic results can be attained by the use of two or three wires, at the same time qualifying this question by stating that it is desirable to use as few wires as possible. I may therefore state at once that all he requires can be attained by the use of one wire only, and in view of the above qualification, I shall not enter into the desirability of employing more than one wire. I have had the same number of telephones that "J. H." requires—viz., eight—working most successfully in this way for the last five years. They are used on an electric power distribution system for which I am responsible. Some of them are in a mine, whilst the others are scattered about, the distance between the two farthest apart from each other being about 2½ miles, though there is no reason why this distance should not be much greater. It will be seen, therefore, that the installation of telephones that I allude to is of nearly the same type as that required by "J. H.," and is used for the same sort of purpose.

The telephones should be of the magneto type, and should all be joined up in series by a single wire, and only the instruments at each end of the line must be earthed. Each station must have its own call signal. Thus the signal for No. 1 may be a single ring; No. 3, three rings; No. 5, five rings; No. 6, two long, two short; No. 7, two long, three short; No. 8, eight rings. This may appear complicated on paper, but in practice it is found to work well, and anybody concerned soon gets to know all the signals. If one station is more important than the others, it will probably be desirable to give it the simplest ring as its call. With this system there can be no secrecy, of course, but probably this is of no practical importance in an industrial concern such as "J. H." mentions. It may even prove an advantage at times, as it is always open for anyone interested to find out what is going on, and so keep himself up to date without necessarily troubling other stations by calling them up. For instance, it often happens in the working of the power plant mentioned above that the engineer is at one or other of the telephone stations and hears another station being called up. If he is interested, he can take the receiver off his telephone without in any way interrupting the other stations, and listen to what is going on. Sometimes he may replace the receiver without remark, or at other times he may break into the conversation with advantage. Again, A may be talking to B and it may be desirable to obtain certain information from C before A finishes his conversation with B. C is called up therefore, and then A and B hear simultaneously what he has to say, and the conversation can be carried on between all three, thereby saving time and trouble.

I may add that on the system I have described above there are two branches, of half mile and 1½ miles respectively (with three telephones connected up), which are not permanently in circuit, but they can be "put through" when required. If "J. H." has any difficulty in carrying out the above suggestion, and will communicate with me, I shall be willing to assist him, if possible.—T. P. O. YALE.

[Other replies to Question No. 768 will be given in our next issue.—ED. *E. E.*]

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APRIL 7, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

### QUESTIONS.

775. A leading stoker in a certain central station is suspected of inefficiency. How can I tell whether he is getting the full duty out of his working boilers before putting in another on a rising load?—W. E. O.

### ANSWERS.

*Question No.* 768.—It is required to establish telephonic intercommunication between eight huts on the banks of a canal. The huts are a half-mile apart. It is desirable to use as few wires as possible, any reasonable system of signalling being permissible. Can this be accomplished with two or three wires, nine being entirely out of the question?

*Answer to No.* 768 (*awarded* 7*s.* 6*d.*).—The number of ways which these huts could be telephonically connected together by two or three wires are many, but of these we will only attempt two. We will assume that outside line construction is very expensive, and that as satisfactory signalling and metallic circuit speaking can be obtained by the use of only two wires, we will assume that it is decided only to use the one pair.

*Method No. 1.*—This system will no doubt give the most satisfactory signalling with far simpler apparatus, of a type which is much less liable to get out of order than any other. Fig. 1 shows a complete wiring diagram of this system—ordinary simple telephone circuit, including transmitter, receiver, switch hook; induction coil and two dry cells complete the listening and speaking circuit. The signalling circuit only comprises one small type of hand generator, with a single-line plug and two single-line jacks for calling and a 1,000-ohm magneto bell for receiving the signals. The plug and jacks in each station can easily be replaced by a one-lever two-position switch, if that is preferred. The circuit almost explains itself—the method of calling being to insert the plug in either jack according to which station is needed, and then giving the hand generator one, two, three, or four separate turns—that is, No. 1 station can be signalled by turning the hand generator at any other station once with the plug in the right-hand jack; No. 2, by giving two turns; No. 3, by giving three turns; and No. 4, by giving four turns; each turn causing the distinct signal on the bell. In the same way, stations 5, 6, 7, and 8 can be called by inserting the plug in the left-hand jack and ringing the requisite number of times. Of course, before anyone should attempt to ring on a line of this description, they must of necessity take the receiver off the hook and listen to ascertain whether anyone else is using the line, and if they are they must wait until it is clear. This system can be highly recommended, and will not give the slightest trouble after having been properly installed. Of course, the usual precautions must be taken against lightning and foreign currents, but that does not enter with the circuit in any way. The resistance between the lines, as can easily be seen, is 500 ohms, and as all of this is composed of wire wound round iron the retardation effect is very high, and absolutely clear speaking will result.

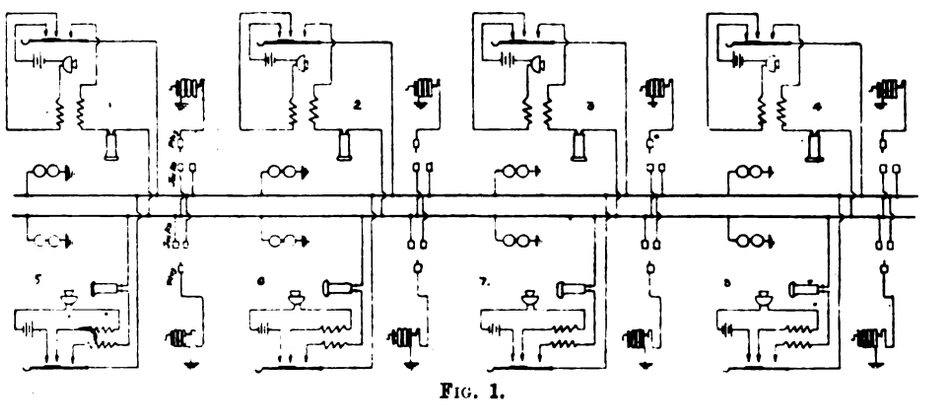

FIG. 1.

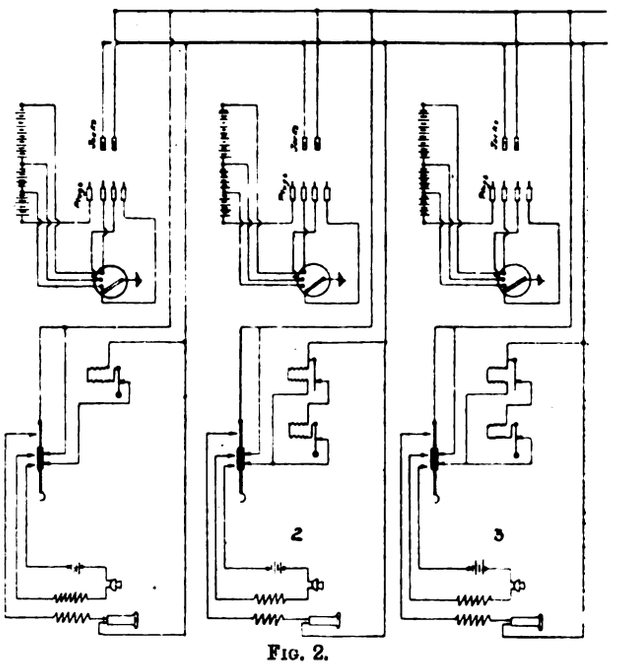

FIG. 2.

*Method No. 2.*—The only real objection that can be raised to method No. 1 is that four bells are rung at the same time instead of any particular one, and although in practice this is not found to have any serious objections, still, a system in which but one bell is rung at once is certainly superior, and we will now attempt to explain a method of connecting up the telephones so that this result is arrived at. Fig. 2 shows the connections of nine separate stations connected up on one pair of lines, and the following explanation will show how the circuit works. The same speaking and listening sets are used as in method No. 1, but the signalling circuit consists of direct-current bells and dry or wet batteries in the place of hand generators. A battery tapped, connected up at the two ends and at two intermediate points so as to give three separate voltages, must be installed at each station, and along with this the complete output comprises one four-point single-lever switch and four single-line plugs, and two single-line jacks must be used for calling. The apparatus for receiving the signals consists of direct-current bells arranged as follows:

*Station No. 1.*—A 1,000-ohm direct-current trembling bell adjusted to work with not less than 24 volts.

*Station No. 2.*—A direct-current trembling bell which will not work with less than 12 volts in series with a cut-off relay. This relay is an ordinary direct-current bell without gong or hammer connected up so as to cut off the current

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from the bell immediately it operates, and adjusted to work with anything over 20 volts.

*Station No. 3.*—A direct-current trembling bell which will work with six volts in series with a similar cut-off relay to that mentioned in station No. 2, which will work with anything over 10 volts.

*Station No. 4* is equipped similar to station No. 1, except that the bell is polarised and adjusted so that it will work with the same current as the bell in No. 1, but only when the operating current flows in one direction.

*Stations Nos. 5 and 6* are similar to Nos. 2 and 3 respectively, except that the bells are polarised.

*Stations Nos 7, 8, and 9* are exactly similar to Nos. 4, 5, and 6 respectively, except that the bells are polarised to work in the opposite direction.

The method of operation is as follows: To ring stations Nos. 1, 2, 3, battery must be put direct across the line without earthing it and three voltages used respectively. Stations 4, 5, 6 are signalled in a similar manner by using three different voltages, but this time one side of the battery is earthed and the other side is put across the left-hand side line. Stations 7, 8, 9 are called by earthing one side of the battery and putting the other side on to the right-hand side. In a similar manner the same precautions must be taken against lightning and foreign currents. Before signalling is attempted the line should be listened upon to find out whether it is in use or not. The only difference between this method and Fig. 1 is in the signalling circuit. All the bells should be wound with the same resistance, say 1 000 ohms each, the variation in the adjustment for working at the different pressures being obtained by altering the number of ampere-turns and the tension in the armature springs. If the bells are of the above resistance, the fact of putting them across the line will not in any way materially affect the efficiency of speech transmission. This system will cost far more to keep up than in the first case, but with good lines, good installation, there is not the slightest reason why it should not work satisfactorily.

*Note.*—We will assume that the line used is of such a resistance that 8, 16, 32 volts will give satisfactory signals between any two stations, whether adjacent or at extreme ends of the line. The battery power selected may seem rather high, but when one considers that overhead lines are subjected to all kinds of weather and leakage effects, and possibly in some cases rather questionable joints, we think that the voltages chosen are not too high, but at the same time it is quite feasible to assume that with properly low resistance, insulated lines, and carefully adjusted apparatus, the pressures of, say, 5, 10, 20 volts, or even lower, might be used.—C. W. A.

*Answer to No.* 768 (*awarded* 7*s.* 6*d.*).—Before dealing with the above problematical, yet most interesting, question from the standpoint of a solution, or of an attempt at solution, it may be of service if we consider it briefly from the point of view of the information which can be gathered from it. In the first instance, we are given to understand that the establishment of telephonic intercommunication between eight huts situated at equal distances apart from each other, and extending from extreme hut to extreme hut over a total length of 3½ miles of the banks of a canal, is a desideratum. Now, although the question states specifically that the huts are situated on the *banks* of a canal, it does not give any information concerning the relative location of the huts—*i e*, as to the position which each hut occupies with respect to each and all of the seven remaining huts. Therefore it is necessary that some pre-assumption anent this point shall be made.

We will here assume that the huts are situated alternately on the two sides of the canal, for which arrangement see Fig. 1, in which figure $H_1$, $H_2$, $H_3$, . . . $H_8$ represent the eight huts, four being on one side and four on the other. This arrangement, until more definite information is forthcoming, appears, in the opinion of the writer, to be in perfect harmony with the conditions and requirements of the question, and yet is something definite as regards the comparative situation of the huts, which in actual practice is of the most vital importance. Again, there is not offered in the question any light respecting the peculiar conditions of the intercommunications—*i e*, as to whether or not it is required that a person in *any* one of the huts shall find it possible to communicate with another person in another hut, even although at that very moment connection may exist between two other persons who would be in actual communication. It is, however, not probable that the former condition of working will be demanded, because then it would not, with ordinary and *reasonable* telephonic apparatus, be possible to work successfully with a maximum of three line wires; hence we will assume here that the latter is the only possible contingency.

As regards the actual systems of lines, instruments, and connections, it may here be stated that there are several possible solutions to the above query which do not involve the use of nine line wires, but only two, three, and four lines respectively. These systems are, however, potentially and intrinsically different; one system possessing advantages which are the disadvantages of the others, and *vice versâ*. We will here consider the above three systems in the order in which they are arranged.

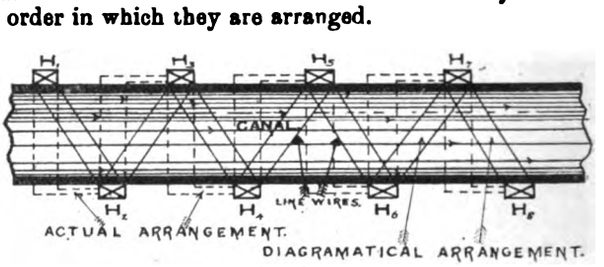


Fig. 1.

*The Two-Line Wire System*.—This system obviously involves the use of only two line wires, one acting as the forward wire and the other as the return wire. But although it possesses distinct advantages in the direction of the number of line wires, it is defective in directions which will be hereafter referred to. And it is on account of these defects having such a great influence upon the efficiency and general workability of the sys em, that only under exceptional and extraordinary circumstances would the writer dare to advise its introduction. In Fig. 2 will be found a diagram of all the necessary connections of the instruments in all the eight huts to accomplish the establishment of telephonic intercommunication between *any* one hut and *any* one of the remaining seven, at one

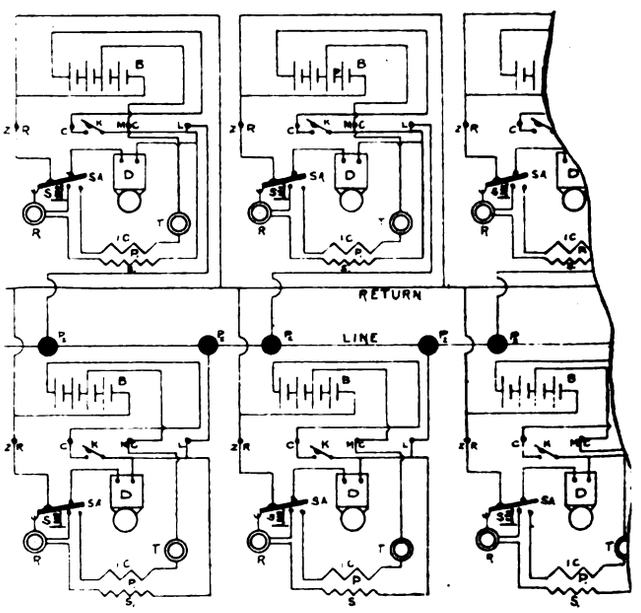


Fig. 2.

and the same time, on this system. On the introduction of such a system the chief difficulties which have to be contended with are those of the simultaneous ringing of the bells of all the instruments, though this may be partially advantageous, and the simultaneous working of all those bells which do not belong to the two instruments in communication during the time of that communication. For reference to Fig 2, the following index of parts may be of service: B is the battery, of about 10 or 12 volts pressure; R is the receiver; T is the microphone transmitter; I C is the induction coil; $P_1$ is the primary of the

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induction coil; $S_1$ is the secondary of the induction coil; K is the key for ringing up other stations; D is the bell; S A is the switch arm or hook upon which the receiver hangs when not in use; S is the spring to pull S A down to the under-contact studs, when R is lifted off the switch hook; Z R is the terminal connection to the zinc of the battery and to the return wire of the system; C is the terminal connection to the end carbon of the battery; M C is the terminal connection to the middle carbon of the battery; L is the terminal connection to the line wire of the system; $P_2$ is a two-way plug switch (enlarged in Fig. 3), which is introduced into all the eight instruments.

A few words concerning the above-mentioned two-way plug switch will, probably, not be out of place here. From a consideration of Fig. 2 it will be observed that if the plug switch had been omitted in every instrument, it would be possible to ring all the bells of six instruments at once, and yet, at the same time, to speak only with another instrument distinctly and efficiently, the bell of which instrument would, consequent upon the falling of the switch arm, S A, be cut out of action. Now, this unnecessary bell ringing is disadvantageous for two prime reasons—the first, because the batteries will not last so long, having to perform more work, as would otherwise be the case; and the second, because the bell-ringing would develop into a nuisance, and prevent any ordinary conversation being carried in the affected huts. If, however, two-way plug switches are inserted in all the instruments, these disadvantages are palliated, if not entirely removed. When the instrument is not in use the plug is inserted in the *a* position, so that that instrument is connected to the line and return, and that no instruments are cut out of circuit. When one

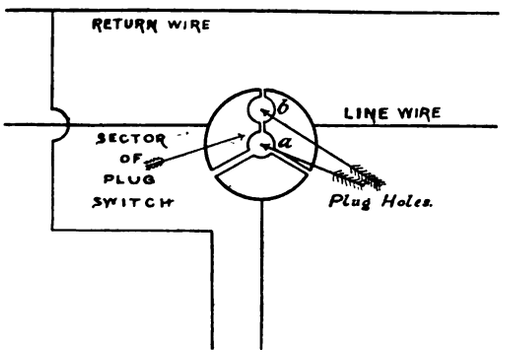


FIG. 3.

instrument is engaged with another instrument, the plug of each instrument which is then non-communicating is moved from the *a* position to the *b* position in order to prevent the continual bell-ringing nuisance. This, too, constitutes a disadvantage, because it can hardly be expected that under the circumstances the use of the instruments will admit of such elaborate manipulation.

The *modus operandi* is now as follows: Suppose that the instrument on the extreme left of Fig. 2 requires communication with the fourth instrument from the extreme left. Then the key, K, of the instrument on the extreme left is depressed, with the result that all the bells are set in action. To indicate which instrument it is required to speak with, a certain number of rings should be given in quick succession according to some prearranged code of signalling. In this case four rings should be sufficient to indicate that it is the fourth instrument which is required. Upon the receipt of the bell signal, every plug should be removed from the *a* position of the plug switch to the *b* position, except in the case of the two engaging instruments, in order to isolate the instruments for the time being and to prevent the continuous bell-ringing. Conversation can then be carried on between the first and fourth instruments without any interference or interruption from any of the other instruments. If a limit of, say, a three or four minutes' converation be imposed, then at the end of the period of the limit the plugs should be reinserted in the *a* position, and when such is accomplished there is no impedance to communication being obtained between any two instruments on the system. Speech on these two lines would probably be fairly satisfactory, but it will readily be seen that much trouble and inconvenience to persons using the instruments would be entailed in the insertion, removal, and reinsertion of the plugs; and if the plug is not in the *a* position, the instrument would not have any line connection, and consequently would not admit of any engagement with another instrument. Hence the whole system is inherently defective, but it is the only system which can be adopted if two-line wires are to be strictly adhered to.

*The Three-Line Wire System*.—This system, as will be shown further on, possesses decided advantages over the two-line wire system. As its name implies, three wires are used in the place of two, as in the previous system, and it is on account of this fact that this system stands in possession of qualities which are absent in the other system. In Fig. 4 there will be found a diagram of all the necessary connections of two of the eight instruments, the connections of all the instruments being identically similar to those of the two represented in the figure, the positions of the instruments making no difference whatever. In this system the defect of the continuous bell-ringing and its attendant nuisance have been obviated and entirely removed. The additional wire is marked "B L wire," and is so provided that one terminal of the bell of the instrument can be connected to it instead of to the receiver of the telephone and to the line wire. Fig. 4 is indexed in exactly the same way as is Fig. 2, and hence no further explanation of the index letters is needed. In this case there is no necessity for a two-way plug switch, as per Fig. 3, or any equivalent appliance, since the introduction of the third wire removes

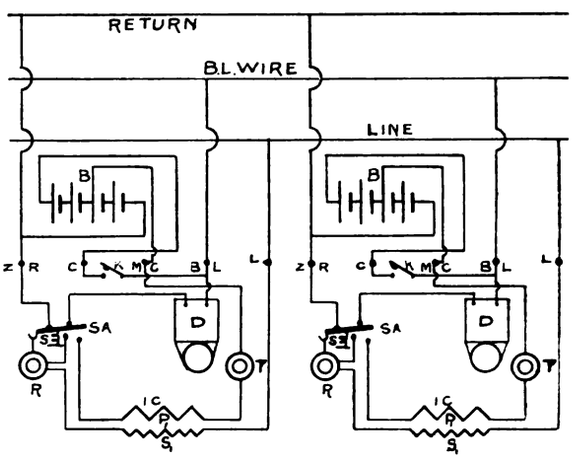


FIG. 4.

the cause of such a necessity. An alteration will, however, have to be made in the internal connections of every instrument. In the two-wire system, the right-hand terminal of the bell (see Fig. 2) is connected to the line-wire receiver and to the end carbon of the battery, whilst the left-hand terminal of the bell is connected to the upper terminal stud of the switch arm, S A. Now, in the three-wire system the first two connections—*i.e.*, the line and receiver connections—are disposed of, while the other two remain as in the former case. In disposing of these two connections another terminal, marked B L, could be well provided, as in the diagram. Then to this terminal the third wire is connected, as shown in Fig. 4.

The *modus operandi* of this system is as follows: When it is required to bring any one instrument into communication with another, the key, K, of the former is depressed, with the consequence that *all* the bells are set in action, and, following the arranged code of signalling, as referred to in the discussion of the previous system, or any other suitable and prearranged code, a certain signal is given to all the instruments. The instrument which answers to the signal given is connected to the communicating instrument by taking the receiver off the switch arm, S A, whilst the remaining six instruments should not—because they need not—be touched at all. When the communication is at an end the receivers are replaced on the hooks, and then the whole system is again normal and ready for the intercommunication between any two telephones. As is readily seen, this system is a great improvement upon the previous one, and the writer would strongly advise the querist to instal this system in preference to *any* two-wire system, even although the number of lines which are used is greater.

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*The Four-Line Wire System.*—This system has been included in our considerations because, whilst not possessing any distinct advantages or qualities over the three-wire system, yet, nevertheless, it is a system which is even more flexible than the three-wire system, though the results obtained will be precisely the same in the two cases. In this case the bells are connected across two line wires, which are separate from the line wires used for the transmission of messages. In Fig. 5 all the necessary connections for two of the eight instruments are shown, the remaining six instruments being connected up in precisely the same manner as the two in the figure.

The *modus operandi* of this system is exactly like that of the three-wire system, and hence there is no need here to explain it, as reference to the latter will show how to work and use the instruments if this system be adopted. It cannot be said, however, that this system is worth adopting, because a fourth wire is run with no resulting increase in the efficiency and general usefulness of the system. The writer has been wondering whether or not an earth-return system could not be devised, and it has occurred to him that, in connection with the three-line wire system, the extra wire could conveniently be dispensed with, and, in place of such, the water in the canal could serve as a conducting medium, especially if there is any trace of metallic matter or salts in the water. In such a case the right-hand terminal of each bell should be connected to a

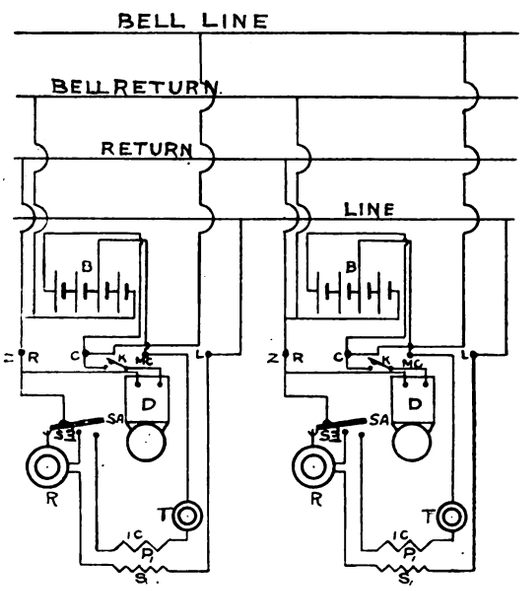


FIG. 5.

wire, which should be slightly weighted, and at the end of which there should be attached a plate or equivalent conductor which would provide a sufficiently large conductor area. Unless this is carried out, the possibility is that, at times depending upon conditions, the bells will refuse to ring, and will not even be coaxed to ring. The wires are then placed in the water at points which are immediately opposite the huts. All other connections remain as in the three-wire system. This method of arranging the third conductor would render this system still more serviceable from the standpoint of the number of wires, it would facilitate erection, and there appears to be no reason why its working qualities should not be, at least, equal to those of the three-wire system.—B. W. G.

*Answer to No.* 768 (*awarded* 5*s.*).—Either of the two usual methods of signalling—viz., battery and magneto—are available for this arrangement, but as there is a considerable length of open wire placed in an exposed position, a magneto system should be chosen in preference, although the cost of instruments is higher than with a battery system. It is less likely to get out of order, the maintenance is less, whilst the strength of the signals is constant, thus ensuring proper discrimination of calls. Two wires should be run throughout, and will be found sufficient. Every precaution should be taken to keep good insulation by the use of standard insulators and indiarubber-covered leads, a pair of which should be shunted from the two lines into each station.

The simple method of bridging each instrument across the line may be dismissed, for, although workable, the signals would be confusing, as the eighth station would require eight signals, and great distraction at the other stations would occur. If, however, the instruments are adapted as shown in Figs 1 and 2, only four rings need pass, which is within reasonable limits. Each instrument should be provided with generator, with automatic cut-out, switch hook, and two simple Morse keys, in addition to the speaking circuit (which should contain induction coil). It will be necessary to specify when ordering the instruments that the wiring should correspond with the sketch. This should cost very little, as the constructional parts are not affected. To describe the arrangement, it is seen that all the bells are permanently shunted from the line to earth, four bells being connected to the A line and the other four to the B line. They should be branched alternately as shown to ensure an even distribution of the bell earths, and conse-

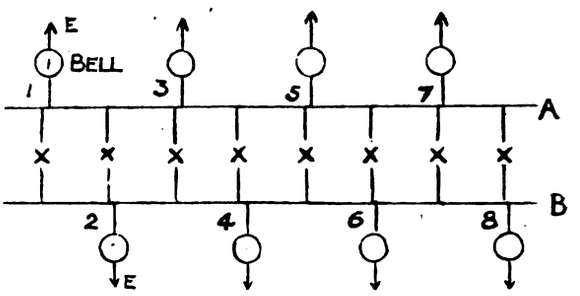


FIG. 1.

quently a quiet line free from inductive noises. When the line is not in use, only the earthed bell of each instrument is on the line, as the switch hook disconnects the other parts of the instruments. When a station desires to call another, No. 3 for instance, he will depress Morse key M, and thus by putting earth on the B line and on his generator he is able to send an earthed ringing current along the A line; only four bells will be actuated, and signals up to four will determine the station wanted. Similarly, stations on the B line are called by operating Morse key $M_1$ during the act of ringing. The cut-out of the generator is a cam action which removes spindle, S, from spring, D, allowing the latter to meet contact, C, during the act of turning. As seen

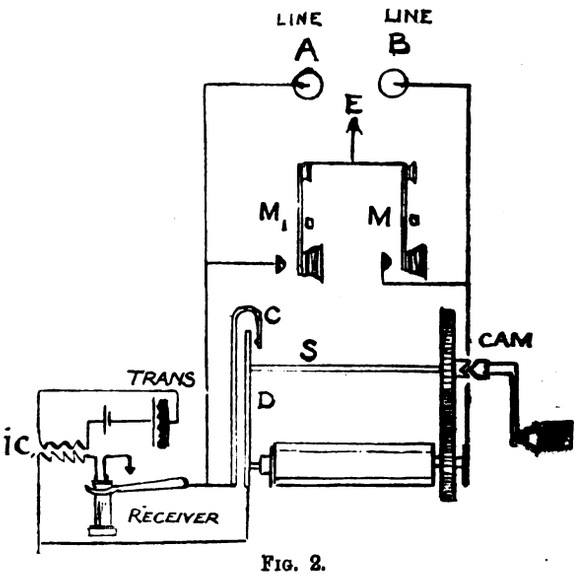


FIG. 2.

in Fig. 2 the contact of spindle, S, and spring, D, normally short-circuits the generator and provides a direct path for the secondary circuit. This short-circuit is removed whilst ringing and current passes through contact, C, direct to line or earth according to the key depressed. It is essential that all earths should be good and free from unsoldered joints. All bells should have a resistance of 1,000 ohms each, whilst if it is necessary to introduce exterior bells or indicators, they should be preferably placed in series with the instrument bell.—F. R.

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Supplement to "The Electrical Engineer,"
APRIL 14, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

776. A four-core telephone cable 4½ miles long connects a sub-station to a generating station. The cores are twisted in pairs and used as two separate telephone lines. It is required to put up a pair of single-stroke bells, one at either end, to be worked by means of Morse keys in order to signal from generating station to sub-station, and *vice versâ*. Can this be done with existing cable, without interfering with the proper working of the telephones? If so, how? If not, why not? The resistance of the line (lead and return) is 350 ohms.—J.

### ANSWERS.

*Question No.* 769.—In a variable-speed motor the speed variation, say from 1 to 3½, is effected by varying shunt excitation by resistance in circuit. Auxiliary coils are placed between shunt coils and are in series with armature. In other respects the machine is connected as a long shunt motor. The machine is sparkless from no load to full load at all speeds, and at all speeds on reversal, with fixed brushes, the output remaining constant. Explain theory of sparkless commutation and influence of auxiliary poles on same. At certain low excitations, if the brushes were shifted 1mm. in the backward direction the motor ran away (hunted), and got up an abnormal speed in a second's notice. Explain this peculiarity.

*Answer to No.* 769 (*awarded* 10*s.*).—In tackling a question like this it is best to first consider what happens at the time of commutation in a machine, then give the theory of sparkless commutation, afterwards considering the case in point. When any one commutator segment is coming up to a brush, it is carrying a current through the coil to which it is attached of a certain magnitude and certain direction. After passing under the brush there will be an equal current now flowing, but in the opposite direction, and whilst under the brush the coil is short-circuited through the brush. Owing to the self-induction of the coil, this current will not die down and then grow again in the opposite direction instantaneously. Hence it is necessary that whilst short-circuited a current shall be generated in it of a similar magnitude and direction as that which will be passing through it after leaving the brush. This is accomplished by having the coil in a field of such a strength and direction so as just to accomplish this. If this is not done, there will be a tendency to sparking. The time necessary for the current to die down and then grow again in the opposite direction may be calculated from the following formula:

$$C = \frac{E}{R}\left(1 - \epsilon^{-\frac{Rt}{L}}\right)$$

In this

C = current in amperes;
E = reversing E.M.F. in volts generated by the coil in the weak reversing field;
R = resistance of coil and brush contact in ohms;
$\epsilon$ = 2·71828 = base of Napierian logarithms;
$t$ = time in seconds;
L = coefficient of self-induction in henries.

If this equation be solved for the value of $t$, we get

$$t = \frac{L}{R}\left(\frac{\log \frac{E}{E - CR}}{\log \epsilon}\right).$$

This gives the time the current takes to grow to the required value, so double this time should give the required time for it to die down and then grow up again. At first sight it may appear that the value E − C R in the denominator of the fraction in the numerator is equal to nothing, but this is not the case here, as if E be sufficiently large, and the time be prolonged, this short-circuit current will grow to a larger value than is required. The above is one theory, that the coil when commutated must be in a sufficiently strong reversing field for a sufficiently strong current to grow in it to the magnitude of that which will be passing through it after it leaves the brush.

Mr. Hobart in his paper read before the Institution at the Glasgow Engineering Congress in 1901, however, says that he doesn't think this idea of a reversing field has so much to do with sparkless commutation as reactance voltage, and goes on to say that he can design a machine to commutate sparklessly in a field of the wrong polarity. The value of this reactance voltage is given by the formula

$$r = 2\pi n L C,$$

where $r$ = reactance voltage in volts;
$n$ = periodicity of the reversal;
L = the coefficient of self-induction in henries;
C = the current in amperes.

The value of $n$ is given by $\frac{P}{2T}$, where P = the peripheral speed of the commutator in inches per second, and T = thickness of brush in inches. The value of $r$ should not exceed 2 or 3 for a well-designed machine. He considers a suitable value per ampere-turn per centimetre length of embedded portion of each turn to be 4 C.G.S. lines, and ·8 C.G.S. lines per ampere-turn per centimetre length of the free portion of the turn to calculate the value of L.

The currents circulating round the windings of the armature create a field which is at right angles to that due to the field poles. This is shown in Fig. 1, where it will

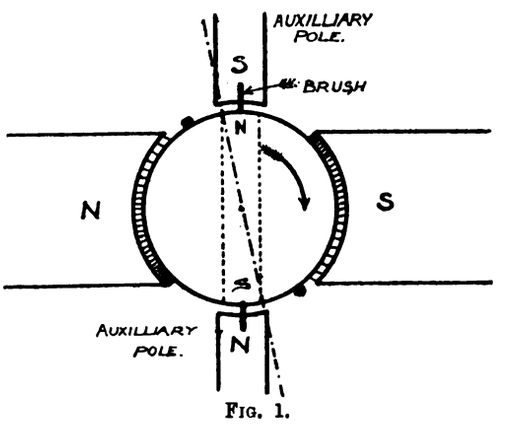

FIG. 1.

be seen that in this particular case I have indicated the flux due to the armature ampere-turn makes a north pole at the top and a south pole at the bottom. This flux is superposed on that due to the field coils, and distorts it in the manner shown, weakening the trailing tips and strengthening the leading tips of the poles in the case of a motor. Now, the necessary reversing field is got from the trailing tip of the pole which a coil is leaving in a motor, and this being weakened by the armature reaction, it becomes necessary to rock the brushes back a little so as to get the coils in a strong enough field to ensure sparkless commutation. I have indicated the direction of the currents in the two halves of the armature by means of the two small circles on the periphery, that with the dot in the centre indicating that the current is coming towards the observer, and that

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with the cross shows the current to be going from the observer. Now, assuming that the brushes in a motor have been shifted back until the plane of commutation lies along the chain dotted line, then considering the turns lying between the two parallel dotted lines, we see that in the top one the current is flowing from us, and in the bottom ones to us. Hence we have so many ampere-turns generating a flux which is directly opposing the field flux, which will have a demagnetising action. In order to counteract or neutralise this armature reaction and consequent necessity for shifting the brushes, etc., many methods have been devised, including special armature windings, as the Sayers winding (strictly speaking, this is not to overcome armature reaction, but to improve commutation by means of generating a reversing E M F. in special armature windings), different shapings of the pole-shoes to prevent the distortion of the field by putting greater reluctance in the pole-tips, the use of a continuous magnetic iron ring round all the poles as used in Bruce Peebles machines so as to obtain a field for commutating in, special windings between and in the poles, the use of slots up the poles parallel to the shaft so as to prevent the flux from shifting, and also, as in this case, by the use of special poles left unwound or wound with series turns, to neutralise and take off the flux due to the armature ampere-turns. It is obvious that as the motor is to be reversible, any compensating device must be put midway between the poles; hence the auxiliary series-wound poles must be in this position. They will be connected up so as to be of opposite polarity to those created by the armature ampere-turns, that they may have the effect of sucking up this flux and preventing it distorting the flux in the ordinary field. As both the flux due to the armature ampere-turns and that due to the auxiliary poles will be proportional to the load, because these poles will be nowhere near the saturation point, the amount of this sucking-up effect will be proportional to the load, and hence the armature flux will not affect the field flux. Hence, as this is not distorted, it is no longer necessary to shift the brushes backwards, but if they are kept in the neutral position they will be in a sufficiently strong reversing field. The use of carbon brushes is also a factor to be considered in the prevention of sparking. These, I believe, have a contact resistance about 10 times as high as copper. By means of this there is a sort of grading effect, which is useful in the following manner. When a segment is just about to leave a brush the cross-sectional area is considerably reduced, and hence the contact resistance with that segment increased. This has the effect of decreasing the current through that segment, the balance passing through the next contact which has the full area, even though the coil itself be short-circuited. This action is very beneficial. Somewhat akin to this is the method by which resistance strips are used connecting the segments to the windings, but this method seems to be going out of favour. The use of equalising connections in the winding may also help the commutation, as it prevents currents circulating from one part of the winding to another through the brushes. So much for the theory of sparkless commutation and methods of promoting it. We will now turn to the part of the question where the motor races.

I beg to question this happening with only 1mm. movement of the brushes, as that is practically nothing. The motor is running with very weakly excited fields, but there will be no cross magnetising, as the auxiliary poles prevent that. When the brushes are moved backward we get a demagnetising belt of turns on the armature as explained before, depending on the angle through which they have been moved. As the armature amperes will be great, owing to the weak excitation, the demagnetising ampere-turns will likewise be great, and this, together with the weak field, which will be more susceptible to changes now, makes an appreciable diminution in the field flux. At a time like this the field due to the auxiliary poles will be at a maximum owing to the large series current and also the large value of the armature cross-magnetising turns, which have a magnetising effect on them. Being, however, approximately 90deg. out of position, they will have little or no effect except to make the machine spark frightfully as we are commutating in this relatively strong field. The net result, then, is that the machine races, being in a very weak field, and sparks dreadfully as described.—R. A. ALEXANDER.

*Answer to No.* 769 (*awarded* 7*s.* 6*d.*).—In order to understand this question we will first consider what conditions must be satisfied for a dynamo to operate sparklessly. In Fig. 1 the coil *a* has half the total current from the brush flowing in it; when it has moved to position *b*

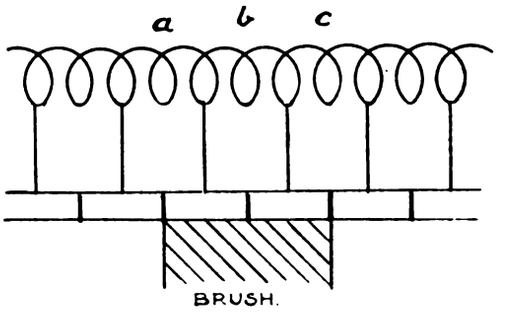


FIG. 1.

it is short-circuited, and when in position *c* the current must be reversed in direction through the coil. In order that the bar may leave the brush without a spark, it is evident the current must be reversed in the coil before the bar leaves the brush, therefore a reversing field must be provided. If the dynamo is acting as a motor, since the induced tension opposes the current, it will be seen that

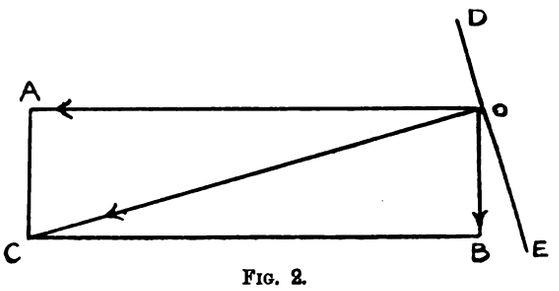


FIG. 2.

the brushes must be shifted from the neutral position in the opposite direction to that which the machine is running. We have so far assumed that there is no armature reaction, but as soon as any load is put on the motor the armature current will tend to distort the field. If O A (Fig. 2) represents the magnetic flux due to the field magnets in magnitude and direction, and O B that due to the armature

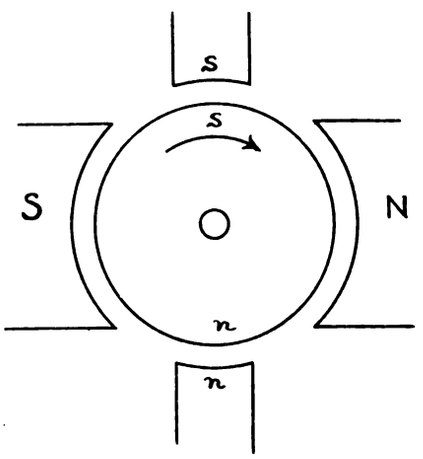


FIG. 3.

windings, the resultant flux will be represented by O C, and the brushes must be set at right angles to this—*i.e.*, on the line D E. Therefore the armature reaction necessitates shifting the brushes still further back. Coming now to the special case mentioned in the question, it is evident that as the motor runs in either direction the brushes must be set midway between the poles: and also they must be of carbon. As the brushes are not to be shifted with change

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of load, it is necessary to provide some other means for the reversing field, and this is accomplished by means of the auxiliary poles.

In Fig. 3, if the machine runs in the direction of the arrow, then the top pole must be a S pole and the bottom one a N pole, in order to neutralise the poles set up in the armature by the armature current. As these poles must reverse when the direction of rotation is reversed, and must also be proportional to the armature current, it is evident that the latter must excite them—*i.e.*, they must be in series with the armature. These auxiliary poles would not be sufficient to entirely stop sparking were it not for the fact that carbon brushes are used, and it is well known that these are of considerably higher resistance than copper, and therefore, as a commutator bar is leaving the brush, the increased resistance tends to stop the current flowing, and hence the bar leaves the brush without a spark.

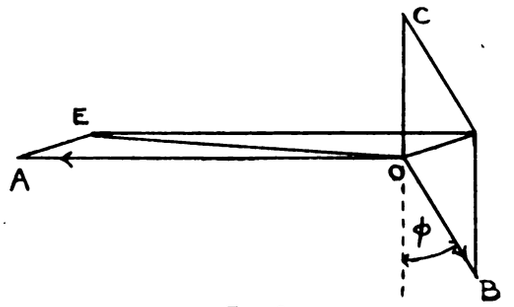


FIG. 4.

We now see how it is possible for the motor to run sparklessly at all loads and in either direction. We can also see why the motor runs away if the brushes are shifted backwards. If we draw the vector diagram of the various fluxes, we should have Fig. 4, where O A represents the flux due to the field magnets, O B that due to the armature, which is at an angle of $(90+\phi)$ with O A, where $\phi$ = angle of brush displacement, and O C the flux due to the auxiliary pole. The resultant of the system is O E, and it is seen that the field is weakened, besides being distorted. As the speed of a motor varies inversely as the strength of the field (neglecting armature resistance), it is seen that the shifting of the brushes may cause the motor to attain a high rate of speed. If the motor was loaded at the time it might pull up, in which case the fuse would, of course, blow, the current being equal to the line pressure divided by the resistance of the armature and leads.—H. C. H.

*Answer to No.* 769 (*awarded* 7*s.* 6*d*).—The motor is presumably of a similar type to that illustrated in Fig. 1.

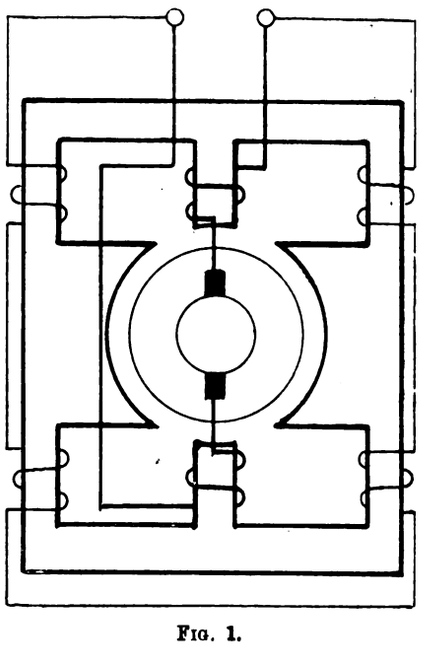

FIG. 1.

These small auxiliary poles were introduced some years ago to prevent the distortion of the field caused by armature reaction. When a motor has its speed regulated by means of varying the magnetic flux through the magnets, armature reaction becomes particularly troublesome; the province of these auxiliary poles is, therefore, to ensure that the sections of the armature winding undergoing commutation are in a pratically neutral field. When a motor—as the one under discussion—has to run in either direction the brushes must be in a fixed position, that position being such that they have neither backward nor forward lead. With a motor of this type it becomes imperative that the armature reaction is reduced to a minimum. In the case of a motor that only has to run in one direction. The brushes may have a backward lead and the result be

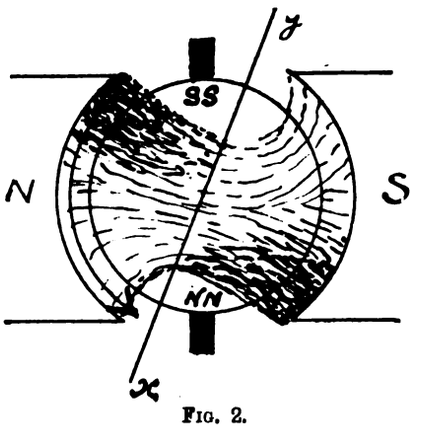


FIG. 2.

satisfactory. To attempt to reverse such a machine, however, would be totally impracticable owing to violent sparking. Figs. 2 and 3 will give a general idea of the theory of auxiliary poles in the neutralisation of armature reaction. In Fig 2 we have the ordinary case, no auxiliary poles; owing to armature reaction the "lines" pass through the armature core in some such manner as shown, the neutral axis being deflected to $x\,y$

In order to obtain sparkless commutation the brushes would require a backward lead, the distance being approximately given by $x\,y$. With a motor that ran in either direction such alteration to the brush position would be impracticable—we should then have more or less violent sparking. In Fig 3 the small auxiliary poles neutralise the magnetic effect due to the armature, and allow the magnetic flux to pass through the armature core as shown. The neutral axis is not deflected, but passes through the brushes, which are in the best position for commutation. As the winding round the auxiliary poles is in series with the armature, the auxiliary poles become stronger as the armature reaction increases. Any extra amount of armature reaction is, therefore, met by a correspondingly greater

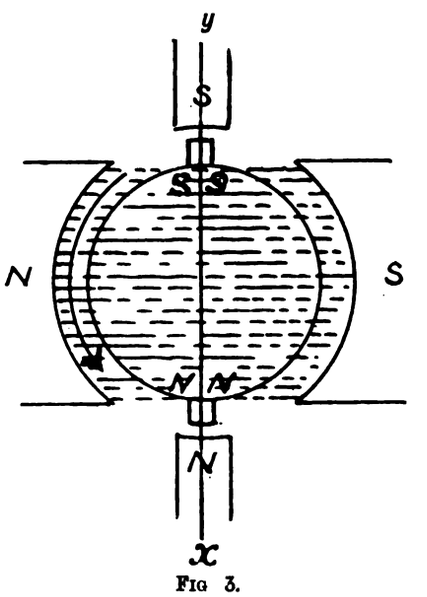


FIG 3.

neutralising effect on the part of the auxiliary poles. The neutral axis is then kept in its normal position, as shown

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in Fig. 3. Auxiliary poles are now a thing of the past, most designers using other methods of construction.

To explain the running backwards when brushes are displaced, the field being weakly excited, consider Fig. 4. The brushes being shifted, so also is the polarity of the armature. Although the movement may be but through a small angle, the auxiliary poles tend to still further deflect the armature's polarity; this is shown diagrammatically by the positions of the letters representing armature poles. The armature is then

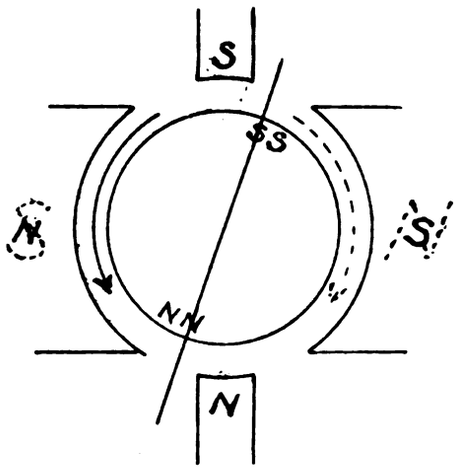


FIG. 4.

enabled to reverse the polarity of the magnets; original polarity is marked in black, reversed polarity in dotted letters. The armature will then run in the opposite direction, shown in the figure by a dotted arrow.—M. M.

*Answer to No.* 769 (*awarded* 5*s.*).—As is now well understood, there are two methods of obtaining sparkless commutation in an ordinary motor—first, keeping the reactance voltage low and depending on brush reversal, and second, using a reversing field by giving a lead to the brushes. In practice a combination of the two methods is generally used, but in the case of a motor with large speed variation neither method is easily applicable, for it is necessary to wind the motor with a large number of turns to get the low speed, with the result that it is almost impossible to get a low reactance voltage at the high speed, while at the high speed it is no use to rock the brushes, as the

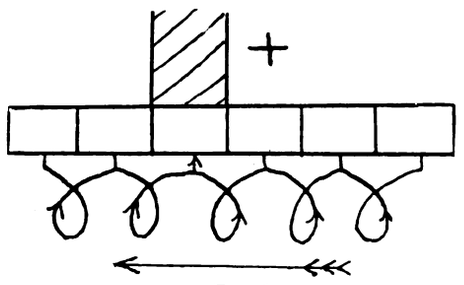


FIG. 1.

armature field completely overpowers the weakened main field and reverses the polarity of the trailing tip. Consequently it is necessary to provide some independent means of reversal.

Considering Fig. 1, it may be seen that the current in all coils to the right of the brush flows in a counter-clockwise direction, and in all coils to the left of it in the clockwise direction. Therefore the current in each coil has to be reversed while it is short-circuited. Now, each coil, being in a slot, is surrounded by a large number of lines of force which reverse with the current, and in reversing cause an E.M.F. in the bar, which always tends to prevent any alteration of the current in intensity or direction. This E.M.F. is called reactance voltage, and to overcome it it is necessary to inject into the coil an equal and opposite E.M.F., and this is the purpose of the auxiliary pole. Note that in a motor the E.M.F. caused by the rotation of the armature is in opposition to the current, therefore the auxiliary pole must have the same polarity as the main pole which the coils have just left.

The reactance voltage may easily be calculated from Hobart's formula, which has many times appeared in these columns, but stated more briefly it is equal to $\frac{d\,N}{d\,t}$, or the rate of change of lines surrounding the conductor. The E.M.F. caused by the motion of the coil under the auxiliary pole may also be expressed by $\frac{d\,N}{d\,t}$, and the two values must be equal and opposite.

Another way of looking at this, and perhaps a more convenient way, is arrived at by integrating $\frac{d\,N}{d\,t}$ over the whole time of short-circuit, which gives us N—that is, the total change of lines around the conductor in the slot must be equal to the total number of lines cut during short-circuit in passing under the reversing pole. The number of lines surrounding a conductor in a slot is given by Parshall as 10 per ampere-turn per inch of slot, and as these change from positive to negative, the total change is 20 per ampere-turn per inch, and this gives the number of lines to be cut under the reversing pole. In calculating the winding on the auxiliary pole, it must be remembered that it is necessary first of all to put on sufficient ampere-turns to balance the ampere-turns of the armature, and then add sufficient to drive the required flux through the auxiliary circuit.

Reversing poles are by no means new. They were mentioned as far back as 1885 by Mather in *La Lumière Electrique*, and Swinburne took out a patent for one of a simple type in 1889. L. B. Atkinson patented a number of similar devices in the early nineties; but although various makers have played with them at different times, they seem to be only now coming into serious use for variable-speed motors and high-speed turbo-driven generators.

With regard to the second part of the question, it will be seen from Fig. 2 that if the brushes are given a backward lead the motor becomes a differentially compounded

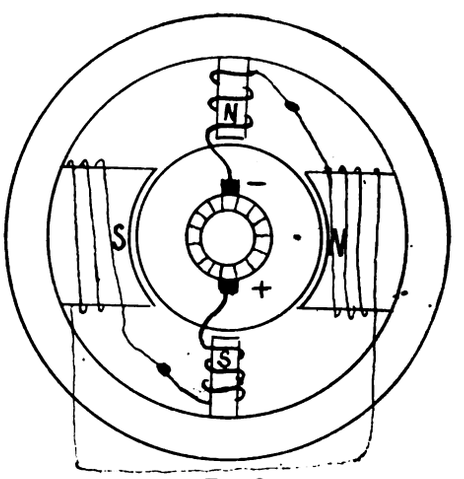


FIG. 2.

one, the series winding giving a field in one direction and the shunt in the other. If the shunt is sufficiently weakened, the total field will be reversed; but if this point is not quite reached the aggregate field will be very weak, and excessive speed will be the result. W.

ELECTRICAL PRINTING.—Messrs. J. H. Holmes and Co. have reissued, under date March, 1905, a revised list of newspapers, printers, and paper mills where their machinery is employed. The regular growth in the size of this issue shows how general the use of electric motors for driving printing machines has become. In glancing through the list one also notices what a large horse-power is needed by some of the printing works electrified. Thus, a rapid glance shows that installations between 100 h.p. and 500 h.p. are quite common. The number of motors employed in these larger installations is also an evidence of the advantage which has been proved of having individual motors to drive each printing machine.

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Supplement to "The Electrical Engineer,"
APRIL 21, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

777. What is the customary limit of density of current (per square inch sectional area) in feeder cables? In what degree is the limit affected by the proximity of other feeders, or by the nature of the coverings, both protective and insulating? The reason for asking this question lies in the observation that a feeder (carrying 1,000 *a* per square inch during a breakdown of another feeder) became heated to such an extent as to alarm the workmen and jointers who were repairing the defective cables and had exposed the sound feeder. The feeders are lead and paper covered copper cables laid in tarred sand in wooden boxes.—E. B.

### ANSWERS.

*Question No.* 770.—In installing boiler feed pumps in generating stations the present-day practice seems to be either a direct-acting steam pump, giving a slow-speed highly efficient pump but a wasteful system of driving, or an electrically-driven three-throw high-speed pump, giving an economical method of driving but a wasteful type of pump, generally driven through two reduction gears. How is it that a combination as described under is not used—viz.: slow-speed electric motor coupled by worm gearing to a slow-speed (2-10 double strokes per minute) three-throw pump, thus giving economy of driving and economy in pumping, worm gears at present obtainable being of high efficiency and large ratio

*Best Answer to No.* 770 (*awarded* 10*s.*).—It has been demonstrated beyond doubt that electrically-driven auxiliary plant is by far the most economical. In a large station the total amount of steam necessary for the auxiliary plant (the latter being electrically driven) need not exceed 3 per cent. of the steam required for running the engines. Where steam is used to drive the feed, circulating, and air pumps, stokers, scrapers, conveyors, etc., the steam consumption of these may reach as much as 15 per cent. of that for the main engines. The minimum which steam auxiliaries use is probably from 10 to 12 per cent. of the steam consumption of the main engines. The following figures are from results obtained in actual practice on the 2,000-kw. direct-connected generators in the Union-street station at Brooklyn, all the auxiliary plant being electrically driven:

| | Percentage. |
|---|---|
| Boiler feed pumps | 0·42 |
| Air-pumps of surface-condensing plant | 0·53 |
| Circulating pumps of surface-condensing plant | 0·87 |
| Total for main auxiliaries | 1·82 |

It may be of interest to compare steam and electrically driven feed pumps. A very good example is to be found at the Pinkston generating station of the Glasgow Corporation tramways, a very complete description of this station and its equipment being given in *Traction and Transmission*, vol i., p. 253, from which the following remarks *re* feed pumps are abstracted:

*Feed Pumps.*—For supplying the boilers with water there are four electrically-driven feed pumps and one steam-driven feed pump, the former from Messrs. the Mirlees-Watson Company, and the latter from Messrs. C. and J. Weir, Limited. The electrically-driven pumps are each capable of delivering 8,000 gallons of water per hour against a boiler pressure of 180lb. per square inch. Each pump has three plungers of 6in. diameter driven by a three-throw crankshaft running at 45 revolutions per minute. The driving motor (supplied by Messrs. D. Bruce Peebles and Co.) is connected up to the 500-volt circuit, and can develop 27½ b.h.p. at 725 revolutions per minute. Double-reduction gearing is used to bring down this speed to 45 revolutions per minute, which is the speed of the pump. The steam-driven feed pump is of the twin-compound type, consisting of two separate direct-acting pumps of the well-known Weir type, connected together in such a way that either pump may be used independently; or, as in ordinary service, the steam from the cylinder of one pump exhausts into the steam-cylinder of the other. In addition to this, the steam is used expansively in the cylinders, which has the effect of slowing down the piston towards the end of the stroke, thereby avoiding the sharp return or shock which would otherwise occur. The steam-cylinders of the pump are 12½in. in diameter and 24in. stroke, while the pump cylinders are 9½in. diameter. The pump cylinders collectively can deliver 16,000 gallons of water per hour, against a boiler pressure of 180lb. per square inch, when running at their normal speed of 12 double strokes per minute.

An interesting paper read before the Queensland Institute on "High-Speed Feed Pumps and their Inefficiency" will be found in the *Electrical Engineer* for Jan. 13, 1905, p. 56, in which the author (Mr. E. C. Barton) gives a comparison between a slow and a high speed pump, pointing out that the greatest source of inefficiency of the high-speed pump lies with the friction of the packing, which is given as being 10 times greater in the high-speed pump than it is in the slow-speed pump. Incidentally, it should be noted that the loss due to inertia of the water in the delivery pipes is very much greater with a high-speed pump than with one built for a slow-speed.

Thus we see that an efficient pump must be of the slow-speed type, and in order to get a good overall efficiency the pump must be driven by an electric motor. In connection with electrically driven auxiliaries, the tendency of modern practice is to instal continuous-current motors for driving purposes, due probably to the economical method of speed regulation of this type of motor compared with induction motors. In cases where a low motor speed is required the induction motor is decidely inferior to the direct-current motor as regards efficiency and operation. In large power plants a supply of direct current is always available, and the pump motors, etc., may be run off this circuit.

A brief inspection may now be made of the effect of speed on continuous-current and induction motors, the following remarks being based on Mr. H. M. Hobart's valuable paper on "The Rated Speeds of Electric Motors as affecting the type to be employed" (*Journal* of Institute of Electrical Engineers, vol. xxxiii., p. 472). Mr. Hobart in this paper gives comparative designs for motors of 150 h.p. of the continuous-current and induction types. The principal conclusions to be drawn from these designs are briefly as follows: (1) the general performance and the mechanical construction of induction motors improve rapidly with increasing rated speed; (2) the general performance and the mechanical construction of continuous-current motors improve rapidly with decreasing speeds; (3) the use of low-speed induction motors and very high-speed continuous-current motors ought to be avoided whenever this is commercially practicable.

The curve of Fig. 1 is of interest, and is plotted from data taken from manufacturers' catalogues for continuous-current motors of 15 h.p. at various speeds. It will be observed

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that for very low speeds the cost of the motor increases very rapidly. With continuous-current motors of a given output the efficiency at full load does not vary very much with the speed, while with induction motors the efficiency and power factor are very low for low speeds. This will probably explain the reason for the preference of continuous-current motors for driving pumps other than those of the centrifugal type.

It will thus be seen that for an economical pump running at, say, 10 revolutions per minute, the motor cannot be built economically unless a large reduction ratio be inserted between motor and pump. It is probably due to this that electrically-driven feed pumps run at comparatively high speeds, as there seems to be a prejudice against the use of worm gearing. The motor, from the economical standpoint, must run at a fair speed, and with spur gearing with a reduction of 1 : 20 or 1 : 30, this gives a high pump speed, resulting in a wasteful type of pump. Thus for an economical pump, and also an economical method of driving, the limiting feature is the reduction gear. In connection with reduction gears for moderate powers we have the choice of (1) ordinary spur gearing, (2) worm gearing, and also (3) spur gearing with special double helical teeth. The first of these may be dismissed, and the final comparison rests with worm gearing and double helical wheels. The

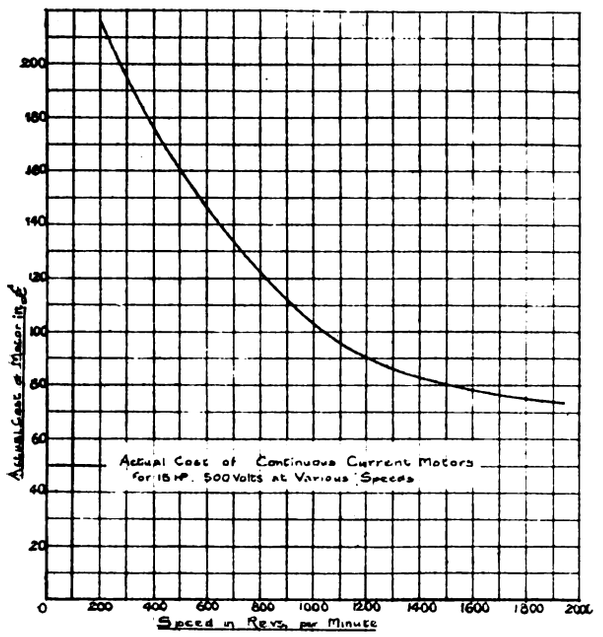


FIG. 1.

principal objections to worm gearing which appear to be apparent are (1) axis of motor at right angles to axis of pump, and (2) end thrust of worm to be taken up by ball bearings. The wear and tear of worm gearing, when properly constructed, is very small, indeed, and it must not be overlooked that to obtain a high efficiency requires a carefully-designed worm, good workmanship, and efficient ball bearings, but a very slight error in design, or the absence of a proper oil bath, may reduce the efficiency enormously. The Oerlikon Company has made extensive use of worm gearing fitted with ball bearings, the results being very excellent.

The curve shown, Fig. 2 (taken from Mr. Philip Dawson's exhaustive work on "Electric Cranes"), is a result of several tests recently made on worm gearing by the Oerlikon Company. The worm in question had five threads, with a diameter of $3\frac{3}{4}$in. at the pitch line, and a pitch of 7·28in., the wormwheel had 68 teeth, and the diameter at the pitch was $31\frac{1}{2}$in. It is to be noted that the efficiency is very high when above 10 h.p. is being transmitted. The motor connected to the worm ran at 780 revolutions per minute, and the ratio was 5 : 68.

The third class of gearing—viz., spur gearing with special machine-cut double helical teeth—has only recently been placed on the market, and it is intended as a substitute for worm gearing. The teeth of this gear are cut on a special machine, and the double arrangement is obtained by staggering the teeth on one side with respect to the other. This arrangement permits of the cutter to finish off the teeth completely, so that no further machinery is necessary. In the pinions, the space where the teeth intersect in the centre is turned down to a diameter corresponding to the diameter at the roots of the teeth. Due to the arrangement of staggering the teeth, the gear is practically noiseless since there is no backlash, and the engaging surface of the teeth is much greater than in other

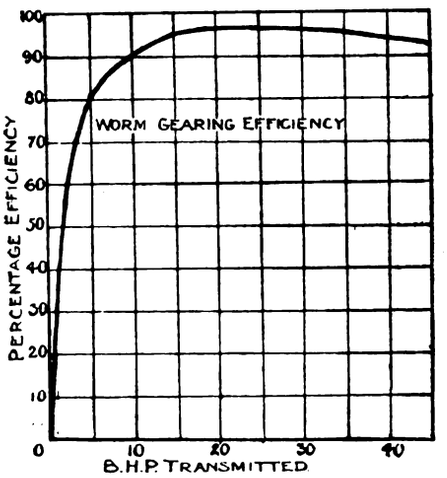


FIG. 2.

forms of spur gear. The arrangement of the double-reduction gear with these wheels is of special interest, and will be clearly understood by reference to Fig. 3, which shows a vertical section through the centre of a double-reduction gear. The shaft of the motor is fitted with a half-coupling, A, which is connected to another half-coupling on the shaft, B. A pinion, C (with double helical teeth), is securely fixed to this shaft as shown. This pinion drives a wheel, D, which is securely keyed to an extension of the boss of the pinion, E. This pinion drives another wheel, G, which is keyed to the low-speed shaft, H. The pinion, E, runs loosely on the shaft, F, which is fixed in the casing, an ample bearing surface being allowed. A striking feature in this gear is the arrangement of the main shafts. It will be noticed that the high-speed shaft runs on the low-speed shaft in the same direction, the end of the low-speed shaft being bored out and bushed to

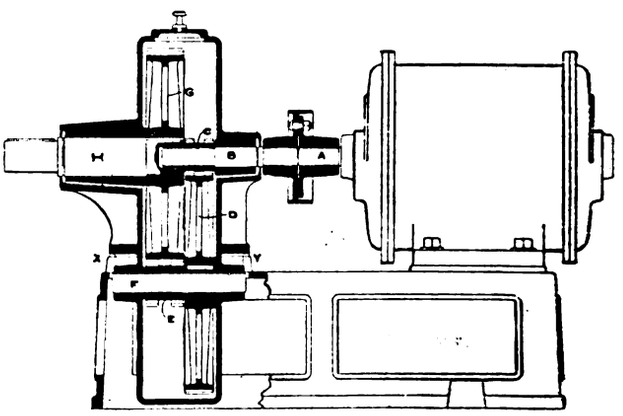


FIG. 3.

receive the high-speed shaft. The gear is enclosed in a cast-iron casing, which serves also as an oil-bath, the casing being divided along the line X Y in the smaller sizes, while in the larger sizes a second division line is added. This gear can be used for reductions up to 1 : 60, with an efficiency of not less than 90 per cent., while the reductions for 1 : 30 and 1 : 40 give an efficiency of from 93 to 95 per cent. This should prove very useful for the purpose previously mentioned, and overcomes the objection to the motor shaft being at right angles to the pump shaft, and incidentally does away with necessity for ball bearings. For a pump running at 10 revolutions per minute the 1 : 60 reduction would give a speed of 600 revolutions

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per minute for the driving motor, thus enabling a favourable design to be made. We should thus have the desideratum of the station engineer.—MONOPHASE.

*Answer to No.* 770 (*awarded* 7*s.* 6*d*).—There are many generating stations where the combination mentioned by "W. T. W." is used. There has been very little published about the matter, and so not much is known about the comparative efficiencies and first costs of the different systems. Mr. H. F. Proctor, in a paper read before the British Association, gives some interesting results obtained from the electrically-operated auxiliary plant at Bristol. The figures given show a decided advantage in electrically-driven auxiliaries over steam-driven. The results are expressed in terms of steam used per brake horse-power hour on the basis of 32lb. of steam per B.T.U.

| | Steam (lb.) | Electrical (lb.) |
|---|---|---|
| Feed pumps | 98 | 43·2 |
| Donkey pumps | 544 | 95·5 |
| Circulating pumps | 90·6 | 48·26 |
| Centrifugal separators | 220 | 37·6 |

Messrs. C. D. Taite and R. S. Downe gave some time ago a very good paper on the subject before the Institution. Full particulars were given of tests carried out on the motor-driven pumps at Salford. They are slow-speed three-throw pumps, driven by slow-speed four-pole motors through worm gearing, the ratio being 1 to 12. A well-known firm

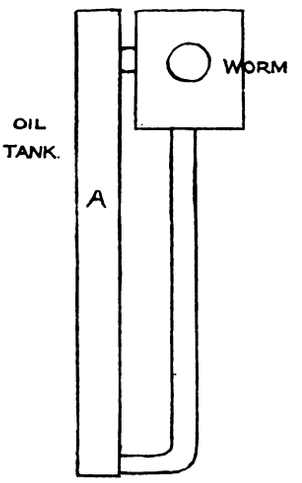


FIG. 1.

of steam-pump makers state the steam consumption of their standard 6,000-gallon pump to be as follows:

| Gallons delivered. | Pounds of steam used per hour at 160lb. pressure. | Pounds of water delivered per pound of steam used. |
|---|---|---|
| 1,000 | 130 | 77 |
| 2,000 | 253 | 79 |
| 4,000 | 490 | 81·5 |
| 6,000 | 714 | 84 |

Tests carried out at Southport on steam-pumps that had been in use three or four years gave the following average results: pounds of water delivered per pound of steam used, 49·1—which is considerably below the figures given by the manufacturers above referred to. The 4,000-gallon slow-speed motor-driven pumps at Salford gave the following results:

| Gallons delivered. | Duration of test. | Units used. |
|---|---|---|
| 1. 8,971 | 4 hours | 27·6 |
| 2. 15,822 | 4 ,, | 36 |

Assuming that each B.T.U. requires 30lb. of steam to generate it, we get the following results:

| Gallons delivered per hour. | Pounds of water delivered per pound of steam used. |
|---|---|
| 2,240 | 108 |
| 3,955 | 147 |

It will be therefore seen that the results obtained at Bristol and Salford are both in favour of the electrically-driven pump. The question of first cost, however, has to be considered, and here the steam-driven pump has the advantage. The high-speed motor-driven pump has also the advantage over the slow-speed motor-driven pump, as a slow-speed motor is much more expensive than a high-speed one of the same brake horse-power. The saving in power due to the electrical driving at Salford was found, however, to more than counterbalance the additional interest and sinking fund due to the increased first cost

The worm gear for the feed pumps at Salford was found to give trouble owing to its getting too hot for safe running. By means of the contrivance shown in Fig. 1 cool running has been obtained, and no further trouble experienced. A sheet-iron tank, A, of large cooling surface was connected by means of two pipes to the case enclosing the worm. The revolving of the worm helped the oil to circulate freely.—RESEARCH.

*Answer to No.* 770 (*awarded* 5*s.*).—The point raised in this question is one which has troubled engineers for some years, and even in these days does not appear to have reached a final and altogether satisfactory solution, as may be seen from the fact that some of the largest and most modern power-houses have been so differently equipped as regards their pumps, but for the very largest power-houses the tendency seems to be at the moment to rely upon the direct-acting steam-driven pump. This choice seems to be based upon reports of highly efficient results obtained with certain makes in this and other countries, emphasised by the fact that direct-acting steam-driven pumps to deal with 120,000 to 150,000 gallons per hour, generally speaking, ought to occupy less floor space. If one notes the size of the buildings and floor space needed for such a power-house as that at Lots-road, Chelsea, for running the Underground trains, one will observe that economy in floor space, foundations, etc., may become of greater importance than the gain of a small percentage in the working efficiency of a pump, especially when one adds to this a comparison of first-cost figures much in favour of the steam-driven pump.

This, then, leads to the point suggested in this question as to the adoption of a combined slow-speed motor and three-throw pump, seeing that highly efficient worm gearing is produced nowadays. The fact is that worm gearing has been used for pump work for several years past with very satisfactory results in those cases where the ratio has not been excessive, but in other cases the gears have proved not very durable, with a gradually decreasing efficiency as wear takes place and a somewhat high cost for renewal. Therefore, where it has been attempted to produce a plant with a high overall efficiency, possessing the element of cheapness as judged from the steam-pump standard, a comparatively high-speed motor and pump with double-reduction spur gearing has been adopted.

From this it will be seen that there is one standard from and to which one has to work and try to improve upon. That standard is the direct-acting steam-pump, whatever its required capacity may be. In a very small pump, perhaps, the poor efficiency of the steam-pump might warrant the extra heavy initial cost of a slow-speed motor and three-throw pump; but in the medium size the cost would be so much in excess, and the percentage gain not being so great, the slow-speed combination would not pay for its adoption; whilst in a pump of, say, 50 h.p, in addition to the excessive cost and floor space, one has to face the difficulty of using worm gearing satisfactorily, and the problematical gain in efficiency of the slow-speed electric over the compound steam-pump.

Thus it is seen that the question resolves itself into one solely of the most economical and satisfactory combination of efficiencies of motors and pumps, floor space, first cost, maintenance, and reliability; and although the suggested slow-speed combined arrangement might give the most efficient results so far as the consumption of power is concerned, it may not give the most economical results so far as the financial results are concerned at the end of the year.—E. A. B.

*Answer to No.* 770 (*awarded* 5*s.*).—There are many things to be considered in the answer to this question, and perhaps the chief thing we must recognise is that in commercial matters every manager is anxious to avoid making a loss, therefore he likes to adopt a method or a machine which has been proved of practical use. The actual efficiency of any machine is apt to vary with its circumstances, and

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many of us know that our local conditions are insuperable, or, at all events, we prefer to endure them rather than to incur the trouble and expense of alterations which may not be sufficiently beneficial in the end. Further than this, we must bear in mind that repairs often have to be done more or less in a hurry, and the process is facilitated by the readiness with which we can buy stock things. Also manufacturers have to meet competition, hence electric motors are made as small as possible, and with as little wire as possible, because it is cheaper to build them in this way, since the speed adds greatly to the horse-power developed while it costs nothing in making the motor. As slow-speed motors are not the fashion, they have to be made to order, hence the cost is considerably enhanced. Then, again, worm gear, although efficient, is not a favourite, because it is very apt to cause a good deal of friction if the worm and the cogs do not fit exactly, and experience shows that this is often the case; then, of course, the actual efficiency of any particular machine is not equal to the possible efficiency of an ideal machine most carefully and expensively made, and running in a bath of oil for the special purpose of a record test. A three-barrel pump is in itself a very good and efficient pump if worked at proper speed and kept in proper order, and it will last almost for ever, which is a great consideration. The direct-acting steam-pumps, now fairly common for feeding boilers, are also satisfactory in all practical ways. I have used both kinds for many years, and can speak well of each.

As a practical man with long experience and sound theoretical knowledge, I cannot help thinking that there is also another reason why the suggestion of "W. T. W." should not be adopted. It is this. We know that centrifugal pumps can be fixed directly on to the spindles of high-speed electric motors, and that then they form a very efficient combination, far more so than the suggestion of "W. T. W.," and they would, moreover, be cheaper in first cost. They can be run at such high velocities that they will quite easily force water into a steam-boiler against a pressure of 100lb. or 120lb. per square inch, and they are not liable to clog as an injector is, nor would they require so much steam, and a further great consideration is that if so placed that the water was delivered to them so as to flood them, they would deal with it at any temperature with equal efficiency. The day cannot be far off when this class of pump will be found extensively used. I have answered the question somewhat shortly, but "W. T. W." will be easily able to expand it to suit his own particular views, and I hope that a little careful consideration will enable him to see the wisdom of it.—F. G. A.

*Answer to No.* 770 (*awarded* 5*s.*).—Since the maximum speed of the crankshaft for the pump mentioned in the question would only be five revolutions per minute, it follows that the motor would have to run at a very slow speed, and also the worm gearing would have a very high velocity ratio. There is nothing to prevent a pump being constructed on these lines, so far as the working and efficiency go, but since the speed of a direct-current motor in revolutions per minute is dependent on $\frac{E \times 10^8 \times 60}{N \times T \times P}$ where E is the applied E.M.F., N the magnetic induction, T the number of turns on the armature, and P the number of poles, then in order to obtain a satisfactory machine it must be a multipolar, and the slower the speed the greater the number of poles required. Now, the less number of poles a motor has for a given power the cheaper it is to construct, and the cost goes up at an alarming rate as the number increase. If, by having a slow-speed motor, gearing could be entirely dispensed with, the additional cost would be partly counterbalanced, but as in the above case a certain amount of gearing would still be required, and which would probably cost nearly as much as the form of gearing usually employed, it is clear that the first cost would be very much more; and manufacturers of machinery know perfectly well that when a machine is put on the market at a high price for the sake of a small gain in economy, business at once becomes bad. It would be interesting to compare the gain by the increased efficiency against the extra interest on capital in the case under consideration.—E. AUSTIN.

*Answer to No.* 770 (*awarded* 5*s.*).—It seems difficult to understand why engineers should continue to instal the very wasteful steam-pump for boiler feed in generating stations when they are being largely discarded on other boiler plants in favour of the electrically-driven. The only apparent reason seems to be neglect to give such a small detail proper consideration. The best type of pump for the purpose is a three-throw single-acting ram of moderate speed, and direct-coupled through two sets of *machine-cut* iron spur gearing, the motor pinion being of raw hide. With carefully designed spring-closed valves having large area but small lift, the combined efficiency—electrical to water horse-power—should be from 78 to 85 per cent., which ought to be quite satisfactory. The combination suggested would be less efficient than this, and the first cost considerably more. A good worm gear *must* be accurately machine cut and run in an oil bath with ball thrust bearings. The wheel must be of gunmetal, and the worm at least double threaded to ensure an angle of not less than 20deg. This means a costly gear, while its efficiency would then be only about 86 per cent., against 95 per cent. for two sets of machine-cut spur wheels. The slow-speed motor will cost more, and the same applies to the pump end, and the combined efficiency under test would not be more than 66 to 70 per cent.—W. F.

## REVIEWS.

**Experimental Researches on the Flow of Steam through Nozzles and Orifices.** By A. RATEAU. Translated by H. Boyd Brydon. Archibald Constable and Co. Price 4s. 6d.

This book, which is small for the price charged, makes up for its size by the large amount of original information which is crowded into its pages. The investigations on the flow of steam through nozzles and orifices carried out by the author were undertaken with a view to the design of steam-turbines. It follows, therefore, that the results he obtained by means of the careful experiments described are of great value to all who are interested in the steam-turbine at the present time. The information obtained from the study of the reciprocating steam-engine is of practically no use to the engineer when he turns to the manufacture of a steam-turbine. Again, the design of these is so largely dependent upon the velocity of steam instead of its pressure, that the problems to be solved were distinctly new. The information of a positive character on the subject under review is scattered widely through the pages of French or German scientific publications. Unfortunately, much of this information is of a theoretical character, and hence the experimental work carried out by Prof. Rateau is particularly valuable in contrast. The book commences with a brief outline on the theory of steam flow and the velocity and weight of steam which will pass through a nozzle of given shape in a given time. The next chapter deals with the many experiments carried out by the author, and these are illustrated with drawings of the apparatus actually used. The third chapter deals with a comparison of the results obtained with those which Hirn arrived at from his historical tests in 1885 on the flow of air. At the end of the book the question of the flow of hot water through nozzles is also dealt with. The tabulated results which are given throughout the volume are exceedingly valuable, and the translator is to be congratulated on having made Prof. Rateau's work accessible to all English-speaking engineers.

SCALE AND CORROSION IN BOILERS.—The British Boiler Fluid and Engineers' Stores Company, Limited, have now issued a second edition of their pamphlet on the above subject, which is written by an expert, and is of interest to all who have to deal with the upkeep of boilers. It points out the damage which may be done to a boiler by the indiscriminate use of a boiler fluid without a previous knowledge of the composition of the feed water and of the fluid used.

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Supplement to "The Electrical Engineer,"
APRIL 28, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

### ANSWERS.

*Question No.* 771.—What is the cause of the difficulties experienced in regulating voltage on a two-phase alternating system supplied through three-core cables, and having a partly inductive load? Are these entirely absent on a four-core or double-concentric system

*Best Answer to No.* 771 (*awarded* 10*s*).—In answering this question I will first briefly describe the chief points of the two ways of connecting up the two-phase system as described in the question. In two-phase working we have two E.M.F.'s in quadrature—*i.e.*, having a phase difference of 90deg. They may be connected in two ways, as shown in Diagrams 1 and 2.

Fig. 1 shows the two phases entirely separate as they are generally worked, but it will be seen that it is quite possible to connect together the lead 2 of phase A and

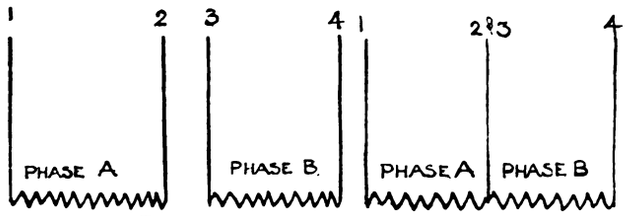


FIG. 1.




FIG. 2.

the lead 3 on phase B, thus having a common conductor for both phases, as in Fig. 2. The former is called the two-phase four-wire system, and the latter the two-phase three wire system. These are the two systems mentioned in the question. Now as the two phases have a phase difference of 90deg, they can be represented as in Fig. 3 by the vectors O A and O B, and thus we see that the difference of potential between the outer conductors is given by A B, and is equal in magnitude to $\sqrt{2}$ O A. Similarly the currents flowing in the two outers will cause a current to flow in the common conductor equal to $\sqrt{2}$ times the current in each of the outers, and I may incidentally

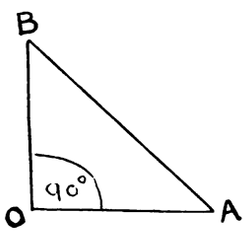


FIG. 3.

mention that we shall for this reason need a common conductor larger in section than the outers. The above condition of things is, however, when there is an inductive load on the system, only attained in theory, as the inductive load has the effect of unbalancing the voltage on the feeder, as I shall now proceed to describe. I am now assuming that both phases are loaded equally as would be the case with a motor load. I will refer to unequal loading later on in the answer.

Now as the load is inductive, it follows that we shall have a small E.M.F. of self-induction flowing in each phase. The value of this E M F. is $p$ L C, where $p = 2\pi \times$ frequency, C = the current flowing, and L is the coefficient of self-induction of the circuit. It is this E M.F. which is really the cause of the difficulties of regulation. First of all, let us consider the direction of this E M.F. of self-induction with respect to the effective E.M.F. It is well known that if we switch a current on to a circuit, the current in the circuit does not immediately attain its full value. This is due to the fact that the E M F. of self-induction *opposes* the applied E M.F. This can also be seen from the well-known law of Lenz, which states that "In all cases of electromagnetic induction, the induced currents have such a direction that their reaction tends to stop the motion which produces them."

We have now to consider the phase relation between the E.M.F. of self-induction and the effective E.M.F. Now in this circuit, if we consider one phase, the linkage of line $= L C$. If the current changes by an amount $d C$ in time $d t$, the change in linkages of lines of force is $L d C$ and the E M F. $- L \frac{d C}{d t}$. The current at any instant in the circuit is $C_m \sin p t$, where $C_m$ is the maximum value of the current. Therefore the E M F. of self-induction

$$= - L \frac{d (C_m \sin p t)}{d t}$$

$$= - p L C_m \cos p t$$

$$= - p L C_m \sin\left(p t - \frac{\pi}{2}\right).$$

Thus the E.M.F. of self-induction lags 90deg. behind the current, and since the effective E.M.F. is in phase with the

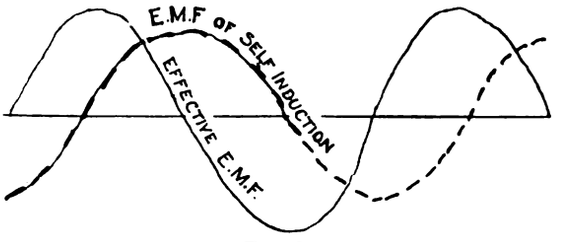


FIG. 4.

current, the E M.F. of self-induction lags 90deg. behind the effective E.M.F., as shown in Fig. 4. Thus it follows that in the two-phase three-wire system, since the effective E.M.F. in one phase is 90deg. out of phase with that in the other, and also the E.M F. of self-induction of the first

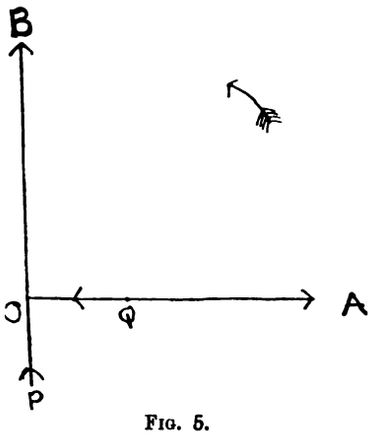


FIG. 5.

phase is 90deg. out of phase with the effective E.M.F. of that phase, the E M.F. of self-induction of one phase will be *in phase* with the effective E.M.F. of the other phase, and the E.M F. of self-induction of the second phase will be *180deg. out of phase* with the effective E.M.F. of the first phase. This very important point will be better seen by referring to Figs. 5 and 6, where I have considered these E M.F.'s vectorially. Let the vectors O A and O B represent the effective E.M.F.'s of the two phases which are 90deg. apart. Now, the E.M.F. of self-induction of phase A is 90deg. out of phase with and in opposition to O A, and is therefore represented by O P. Similarly, the E.M.F. of self-induction of phase B is 90deg. out of phase with and in opposition to O B, and is therefore represented by O Q. Thus we see that the total E M.F. acting along O B is

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P O + O B = P B, and along O A it is O A − O Q = Q A. Thus we see that at the far end of the feeder we have an unbalancing of the E M.F.'s, as shown in Fig. 6. This is the real cause of the difficulties experienced in regulating the voltage as described in the question, since it will be seen that although we have equal pressures between the common conductor and outers at the generator end of the feeder, with an inductive load, through the causes shown, the voltages at the other end of the feeder will be unequal.

I think a few figures given by M. A. Oudin will give a better illustration of this phenomenon. The system was a two-phase three-wire system, like the one I have just discussed. The amperes flowing in the outers were 400, and in the common conductor 566. The voltage at the generator end of line was 100 volts between each outer and

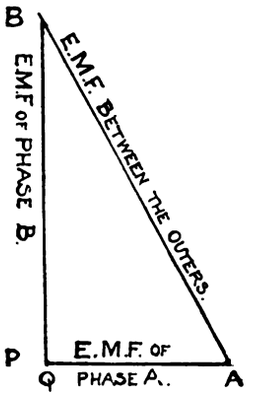


FIG. 6.

the common conductor, and 142 between the outers. Then, at the far end of the line with a frequency of 60 cycles, the voltages between (*a*) one outer and the common, (*b*) the other outer and the common, and (*c*) the two outers, were (*a*) 90, (*b*) 97, and (*c*) 134. Also, with a frequency of 125 cycles the voltages were (*a*) 87, (*b*) 99, and (*c*) 136. I think these figures clearly illustrate my argument, since it will be seen that allowing for drop in the line, on one side the voltage goes down and up on the other.

Of course, with a four-wire system there will be no such unbalancing, since the two phases are not connected together in any way whatever, and therefore the E.M.F. of self-induction in one phase can have no effect on the effective E.M.F. in the other. There may be, however, an unbalancing effect due to ordinary inequalities in the load, as is the case with the lamp load. These difficulties will, of course, be the same with a four-wire as with a three-wire system.—ERNEST P. HOLLIS.

*Answer to No.* 771 (*awarded* 7*s.* 6*d*).—The cause of the difficulties which are experienced in the regulation of the voltage on a two-phase alternating-current system working with three-core cables is one which, in itself, is due, primarily and directly, to the inductive actions upon and the inductive interactions between the cables. Also, as the conductors are situated in the three-core cables, there is a total absence of balance of these actions and interactions; in fact, speaking from a practical point of view, it may be said that there is little or no tendency, even, to provide such a state of balance, but that there is a very large mutual tendency on the part of the currents traversing the conductors of the cable to upset and derange the conditions of working. This total absence of balance leads, as a consequence, to a sequence of effects being impressed on each of the three conductors, and such effects are really the connecting links between the primal cause and the difficulties which have to be contended with in the regulation of the pressure of each of the two sides of the system, and also in the maintenance of the equality of the pressures of the two sides.

The chief subsidiary cause is, perhaps, the peculiarity of the relative positions of the three conductors one with another, the cables referred to in the above question being practically the most suitable cables it is possible to choose for a two-phase three-wire system of supply. In such a case the relative positions are out of all harmony with the principles which govern the working of the system, because the inductive action of any one conductor on either of the other two does not counteract and neutralise the inductive action of the remaining conductor on the same objective conductor. But in place of such a condition the inductive effect of the current passing along one conductor on another aggravates and augments the inductive effect of the current passing along the remaining conductor on the same one hence developing and extending, disturbing and distorting influences on the system, and not resisting and choking them. It should also be borne in mind that a very important factor, and one which should not be neglected in this connection, is the fact that all the three currents in the three conductors are "out of phase" with each other; or, in other words, that they possess phase relationships with each other. The direct result of this is not to provide the condition of balance or neutralisation of the inductive effects on each of the three conductors, even if the conductors are placed in the theoretically correct positions with relation to each other, since the two effects on any one conductor are not equal and opposite to each other, and consequently cannot neutralise each other.

Another effect which is produced in each of three separate conductors is that of the self-induction of each conductor in itself. This effect will not be very serious, or even material, compared with the mutual induction effects, owing to the peculiar condition of each conductor, inasmuch that it is a straight wire. Hence we may neglect it except in the inclusion of *all* tendencies likely to aggravate the difficulties of the regulation. Again, it is clear that if the loads on each side of the system are not equal, and the pressure at the receiving end is the same on both phases, then the currents traversing the two outers will not, as a general case, be equal, and they also will differ from the current passing along the middle wire. From this we see the self-induction effects of the conductors will vary, the extent of the variation depending wholly on the extent of the variation of the two loads and the value of the power factor of each phase.

We shall now consider this question in a graphical manner. Suppose that it is required to maintain, for *all* loads, a constant pressure of, say, E volts at the receiving ends of each of the two sides of the system, and that the angle of phase difference between the two pressures is 90deg. We can graphically represent these two pressures (as in Fig. 1) by two vectors, $E_1$ and $E_2$, situated at 90deg.

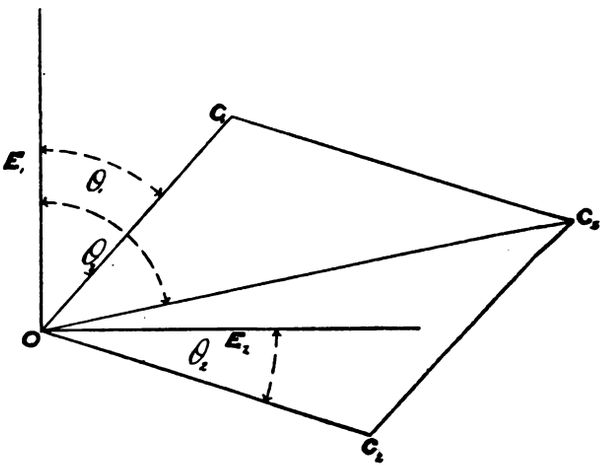


FIG. 1.

apart. Let $O_1$ be the angle of lag of the current in the first outer behind the pressure $E_1$ due to the inductiveness of the load, and $O_2$ the angle of lag of the current in the second outer behind the pressure $E_2$; also let O $C_1$ and O $C_2$ be the two currents respectively. Then, since the current in the middle wire is the resultant of O $C_1$ and O $C_2$, by completing the parallelogram, O $C_1$, $C_3$, $C_2$, and drawing the diagonal, O $C_3$, we obtain O $C_3$ as the middle-wire current, with $O_3$ its angle of lag referred to the pressure $E_1$. Now, considering the first phase, $E_1$ is the receiver pressure; O $C_1$ gives rise to the induced pressure, $e_1$, in the outer wire and $e'_1$ in the inner, these having a phase difference of 180deg, and also being unequal in magnitude; O $C_2$ induces the pressure, $e_2$, in the outer and $e'_2$ in the inner, these being equal in magnitude and having a phase angle of 180deg; O $C_3$ gives rise

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to an induced pressure, $e_3$, in the outer and an induced pressure, $e'_3$, in the inner, these being unequal and differing in phase by 180deg. We can arrange the curves of these pressures on a base-line and find the resultant pressure

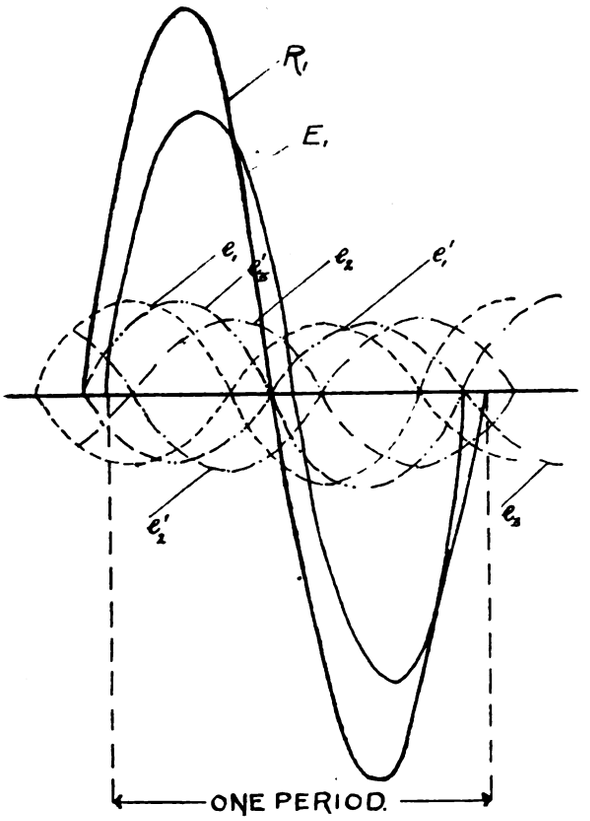


FIG. 2.

which would, for the load, be required. This resultant pressure is the generator or 'bus-bar pressure for that one phase. This process is exemplified in Fig. 2, in which, for the sake of simplicity, the pressures have been regarded as sinusoidal

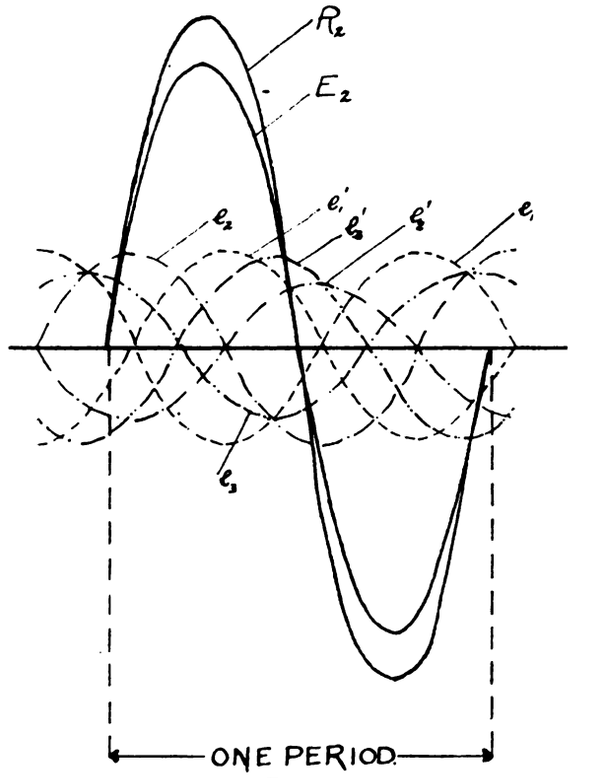


FIG. 3.

quantities; in this figure the resultant curve is marked $R_1$. This process is also used to determine the resultant for the second phase, although the induced pressures due to the actions of the various currents will not *necessarily* be the same as in the former case. In Fig. 3, $R_2$ is the resultant of the second phase. Comparison of these two curves will serve to show that they are not alike so far as general shape, maximum values, and phase displacement from the receiver pressure are concerned. If the loads are altered in magnitude or inductiveness, these curves will, clearly, be altered because the component curves will themselves be altered owing to the changed conditions. Also, the alteration of the resultant curves is not governed by any special law, hence extreme difficulty in proper regulation is the direct result.

As regards the latter part of the question, it follows from the above considerations that unless the various members of the cable are so situated that the total inductive action of *all* the members is zero, then difficulty in the regulation of the voltage of the system will be present. In the case quoted in the question, seeing that the conductors of the cable are not in such a position, inductive influences will make themselves felt in the system. But it may be said as an offset to this, that in this case the conductors are so situated that they act as condensers, and the effect of these actions is to neutralise the inductive effects. Consequently, the difficulty of regulation will not be so great as in the former case, although it cannot be said that it will be *entirely* absent. Incidentally, it may be mentioned that the ideal relative positions of the four conductors are at the corners, or ends of the diagonals, of a square, with the two conductors of one phase at the ends of *one* diagonal and those of the other phase at the ends of the other diagonal. In this arrangement the natural tendency of each conductor is to affect the other three, but, owing to the peculiar positions of the conductors, the sum total of the effects of all the conductors is almost, if not quite, zero.—B. W. G.

*Answer to No.* 771 (*awarded* 5*s.*).—The difficulty is due to the difference of the effect of the voltage drop in the common return cable on the two-phase voltages at the far end of the line. The current carried by the common return cable, $B_1$ $B_2$ (Fig. 1), is the vectorial sum of the two separate phase currents, and since the latter are displaced 90deg. or quarter period from one another, and (if the two phases are equally loaded) are equal to one another, the common return current is displaced 45deg. or one-eighth period from either of the phase currents. The voltage drop in the common return is, therefore, also at 45deg. to that in either of the other cables. The effect of these various voltage drops on the actual phase voltage measured at the far end of the line (between $A_2$ and $B_2$ or between $B_2$ and $C_2$, Fig. 1) depends not only on the value of the drops, but also on the angle of lag between the phase current and the phase voltage—*i e*, on the power factor of the external load—and for any other than a non-inductive load the effect is not the same on the two phases. This can be

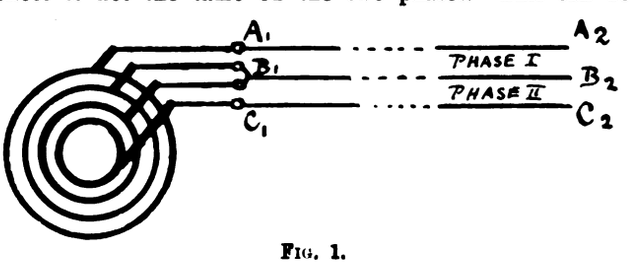


FIG. 1.

shown by two simple vector diagrams. Fig. 2 represents the case when the output at each phase of the alternator is non-inductive. In order to complicate the diagrams as little as possible, the drop in the cables has been assumed to be solely due to resistance—the presence of an additional reactance or inductive drop in the lines would only affect the results quantitatively, but not qualitatively. The lines O $A_1$ and O $C_1$ at 90deg. to one another represent the voltages of phase I. and II. measured at the generator, between $A_1$ and $B_1$ and between $B_1$ and $C_1$ (Fig. 1). As the alternator load is assumed non-inductive, the lines representing the phase currents will lie along O $A_1$ and O $C_1$ respectively. Let O A and O C be these phase currents. Then the current in the common return cable ($B_1$ $B_2$, Fig. 1) will be the resultant of O A and O C, and is shown as O B (Fig. 2). The voltage drop in the line $A_1$ $A_2$ and $C_1$ $C_2$ (Fig. 1) will be in phase with the phase currents O A and O C (Fig. 2) respectively, and may be represented by the

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line $A_1$ $a$ for phase I. and $C_1$ $c$ for phase II. The drop in the common return ($B_1$ $B_2$, Fig. 1) will be in phase in with the resultant current, O B, and may be represented for the two phases by the lines $a\ b_1$ and $c\ b_2$ respectively, drawn parallel to O B. The lines $o\ b_1$ and $o\ b_2$ will then represent the phase voltages available at the far end of the line. It is clear from the symmetry of the diagram that these two voltages are equal, so that it would only be necessary to increase the exciting current of the alternator slightly at full load in order to ensure the same voltage at full load as at no load in both phases at the far end of the line.

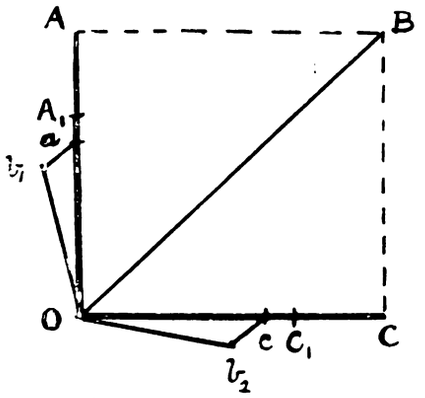


FIG. 2.

When the load becomes inductive, however, the result is very different. Fig. 3 represents this case on the assumption that the power factors and amounts of the loads are alike on the two phases. The lines O $A_1$ and O $C_1$ at 90deg. to one another will again represent the voltages of phases I. and II. normal between $A_1$ and $B_1$ and between $C_1$ and $B_1$ (Fig. 1). Let O A and O C represent the phase currents lagging considerably behind their respective terminal voltages, O $A_1$ and O $C_1$. The current in the common return will now be represented by O B, which is, of course, still at 45deg. to the currents O A and O C, but is at very unequal angles to the voltage lines O $A_1$ and O $C_1$. The voltage drop in lines $A_1$ $A_2$ and $C_1$ $C_2$ (Fig. 1) will be represented by the lines $A_1$ $a$ and $C_1$ $c$ (Fig. 3) drawn

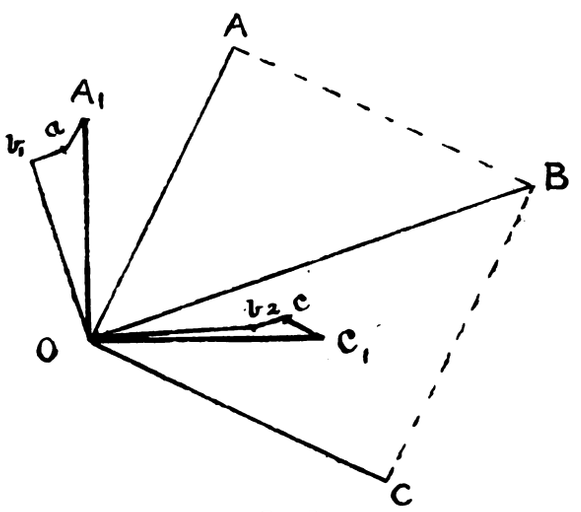


FIG. 3.

parallel to O A and O C respectively. The drop in the common return will be given by the lines $a\ b_1$ and $c\ b_2$ drawn parallel to the line O $B_1$, and the effective phase voltages at the far end of the line will again be represented by $o\ b_1$ and $o\ b_2$. It will be seen that these voltages are very unequal in this case, so that the voltages at the far end of the two phases will no longer be equal even if the phase voltages at the generator terminals are exactly alike. In such a case the voltages at the far end can only be maintained equal by separate regulation of each phase by means of feeder regulators, etc.

If, on the other hand, the two phases are kept quite separate by employing a four-core cable, the difficulty will be practically overcome, for the voltage drops in the two phases will then remain relatively alike, both in amount and in their phase relation to the terminal voltages, under all conditions of load, provided that the loads on the two phases are equal as regards amount and power factor and that the inductances of the two pairs of lines are not materially different. Fig. 4 represents this case for an inductive load. The drops in the separate return cables are here shown by $a\ b_1$ and $c\ b_2$ drawn parallel to the phase currents O A and O C, and, therefore, in line with

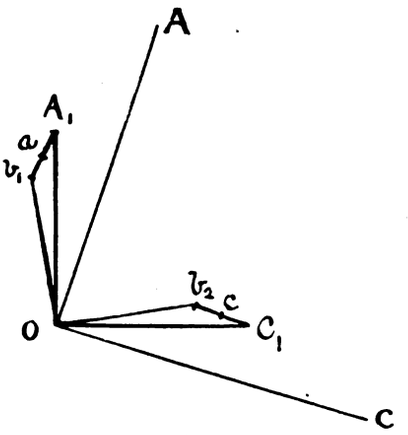


FIG. 4.

$A_1$ $a$ and $C_1$ $c$ respectively. The phase voltages $o\ b_1$ and $o\ b_2$ are equal.—Q.

*Question No.* 772.—In testing a short length of triple-concentric, lead-sheathed cable with a Silvertown set battery, volts 200, no deflections were obtained on the galvanometer unshunted, ·23deg. with 100 shunt through 50,000 ohms. On testing the same cable with an Evershed ohmmeter set, the following readings were obtained: + to −, 40 megohms; + to ⏜⏝, ∞; + to lead, ∞; − to ⏜⏝, 5 megohms; − to lead, 50 megohms; ⏜⏝ to lead 5 megohms. What is the reason for the differences?

*Answer to No.* 772 (*awarded* 5*s.*).—There is not only a discrepancy between the results of the insulation tests taken with the Silvertown testing set and the Evershed ohmmeter set respectively, but there are discrepancies in the individual readings of the latter. For instance, the insulation resistance between the negative and the neutral comes to five megohms, and that between the neutral and the lead is five megohms, and yet the insulation resistance between the negative and the lead, instead of being 10 megohms, is given as 50 megohms, therefore it is apparent that the Evershed ohmmeter readings are unsatisfactory, and hence we may conclude that the source of all the observed discrepancies is most probably here. Now the readings of this instrument will give a lower value for the insulation resistance than ought to be the case if the leads which are used to connect the instrument to the cable under test are not satisfactorily insulated from each other. Evidently in some cases this insulation was satisfactory, or the infinity readings would never have been obtained. The fact that such readings were sometimes obtained proves also that there is no leak in the testing set itself, between the terminals to which the leads are attached, sufficient to account for any error in the readings. Also between the various tests the leads have to be moved in changing their connections, and it is not to be expected, therefore, that the insulation resistance between them even if sometimes very low will always be so. The conclusion is, therefore, that leads with a poor insulation resistance were used to connect the cable under test to the Evershed testing set, and that these leads were allowed to lie on the ground, or in proximity to one another or some conductor.

If "E. H. H." will repeat the test using high-class insulation connecting leads, or taking care that the leads used do not touch anything but at their ends, he will most probably find that in every case the insulation resistance will be what is commonly called infinity, a term which really means that it is beyond the range of the testing set used.—SUPERHEAT.

[Other replies to Question No. 772 will be given in our next issue.—ED. *E. E.*]

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MAY 5, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

778. A large institution requires a 14-h.p. motor for a laundry and also want the same motor to augment a deficient water pressure—due to high ground on which building is situated—in case of fire, by working a pump fed by the water suplpy. How can the motors be best arranged to fulfil this two-fold purpose?—A. R.

779. A three-phase induction motor, with star-connected stator windings is so arranged that each limb of the star consists of two parallel circuits, each circuit producing one set of poles and its neighbour the opposite set (see Fig. 1). If these circuits were

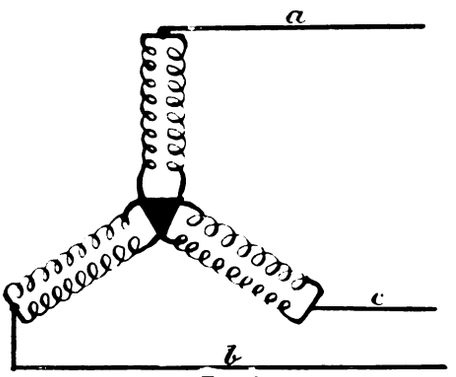


FIG 1.

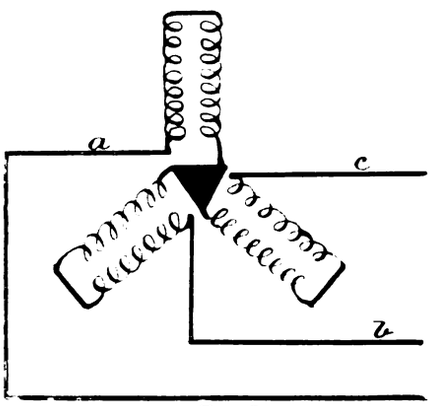


FIG. 2.

placed in series, still star connected (see Fig. 2), in what manner would the machine power factor and efficiency be affected at light and full loads —MESH.

### ANSWERS.

*Question No.* 772.—In testing a short length of triple-concentric, lead-sheathed cable with a Silvertown set battery, volts 200, no deflections were obtained on the galvanometer unshunted, ·23deg. with 100 shunt through 50,000 ohms. On testing the same cable with an Evershed ohmmeter set, the following readings were obtained: + to −, 40 megohms; + to ⌒⌣, ∞; + to lead, ∞; − to ⌒⌣, 5 megohms; − to lead, 50 megohms; ⌒⌣ to lead 5 megohms. What is the reason for the differences?

*Answer to No.* 772 (*awarded* 7*s.* 6*d.*).—An explanation is evidently required, not only of the different readings obtained from the two instruments, but also of the apparent inconsistency of the results given by the ohmmeter. In the first place, the fact that with a 200-volt battery with 100 shunt a deflection of only ·23deg. is obtained with the standard 50 000 ohms points to a defect in the Silvertown apparatus. Under the same conditions an equal deflection would be obtained with unshunted galvanometer through a resistance of 5 Ω. The resistance which would correspond to a scarcely readable deflection would, therefore, not be necessarily a very large one. It must be remembered also that resistances of this type are not constant, but depend to a certain extent upon the E.M.F., decreasing as the latter increases. The ohmmeter gives 500 volts, and the lowest resistance in this case is 5 Ω. Now, as shown above, the Silvertown set with a 5 Ω resistance would give ·23deg. deflection. That it does not when testing from − to ⌒⌣ and from ⌒⌣ to lead is probably due to the fact that the battery gives 200 volts at the most, probably a good deal less, the insulation resistance at this voltage being considerably more than 5 Ω. The battery should be examined for voltage and loose connections, and the fault will perhaps be discovered. In the rather unlikely case of its not being found here, the instrument should be examined, as the needle may be demagnetised, or the jewel dirty or damaged. The needle may be remagnetised by a few strokes from a magnet, and the jewel, if dirty, may be cleaned with a splinter of wood. Damage to the jewel or pivot is the result of carrying the instrument about without closing the lid, and so lifting the pivot off the jewel.

Of course, broken or bad connections to outside circuit would account for the failure of the Silvertown set to give a deflection, but the fact that the standard deflection is also low puts this explanation on one side. If defect lies neither in battery nor needle, it may be assumed that an internal connection has broken or become damaged, this connection being in 50,000 ohms circuit, and also in circuit with cable under test.

In the second place, as regards the apparent inconsistency of the ohmmeter readings—*e.g.*, − to ⌒⌣ 5 Ω, ⌒⌣ to lead 5 Ω, − to lead 50 Ω—it might be thought that the latter ought to be approximately the sum of the former, but when testing from − to ⌒⌣ and from ⌒⌣ to lead, the potential difference per millimetre of dielectric measured radially would be about double the potential difference per millimetre in the test from − to lead, and considering the nature of the resistances as above, the readings obtained probably represent the actual state of affairs.—D. M. H.

*Answer to No.* 772 (*awarded* 7*s.* 6*d.*).—The question does not state the conditions explicitly enough to say definitely what is the reason for the differences. Firstly, the testing pressure of the ohmmeter set may be considerably higher than that of the Silvertown set, and may produce a partial breakdown of the insulation which remained unaffected by the 200 volts, thus causing the differences. Secondly, if the "·23deg. with 100 shunt through 50,000 ohms" refers to the standardising test, the galvanometer is not nearly sensitive enough, although, of course, it should give a deflection of ·23deg. with five megohms when unshunted; but still, a tester who uses the above as a standardising test, when there can be no reason why he should not standardise it unshunted, cannot be relied on at all, and very probably used some old bell wire for connecting the ohmmeter to the cable, and sometimes happened to have them touching and sometimes not. Thirdly, assuming the decimal point is a mistake, and the deflection should be 23deg. (which would point to the great advisability of putting a cipher before a decimal fraction, as 0·23), and also that the ohmmeter set testing pressure is 200 volts, then the most probable reason is that the testing set is an alternating one, and the reading produced by capacity currents. We now assume the insulation perfect as indicated by the galvanometer, and treat the cable as a condenser. Connections:

+ to lead, the area of one plate is small and the distance apart large, so the capacity current is insufficient to affect the ohmmeter;
+ to neutral, ditto ditto;

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+ to −, the area of one plate is still small, but as the distance apart is so much decreased, the capacity effect is quite noticeable;
− to lead, area increased and distance also increased, so effect about the same;
− to neutral, distance decreased, so effect increased;
Neutral to lead, area and distance about the same, so effect about the same.

This only holds true because the soft iron needle of the ohmmeter is not affected by phase difference.—J. LEWIS COOK.

*Answer to No.* 772 (*awarded* 5*s.*).—In testing the insulation of a cable whose ends are exposed to the atmosphere, or have been at some time after leaving the maker's test-room, where an even temperature was kept up during their tests, a great variation will be found, depending chiefly on the condition of the atmosphere during the various tests at various times; but assuming the cable under test by the different methods to be under the same conditions on which I base my figures, and the sets to be correct as far as comparison one with the other.

The readings obtained by the Evershed ohmmeter set are not in the least to be doubted, and the same would have been recorded on the "Silvertown set" had it been possible to obtain a higher constant than 1,150,000 (or 1·15 Ω for test convenience), and, to compare the "Silvertown set" with K = 1·15 Ω with "Evershed set" readings, the following deflections would have been obtained had it been possible to read them:

| | Evershed set. | Silvertown set with galvanometer unshunted. Battery volts 200, K = 1·15 Ω. |
|---|---|---|
| A + to − | 40 Ω | ·0287deg. |
| B + to ⌒ | ∞ | — |
| C + to lead | ∞ | — |
| D − to ⌒ | 5 Ω | ·23deg. |
| E − to lead | 50 Ω | ·023deg. |
| F ⌒ to lead | 5 Ω | ·23deg. |

As "E. H. H." does not give the value of his infinity, or to express myself better, the infinity in this case may mean anything above 50 Ω, being the highest figure given, and consequently the reading on "Silvertown set" would be less than ·023deg. I may say I have had a constant with the same type of set, though by not the same maker, with 200-volt battery = 600 Ω, and more. The reasons for the differences in readings taken by "Evershed set" are simple, and which occur with all cable tests, following the above. + to lead, which is ∞, would be A together with B and F, and + to − being 40 Ω, F = 5 Ω, B = ∞ something higher than 50 Ω, therefore + to lead would be of such value as to be unable to give a reasonable deflection on "Silvertown set," and similarly with other readings.—A. P.

*Question No.* 773.—A quantity of lighting cable (200 volts, say) is suspected of being largely composed of reclaimed rubber instead of pure. Is it possible to decide the point, naturally without referring to the makers, and what would be the effect on the cable were such found to be the case?—R. R. R.

*Answer to No.* 773 (*awarded* 7*s.* 6*d*).—In reply to the above, the decision of the point in question can be arrived at through the medium of proper and thorough tests on the suspected cables. Presuming that the cables have not been as yet laid down or used in anywise, but that they are set aside for future use, it is not a very difficult matter to conduct such tests with a certain amount of facility. In the first place, it will be well to consider briefly a few necessary points in connection with the difference which exists between pure rubber and reclaimed rubber. It is taken for granted that by reclaimed rubber is meant rubber which has been used in other cables previous to its use in the insulation of the cables in question. In all probability then, considering the trend of the modern manufacture of cables, this rubber may have been used in conjunction with sulphur and other insulating materials, as well as substances acting as mechanical protectors. In the new state, however, this rubber will have had removed from it all these foreign substances, but there will still remain traces of them in the rubber, owing to the persistence of the association of the substances with the rubber. In pure rubber, of course, no such substances are to be found, since there never exists the occasion for it to come into contact with them before it is requisitioned into use. The supreme object, therefore, of the test is to detect, as far as it is possible, any trace of these foreign substances. The first test which should be made should be an insulation test, the objective being to determine whether the insulation of the cable is as good, better, or worse than that of a cable insulated entirely with pure rubber. This can be done by taking equal lengths of the cable in question and a pure-rubber insulated cable, and testing them, in turn, by means of a Silvertown testing set or an Evershed ohmmeter set. Comparison of the two results will then clearly show which of the two cables is the better insulated. If this should be the cable in question, the tester could well conclude that his cable is a pure-rubber insulated one, but, in cases like this, it is always well to perform one or more confirmatory tests. In any case, therefore, the test should be performed with the cables immersed completely in water, and the readings of the instrument then taken. The comparison can be then made again. Also, if the tester has the time and the facility, he would do well to conduct a heat test on the rubber of the cable. An inch or two of the braiding or equivalent covering is entirely removed, and the rubber underneath this is cut away from the conductor. This rubber is then placed in a test-tube or other convenient vessel, and heat applied to it by means of a flame. The rubber is carefully watched, and the temperature is noted at which it begins to soften. If this temperature is more than 75deg. C., it may be taken for granted that the rubber is not pure; but this test is by no means conclusive, because the above temperature depends upon a large number of conditions. To test the rubber for weight will be far more conclusive than the above. If a certain volume of the rubber is taken and weighed, then the specific gravity can be readily calculated. Should this exceed 0·933, it shows that the rubber is not pure, but reclaimed. If the rubber were found to be impure, then it would in all probability lack that homogeneity which is so necessary. Also, its waterproof qualities would be in the declension. Its durability would be diminished, and the conductor, unless thoroughly tinned, would be attacked and eaten away. And, above all, the insulation would be poorer, thus producing a poor cable, whose use would probably lead to dire results.—B. W. G.

*Answer to No.* 773 (*awarded* 7*s.* 6*d.*).—There are several methods of testing the purity of rubber; perhaps the simplest and most handy test is that of burning. To take this test it is only necessary to secure a small quantity of the rubber with which the cable is insulated. If the rubber is pure, when burned it should leave a soft white ash, the dimensions being much smaller than it was before being burned; should the rubber be of a poor quality, not only will the ash be hard, but its dimensions will be practically the same. As a rule, cables are not insulated with pure rubber throughout, but have only a thin covering of pure rubber next to the copper conductor, the pure rubber being covered with vulcanised rubber. This rubber is of a different quality, and is mixed with certain compounds, of which a portion is sulphur. Should the sulphur not be thoroughly mixed the sulphur may form crystals, which dissolve out of the cable when exposed to moisture, causing small holes to appear, which will tend to weaken the insulation properties of the cable. All cables should be tested at the manufacturers according to the specification, and should stand at least a current at a pressure equal to four times the ordinary working pressure for a quarter of an hour after the cable has been immersed in water.—G. M.

*Question No.* 774.—In a description of the electrification of a railway in France some weeks ago, rotary converters were mentioned as running compounded with the series windings opposing the shunt. Explain how such machines work, and give any advantages which they possess over ordinary compound rotaries.

*Answer to No.* 774 (*awarded* 7*s.* 6*d.*).—The object of a differentially-wound converter or dynamo is to supply current automatically and alternately at voltages about two mean values as occasion requires. It is used in parallel with a battery which it charges at the higher voltage, and, in parallel with which, it supplies current to a network at the lower voltage. Its characteristic curve is represented in the figure, and from this it will be immediately seen that, running alone, it becomes demagnetised at a certain

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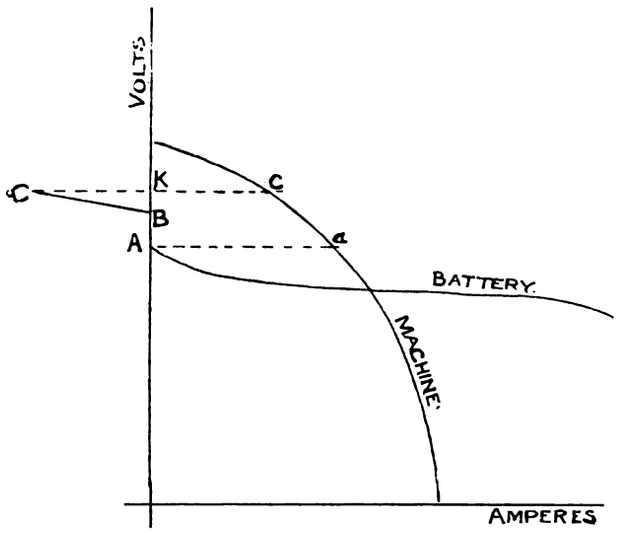
load; this, however, is prevented by a battery, a characteristic curve of which is also represented. It is quite clear that, so long as the battery and the machine are in parallel, their voltages must be the same, from which it follows that horizontal lines cut the two curves at points representing their respective shares of the load. If the capacity of the battery is large, the horizontal part of its curve will be long, and the maximum load taken by the machine is practically represented by the point at which the curves cut. The volts supplied to the network at large loads are also roughly represented by this point. If we examine the curves we see that when the load on the battery has dropped to zero (as at A), the machine—to keep at the same voltage—must supply a certain load (*a*) Now, as soon as the demand on the network drops below this value and the volts tend to rise, the machine would




immediately begin to charge the battery but for the fact that the battery volts still rise about 15 per cent. (to B) before charging commences, and another 5 or 10 per cent. before it becomes general. When this point is reached, and the battery volts have ceased rising with the machine volts, the machine will be supplying current represented by (*c*), so that the battery curve passes through a point, C, such that C K = K *c*. Now, since the volts cannot rise beyond this in the machine (on account of the battery), the points C *c* are the last we can reach on both curves, and the machine continues to charge the battery at this rate until load again comes on the network, when the series winding and the armature drop bring the volts down below A, and the battery begins to discharge again. The points A, B, and C, of course, vary slightly according to the state of the battery.

The advantages and disadvantages of these machines over ordinary compound rotaries are obvious, each for its own particular work. This machine would, of course, be quite useless for keeping a steady voltage on, say, a traction system, apart from its battery. On the other hand, an ordinary compound-wound rotary converter would be out of the question where a battery is used, as the latter would never have a chance of discharging in parallel with the machine. A shunt-wound machine would not automatically give enough variation in voltage to charge and discharge the battery unless its characteristic curve was very steep, a result most simply and economically obtained by adding a suitable number of series turns in opposition to the shunt turns, and, in short, making a differentially-wound machine.—W. E. P.

*Answer to No.* 774 (*awarded* 7*s.* 6*d*).—This reversed series winding gives a falling pressure with an increasing load, which enables a floating battery to equalise the load on the generating plant. To anyone who is familiar with the regulation of rotary converters the above statement will make the whole question clear, and there is really no need for further explanation, but to anyone who is not versed in this matter the following should enlighten: The ratio of the alternating-current and direct-current voltages of a rotary converter is a fixed quantity, consequently one cannot be raised or lowered without the other, and is also independent of the excitation; therefore, in order to vary the pressure on the direct-current side, the applied pressure at the slip-rings must be altered. In some cases this is done by altering the transformer ratio or by induction regulators, but for automatic regulation the machine is usually provided with a series winding. At first sight it appears that this would be valueless, for it has been stated that the ratio is independent of the excitation, but with a little consideration it will be seen that this series winding can be made to vary the pressure at the slip-rings. If the excitation of any synchronous motor is varied, the driving current will also vary; and on all such machines it will be found that for a given load there is one excitation which gives a minimum input. Any increase in this excitation will cause the machine to draw a greater current, which will be a leading one, while any decrease will also cause it to draw a greater current, but in this case it will be a lagging one. In short, by varying the excitation the power factor of the machine is altered. Now, it is well known that any circuit having inductance, a leading current will cause a rise in pressure, while a lagging one will cause a fall. This inductance is generally provided by putting reactance coils between the secondaries of the trans-

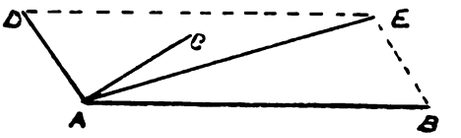



FIG. 1.

formers and the slip-rings. In order to see how the pressure is varied, a vector diagram may be employed. Let A B (Fig. 1) represent the terminal voltage of the transformers, and A C the lagging current. Then A D will be the reactance voltage at right angles to it, and A E is the vectorial sum of A B and A D which may be taken as the voltage at the slip-rings. In Fig. 2 the machine is supposed to be running with a heavier load, and the current vector, A C, is consequently made longer and is now leading on the E.M.F.; also the reactance vector, A D, is longer to represent the greater reactance voltage. By drawing A E as before we again obtain the pressure at the slip-rings, which is obviously greater than when the current was lagging. In nearly all cases the series winding is arranged so that as the load increases the magnetomotive

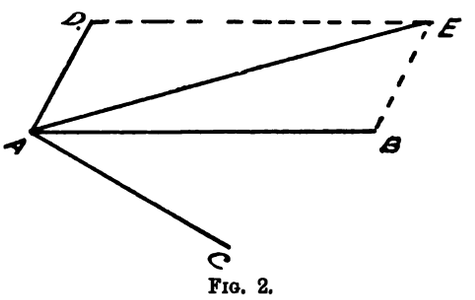



FIG. 2.

force due to it assists that due to the shunt winding, consequently with an increase in load we get a leading current, and, therefore, a rise in pressure; but in the machines under consideration the reverse is the case, for obviously the magnetomotive force due to the series winding is in opposition to that due to the shunt, therefore with an increase in load the field is weakened, the current lags, and the pressure falls, which will, of course, cause a battery to discharge which has previously been floating at the higher voltage. There is little to recommend this system except that it saves the cost of a reversible booster, and the pressure regulation is bad, and it is much better to use a reversible booster, for not only would the load on the generating plant be equalised, but the pressure would also be maintained constant.—E. AUSTIN.

*Answer to No.* 774 (*awarded* 7*s.* 6*d.*).—A compound-wound rotary converter with the series winding opposing the shunt is sometimes used on a traction load in conjunction with a "floating" battery—that is to say, a battery directly connected to the 'bus bars through switches, without a booster or any automatic arrangement for discharging it.

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The usual regulating cells are, of course, a part of the battery, but are cut in or out by the switchboard attendant.

The method of working is thus. Under normal conditions from no load to about full load the rotary converter supplies the current to the line, but in the event of a heavy demand being made, the increased current through the series coil weakens the field, and causes the voltage to drop considerably. Simultaneously with the drop of voltage the battery begins to discharge, the rate of discharge increasing as the generator voltage become less—*i.e.*, as the demand for current increases. Thus the generator takes the load up to a certain point, after which it is relieved by the battery.

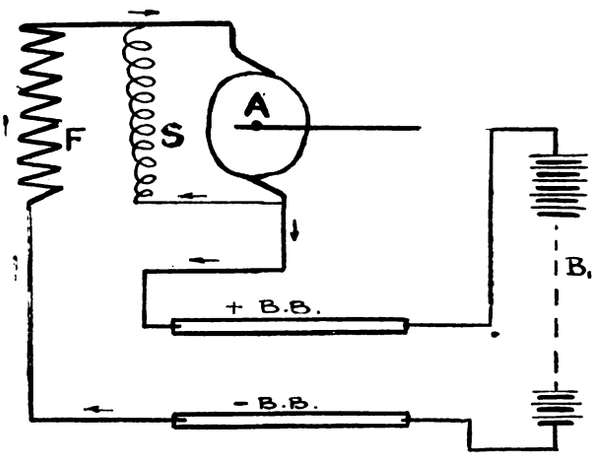



FIG. 1.

Fig. 1 is a diagram of the connections: B B are the 'bus bars from which the feeders may be taken. A represents the generator side of the converter, which is connected to the 'bus bars in parallel with the battery, $B_1$. S is the shunt winding and F the opposing series. Fig. 2 shows how the work may be divided between the generator and battery. The dotted line is the generator characteristic, the full line the combined characteristic of generator and battery. The shaded portion shows the watts added by the battery. The point at which the battery commences to take up the load should be slightly beyond the point at which the maximum efficiency of the generator is attained.

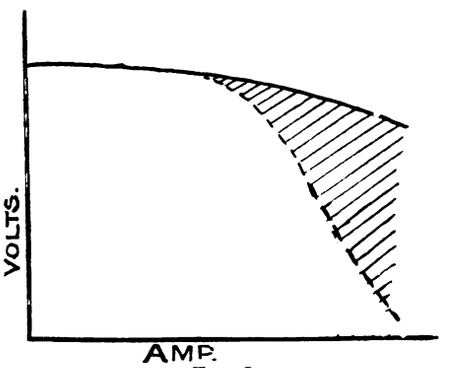
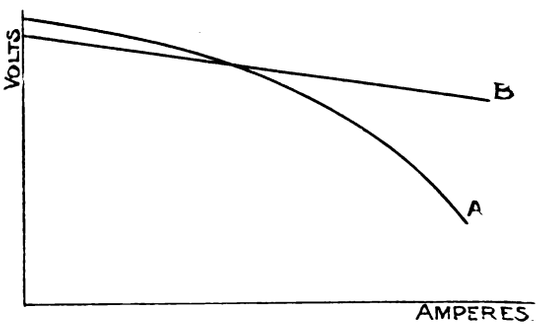



FIG. 2.

The advantage of reversed series coils for traction work is that the generator can be used in conjunction with a battery without any special boosting arrangements. Naturally, the line voltage is anything but steady, but on a traction load this is not always of such vital importance as to warrant the additional expenditure on plant necessary to obtain close regulation.—J. B. F.

*Answer to No.* 774 (*awarded* 5*s.*).—The purpose of the type of rotary in question is that it shall be used with a battery, thus working itself at a fairly constant load, the battery discharging at heavy loads and charging at light loads, the effect of using a reversible booster being obtained without the use of auxiliary machinery. If this type of rotary is installed throughout the system, the load on the main generating station will, of course, be kept very nearly uniform. The action of the machine is that at a certain predetermined load the series field exercises a weakening effect on the shunt field sufficient to lower the volts on the rotary and to allow the battery to discharge to the line. The load on the rotary being thus slightly relieved, the series field loses its predominance, and consequently the rotary supplies its normal output. In a carefully designed machine of this type the variation in the load on the rotary can be made very slight, and by using a diverter in parallel with the series field it can be adjusted to allow the rotary to work at different outputs, and for each different output be able to main that load very nearly constant, the line voltage, of course, being kept up by the battery. The rotary is simply a differentially-wound compound machine, and being differentially wound will not work at as good an economy as a cumulatively-wound machine, but the idea is that by sacrificing a little in the economy of the rotary and being able to do away with a reversible booster, that a higher total economy will be secured. An impression obtains in some quarters that the line voltage regulation on such a system would be very bad, but it would seem that this impression is owing to the fact of the machine having its series field energised by its own outgoing current and not by the line current, as in some types of differentially-wound boosters, being overlooked. In the first case the output of the machine is to a great degree self-regulating; the instant the machine attempts to supply anything above the predetermined load the series field at once checks it, and its normal load is resumed. In the second case the machine would not obtain any relief until the line load lightened, and the load might continue heavy for so long that the polarity of the machine would need a good deal of power from the shunt field when the load lightened to bring about normal conditions. In the first case the regulation of the machine is independent of the line load, and the only effect of the battery trying to back on to the machine is to weaken the series field, and thus tend to restore normal conditions. From the above description the idea of installing such machines will be understood, and also the fact that with the first method of energising the series field good regulation should be obtained.—W. T. W.

*Answer to No.* 774 (*awarded* 5*s.*).—In the station mentioned there is a battery installed in order to take any sudden rushes of current, and so prevent overloading the converters. The usual system is to instal a reversible booster to look after the battery, and in this case the machines would, of course, be compounded so as to keep




at approximately constant voltage. As this is a railway scheme, variations in voltage are not of much importance, hence it was decided to use machines with a large pressure drop, and to dispense with the booster. With this arrangement, when a heavy load comes on, the volts of the rotaries will fall off more rapidly than the battery, and hence the latter will take up most of the extra load. This will, perhaps, be better understood from the diagram, where A represents the characteristic of the machine and B that of the battery. Up to a certain point the machine will charge the battery, but if more current is required the battery will supply it, as the generator volts drop more quickly than the battery. The only advantage of the system is that no booster is required, and against this must be set the very bad pressure regulation. I do not know if lights are run off the traction mains, but if so, I should imagine they would be very unsteady.—H. C. H.

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Supplement to "The Electrical Engineer,"
MAY 12, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

780. How would you arrange the Hopkinson test and determine the efficiency on two 900-kilovolt-ampere 500-volt compound generators or machines?—F. V.

781. Describe with sketch the best vat to use for loading a 600-kilovolt-ampere 400-volt generator.—F. V.

### ANSWERS.

*Question No.* 775.—A leading stoker in a certain central station is suspected of inefficiency. How can I tell whether he is getting the full duty out of his working boilers before putting in another on a rising load?

*Answer to No.* 775 (*awarded 7s. 6d.*).—Central-station engineers are now turning their attention to the boiler-house more than they used to do, with a consequent reduction in the number of pounds of coal burnt per unit generated. A boiler-house may be full of the most up-to-date arrangements and automatic appliances, and yet the coal bill will be excessive if the stokers themselves are inefficient. As a rule, so long as a stoker keeps a steady pressure on his boiler nobody troubles him, but this is not enough. A stoker, in order to secure for himself the minimum of exertion and avoid words with the shift engineer about the pressure, is tempted to have more boilers working on the steam range than he should do, and also to put on another boiler before it is actually required. This practice results in large radiation losses, which under ordinary conditions amount to as much as from 5 to 10 per cent. If a boiler is worked under its full power, the amount of loss due to radiation will be the same as if was doing its full output, because the temperature of the steam is not altered. A boiler working at half its capacity will, therefore, lose twice as much by radiation as if it were doing its full share of work, speaking in regard to the amount of work done. If a boiler is overworked, the relative loss by radiation is very much reduced. It will thus be seen that for efficient working it is most important to keep the number of working boilers as low as possible.

Let us take the case of the average large central station, where the coal is fed by shutes into hoppers attached to the boiler front, and moving firebars are fitted to prevent the formation of much clinker. The inefficient stoker puts 10 boilers working on a certain load for which eight would be quite sufficient. The steam pressure will not cause him much anxiety, as the 10 boilers would manage any sudden peak that came on without being pushed at all. With only eight boilers on he would have to keep his fires the right thickness, and a sudden rise in the load would mean considerable poking and slicing of the fires so as to keep them quite clear of clinker and working at their full capacity. He would also have to avoid feeding much water into the boilers when they were being pushed, so as not to lower the temperature. A good stoker will not start up another boiler for every increase in load if he thinks the increase is only a temporary one. He will know from experience how many boilers are required for certain shifts, and on those shifts get the required number either working or ready with fires banked up for putting on the range. Mr. Bryan Donkin mentions a test where four good stokers were put to fire the same boiler—a two-flued 30ft. Lancashire—under the same conditions. There was a difference between the most and least expert of 23 per cent. in capacity and 18 per cent. in economy, a saving of £7 to £8 per week with coal at 10s. a ton.

I will now describe a method of comparing the efficiencies of the leading stokers which is used in an up-to-date large central station. In order to find out how much coal each stoker uses on his shift, the shutes for each boiler are fitted with an arrangement whereby, when the hoppers require filling, the stoker pulls a handle, and a known quantity of coal falls into the hopper. A meter is attached to the handle, which registers how many times the shute is opened. There are different methods of weighing the coal; the one described above is a very common one. Each stoker as he goes off shift takes the readings on the dials of the meters, and notes the numbers of the boilers that have been working.

Name of stoker. ..... Date.....
..... Time.....

| No. of boiler working. | Time On. | Time Off. | No. of pumps working. | Time On. | Time Off. |
|---|---|---|---|---|---|
| | | | | | |

Meter readings.
Coal..... Water.....

FIG. 1.

In Fig. 1 is shown sheet that stoker has to fill up on each shift. The switchboard attendant takes the number of units generated at the end of each shift, and works out the number of pounds of coal and water per unit generated. The various shifts can thus be compared. A good plan would be to mark on the day's load curve when each boiler was put on. Do this for three weeks when similar loads are experienced, and it will at once be seen which stoker is the most conscientious worker.

In Fig. 2 I give some actual results obtained in a central station having a good day load. It will be noticed that the figures obtained for the night shift are always higher than those during the day, and that the highest figure is obtained on the Sunday morning. This is owing to the very small load on at these times. To compare one stoker with another, compare them on similar shifts and with the same boilers working, as boilers, though of the same size, vary very much in their steam-raising qualities. Also watch that the readings are taken at the *end* of the shift, not half an hour before. If the stokers know there is a test on, an artful one will use almost every bit of coal on his fires, and the man following him will have to use a lot of coal immediately to keep up the pressure.

| Days of week. | Pounds of coal per unit. 10 p.m. to 6 a.m. | 6 a.m. to 2 p.m. | 2 p.m. to 10 p.m. |
|---|---|---|---|
| Sunday ..... | 4·4 | 6·7 | 4·8 |
| Monday ..... | 5·4 | 4·5 | 4·4 |
| Tuesday ..... | 5·7 | 4·2 | 4·2 |
| Wednesday..... | 5·2 | 4·5 | 4·2 |
| Thursday ..... | 5·4 | 4·5 | 4·1 |
| Friday..... | 6·0 | 4·2 | 4·1 |
| Saturday..... | 4·8 | 4·8 | 4·1 |

FIG. 2.

A $CO_2$ recorder is most useful in a boiler-house to ensure efficient working, and will almost certainly pay for its cost

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in the first six months. The firemen can then see for themselves whether there is too much air passing through the furnaces. Mr. R. S. Downe in a paper recommends a bonus system for the stokers that he has tried with success at Southport. Certainly a small monetary reward will have a great effect on the way a stoker looks after his boilers.—W. A. T.

*Answer to No.* 775 (*awarded* 7*s.* 6*d.*).—"W. E. O." gives absolutely no particulars of his boiler-house, and, therefore, only general and not particular advice can be offered to him. In the first place, let him learn to fire and get a thorough understanding of the combustion of coal as applied to steam-boilers, for nothing is so efficacious to economical working as a skilful and intelligent operation of the boiler plant. He should ascertain the amount of evaporation his boilers will easily give under the conditions normal to his station, and should also know the amount of water used per kilowatt-hour in the station, including all auxiliary plant and unavoidable losses. He will then by comparing the load demanded with the number of boilers in service be able to form a very good idea of how things are being worked; he must not, however, think that the man who works with the fewest boilers in service is getting the most economical results, for this by no means follows. For instance, suppose he has a plant of 11 Lancashire boilers set in the usual manner, and that with the present load he can just manage with six boilers in service. The load, however, is rising, and he will require at least two other boilers to get through the heaviest part of the load, and for at least an hour will have to force all eight boilers to get through. Then he must have, in order to be safe, another boiler up to or nearly up to pressure under banked fires, so as to safely meet a breakdown on any one of his boilers. Now, with Lancashire boilers especially, one boiler keeps its fellow warm, and radiation losses are thus to a great extent minimised, so that it would be by far the best policy in this case to work with nine boilers always in service, and for the following reasons: A boiler, unlike an engine, works best at an easy load—each 1lb. of water evaporated is evaporated at a more economical rate than if the boiler was pushed—priming is avoided, the life of the boiler is prolonged, there is a good reserve of power in case of sudden calls occasioned by sudden and severe overloads, the amount of feed water necessary to be fed to the boiler is reduced to a minimum, with consequent good effect on the economy of operation and life of the boiler and consequent on the fires not having to be pushed, there is time for complete combustion (or as nearly complete as is possible in practical working) to take place. The best test, of course, to apply is to note the amount of coal used by each leading fireman on similar loads and under similar conditions; but it is quite easy for an engineer not thoroughly conversant with the best methods of working his plant to so work matters in the engine-room that the fireman receives blame for what is not his fault. In many stations using reciprocating engines, the engineers pride themselves on maintaining a 27in. vacuum. Now, the economy to be obtained by a 27in. vacuum over a 25in. or 24in. vacuum on reciprocating engines is decidedly small, but the increase of power required to obtain this increase of two or three inches is considerably over 75 per cent., and if the condensed steam is used again for boiler feeding the evil is still further aggravated, as the hot-well temperature is greatly reduced and more coal is required to be burnt in the boiler furnaces (owing to the influx of cold feed) than is necessary. The above instance will show how without exact particulars of the plant it is impossible to give any definite rules for working it at its highest economy. In conclusion, the leading fireman who is continually on the trot, and whose men are always sweating, is no good; the skilful and economical fireman is always able to manage his work without killing himself, and with time to sweep up round the boiler and keep things tidy.—W. T. W.

*Answer to No.* 775 (*awarded* 7*s.* 6*d.*).—The surest way of checking the leading stoker in question would be to measure the amount of water *actually used* during a certain time by the boilers under steam. A short test of, say, a quarter-hour or half-hour's duration would be sufficient. The evaporative capacity of the working boilers being known, it would be seen at a glance whether or no full evaporative duty was being got out of them. It is hardly necessary to point out the importance of having the level of the water in each boiler at exactly the same mark at the finish as at the start of the test. The quality of coal used should also be taken into consideration, and, if poor, allowed for.

By inefficiency, it is presumed that the stoker in question cannot work his boilers to the same advantage when working under the same conditions as the other stokers. It is the exception rather than the rule to find two (human) stokers who possess even in a small degree the same firing characteristics. This is more marked in the case of hand firing, and with machine stoking the writer has never known two firemen to work their boilers and stokers alike, even with men on shift together, and working under precisely the same conditions of load, etc., and using the same quality of coal; and, with few exceptions, firemen as a rule refuse to accept makers' instructions as to the best methods of working their machines, preferring, instead, to work on lines of their own; especially is this so when one has to deal with men who have been used to hand firing for 10 or 15 years.

In many lighting stations, particularly those where the areas supplied are mainly residential, the evening load (which is usually the heaviest) can be gauged from year end to year end to such a nicety as to make it almost possible to draw up a table of times for putting in boilers, starting engines, etc. In the case of large stations with variable loads, such as combined lighting and traction stations, the working conditions are, of course, different, and it does not always pay to leave the coupling up of additional boilers until the last moment. Boilers, when properly fitted with isolating valves, can be coupled to the range at a few pounds below working pressure a short time before being allowed to steam, thus obviating the risk of getting "steam bound"; this plan is advisable where superheaters require to be drained before opening out the boiler to range. The writer knows of at least one case of cracked cylinder covers owing to insufficient draining in the hurry for steam. Nearly all types of machine stokers have forced or assisted draught arrangements, usually in the form of a number of steam jets; in fact, two well-known makes of machines depend entirely on their forced-draught attachment for their excellent steam-raising qualities. The nozzles or holes in the jet pipes should be examined frequently, as they are very apt to become stopped up. With the chain-grate type of stoker it is most important that the grate be kept well covered with fuel in order to prevent any inrushes of cold air, which would otherwise work through the grate if the fire was allowed to get patchy or broken. If this type of stoker is used and the boilers are grouped in pairs with side passages between adjacent pairs, a peep through the small inspection doors will soon show whether the fires are being worked properly or not.

In all well-appointed stations periodical evaporative tests are regularly made on the boilers, usually after being laid off for cleaning, as where large contracts for coal extending over six or twelve months are given it is most important to know that the coal supplied is being kept up to specification, as it is not an uncommon occurrence for coal to vary in quality, usually on the poor side for the station. In some large stations where the boilers are hand fired, the firemen work on similar lines to the system in vogue on many large liners. The firemen all work their fires together at given signals from the leading stoker. This system possesses many bad features, and does not help to solve the smoke problem. The writer has found it a good plan on a rising (evening) load to run the water in boilers up to about seven-eighths glass, and has many times thus got over the "peak" without the usual extra boiler.

By paying close attention to the methods of working his boilers and noting generally the amount of intelligence the fireman puts in his work, "W. E. O." should soon find out whether the man is worthy of his hire or not. But, as before mentioned, it is seldom of much use to set up one fireman as a standard for the others to follow, and it does not always pay to change hands too often; new firemen invariably require initiating into their work at the added expense

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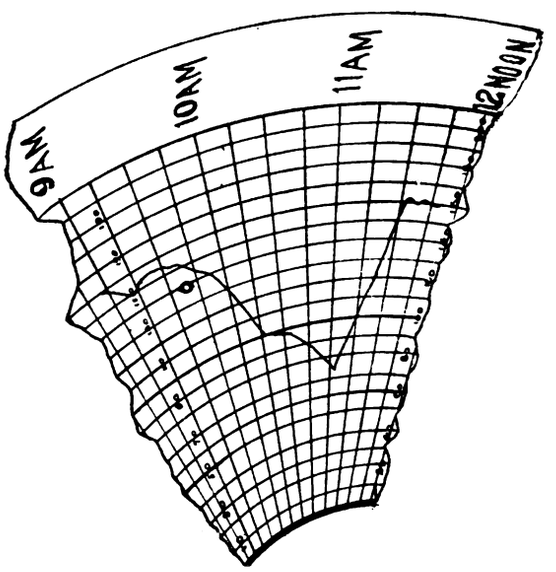
of a few tons of coal. The bonus system has been introduced in several large stations with the object of getting the best out of the boilers and firemen, but it can hardly be said to have proved a success. If kept in good working order, a $CO_2$ recorder soon pays for itself. A draught gauge should always be provided, as it is an indisputable authority at times when the fireman most emphatically declares "that the draught is bad." A recording steam pressure gauge is (in the writer's opinion) an indispensable instrument to every central station. It is, however, advisable to keep it under lock and key for obvious reasons. The sketch shows




a part record—pricked from the original chart—which proved to be the undoing of a very careless fireman. The boiler was steaming at about half its normal load, but the fireman could not get the steam on the rise. The engineer-in-charge then took the boiler in hand himself, and, as shown on the chart, brought steam back to normal within half an hour. The sharp rise in the curve makes it hardly necessary to add that the boiler was of the water-tube type, and fitted with chain-grate machine stoker.—S. L.

*Answer to No.* 775 (*awarded* 5*s.*).—It would be more than a difficult question to determine, by any fixed rules, the capability of any stoker in charge of boiler plant. But observation coupled with knowledge of the capability, so to speak, of the plant under his control should enable a charge engineer to readily determine the question set. The steaming capacity of the boilers and the steam consumption of the engines should be known to all in charge—not the theoretical, but the ordinary practical figures. An engineer knowing the station load and its likelihood should know how many boilers he requires—it is a matter of predetermination. If the stoker be incompetent an observant engineer should easily see his weakness, for, except in cases of sudden rushes of load, a boiler-house works under absolutely uniform conditions, or should do so. A skilled man, by a glance at the fires, should detect bad firing; the pump speed is a matter of experience and its variation a factor which every charge man should be aware of. Water-meters, gas-recorders, and the like make for efficiency, but they should be of more use in determining defects in machinery than incompetency in workmen. If an incompetent stoker cannot be detected by the observation of what work is being done, and the knowledge of what ought to be done, it would seem that not only is the stoker at fault, but that the charge engineer is not free from blame.—S. E. T.

*Answer to No.* 775 (*awarded* 5*s.*).—In the central station to which the writer has the pleasure to belong, the capacity of each boiler is reckoned out in amperes at the mean 'bus-bar pressure on the assumption that each unit requires 30lb. of steam. Thus, supposing the boiler to be capable of evaporating 10,000lb. of steam per hour, by dividing by 30 we get the equivalent units—viz, 333 or 333,000 watts—and this again divided by the mean 'bus-bar pressure, say 450 volts, gives us 740 amperes. By this means the engineer in charge can tell by a glance at his ammeters how near he is running to the capacity of his boilers, and a competent fireman should have no difficulty in maintaining his steam at the proper pressure under ordinary normal working conditions if this load be not exceeded. On a rising load it is well to get on another boiler half an hour before it is actually wanted, as more coal is used by fixing boilers than by working easily with an additional boiler for a short time. By employing this method no difficulty is experienced as to the time a boiler should be put on to the main, and by reference to the load curve of the same or a similar day of the previous week the writer has been able to go round to the boiler-house before the evening load comes on and instruct the leading fireman as to the exact time each boiler is to go on and come off.—J. M. A. M.

*Question No.* 776.—A four-core telephone cable 4½ miles long connects a sub-station to a generating station. The cores are twisted in pairs and used as two separate telephone lines. It is required to put up a pair of single-stroke bells, one at either end, to be worked by means of Morse keys in order to signal from generating station to sub-station, and *vice versâ*. Can this be done with existing cable, without interfering with the proper working of the telephones? If so, how? If not, why not? The resistance of the line (lead and return) is 350 ohms.

*Answer to No.* 776 (*awarded* 7*s.* 6*d.*).—Yes; this can be accomplished in several ways without interfering with the present telephone circuits, but the precise arrangement would be dependent on conditions not stated in the question, and which I therefore propose to assume in discussing a few ways of making a successful arrangement. From the question I understand that the two separate telephone circuits also includes two telephones at each end, with the probability, therefore, of simultaneous conversation on each pair of wires. It is thus obvious that any arrangement for signalling purposes should not include any combination of the two circuits if an high efficiency of working is desired. Such a combination would cause more or less cross-talk and strong induction from adjacent power cables. The question is now simplified: the two signalling circuits must be kept distinct, and each connected one to each separate loop. We may now only consider the case of one loop and the signal in one direction only, as the other loop and return signal is merely a reverse arrangement.

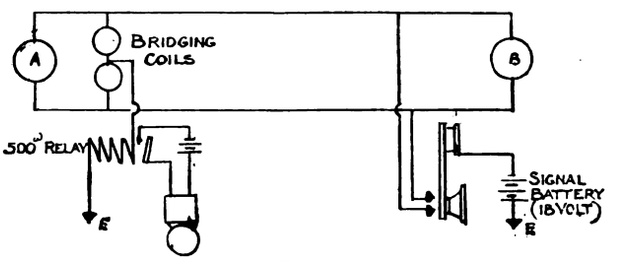



FIG. 1.

Now, is it required that conversation shall be possible whilst signals are being sent? Assuming the simplest case first, where it is not desired that conversation shall take place at the same time, then Fig. 1 will be seen to meet the case. At end A, where signals are to be received, we have shunted across the loop a pair of bridging coils of 600 ohms each in series with each other. These coils should preferably be iron cased, because of the higher impedance offered to the shunted fluctuating speaking currents than where simple resistance coils are used. Branched from the middle of these two coils is a single make-and-break relay of 500 ohms resistance, with its other terminal joined to earth. This balanced earth, having 1,100 ohms interposed between itself and either line wire, will present no inductive effects, and is, in fact, a method adopted at certain exchanges for trunk clearing. The single-stroke bell is now joined up with its own separate battery to the local contacts of the relay, and should be kept as a separate circuit from the other apparatus. At the B end, one of the two lines is branched on to the under contact of the Morse key, the spring of which is joined to an earthed battery. If we combine two keys together to make two under contacts, both line wires may be branched to these, thus reducing the resistance in the signalling circuit. If the relay is operated by a minimum current of 15 milliamperes, then a battery of about 18 volts will be required, but where only

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one under contact is made use of, a battery of 22 volts will be wanted.

Considering now the other case, where it is required that the transmission of signals shall not interfere with conversation taking place at the same time, it is seen in Fig. 2 that it is necessary to balance the signalling battery at B end, exactly as we have already done with the relay. Two similar bridging coils of the same resistance are used, and the Morse key under contact is connected to the middle point, the spring being, as before, connected to an earthed battery. When the key is depressed the current divides equally through the coils, passes along both lines, through

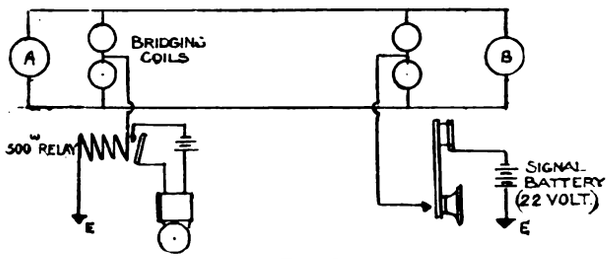


FIG. 2.

the distant coils, and rejoining at the relay, passes through the latter to earth. The resistance in the signalling circuit is 1,450 ohms, and with the same relay efficiency as before a battery of 22 volts would be required to operate it, exactly the same voltage as in the last case, but with the advantage of simultaneous signalling and speaking. The writer has had under his notice an arrangement very similar to this, and is confident that "J." will experience no trouble if he adopts the system I have just described. He will find it equally applicable to either a battery or magneto system.

The following arrangement is an exceedingly simple one, and has been experimentally tried where a magneto system with low-resistance telephone bells of 100 ohms each is in use. At the end where signals are required, a two-ohm relay is placed in series with the line as in Fig. 3. At the B end the Morse key is connected so that it may substitute a battery for telephone when depressed, in which case the current will pass through the 100-ohm bell and the two-ohm relay. If the latter has an efficiency of about 60 milliamperes, it will require a battery of 30 volts at the other end to operate it. As before, the local contacts are joined

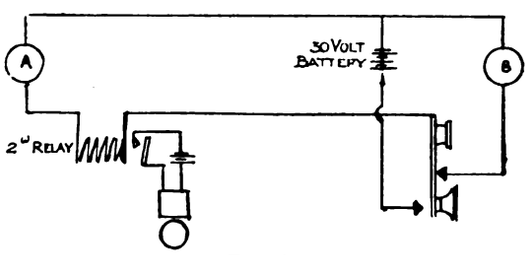


FIG. 3

to the bell and separate battery. The passage of generator currents through this relay will not cause trouble, owing to the frequency of the current and the inertia of the armature. The latter will slightly vibrate as a consequence, but the rapidity of the alternations prevent it from closing the local contacts. The success of this system, however, will depend on the local conditions not stated in the question. If the bells are of higher resistance than 100 ohms, the battery of 30 volts would have to be increased. This would then compare unfavourably with the system I have recommended, which has the additional advantage of being able to give signals without interfering with any conversation taking place at the same time.

In conclusion, it would not be out of place to briefly mention that if "J.'s" telephones are of the magneto type, he could superimpose a third telephone circuit by the use of translators. This, of course, would present greater advantages than the signalling circuit asked for. As it is beyond the question, I will not discuss it further, but if "J." desires to know more of this I shall be glad to oblige him.—F. RADCLIFFE.

*Answer to No.* 776 (*awarded* 7*s.* 6*d.*).—It is perfectly practicable to arrange the terminal conditions of the two pairs so that single-stroke bells may be introduced at each end and worked by Morse keys without any disturbance to the telephonic working. To effect this it is necessary to employ a special form of induction coil, known as a transformer, the function of which will be readily seen by con-

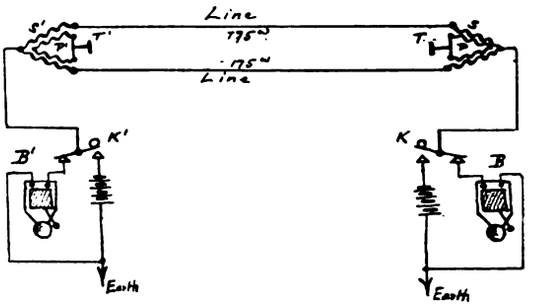


FIG. 1.

sidering the manner in which it is introduced, as shown diagrammatically in Fig. 1, where the connections of only one pair of wires are shown. T T′ are the telephone sets at the respective ends; S P and S′ P′ the transformers; K K′ the Morse keys (single current); and B B′ the single-stroke bells. The internal connections of the transformer, which is of the Hedgehog pattern, are shown clearly in Fig. 2. The line and earth (or return) wires of the telephone set are joined to P and P′. The two lines of the particular pair considered are similarly connected to S and S′. The resistance of the primary and secondary coils of the transformers are the same—viz., 150 + 150 ohms each. The resistance of an average pattern of single-stroke bell is 100 ohms, and the current required varies from a minimum of 45 milliamperes to 100 milliamperes. Estimating for a current of 80 milliamperes,

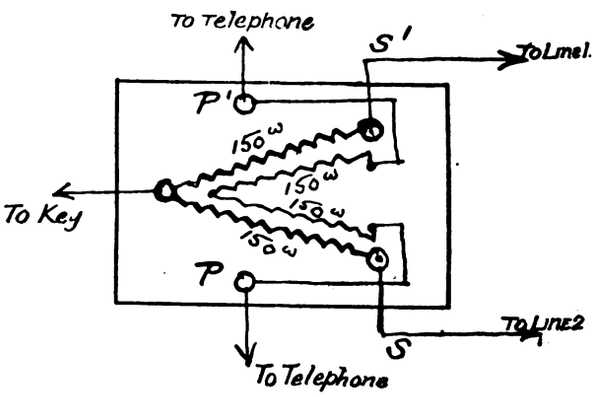


FIG. 2.

and noting that the total external resistance is $\frac{150+175+150+100}{2} = 288$ ohms approximately when either key is depressed, we may determine the battery power required from the expression $C = \frac{ne}{nr+R}$, where $n$ is the number of cells, $r$ and R the internal and external resistance, and $e$ the E.M.F. of a single cell. If Leclanché cells are used with an E.M.F. of 1·4 volts and an internal resistance of one ohm per cell we have $\cdot 080 = \frac{n \times 1 \cdot 4}{n+288}$, from which $n = 17$ cells. The system outlined above is coming largely into use in methods of combined telegraphy and telephony where "superposition" is found to give excellent results.—A. F.

[Other replies to Question No. 776 will be given in our next issue.—ED. *E. E.*]

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Supplement to "The Electrical Engineer,"
MAY 19, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

### QUESTIONS.

782. I want to connect a booster in circuit with one of the feeders in an alternating-current single-phase station, 2,000 volts earthed return. Should it be connected to the earthed or unearthed main, and why?—G. E.

783. Certain motors and generators are fitted with a continuous ring, connecting all pole-shoes together. What is the object of this ring, and what is its effect on the working of the machine?—W. M.

784. The system known as the free-wiring system has now been in vogue in certain towns for upwards of five years. How does it satisfy (1) the consumer; (2) the supply company; (3) the local contractor; and how are difficulties caused through tenants leaving and the new tenants refusing the use of the light adjusted?—W. T. W.

### ANSWERS.

*Question No.* 776.—A four-core telephone cable 4½ miles long connects a sub-station to a generating station. The cores are twisted in pairs and used as two separate telephone lines. It is required to put up a pair of single-stroke bells, one at either end, to be worked by means of Morse keys in order to signal from generating station to sub-station, and *vice versâ*. Can this be done with existing cable, without interfering with the proper working of the telephones? If so, how? If not, why not? The resistance of the line (lead and return) is 350 ohms.

*Answer to No.* 776 (*awarded* 5*s.*).—The answer to the above question, so far as the possibility or impossibility of working the two bells by means of the wires already in use is concerned, is a decided affirmative, although as to the method of satisfying the requirements of the question much depends upon the circumstances and conditions of working, as well as upon the type of telephonic instrument, with its necessary connections, which is in use at the present time. One of the chief difficulties encountered in solving this problem is found in the lack of definite information as regards the type of telephone in use—that is, whether it is of the battery or magneto type. That such is the case is readily seen when it is pointed out that a system applicable to one type of telephone may be wholly unsuited to the other type, on account of the existing difference in the internal and external connections. For the sake of exemplification, therefore, we will here assume that the battery system is in use, and, following this, will treat of several methods whereby the above requirements can be fulfilled.

*Method No.* 1.—This method will no doubt be one of the simplest methods which can be adopted, and, if proper precautions are taken, there appears to be no reason why it should not work satisfactorily, without interfering with telephonic intercommunication. In Fig. 1 will be found a diagram of the necessary connections for the bells, with wires leading to the two telephones. For the sake of reference the following index of parts has been drawn up: B C is a battery of cells, whose E M.F. is about 30 volts; M is a Morse key; D is an ordinary single-stroke bell; E is an earth connection; A and B are the two stations respectively. Consulting Fig. 1, we see that only one wire is used for the bells, whilst the earth acts as a return for the current passing through *either* one of the two bells. When it is required to communicate from either end of the system to the other, the key, M, is depressed, with the result that a current traverses the battery, line wire, A′ B′, bell, D, and the earth, E, returning to the same battery, This, however, can only be the case when the telephones are not being used, and it is presumed that the bells are not required when the telephones are in use, but only when they are out of use. Certain precautions must be taken, or else complications will arise and unsatisfactory working result. In the first place, it will be observed that between the points A′ and B′ there will be a difference of potential when the telephones are being used, and this difference of potential will tend to send a current through the two bells and the earth; if the tendency becomes an actuality, then the bells will ring and false signals will be given. Now, although this difference of potential may not reach more than 20 per cent. of the voltage of the telephone system, depending upon the peculiar circumstances of the case in question, yet it is advisable to reduce this tendency to its smallest limits. To effect this, the bells should each have at least a resistance of 1,000 ohms, whilst a still higher resistance would not be out of place or beyond reason. If this precaution be made, then the two bells will not ring when the telephones are working, because the current passing round the coils of the bell will be too small to be effective. Another precaution which should be made is to make sure that the insulation of the system is good, for if

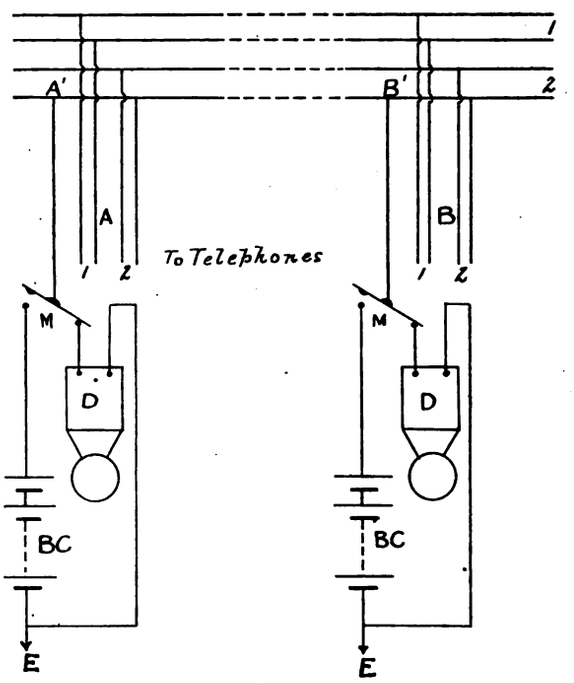


FIG. 1.

this is not the case, then earth leakage currents will pass between the bells and the telephones, causing sad havoc to be made of any communication which may be in progress.

*Method No.* 2.—This method is differentiated from the above, inasmuch as the earth return is displaced by a line wire return. Fig. 2 shows a wiring diagram of this method, indexing being the same as in Fig. 1. As will be seen from a perusal of the figure, two lines are used, one from each of the two telephone systems, thus interconnecting

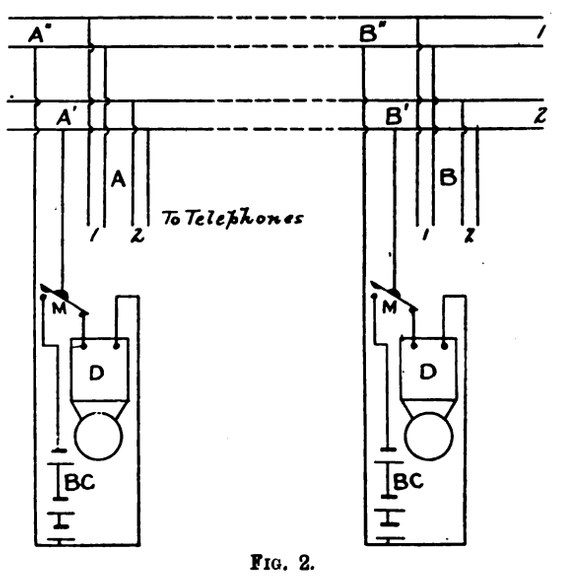


FIG. 2.

these two systems through the two bells. The method of procedure in this case is precisely the same as in the above, the function of the earth being performed by the newly introduced line. In this method, too, the resistance of each bell should be at least 1,000 ohms, this being increased if possible. The increase is more necessary here than in the preceding method, because at times when the two telephone systems may be in use simultaneously there will be two differences of potential acting together

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on the bells, tending to send double the current round their coils. Therefore, if possible, use a resistance of 2,000 ohms for each bell, and, if practicable, a slightly higher battery voltage than 30 volts.

In the above it has been assumed that no bell signalling is required when the telephones are in use. If, however, bell signalling is required then, or at *any* time, it is clear that the above methods are of no use, and it is feared that no reasonable and simple method is, without introducing fresh line wires. Concerning the above two methods, it may be found that greater practical convenience and more satisfactory working is secured by introducing a relay into each bell circuit, and then the connections and wiring must be altered accordingly.—G. W. B.

*Answer to No.* 776 (*awarded* 5*s.*).—The question states that the cores are twisted in pairs and used as two separate lines, so I presume they are as shown in Fig. 1. If the

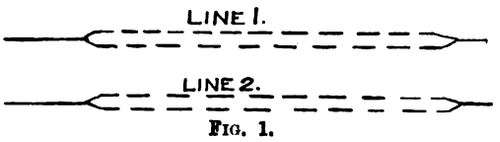


FIG. 1.

wires were connected in this way it will give a larger sectional area of copper, and therefore offer less resistance than if they were separate. As there is a considerable distance (4½ miles) for the current to travel, a relay will be required. Fig. 2 is a diagram of connections of two single-stroke bells, with telephone connections, that I have working every day, and they give no trouble at all. The telephones are the ordinary watch pattern type. I suppose the telephones in question will be of the humming transmitter type. This type will even work better on a bell circuit than the watch type, on account of the induction coil. As the receiving circuit is connected across the ends of the secondary of the coil, this reduces to a minimum inductive disturbances, which are generally a trouble in the watch type. I presume the signalling for the telephones will be done by the single-stroke bells, therefore a certain call will be necessary when telephone communication is required. A switch is put in the telephone circuit to cut

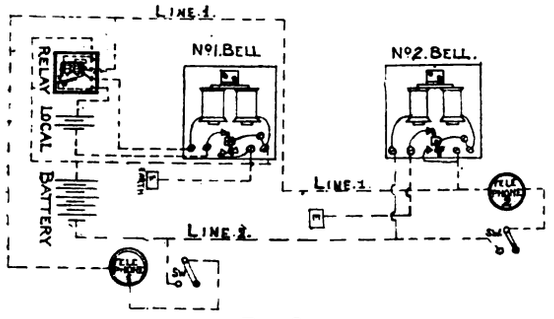


FIG. 2.

the telephone out when not in use. This arrangement, if tried, will be found to give every satisfaction.—J. P. S.

*Question No.* 777.—What is the customary limit of density of current (per square inch sectional area) in feeder cables? In what degree is the limit affected by the proximity of other feeders, or by the nature of the coverings, both protective and insulating? The reason for asking this question lies in the observation that a feeder (carrying 1,000 *a* per square inch during a breakdown of another feeder) became heated to such an extent as to alarm the workmen and jointers who were repairing the defective cables and had exposed the sound feeder. The feeders are lead and paper covered copper cables laid in tarred sand in wooden boxes.

*Answer to No.* 777 (*awarded* 7*s.* 6*d.*).—It is impossible to state whether the current density of the cable in question had exceeded its assigned limit, because this current density is by no means a constant, and varies greatly. Let us consider a cable $d$ inches diameter conveying a current C amperes. The area of the cable is $\pi d^2$ square inches and its current density is $\frac{C}{\pi d^2}$ amperes per square inch. Its cooling surface per inch of length is $\pi d$ square inch. Now let us double the area of the cable and find the ratios of the cooling surface in the two cases per ampere with the same current density. With diameter $d$ the cooling surface per ampere $= \frac{\pi d}{C}$. With area $2\pi d^2$ the diameter of the new cable will be $\sqrt{2}d$ and the cooling surface per inch length $= \pi\sqrt{2}d$. The current is now, of course, 2 C. Therefore, the cooling surface per ampere is now $\frac{\pi\sqrt{2}d}{2C} = \frac{\pi d}{\sqrt{2}C}$ Thus we have considerably reduced the cooling surface per ampere. Therefore, to work with the same maximum permissible rise in temperature of the cable, we shall have to reduce the current density in the larger cable.

Now, when the temperature of a cable has assumed a steady condition, the amount of heat generated and the amount radiated and conducted are equal. Therefore, the nature of the surrounding soil and the depth in the earth the cable is buried will play an important part in this question. If the surrounding earth is moist, the heat will be conducted away quicker than if the earth is dry. I am of the opinion that the sand in which the cable in question is laid will prove very non-conducting, and thus render the temperature of the cable higher than it would ordinarily be.

Four years ago the principal German cablemakers attacked this question, and a committee was formulated with a view to conduct experiments to decide this question. These experiments were conducted on cables buried in the garden of the Munich Laboratory. After long experiments they adopted a formula which was found to give results very much in accord with experiments, as follows:

$$\frac{qt}{J^2} = \frac{1}{C^2} \log \frac{4h}{d}$$

where $d$ = the diameter of the cable;
$q$ = the cross-section in square millimetres;
J = the current;
$t$ = the temperature rise (degrees C.);
$h$ = the depth of the cable below the surface of the earth;
C = a constant the mean value of which as the result of many experiments was found to be 11.55.

The maximum permissible temperature rise can be taken as 25deg. C. above the earth, giving an actual temperature of 40deg. C. on a hot day. Supposing the cable to be laid at a depth of 700mm. and that only go and return are considered, the following figures may be taken as giving the loads cables can carry: A cable of 16 square millimetres section will carry 140 amperes, of 50 square millimetres 260 amperes; of 95 square millimetres 370 amperes, of 150 square millimetres 475 amperes; of 310 square millimetres 705 amperes, of 500 square millimetres 920 amperes; of 625 square millimetres 1,040 amperes, and of 1,000 square millimetres 1,350 amperes. These results are the latest and most accurate to hand, and are being put into practice by the leading cablemakers. The question also asks whether the limit of current density is affected by the proximity of other cables. Most certainly it is, as it will be seen that a greater amount of heat has to be conducted away by the earth in proximity to the cables. This will mean an increase in the temperature of the cables. In the above experiments it was found that in such cases the loads given must be lowered by 25 per cent. The nature of the coverings has very little effect on the current density.—ERNEST P. HOLLIS.

*Answer to No.* 777 (*awarded* 7*s.* 6*d.*).—The current density of an insulated cable is limited by the maximum safe rise of temperature which takes place due to the $C^2R$ losses in the conductor. An insulated conductor dissipates this heat by radiation and convection from its exterior surface of insulated covering, and, therefore, the maximum current density depends partly on the nature of the insulation—*i.e.*, how far this will stand heat without deteriorating—and partly on the disposition of the conductor with reference to its surroundings—*i.e.*, the amount of surface exposed for radiation and the heat-conducting properties of the surrounding materials. In the old days it was sufficient to say that the maximum current must not exceed 1,000 amperes per square inch of conductor area, and this rule is often found in use now. It is obvious, however, that this is not true for all sizes of conductor, for it does not take into consideration the *sine quâ non* of the whole problem

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—*i.e.*, the maximum safe heating effect of the current. As a matter of fact, it is too small a current density for small insulated conductors and too large for heavy conductors when laid in the usual way. For the same current density it is obvious a small conductor will not get so hot as a large conductor, for its radiation surface is larger in proportion to its area.

Kennelly found that the rise of temperature which should govern the maximum amperes carried varies nearly as the square of the current for any given wire, and that the square of the current varies as the cube of the diameter of the wire. He published a table based on the rule laid down by the I.E.E, that "the sectional area of any conductor should be so proportioned that if double the current be passed through it the temperature of such conductor shall not exceed 150deg. F.—*i e*, assuming an average temperature of 75deg. F., then the *rise* of temperature shall not exceed 75deg. with double the normal current. The rule following expresses this:

$$d = \cdot 0147 \sqrt{C^2},$$

where $d$ is diameter of conductor in inches and C the current in amperes.

I have found from experience of town feeders that the I.E.E. rule regarding current density is safe and reliable for feeders laid in the ground. This rule is as follows:

$$\text{Log } C = \cdot 82 \log A + \cdot 415,$$

where C = current in amperes and A = area in one-thousandth of a square inch. This gives a maximum rise of about 20deg. F. on large sizes, and is a good practical rule, which I take it is what the enquirer wants.

In order to see at a glance what is the correct maximum density for all sizes of cable, I give the following table calculated from this rule. I have also added in a separate column the density in accordance with Kennelly's rule.

| Sectional area of conductor in square inches. | Maximum current in amperes — According to I.E.E. formula. | According to Kennelly's formula. |
|---|---|---|
| ·025 | 35 | 46 |
| ·05 | 64 | 76 |
| ·075 | 90 | 105 |
| ·100 | 113 | 130 |
| ·125 | 136 | 155 |
| ·150 | 158 | 178 |
| ·2 | 200 | 225 |
| ·25 | 241 | 255 |
| ·3 | 279 | 300 |
| ·35 | 317 | 335 |
| ·4 | 354 | 370 |
| ·5 | 425 | 440 |
| ·6 | 493 | — |
| ·7 | 560 | — |
| ·75 | 592 | — |
| ·8 | 624 | — |
| ·9 | 688 | — |
| 1·0 | 750 | — |

—DUPLICATOR.

*Answer to No.* 777 (*awarded* 7*s.* 6*d.*).—It is a difficult matter to fix a limit for the current density in a cable. As the case quoted is a special one, the feeder being loaded up owing to the breakdown of another feeder, it is possible to neglect the question of the economical current density and drop of pressure, and to consider only the maximum current density admissible without heating the cable to such an extent as to cause damage. The result of passing a heavy current through a cable might be a temporary or a permanent weakness, in the former case the insulation resistance becoming less for the time being, and improving again to its normal value under normal conditions; and in the latter case, the insulation resistance becoming less permanently, and either breaking down during the time the extra stress is on the cable, or at some future time.

The extent to which the insulation of a cable is impaired depends upon the value of the current and the time the current is passing, and the pressure will considerably influence the result in the case of an excessive current. It is quite possible for a very large current to be carried for a short time without doing any damage, as the cable will take some time to heat up, but as the temperature of the cable increases, the insulation resistance will fall to a greater degree. Thus, in the case of a temporary weakness, no actual damage would probably be caused, owing to the current not reaching an excessive value or only being excessive for a short period, not sufficiently long to distort or physically damage the insulation. In the case of a permanent weakness, however, the insulation may be so distorted, either due to the heat alone, or due to the failure of the cable mechanically, or the properties of the insulation may be completely altered, and in most cases the insulation would become dried up or charred. It is possible that neither of these faults would show on an ordinary insulation testing set of the usual voltage, and in the case of low-pressure cables there might be no actual breakdown for some time, but in the case of high-pressure feeders it is probable that the cable would break down at the time or when the current again reaches a high value, or should a sudden rise of pressure occur.

The damage liable through overheating varies with the class of cable, but a few instances might be mentioned. With vulcanised bitumen cables probably a permanent set would take place owing to their mechanical weakness; with rubber cables, the rubber would be impaired and charred, and the author has seen cases where rubber or rubber composition has become quite hard and brittle; whilst with fibrous cables impregnated with compound (such as paper cables), the compound may be caused to run or volatilise and the insulation to dry up, the mechanical protection remaining perfectly good, and these cables would probably suffer more damage than those of the other classes. Damage may also be caused at the joints, but if these are well made, and the cross-section of the connectors sufficiently large, they should stand as much or even more current than the cable.

The best condition under which a cable can work, as regards heating, appear to exist when the cable is as free as possible, and if other cables in proximity are sufficiently far away for the heat generated by them to be dissipated without affecting the temperature surrounding the cable carrying a heavy current, the carrying capacity of the latter will not be affected, and, *vice versâ*, a cable in a position where it receives heat from the exterior will not carry such a heavy current as one which only has to dissipate its own heat, the heat emitted being dissipated in proportion to the difference of temperature which exists between the cable and the surrounding medium, and the conductivity of the latter. It would appear, therefore, that cables laid direct in the soil or in troughing will not carry such heavy currents as those drawn into conduits, providing the latter are efficiently ventilated, owing to the air conducting the heat away better than the soil. Few experiments, however, as far as the author is aware, have been made to ascertain the actual and safe temperatures of underground cables, and it is therefore difficult to form an opinion of the effect of heavy currents on cables with insulating and protective coverings of different kinds working under various conditions. One of the Board of Trade regulations states that the rise of temperature in a conductor shall not exceed 30deg. F., but probably few engineers know whether they conform with this regulation, and to what extent damage would ensue if the limit given is exceeded.

The author is of opinion that 1,000 amperes per square inch should be a perfectly safe current density, and for short periods cables should stand considerably more. The following axioms may be mentioned: larger current densities are permissible with small than with large cables, with single cables than with concentric cables, and generally with private lighting than with street-lighting cables, owing to the smaller amount of heat to be dissipated in the first and last cases and to the larger conducting surface in the second case. For ordinary working, a good current density on maximum load is about 700 or 800 amperes, but some engineers adopt 1,000 amperes per square inch as a standard. The current density allowed on ordinary maximum load should, however, be calculated in conjunction with the drop in pressure and the most economical current density, the latter being fully explained in an answer by the author to Question No. 753, appearing in the *Electrical Engineer* of Feb. 3, 1905.—H. A. N.

*Answer to No.* 777 (*awarded* 5*s.*).—The customary limit of density of current is 1,000 amperes per square inch in cables used for feeders and distribution, but although this limit is set by many fire offices, it is not altogether a good one for all sizes of cables. A maximum rise in temperature

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for conductors is also set at 75deg. F. above atmosphere with double the normal maximum current—that is to say, with normal maximum working current a rise of 19deg. F. is permitted. Kennelly gives the rule

$$d = \frac{\sqrt[3]{C^2}}{68},$$

connecting the diameter of the cable with the current so that the above limit is observed. If the limit of 1,000 amperes per square inch were worked to, it is apparent that for large conductors—over ·2 square inch—a greater rise in temperature than the 19deg. would result, and at one square inch area the 1,000 amperes is 50 per cent. more than Kennelly's rule admits. Probably "E. B." will calculate out the permissible current from Kennelly's rule and may find that the 1,000 amperes per square inch is too high. Of course feeders, insulation, etc., have bearing on this question, but the rule given will cover most natural modern conditions. Often abnormal and unexpected effects are met with—for instance, with alternating current transmitted some 2,400 yards, six ·3 square inch feeders working in parallel at a current density of but 500 amperes per square inch allow of a drop of 90 volts. Further details of the conditions of the case "E. B." presents might throw more light on the reason for the excessive heating.—S. E. T.

*Question No.* 778.—A large institution requires a 14-h.p. motor for a laundry and also want the same motor to augment a deficient water pressure—due to high ground on which building is situated—in case of fire, by working a pump fed by the water supply. How can the motors be best arranged to fulfil this two-fold purpose?

*Answer to No.* 778 (*awarded* 10*s.*).—The requirements of the question seem to be that a 14-h.p. motor shall be used for driving the laundry machinery, and shall be so arranged that, in case of fire, the laundry load can be thrown off the motor and a pump coupled up. Well, now, it is obvious from the nature of the question that the change from machinery to pump must be a quick one, and the quicker it is the more valuable will the arrangement be.

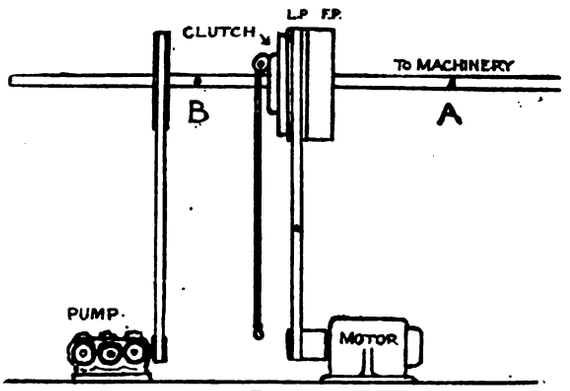



FIG. 1.

I should suggest the following method: In Fig. 1, L P and F P are the loose and fast pulleys respectively of the main shaft, A, driving the laundry machines. To the left of these pulleys is a short length of shaft, B, supported by

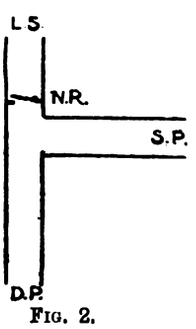


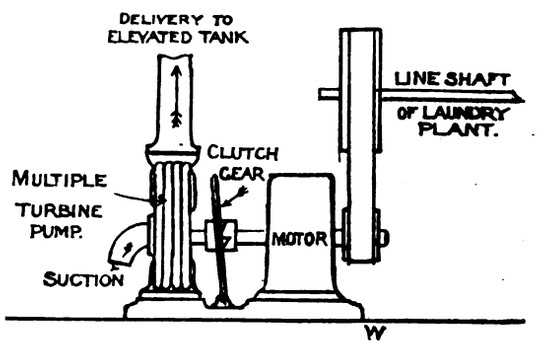

FIG. 2.

its own bearings, and quite separate from A, but in a direct line with it. A pulley friction clutch is fitted to the loose pulley and shaft B, so that they may be coupled together by means of turning a handle, H. The pump is driven by belt from a pulley on B. In case of fire the method of procedure would be as follows: Suppose the laundry is being driven, and belt, C, is on F P. By means of a belt shifter the belt is put on L P, and this disconnects the shaft A. The clutch is next tightened up, and this drives B and the pump. In stopping the motor, the clutch should be released before the current is cut off.

To facilitate quick change, a slight modification in the pipe connections for the water is advisable. In Fig. 2 let D P be the water supply for the institution. A branch, S P, is taken to the pump suction pipe, and L S is the ordinary water supply to the laundry. If a non-return valve, N R, be fitted in L S, then, as the pump is full of water, it may be started without the opening or closing of any valves, which, as a rule, take up a considerable amount of time.

To ensure readiness and effective working, the whole arrangement should be tried at least once a week, and the working parts of the friction clutch well inspected.—P. D.

*Answer to No.* 778 (*awarded* 7*s.* 6*d.*).—From the wording of the question it is understood that a 14-h.p. motor is to be installed for driving the line shafting in the laundry, and that the same motor is to be able to drive a pump which will augment the head of water sufficiently to deal with an outbreak of fire. The leading feature, then, about the pumping arrangement must be that it shall be absolutely reliable; it thus follows that it must be as simple as possible, and that there must be no parts liable to get out of order and require adjustment. Centrifugal pumps can now be obtained from the leading makers which are capable of pumping to any height desired, from a few feet, say 20ft., to 2,000ft. They are extremely simple, reliable, require no adjustment, and are low in first cost, and if the right sort of pump is selected they work at a good efficiency; they can also run at high speeds, and can thus be direct connected to a motor. The scheme suggested is shown by the accompanying rough sketch. The motor drives the laundry line shafting in the usual way and is mounted on a sole-plate, which also carries a multiple turbine high-lift pump and a simple form of clutch gear which allows the motor to drive the pump direct. The pump is fed by the water supply, and delivers into an elevated tank, which tank should be




about 30ft. above the highest point of the building it is wished to protect. Various points of vantage should be marked off, and each furnished with a water service from the tank, and the tank should be of such a size as to be able to hold a reserve of two hours' supply without calling upon the pump, and with all the fire service hoses in full play. The tank should, of course, be suitably housed, and each week the various jets should be tried, the water not needing to be wasted, as the top windows, etc., of the building can be swilled in this way; the tank should then be filled up again, and the time noted that it takes the pump to refill it—this will keep a check on the working of the pump. From the wording of the question it has been understood that there will be no chance of the pump losing its water as the water supply flows to it, and enables it to work just drowned; however, if this is not the case, a couple of pipes run from the top tank to the suction of the pump will do all the priming required. An installation on the above lines will afford adequate protection against fire, a full supply of water being available any time, thus allowing an outbreak to be tackled at once without any waiting.—W. T. W.

[Other replies to Question No. 778 will be given in our next issue.—ED. *E. E.*]

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Supplement to "The Electrical Engineer,"
MAY 26, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

785. It is noticed that dust collects much more on the positive than on the negative 'bus bars in a central station, also that it collects on the glass panes opposite the bars, and that more collects opposite the positive bar than the negative. How is this explained?—H. G. H.

786. At a hydro-electric installation some surplus power is available. State the best method of obtaining a record of the same with a view to installing another turbine 12 months hence. Fall, 11ft., subject to frequent floods.—A. R.

### ANSWERS.

*Question No.* 778.—A large institution requires a 14-h.p. motor for a laundry and also want the same motor to augment a deficient water pressure—due to high ground on which building is situated—in case of fire, by working a pump fed by the water supply. How can the motors be best arranged to fulfil this two-fold purpose?

*Answer to No.* 778 (*awarded 7s. 6d.*).—The best arrangement for this two-fold purpose seems to me to be that the pump and motor be fixed on a bed-plate and coupled together by a jaw clutch when working together. This method keeps a very compact set, and, if anything, is cheapest.

The method of connecting the motor to the pump depends on the speed and type of pump used. The speed of a 14-h.p. motor is about 700 revolutions per minute, which is about the same speed as an 8in. centrifugal pump delivering 1,050 gallons per minute with a 20ft. lift and requiring 15 h.p., so we will assume that this pump be used. The arrangement shown in Fig. 1 may be applied satisfactorily,

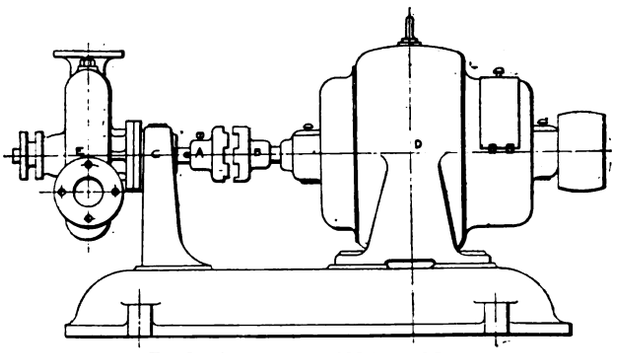

FIG. 1.—Arrangement of Motor and Pump.

the motor, D, being fixed to an extended bed-plate supplied with facings to carry the pump bearing, C. On the back end of the motor shaft is keyed one half of a jaw clutch, B, which engages the other half, A, which slides on a feather key let into the pump spindle. When the motor is driving the laundry shafting, the loose half of the clutch, A, is thrown out of gear along the shaft, and held so by a set pin. When it becomes necessary to use the pump, the motor must be stopped, the belt thrown off, and the loose half of the clutch put into gear and tightened by the set pin. All this may be done very quickly in case of fire. It will be noted that the pulley is keyed on to the commutator end of the motor shaft. Complete shifting gear in the shape of a lever may be applied for throwing the clutch in and out, but as a fire is a very rare occurrence this is unnecessary, and entails more expense.

A shunt-wound motor would suit the purpose best, and the direction of rotation must be chosen so that it suits both pump and shafting, and if this cannot be done effectively, a change-over switch should be placed between the motor and starter and connected as shown in Fig. 2.

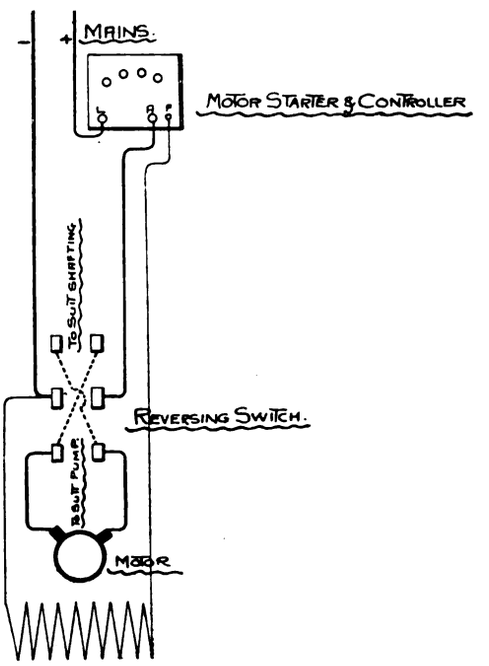


FIG. 2.—Diagram of Connections between Shunt-Wound Reversible Motor and Starter.

This may be used instead of a reversible controller, which, with its two sets of contacts, might "fog" the attendant as to which direction to turn when starting. If the motor connections are on the outside, the armature or shunt leads may be changed by hand almost as quickly to reverse the direction of rotation. With a shunt-wound motor either the armature leads or the shunt connections must be changed, and not both If the speed of the motor requires a little alteration to drive the pump at its most effective speed, a resistance may be placed in the armature or shunt circuit of the motor, to enable the speed to be either raised or lowered as required. If the speed needs decreasing, the motor starter may be wound as a controller at a little extra cost.

Should a double-acting slow-speed pump be used, it will require either a single or double reduction gear fixed between itself and the motor, and the wheel that gears into the motor pinion must be free to slide on a feather, in or out of mesh as required. If for any reason the pump cannot be coupled direct to the motor, it may be driven off a countershaft by belt, but I believe the best method is as described above, and as shown in sketch.—P. DEAN.

*Answer to No.* 778 (*awarded 7s. 6d.*).—The best arrangement would be to have an overhead tank fixed on the top of some building at a sufficient height to get pressure enough for the purpose and keep this tank full by means of a centrifugal pump driven by the laundry motor. With this arrangement a plentiful supply of water would be ready at any time of the day or night in case of fire. One important point would be that if the fire was not of very large dimensions, it would be immaterial whether the electrical supply were on or off. The laundry motor is shown in Fig. 1, and the method of driving indicated. The arrangement is very simple, and probably all the laundry machinery will be stopped and started in the same way. The only difference between the two cases is that in Fig. 1

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the pulley *b*, instead of being loose, is keyed to a small countershaft which drives the pump. Under normal conditions the belt will be on pulley *a* driving the laundry machinery, but in case of fire the motor would be started up, the handle, *c*, pulled, causing belt to move on to pulley *b*, the stop valve, *e*, shown in Fig. 2, opened, allowing water from town mains to rush up into the pump and be delivered into tank. If the supply of electricity can

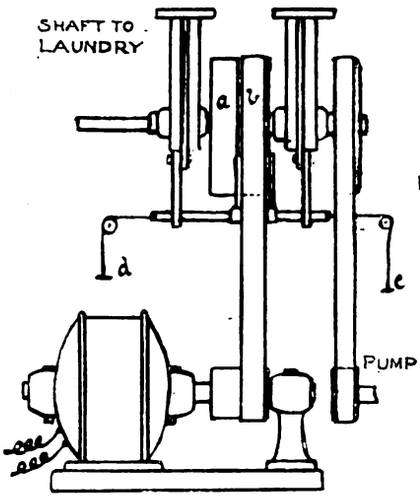


FIG. 1.

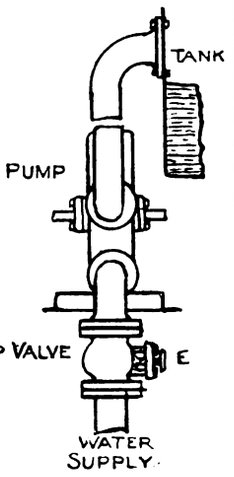


FIG. 2.

be absolutely relied on, then the expense of the overhead storage tank can be dispensed with. The same arrangements hold good with the exception of the pump delivering the water direct to the fire hose. Two centrifugal pumps may be connected in series if a high pressure is desired. This type of pump is very suitable for electrical driving, as it runs at a high speed, and thus saves a lot of expensive gearing. The laundry motor may be coupled direct

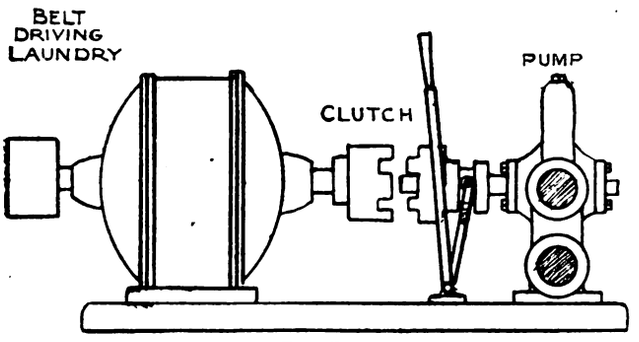


FIG. 3.

to the pump, if desired, through some simple form of clutch, as shown in Fig. 3. Both machines would be mounted on the same bed-plate, and the pump connected to the motor whilst it was standing, the belt being thrown off the laundry machinery countershaft if desired.—RESEARCH.

*Answer to No.* 778 (*awarded* 5*s.*).—"A. R." does not state very clearly what is exactly required. It is assumed that the motor will require to drive a line of shafting from which the various machines will be driven by fast and loose

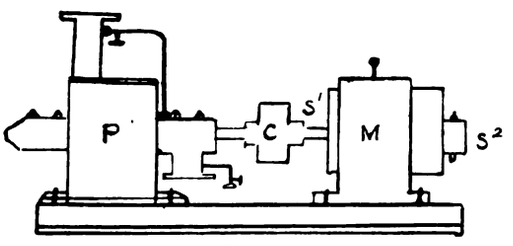


FIG. 1.

pulleys. The driving of the pump will depend upon the type chosen. Pumping may be done either by a direct-driven centrifugal pump or by ram pumps driven through gearing or belt. If a centrifugal pump is chosen, one sole-plate could be made suitable for motor and pump as shown on Fig. 1—P, pump; C, clutch; M, motor. It would be advisable to have some form of clutch in case of fire, which is easily engaged and disengaged while the shaft is in rotation. The act of engagement should be practically without shock, yet take up the motion quickly. A suitable armature spindle could be made so that pulley for line shafting could be put on either at $S^1$ or $S^2$. The belt would

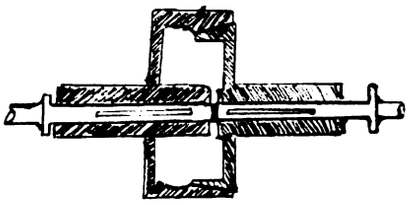

FIG. 2.

be off when driving pump. One type of friction clutch is shown on Fig. 2. Claw clutches are used when it is possible to stop for purpose of coupling. A belt-driven pump could be arranged as shown on Fig. 3, providing "A. R." has

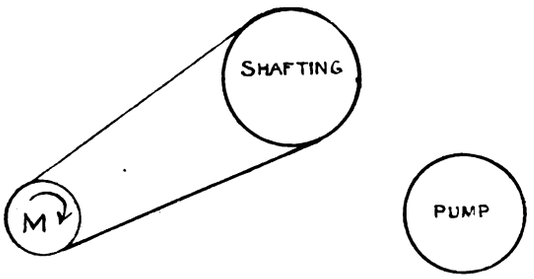


FIG. 3.

plenty of room, and could find suitable positions for motor and pump giving the right direction of rotation for pump and shafting. Fig. 3 shows belt driving line shafting and Fig. 4 driving pump. It is assumed "A. R." knows the

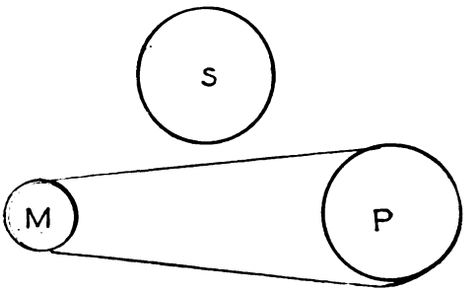


FIG. 4.

horse-power of pump which can be driven by a 14-h.p. motor.

$$\text{H.P. of pump} = \frac{\text{number of gallons} \times 10 \times \text{total head in feet}}{33{,}000}$$

Allow 20 to 40 per cent. for friction, bends, etc. The above is a formula which may prove useful to "A. R."—C. W. H.

*Question No.* 779.—A three-phase induction motor, with star-connected stator windings, is so arranged that each limb of the star consists of

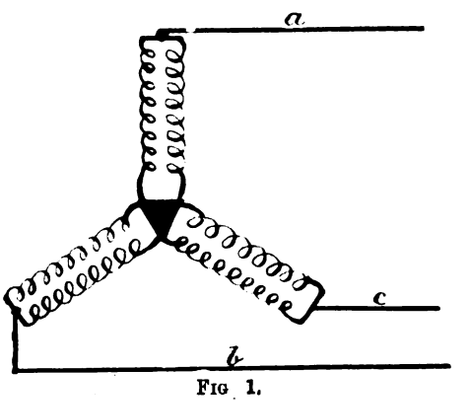


FIG. 1.

two parallel circuits, each circuit producing one set of poles and its neighbour the opposite set (see Fig. 1) If these circuits were

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placed in series, still star connected (see Fig. 2), in what manner would the machine power factor and efficiency be affected at light and full loads?—MESH.

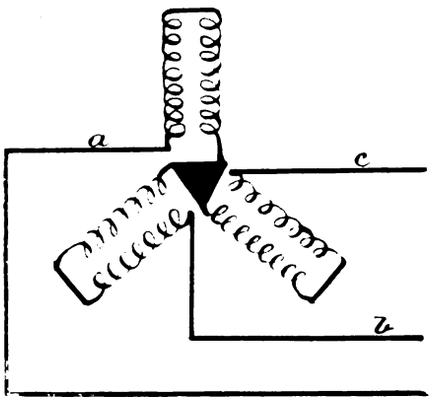


FIG. 2.

*Answer to No.* 779 (*awarded* 10*s.*).—The question does not state what voltage is to be used on the motor after reconnecting from Case I. to Case II, but it is presumed that twice the voltage used with the former is to be used with the latter connection. If the same voltage were used in both cases, it will be seen that by doubling the number of turns in series per phase we halve the flux per pole, and thus reduce the output of the motor approximately in the ratio of 4 to 1, and in all probability it would be unable to perform the duty required of it. Assuming, then, that the voltage is going to be doubled when the motor is running with all the poles in series per phase, we shall see that the power factor and efficiency will remain the same in the two cases.

Let the notation for the case when we have two poles in parallel per phase be as follows:

V = stator voltage per phase;
I = stator current per phase;
$x_f$ = stator reactance per phase;
$x_a$ = rotor reactance per phase ($x_a$ being here reduced to have that value it would have if there were the same number of phases in the rotor as in the stator and the same number of turns in series in each);
$C_m$ = magnetising current per phase in stator.

Taking first the power factor into consideration we have the well-known formula,

$$\cos\phi = \frac{1}{\sqrt{1 + (\%\, x_f\, I + \%\, x_a\, I + \%\, C_m)^2}}$$

where

$$\%\, x_f\, I = \frac{x_f\, I}{V};$$

$$\%\, x_a\, I = \frac{x_a\, I}{V};$$

$$\%\, C_m = \frac{C_m}{I}.$$

Now, the reactance per phase will vary with the square of the number of turns in series per phase, so that, as in the second case, we have twice the number of turns in series per phase that we have in the first case, the stator reactance will be altered to $2^2\, x_f\, I$, and the rotor reactance per phase will be $2^2\, x_a\, I$. The magnetising current in Case II. will be $C_m/2$, for to get the same flux per pole we shall require the same number of ampere-turns per pole as before, but now, since all the poles are in series instead of two in parallel, we shall only require half the former current from the line—*i.e*, $C_m/2$. Thus for the power factor in the second case we have, with line current I/2 and line voltage 2 V,

$$\cos\phi = \frac{1}{\sqrt{1 + \left(\frac{4\, x_f\, I}{4\, V} + \frac{4\, x_a\, I}{4\, V} + \frac{2\, C_m}{2\, I}\right)^2}}$$

$$= \frac{1}{\sqrt{1 + \left(\frac{x_f\, I}{V} + \frac{x_a\, I}{V} + \frac{C_m}{I}\right)^2}}$$

*i.e.*, it is the same as before, and since I is an arbitrary value of the current, this will hold for any value from no load to maximum output.

Looking now at the question of efficiency, with the same flux in the machine we will have the same core loss, also the friction will remain unchanged. For the same watt input we shall have half the current in Case II. that we have in Case I., since the power factor, as shown above, is the same in each case. The resistance in Case II. will, however, be four times what it is in Case I., since we have now twice the length and half the cross-section of copper per phase, so that although $I^2$ is, in the latter case, one quarter of what it is in the former, this increase of resistance just balances again the $I^2\, R$ losses in each. This, of course, applies to the rotor as well as to the stator, since, as stated before, we can always consider the rotor winding to be reduced to the same number of phases and the same number of turns in series per phase as in the stator. For the same watt input, then, we have the same losses in the two cases, and thus the same output, and, following on that, the same efficiency. As in the case of the power factor, this holds good for any value of the current in the motor.—MAC.

*Answer to No.* 779 (*awarded* 7*s.* 6*d.*).—The change contemplated amounts to doubling the effective stator turns in series per phase, and reducing the effective sectional area of the stator wire by half. In order to make the result of these changes clear, it will be necessary first to describe the action of an induction motor shortly. When such a motor is running unloaded, a small current, consisting partly of the wattless magnetising current producing the flux of the motor, and partly of a power current representing the no-load losses of the motor, flows into the stator. The value of the magnetising current depends on the dimensions of the magnetic circuits, the number of turns, etc., and adjusts itself automatically until sufficient stator flux to produce a back voltage in the stator windings nearly equal to the supply voltage is set up. The value of this flux is given by the expression

$$\text{Flux} = \frac{\text{internal stator volts per phase} \times 10^8}{\text{stator turns in series per phase} \times \text{periodicity} \times 4\,44}$$

The speed of the rotor at no load is slightly less than the synchronous speed—*i.e*, than the speed of rotation of the magnetic flux—so that the rotor conductors may cut the flux at a rate just sufficient to induce the small rotor current, which, in combination with the flux, produces the no-load torque, overcoming the friction, etc., of the motor.

When load is put on to the motor pulley, the rotor slows down slightly so that its conductors cut the flux at a greater rate—*i.e*, so as to produce a greater difference in speed or a greater "slip" between the rotor conductors and the rotating flux—so as to increase the rotor current and the torque. This torque is proportional to: rotor current × useful rotor flux. As the load and the current increase, however, the flux set up by the stator windings would very soon be reduced to zero by the opposing action of the rotor ampere-turns, and to avoid this the stator current automatically increases step by step with the rotor current, so as always to leave sufficient excess stator ampere-turns over rotor ampere-turns to produce the working flux. Now, in every motor some leakage of magnetic flux takes place between the stator where the flux is produced and the rotor where the flux is used. Such leakage, for instance, occurs across the slots, around the ends of the coils, and across the tops of the teeth, and it is practically proportional to the total ampere-turns. The amount of this leakage is usually defined as the difference between total stator flux at no load and useful rotor flux at no load stated as a percentage of the latter, and it usually lies between 5 and 10 per cent. The total stator flux being practically constant at all loads, the useful rotor flux has its maximum value at no load and diminishes gradually as the load increases, until when the stator current has reached a value which is approximately equal to as many times the no-load current as the total flux is times the no-load leakage flux, the whole of the flux is leakage, so that no useful rotor flux is left, no torque is exerted, and the motor caused to rest on short-circuit.

We can now consider the effect of the change of stator turns on (1) the losses and efficiency, (2) the power factor,

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and (3) the speed of the motor at no load and full load. At no load the action of the motor will be improved all round, for the halving of the stator flux will reduce the necessary magnetising ampere-turns by half, and since the effective turns of the stator are doubled, the actual magnetising current will only reach one quarter its old value. The halving of the flux will further reduce the iron losses in the motor to about one-third of their old value. The friction losses will remain unchanged, whilst the $C^2R$ losses will be considerably reduced, but since these are in any case negligibly small at no load, they need not be considered. The power factor will be considerably improved, because whilst the losses as a whole have only fallen slightly, the wattless magnetising current (on which the no-load power factor chiefly depends) has fallen to one quarter of its old value. The speed of no load will be slightly less than before, but still practically indistinguishable from synchronous speed.

Turning next to the full-load conditions, the results will be found far less satisfactory. With the same input current the ampere-turns after the alteration will have double their old value because of the increased stator turns. This will mean practically double the actual leakage flux, and since the total flux is halved, the leakage, stated as a percentage of the total flux, will be four times as great as before. Now the rotor torque is approximately $\propto$ . Useful rotor flux $\times$ rotor current, and since the rotor current is doubled whilst, owing to the increased percentage leakage, the useful flux is considerably less than half its old value, the rotor torque and output will, for the same input, be considerably less than before the alterations. The iron loss will be reduced (as at no load) to about one-third of its old value. The friction losses will remain unchanged, whilst the $C^2R$ losses will be four times as great as before the alteration. This increase in $C^2R$ losses will usually far outweigh the fall in iron loss, and the increased losses together with the reduced useful output will greatly reduce the full-load efficiency after the alteration. The slip after alteration will be approximately four times as great as before, because besides the flux reduction there is an increase in rotor current to be produced. The power factor at full load will be considerably lower after the alteration, because it is proportional to $\frac{\text{rotor torque}}{\text{input current}}$, and, for the same input current, the rotor torque is considerably reduced.

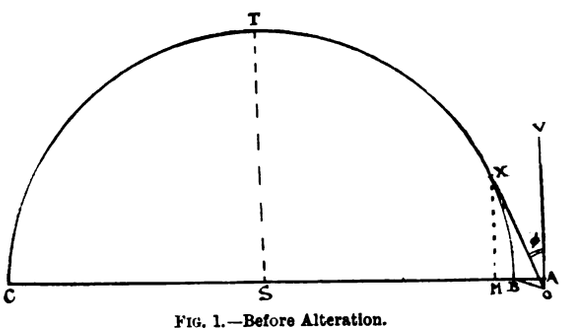


FIG. 1.—Before Alteration.

The approximate numerical effects of the alteration can be most simply arrived at by means of the Heyland diagrams shown in Figs. 1 and 2. Set off A B horizontally to represent the magnetising current to some scale. Continue A B to C, making B C equal to magnetising current $\times \frac{\text{total useful flux at no load}}{\text{leakage flux at no load}}$, or (which is practically the same thing) make B C equal to the stator current taken by the motor on short-circuit. On B C draw a semicircle. From A draw A O equal to the no-load power current, and at right angles to A B. Then O B is the no-load current, and lines like O X drawn from O to the semicircle represent stator input currents to the same scale as that to which A B represents the magnetising current. The full load of a normally-designed motor would occur approximately at the line O X. Vertical heights like X M are proportional to the torque corresponding to the current O X. The cosine of the angle V O X is the power factor at the current O X. The proportions of Fig. 1 apply to the motor before alteration, and are drawn on the assumptions that (1) the magnetising current, A B = 25 per cent. of the full-load current, O X; (2) the leakage at no load is 6 per cent. of the useful flux at no load—*i.e.*, B C = A B $\times \frac{100}{6}$; (3) the no-load loss current, A O, is 5 per cent. of the full-load current, O X, 3 per cent. being taken as iron loss and 2 per cent. as friction.

Fig. 2 represents the diagram for the same motor after the alteration, and is drawn to the same scale as Fig. 1.

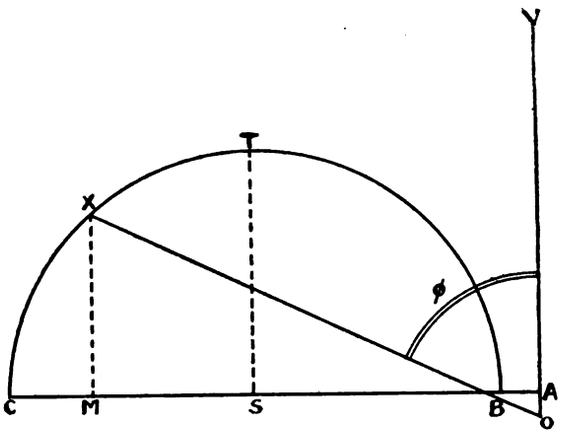


FIG. 2.—After Alteration.

O X is the same length, and represents the same current in both diagrams. A B in Fig. 2 is $6\frac{1}{2}$ per cent. of O X. B C is equal to A B $\times \frac{100}{6}$ (*i.e.*, B C in Fig. 2 is one-fourth the length of B C in Fig. 1). By scaling off the diagrams the following approximate results are obtained:

*At No Load.*—Power factor before alteration (= cos A O B in Fig. 1) = ·19.

Power factor after alteration (= cos A O B in Fig. 2) = ·48.

No-load losses before alteration = 5 per cent.

" " after " = about 3 per cent.

*At Full Load* (*i.e.*, at the same input current O X before and after alteration):

Power factor before alteration (= cos V O X, Fig. 1) = ·92.

Power factor after alteration (= cos V O X, Fig. 2) = ·44.

$$\text{Efficiency before alteration} = \frac{92\% - (3\% + 2\% + 5\%)}{92\%} = 89\%.$$

$$\text{Efficiency after alteration} = \frac{44\% - (1\% + 2\% + 20\%)}{44\%} = 48\%.$$

$$\text{Ratio of torque before alteration to torque after alteration at the same input} = \frac{\text{X M in Fig. 1}}{\text{X M in Fig. 2}} = 2{\cdot}1.$$

Since the speed after alteration is somewhat less than before, the ratio of brake horse-power in the two cases will be even less favourable to the altered motor. Ratio of maximum possible torque before alteration to the same after alteration $= \frac{\text{T S in Fig. 1}}{\text{T S in Fig. 2}} = 4.$

It will be seen that whilst the motor is improved at no load or very light loads, it is greatly altered for the worse at full load—in fact, with the data assumed (and these are not particularly unfavourable), the motor would be quite unable to give its full-load output after the alteration, even supposing it to be worked at the maximum output, T S in Fig. 2. The alteration would, therefore, be quite out of the question, except as a temporary expedient for improving the no-load working conditions.—Q.

[Other replies to Question No. 779 will be given in our next issue.—ED. *E. E.*]

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Supplement to "The Electrical Engineer,"
JUNE 2, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS.

787. Has Reuleaux's diagram been adapted to the analysis of the Corliss valve motion? If it has, explain the method and show how by its use problems relating to a double eccentric gear may be solved.—G. H. H.

788. A three-phase 3-h.p. induction motor with squirrel-cage rotor takes 20 amperes at starting on no load. When the speed has got up to normal the current is two amperes. With the idea of decreasing starting current, a choker is connected in circuit. This choker consists of three separate superimposed windings, one in each phase. On again starting motor, the initial current is now 14 amperes, and running current scarcely readable. What is the reason for this apparent increase of power factor?—P. D.

### ANSWERS.

*Question No.* 779.—A three-phase induction motor, with star-connected stator windings, is so arranged that each limb of the star consists of

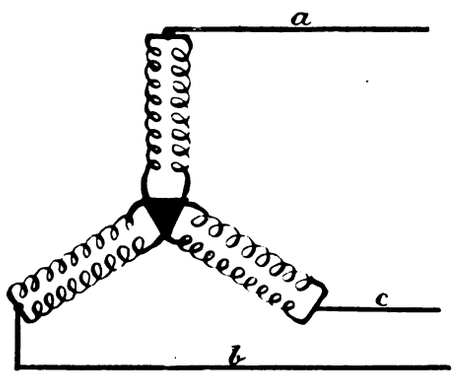


FIG 1.

two parallel circuits, each circuit producing one set of poles and its neighbour the opposite set (see Fig. 1) If these circuits were placed in series, still star connected (see Fig. 2), in what manner

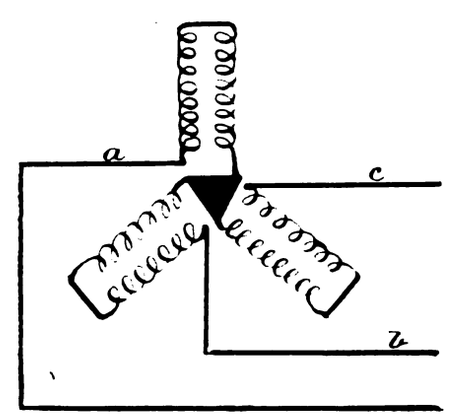


FIG. 2.

would the machine power factor and efficiency be affected at light and full loads?—MESH.

*Answer to No.* 779 (*awarded* 7*s.* 6*d.*).—The connections shown in the second figure given with the question would change the motor into one with half the number of poles. If the first winding gave + − + − + − + −, the second would give + − − + + − − +, as the current would be reversed in half the stator windings. Since the impedance is doubled the voltage applied must be doubled, and then the current in each stator conductor will be the same as before. Since the number of poles is half, the speed will be twice as great and the torque half. This means less slip, and therefore greater efficiency at full load. As the rotor will be too big for its new speed, the no-load current in each conductor may be somewhat larger. Since the poles are now of greater pitch there will be less dispersion, and the power factor will be improved. The iron loss will not be altered, as the densities and the number of the reversals are as before. The copper loss in the stator will be practically the same, but that in the rotor will be one-fourth of its previous value, as the current needed for the torque is halved. If the current be sent round the stator to produce the same fields as before, the resistances and reactances are simply put in series. The voltage must be doubled to get the same current in each stator conductor. The flux, dispersion, copper and iron losses, and slip remain exactly as before.—E. S.

*Answer to No.* 779 (*awarded* 7*s.* 6*d.*).—The question which is raised above is a most important one, because it is one which, in one form or another, has always, without *exception*, to be carefully considered in the correct design of polyphase and single-phase induction motors, comprehending, as it does, the influence of the pure ohmic resistance of the windings of the stator of the motor upon the working of the motor and all the quantities, such as torque, slip, power factor, etc., which are connected therewith. Perhaps the simplest and, at the same time, the clearest way of determining the manner in which the alteration of the internal connections of these windings affects the power factor and the efficiency of the motor at light load—or no load—and full load is through the medium of that comprehensive diagram known as Heyland's diagram. The writer has, however, no intention of treating of the theory and construction of this diagram as a whole, but will assume its correctness, and merely deal with so much of it as is required by the demands of the above question. As a prelude to dealing with the diagram proper, it is obvious that if $r$ is the pure ohmic resistance of the winding of each limb of the star, then $2r$ is the resistance of each of the parallel circuits composing each limb. When, however, the internal connections have been so altered that the second figure of the question represents the new conditions, then the two circuits are in series one with the other, and the resistance now of each limb of the star is double that of either of the separate circuits—namely, $4r$—or four times the original resistance of the limb.

Turning now to the application of the Heyland diagram to the case in question, we shall first consider whether the power factor of the motor is affected by the aforementioned change or not, and, if it is, in what peculiar way. In Fig. 1 we have a portion of the ordinary form of the diagram, and in it O A represents the stator flux; O C represents the light-load current, O C, represents the full-load current; O E represents the E.M.F. induced in the primary or stator conductors, which E.M.F. is of the nature of a back pressure; E $e_p$ represents the drop in pressure in the stator windings, at the light load, due to the pure ohmic resistance of $r$ ohms; E $e_p'$ represents the corresponding drop at full load; E $e_p''$ represents the drop in pressure, at light load, due to the pure ohmic resistance of $4r$ ohms; E $e_p'''$ represents the corresponding drop at full load; O $e_p$ represents the impressed E.M.F. for the first arrangement of windings at light load; O $e_p'$ represents the corresponding E.M.F. at full load; O $e_p''$ represents the impressed E.M.F. for the second arrangement at light load; and O $e_p'''$ represents the corresponding E.M.F. at full load.

*First Arrangement—Light Load.*—Referring to Fig. 1, it is evident that the current lags behind the impressed

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pressure, O $e_p$, and that the phase relationship of the pressure to the current is the angle C O $e_p$. Therefore, the angle C O $e_p$ is the angle of lag of the current supplied to the motor for this load, and the cosine of this angle is the power factor of this motor.

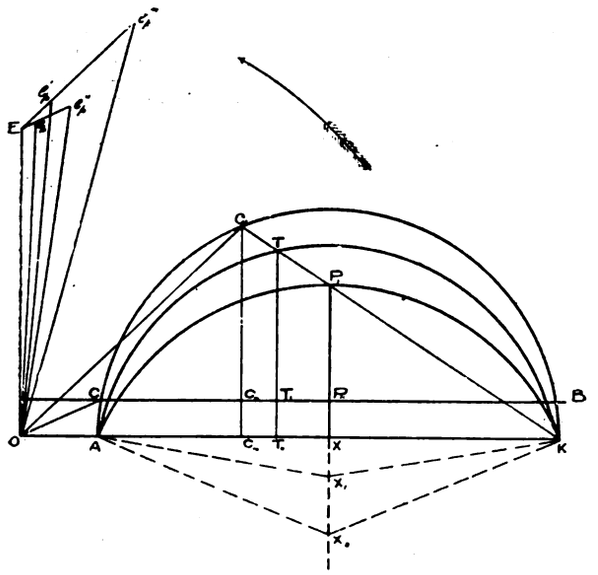

FIG. 1.

*Second Arrangement—Light Load.*—In this case it will be observed that the position and direction of the vector representing the impressed pressure have been changed; this is the direct result of altering the resistance of the stator windings. Also the change has been such that the magnitude of the angle of lag—which is now the angle C O $e_p''$ instead of C O $e_p$—has been diminished. But as the cosine of any angle within the limits of 0deg. and 90deg. increases as the angle decreases, it follows that the cosine of the new angle is greater than that of the old angle. Hence, in this case, the power factor has been *increased.*

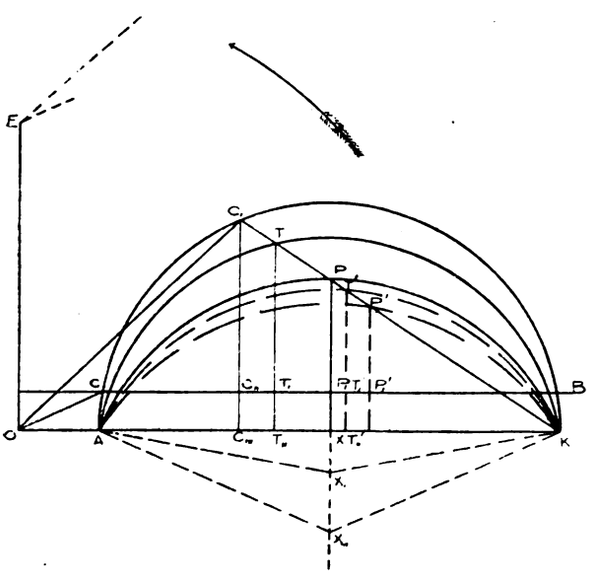

FIG. 2.

*First Arrangement—Full Load.*—Following the lines of reasoning as above, we see that the angle C, O $e_p'$ is the phase relationship between the pressure and the current, and that the cosine of this angle is the power factor of the motor for full load.

*Second Arrangement—Full Load.*—As in the above case, the position and direction of the vector representing the impressed pressure across the terminals of the machine have been changed, with the result that the angle C, O $e_p'''$ is less than the angle C, O $e_p'$; or, in other words, the angle of lag of the current has been made smaller. Hence the cosine of the angle of lag has been made larger, and, as a consequence, the power factor of the machine has been *increased.*

Therefore, in both cases of light load and full load, the change proposed in the question would lead to an increased power factor.

Considering, now, the effect produced on the efficiency of the motor, we have in Fig. 2 another portion of the Heyland diagram. It is clear that at light load there cannot possibly be any efficiency, for the very simple reason that no external work is done; that is, what energy is absorbed by the motor is utilised in making up for such losses as core losses, heating losses, frictional losses, etc. At full load, however, the conditions are different, and, since there is external work done, there will be an efficiency. Referring to Fig. 2, if there were no losses in the motor of any kind, then C, C,,, to a certain scale would represent both the input and the output watts. To take into account, however, the internal stator heating loss, C, T is made, to a certain scale, representative of such, and to include the effect of slip, $\frac{P\,T}{T\,K}$ equals the percentage slip. Then the output watts are equal, to a certain scale, to P P,. The efficiency of the motor equals $\frac{P\,P_,}{C,\,C_{,,,}}$.

In the second arrangement the resistance of the winding is increased four-fold, and, consequently, the loss will be four times as great as it was before. This second loss is represented by C, T', and the slip by T' P'. The new output power is represented by P' P,', which, evidently, is smaller than P P,. Hence the *new* efficiency, which is $\frac{P'\,P_,'}{C,\,C_{,,,}}$, is *smaller* than the *old* one. This shows in a clear manner the effect of the proposed change.—G. W. B.

*Answer to No.* 779 (*awarded* 5*s.*).—

Let $r$ = the stator resistance;
$E_0$ = the supply voltage;
J = the current taken per phase;
$\phi$ = the angle of lag of J with respect to E.

In the first place, I wish to show the effect of the stator resistance on the power factor and efficiency of the motor, and then the effect of increasing the resistance, as it is obvious that the operation described in the question increases the stator resistance four times.

Now, owing to the resistance of the stator, there will be a small voltage drop, $e$, due to this cause. Its value will be $e = J\,r$. This drop will, of course, be in phase with the current, J. The voltage, E, used for power purposes in the motor will be the supply voltage reduced vectorially by $e$. In all calculations on the induction motor E is used, and a correction made afterwards as in Fig. 1. Now, of

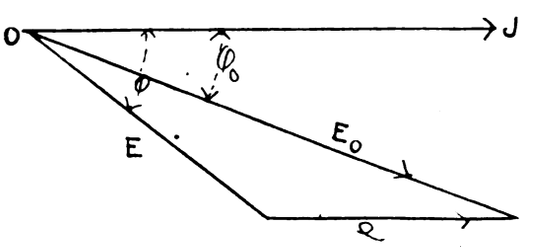

FIG. 1.

course, $e$ is very small compared with $E_0$ (but, of course, not small enough to be neglected). We get, therefore, the very approximate relation

$$E = E_0 - J\,r\cos\phi \quad . \quad . \quad . \quad . \quad . \quad (1)$$

This will easily be seen by referring to Figs. 1 and 2. I now wish to obtain in absolute terms the increase of power factor due to stator resistance

$$\cos\phi_0 = \frac{O\,N}{O\,Q} = \frac{O\,N}{E_0}$$

$$O\,M = E\cos\phi \text{ and } M\,N = e$$

$$\therefore \cos\phi_0 = \frac{O\,M + M\,N}{E_0} = \frac{e + E\cos\phi}{E_0}.$$

Substitute for $E_0$ the value obtained in equation (1), and we get

$$\cos\phi_0 = \frac{e + E\cos\phi}{E + e\cos\phi}$$

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$$\therefore E\cos\phi_0 + e\cos\phi_0\cos\phi = e + E\cos\phi.$$

Now, $\cos\phi\cos\phi_0$ is very approximately equal to $\cos^2\phi$. Since $\phi - \phi_0$ is very small, indeed, and $\cos^2\phi = 1 - \sin^2\phi$.

$$\therefore E\cos\phi_0 + e(1-\sin^2\phi) = e + E\cos\phi.$$

$$\therefore \cos\phi_0 = \cos\phi + \frac{J\,r}{E}\sin^2\phi \quad . \quad . \quad . \quad (2)$$

This gives us in absolute terms the increase in power factor at any load due to the stator resistance. These two equations (1) and (2) are the ones given by Dr. Behn-Eschenberg in his paper on induction motors read before the Institution of Electrical Engineers, Jan. 14, 1904, p. 272. We have now to apply this equation (2) to the

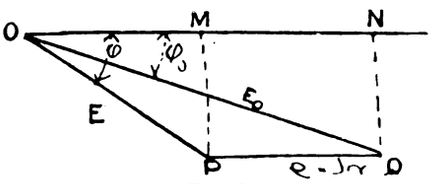


FIG. 2.

motor in question. Let its original resistance per phase be R. Then, on putting the stator coils in series as described, this becomes 4 R, and we get the two equations:

$$\left.\begin{aligned} \therefore \cos\phi'_0 &= \cos\phi + \frac{J\,R}{E}\sin^2\phi' \\ \text{and} \qquad \cos\phi''_0 &= \cos\phi + \frac{4\,J\,R}{E}\sin^2\phi'' \end{aligned}\right\}$$

$$\therefore \cos\phi''_0 - \cos\phi'_0 = \frac{3\,.\,J\,R}{E}\sin^2\phi''.$$

$\sin^2\phi''$ is very approximately equal to $\sin^2\phi'_0$. Therefore we obtain the result that by increasing the resistance of the stator coils as described we increase the power factor by an amount $\frac{3\,J\,R}{E}\sin^2\phi'$. The power factor of the motor can easily be obtained from the Heyland diagram, and I do not think it necessary to describe this here, as it is so well known. We have now to consider the effect on the efficiency of the motor.

Let W = the no-load losses;
„ S = the slip per revolution.
The copper losses = $3\,J^2\,R$.
The efficiency, $n$, of the motor is given by

$$n = \frac{3\,J\,E\cos\phi\,(1-S)}{3\,J\,E\cos\phi + W + 3\,J^2\,r}.$$

As is well known, $S \propto \frac{1}{E}$

We shall therefore have to correct S by multiplying by

$$\frac{E + J\,r\sin^2\phi}{E}.$$

W is a constant. $\cos\phi$ I have shown will have to be increased as described, also E. We shall, of course, have to substitute for $r$ the value for our motor—*i.e.*, $R\,\phi + R$—and the difference will give the change in efficiency. The change of efficiency can be roughly calculated as follows: estimate the stator and rotor copper losses based on their resistance, and also the iron and friction losses, which Dr. Behn-Eschenberg gives as about five watts per kilogramme of iron, and then if A is the total output of the motor, B is the stator copper loss, C is the rotor copper loss, and D is the iron and friction losses. We get efficiency at full load

$$= \frac{A}{A+B+C+D}$$

and with B increased to 4 B we get the efficiency

$$= \frac{A}{A+4\,B+C+D}$$

and the loss of efficiency at full load is given by the difference

$$= \frac{3\,A}{(A+B+C+D)(A+4\,B+C+D)}.$$

I think that from the above note it will be possible to estimate the changes in efficiency and power factor, but, of course, a knowledge of the motor short-circuit characteristics and no-load characteristics will have to be known.—ERNEST P. HOLLIS.

*Answer to No.* 779 (*awarded* 5*s.*).—The suggested alteration in the stator coils mentioned introduces twice the original resistance into the circuit; this change would probably be productive of the following results, in describing which, for the sake of brevity, I will refer to the parallel arrangement as Case I. and the other as Case II. It is also here assumed that the induction motor is fitted with a squirrel-cage rotor and started up by means of a compensator or auto-transformer.

Considering, first, the condition of things on starting up the machine with either arrangement of windings, the same torque is necessary to overcome the inertia of the rotor and run it up to speed. With a doubled resistance only half the former current would flow in the stator coils, at the instant of closing the switch, thus only half the former torque would be exerted; consequently the rotor will not revolve and run up to speed so quickly, more slip being necessary to provide the turning effort. In Case I. the speed at no load will always be nearer synchronism than in Case II., due to the additional slip required to compensate for the higher ohmic resistance in the stator coils; it being here remembered that as the frequency of the currents in the rotor depends upon the slip, hence the torque increases—within limits—as the rotor speed lags behind that of the stator flux. The direct result due to the greater slip will be larger currents circulating in the rotor conductors, which will have the same effect as strengthening the fields of a synchronous machine—namely, an improved power factor. With an increasing load up to the economical carrying capacity of the windings in Case II., the power factor would still be higher than in Case I Reference has already been made to a certain limit, upon attaining which any addition to the rotor slip does not increase the torque. This limit is reached when the currents in the rotor circuit lag behind the E.M.F. producing them by 45deg, or when the E.M.F. necessary to overcome self-induction equals the E.M.F. required to overcome ohmic resistance alone. Therefore, in Case II., this limit of maximum torque is reached before Case I., and in the latter the power factor continues improving beyond the limit of Case II. Thus, with the improving power factor, the bigger load does not require a corresponding increase of current in the stator coils. In all probability a machine wound as in Case I. will not attain the limit of maximum torque until it is transmitting nearly double the energy of a similar motor wound as in Case II.

It would appear from the foregoing results that each type of winding had certain merits. In Case II., though the starting torque is low, on a varying load up to its limit of maximum torque, its efficiency would be greater than the other, owing to the power factor being better and the losses resulting from wattless currents being less. In Case I., the limit of maximum torque being reached later than in Case II, if the machine is subject to overloads, a higher efficiency ensues. From this it will be seen that induction motors wound with two parallel circuits, as in Case I., are well suited for starting up fully loaded, necessitating a large starting torque, and for running on full load with repeated heavy overloads of, perhaps, 100 per cent. Machines arranged as in Case II., to deal with heavy overloads, would require a greater area of copper in the windings—in fact, the motor would have to be of larger construction throughout. It is, however, specially, adapted for a varying load fluctuating between zero and its limit of maximum torque.

To put the whole subject briefly, the effect of increasing the resistance of the stator coils is to reduce the rotor flux, and with it also the torque; therefore, any reduction of the ohmic resistance in the stator coils will enable a machine to increase its torque, and, therefore, its mechanical efficiency, though at the cost of a diminished power factor on light loads.—WALLSEND ON TYNE.

*Question No.* 780.—How would you arrange the Hopkinson test and determine the efficiency on two 900 kilovolt-ampere 500-volt compound generators or machines?

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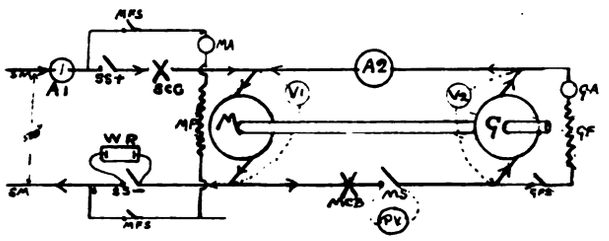
*Best Answer to No.* 780 (*awarded* 10*s*).—The two generators are presumably directly coupled together, probably with the addition of a third bearing between the two armatures; also a supply of current at 500 volts is available. The question does not state whether the machines are compounded for constant or an increased voltage. However, to simplify matters, the series winding had better be cut out on both machines for the first test. Afterwards the series turns on the generator may be used either separately excited by a booster or self-excited and regulated by a shunt rheostat; this latter arrangement requires some skilful manipulation. Connect up as shown in the diagram. M and G are the motor and generator




M, Motor; MF, Motor Field; G, Generator; GF, Generator Field; SM, Supply Mains; SS, Single-Pole Switch in each Main; SCB, Circuit Breaker in Series with Positive Supply Main; WR, Water Rheostat across Negative Supply Switch; MS, Main Switch for Paralleling; MCB, Circuit Breaker in Series with Main Switch; MFS, Motor Field Switch; GFS, Generator Field Switch; A1, External Supply Ammeter; A2, Main Ammeter reading Circulating Current; MA, Motor Field Ammeter; GA, Generator Field Ammeter; V1, Motor Voltmeter; V2, Generator Voltmeter; PV, Paralleling Voltmeter.

armatures, the field of the generator self-excited. The brush leads on one side of each of the armatures are connected together through an ammeter shunt. The brush leads on the other side are connected together through a main switch and circuit breaker. It is advisable to use a circuit breaker here, as this gives the machines greater protection. The circuit breaker is also convenient to throw the whole load off the generator suddenly, a test frequently specified. The external supply circuit is brought through two single-pole switches with a circuit breaker on the positive side and a water rheostat across the negative switch for starting. A tachometer should be put on the shaft to facilitate speed regulation. The instruments should all be together on one board if possible, so that they can be seen at a glance. The main ammeter must be within sight of the operator while his hand is on the field rheostats; the tachometer and field ammeters should be also within sight.

To start up, close the field circuit of the motor and increase the field to its maximum value. Set the supply circuit breaker to about half full-load current—it may take more than this to start the first time—close the positive supply switch, dip in the water rheostat plates, and if the direction of rotation is right bring them together slowly, watching the supply ammeter meanwhile; when shorted, close the negative supply switch and take plates out. The direction of rotation should be made right for the machine—that is, to run as a generator. Then weaken the motor field, bring the combination up to speed, and calibrate the tachometer. Close the generator field circuit and main circuit breaker, and allow the machine to excite; adjust the voltage and parallel in the ordinary way with the main switch. Before paralleling, try the volts across the main switch, and see that this is zero or two or three volts in favour of the generator. It is wise to try this with a few volts on the generator, as then there is less risk of burning out the paralleling voltmeter in case the polarity of the generator is wrong. If the polarity of the generator is wrong, reverse the brush leads. Then adjust the motor field to give correct speed, and at the same time increase the generator field so as to get full-load current circulating between generator and motor. If the generators are good machines, the motor will easily carry the extra load, about 10 per cent. While on full load adjust the brush position. A very slight backward lead on the motor is generally sufficient; more lead than necessary on either machine, of course, reduces the efficiency. The direction of the current is shown by the arrows.

Before taking efficiency readings it is as well to run for some time to ensure the bearing friction being fairly constant, or, better still, take the efficiency readings after a temperature test. Then, keeping the speed constant, take readings of all instruments at regular intervals from no load to about 30 per cent. overload—about 10 readings in all. The brush lead should not be altered from full-load position. The approximate efficiency is given by

$$\sqrt{\frac{\text{output of generator}}{\text{input of motor}}} = \sqrt{\frac{A_2 \times V_2}{(A_1 + A_2) \times V_1}}.$$

This takes into account the losses in the field rheostats and friction in three bearings, which latter is not quite fair; it will probably make a difference of ½ per cent. to each machine. The hot resistance of the generator series field should be taken, and the $C^2R$ losses allowed for at the various loads.

To obtain readings with the generator series winding in circuit: Start up and parallel with this series winding shunted with a large water rheostat; the plates of the rheostat being shorted. Then, to bring up the load, gradually separate the rheostat plates, and at the same time weaken the shunt field until the full main current is passing through the series turns—or the series turns and the permanent shunt to them supplied with the machine. If paralleling is tried with the series in circuit and not shunted, the generator will build up the load before it can be controlled and open the main circuit breaker.

The above Hopkinson method is the one usually applied, but another one may be used provided there is at hand a booster capable of supplying full-load current and about 40 volts, and a supply of current at 500 volts for exciting the fields. The above method is very convenient for a temperature test, but, to obtain the efficiency with greater accuracy, the following may be followed to separate the losses: Run the combination at the correct speed, the generator not excited; read carefully watts supplied to the motor armature—probably a lower reading ammeter will be needed to read the supply current. This reading gives the watts lost in friction in two machines and the iron losses in one—call this A. Now separately excite the generator to full voltage, and, keeping the motor speed and field current absolutely constant, the speed may be regulated with a rheostat in the motor armature circuit. Do not include it in the voltmeter reading. Read the motor watts again. This gives the friction and iron losses in two machines—call this B. Then B – A = iron loss in the generator (call this C), and A – C gives the total friction loss, approximate enough for ordinary purposes. The friction loss may be halved between the two machines. Then repeat with the motor as generator. The $C^2R$ loss in each armature, in the series, in the shunt, and in the brushes can all be calculated for any temperature after the resistances have once been measured. For further separation of the friction losses take readings of the motor watts, the generator brushes lifted, and also with the generator armature out. From this last the friction of one bearing can be found.

To use the booster method mentioned above, connect all three armatures in series, the fields being excited off 500-volt supply. In this arrangement the armatures are connected to revolve in opposite directions, the motor field being increased until the torque is sufficient to turn the generator round. This method overloads the motor field instead of the motor armature, and is a little awkward to start up.—TESTER.

[Other replies to Question No. 780 will be given in our next issue.—ED. *E. E.*]

## QUESTIONS AND ANSWERS—CORRECTION.

SIR,—May I point out, in reference to my answer to Question 779 in your last issue, that the scale of Fig. 2 as printed is four times that of Fig. 1, instead of being equal to it, as stated.

Also that in calculating the efficiency the full load $C^2R$ losses before alteration have been taken as 5 per cent. of the input.—Yours, etc., Q.

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## QUESTIONS AND ANSWERS.

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### QUESTIONS.

789. How may extra high electric pressures be measured by a low-reading electrostatic voltmeter and two condensers? Express the multiplying power of the arrangement in terms of the capacities, and state the conditions necessary for its constancy.—J. A. V.

790. Make a sketch and describe a mains-charging device suitable for a 1,000-kw. three-core power cable working at 10,000 volts. Explain fully why this apparatus is used on high-pressure alternating circuits.

### ANSWERS.

*Question No.* 780.—How would you arrange the Hopkinson test and determine the efficiency on two 900-kilovolt-ampere 500-volt compound generators or machines?

*Answer to No.* 780 (*awarded 7s. 6d.*).—For machines of such a large size, it would usually be more convenient to carry out the "parallel" rather than the "series" Hopkinson test, as the latter necessitates the provision of a low-volt dynamo or battery of about one-tenth of the capacity of one of the main generators, and capable of carrying the full current of the generator—*i.e.*, in this case, 1,800 amperes—and a dynamo for such an output as 50 to 100 volts by 1,800 amperes is rather an unusual one. The "parallel" Hopkinson test only requires a source of supply (dynamo or battery) of the same voltage as the generators (500) and capable of delivering a current of 10 to 20 per cent. of that of one generator. The connections for this test are shown

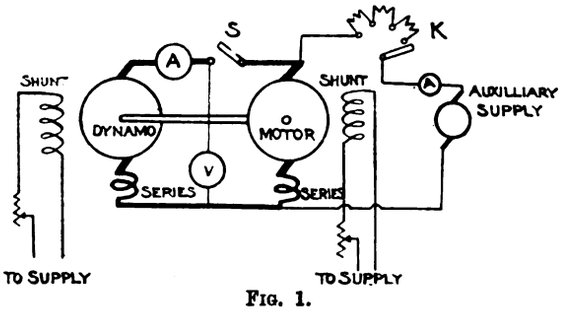


FIG. 1.

in Fig. 1. The shunt winding of both machines should, preferably, be separately excited, whilst the series windings can be self-excited in the ordinary way, although the test will be more perfectly under control if the series windings are left out altogether, provided that the whole excitation can be safely supplied by the shunt windings. If the series windings are used, care should be taken that the motor machine series winding is reversed relatively to the armature, so that it helps the shunt winding instead of opposing it.

To start the test, the two main generators are directly coupled together mechanically, and the main switch, S, between them is left open. The shunt of the machine which is to act as the motor is then excited, and the set is started up as an ordinary motor by switching on the auxiliary supply through the starting resistance, K. The shunt of the machine which is to act as generator is then excited until that machine gives the same volts as the auxiliary supply volts. Then switch, S, is closed and by slightly strengthening the shunt of the generator machine, or weakening the shunt of the motor machine, the current passing between the two main machines can be adjusted to the full-load current or any other value at which the efficiency is to be measured. It is best to weaken the motor field slightly and strengthen the generator field slightly, so that the average strength of field may be the normal value.

As the current flowing between the main machine increases, the current taken from the auxiliary source will also increase to correspond with the increased losses. The current in the motor machine is equal to the sum of the current in the dynamo machine and the auxiliary current. The output of the dynamo machine is, of course, terminal volts × dynamo amperes, whilst the output of the motor machine is (terminal volts × motor amperes) – (losses in motor), and this is equal to terminal volts × (dynamo amperes + half auxiliary amperes), for half the auxiliary amperes multiplied by the terminal volts are equal to the losses in one main machine. The *average output* of the two main machines is, therefore:

$$\text{Terminal volts} \times \left(\text{dynamo amperes} + \frac{\text{auxiliary amperes}}{4}\right)$$

and the commercial efficiency of one main generator at this average output, W, is given by the expression:

$$\frac{W}{W + \left(\frac{\text{terminal volts} \times \text{auxiliary amperes}}{2}\right) + \left(\begin{array}{c}\text{average of the } C^2R \\ \text{losses in the two shunt} \\ \text{windings.}\end{array}\right)}$$

Care should be taken that the leads between the main machines are short and of heavy section, as any loss in them appears as additional armature $C^2R$ loss in the efficiency calculation.—Q.

*Answer to No.* 780 (*awarded 7s. 6d.*).—I take it that the machines in the question are direct-current, although the phrase "kilovolt-amperes" is generally used in connection with alternating-current machines. The Hopkinson test is used to find the losses and efficiency of one of two similar machines. They must be exactly alike, both electrically and mechanically. These two machines are connected together by means of a flexible coupling. One of these machines is going to be driven as a dynamo and is going to drive the second machine as a motor. Obviously, we shall need an auxiliary source of power to supply the losses.

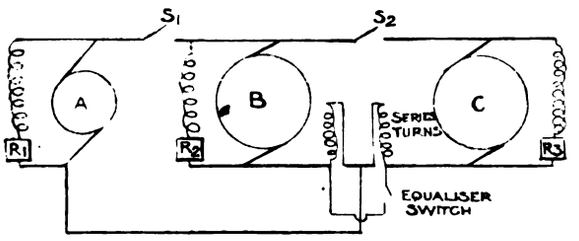


FIG. 1.

In Fig. 1 A is the auxiliary dynamo, which is, of course, one which will generate a pressure equal to the rated pressure of the generator to be tested. A is shunt-wound. I may state here that a battery could take the place of A if one is available. B and C are the two similar generators mechanically coupled together. I will suppose we are to test B. B will be run as a generator, and will motor C. As these generators, B and C, are compound wound, it is obvious that we must have an equalising connection, as is usual with compound-wound machines for well known reasons. This connection is made through an equalising switch shown in the diagram. Now, as the machines are compound-wound and self-excited, it follows that in C the series turns oppose the shunt, giving a differential winding, and, therefore, when we attempt to start the machine up, we shall probably reverse C. This can be got over either by separately exciting the shunt fields of C, and thus getting a strong shunt field to start with, or to reverse the series connections. I should advise the former method. It is often the practice to run each machine separately excited. $R_1$, $R_2$, and $R_3$ are rheostats in the shunt field, $S_1$ and $S_2$ are the main switches on each machine. The procedure of starting the machines is as follows: If the machines are to be separately excited, make

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the fields first. Put in the equaliser switch, then $S_2$. Weaken the field of B, which is going to act as generator. If the machines are self-excited, just put in the above switches, and put nearly all the resistance in $R_2$. Start up the auxiliary dynamo, A, having it connected in such a way that its voltage assists the voltage of B and C. Adjust R until the voltage of A is about 100, and close $S_1$. Now B and C will start up, and the speed and the current passing can be adjusted by means of the rheostats, $R_1$, $R_2$, and $R_3$. Both machines will then be running at full load both in volts and amperes and yet the power supplied from the auxiliary dynamo will only be equal to the total loss in both machines.

The following measurements must be taken: (*a*) the current, *c*, generated by the auxiliary dynamo; (*b*) the current, J, passing between B and C; and (*c*) the pressure, V, of the machines. Then, from the principle of conservation, the power lost is equal to that supplied, or the losses, L, for each machine are given by

$$L = \frac{c\,V}{2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The efficiency of each machine at a load J V is given by

$$n = \frac{J\,V}{J\,V + \frac{c\,V}{2}} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$= \frac{J}{J + \frac{c}{2}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

If the machines are separately excited, the power taken by the shunt will have to be measured. Let it be *w* watts each. Then equation (1) becomes

$$L = \frac{c\,V + w}{2},$$

and equation (2) $$n = \frac{J\,V + w}{J\,V + \frac{c\,V}{2} + w}.$$

—Ernest P. Hollis.

*Answer to No.* 780 (*awarded* 7*s.* 6*d.*).—There are two methods of arranging the Hopkinson test. The first one consists of supplying the losses in the two machines by inserting an auxiliary dynamo in series with them, and in the second method putting it in parallel with them. The

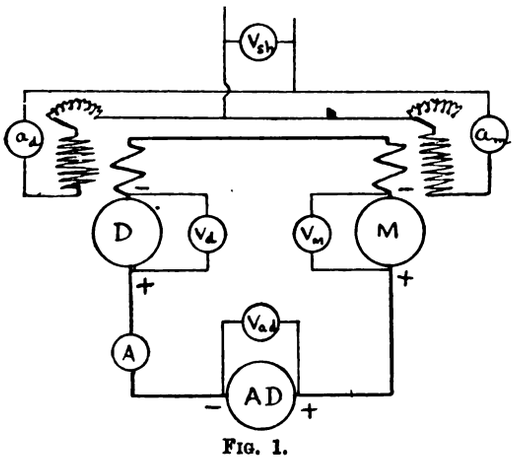


Fig. 1.

sketch (Fig. 1) shows the connections for the first case. It will be seen that the auxiliary dynamo has to carry the full-load current of the 900-kw. machines, so it will need to be a large-current low-voltage machine. In the second case (Fig. 2) the auxiliary dynamo will be of same voltage as two machines, but will only have to supply a small current. The choice between the two methods will be decided by what dynamo is available as an auxiliary machine.

Connect the two machines together mechanically if possible, as it is advisable to avoid belts. If they are designed for direct connection to engines, it will be an easy matter. If not, and their pulleys are made with spokes, the pulleys may be fastened together by means of clamps. Another way would be to take the pulleys off, and slip a steel sleeve over the two shafts, keying it on to each. The machine which is to act as motor must have its series coils connections reversed, so that the series coils will not be tending to counteract the effect of the shunt windings. The ammeters and voltmeters shown in diagrams will be needed, and a speed counter. It is usual to connect up the shunts of both machines to an external source of current having a steady voltage.

Assuming that the method shown in Fig. 1 has been adopted, we will now go into the question of starting up the machines and finding their efficiency. The machine M should be given a stronger field than machine D. The small machine, A D, is now started up with a resistance in series in order to prevent a rush of current. This resistance is gradually decreased until the two large machines have started up. In order to get the correct speed and full-load current, adjust small machine's pressure and increase the shunt current of machine M and decrease that of machine D more or less above or below the ordinary working shunt current. Take readings on the meters shown in sketch. The efficiency of the dynamo will be

$$E_D = \frac{A\,V_d\,100}{\left(V_d + \frac{V_{ad}}{2}\right)A + a_d\,V_{sh}}.$$

The efficiency of the motor will be

$$E_M = \frac{V_d + \left(\frac{V_{ad}}{2}\right)A\,100}{(V_d + V_{ad})\,A + a_m\,V_{sh}}$$

If the method shown in Fig. 2 is decided on, the main switch connecting the negative poles of the dynamo and

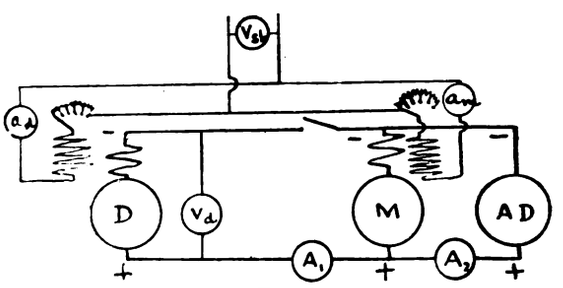


Fig. 2.

motor is left open and the motor started up from the auxiliary dynamo in the usual way. The dynamo being mechanically connected to the motor it starts generating, and when its voltage is equal to the voltage of the auxiliary dynamo the main switch is closed. The shunt currents of the dynamo and motor are now adjusted, as before described, so as to get the required current flowing through the armatures. The efficiency of the dynamo will be

$$E_D = \frac{A_1\,V_d\,100}{\left(A_1 + \frac{A_2}{2}\right)V_d + a_d\,V_{sh}}$$

and the motor efficiency

$$E_M = \frac{\left(A_1 + \frac{A_2}{2}\right)V_d\,100}{(A_1 + A_2)\,V_d + a_m\,V_{sh}}.$$

There is a good description of a Hopkinson test carried out at Crompton's works on two 800-kw. dynamos in the *Electrical Engineer*, vol. xxx., p. 150. There are also some particulars of this method of testing given in the *Electrical Engineer*, vol. xxviii, p. 888.—Research.

*Question No.* 781.—Describe with sketch the best vat to use for loading a 600-kilovolt-ampere 400-volt generator.

*Answer to No.* 781 (*awarded* 7*s.* 6*d.*).—Water loads for testing generators may be broadly divided into two classes—viz.: type A, those consisting of metallic plates dipping into water or a solution of salt, or sulphuric acid; type B, coils of resistance wire mounted on a frame or other suitable support, the coils being either air or water cooled. An example of each type is submitted; either of these is capable of dealing with the output from a 600-kw. generator.

*Type A.*—The containing vessel consists of a strong wrought-iron tank, strengthened with angle irons; size of

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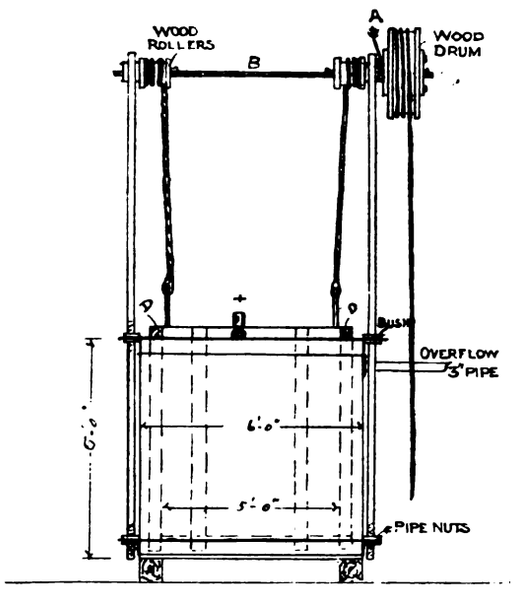
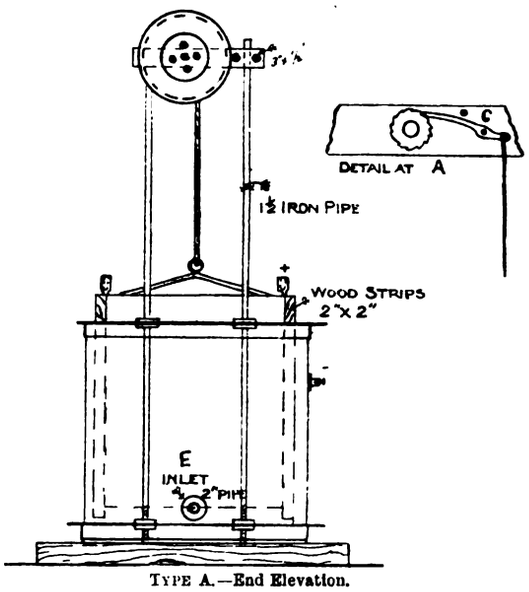
tank, 6ft. × 6ft. × 6ft. The inner and movable electrode also consists of a bottomless wrought-iron tank, 5ft × 5ft. × 5ft. 6in., capable of being raised or lowered by means of windlass, B, there being ratchet wheel at A to keep the tank at any given depth in the water. The ratchet is lifted out of gear when the inner electrode is required to be lowered by means of a cord, as shown in the detail of A. To the inner tank are screwed paraffined teak strips, 2in. × 2in.

To prevent the two electrodes coming into contact with one another, the supports for the windlass consist of wrought-iron gas-pipe 1½in. diameter, secured to bottom angle iron by means of pipe nuts. The bearing for windlass spindle is of iron plates, bolted to the top of the pipes. The amount of water flowing through the tank,




TYPE A.—Side Elevation.




TYPE A.—End Elevation.

and consequently the temperature, may be regulated by means of a tap on the inlet pipe, E. If it is desired to keep both poles of the generator insulated from earth, the tank must be supported on insulators, and the inlet and overflow pipes connected with the hydrant and drain respectively by means of rubber hose pipe, about 15ft. of 1in. pipe being suitable; if it is proposed to use other solution beside water, the outer tank would be better made of wood, and the movable electrode of lead if acid is used, as this is more durable under these circumstances. Iron plates are usually used for alkaline solutions, and lead plates for acid ones. In designing the above tank, the resistance of one square foot of hydrant water 1ft. thick was taken as equal to 100 ohms resistance; of course the resistance will fall as the temperature increases. The addition of foreign substances to the water enormously decreases the resistance, as the following tables show.

Solution of Salt and Water.

| Per cent. of salt. | Resistance in ohms per square foot 1ft. thick. |
|---|---|
| ·23 | 7·84 |
| ·46 | 4·65 |
| ·7 | 3·12 |
| ·93 | 2·38 |
| 1·16 | 1·9 |
| 1·39 | 1·48 |

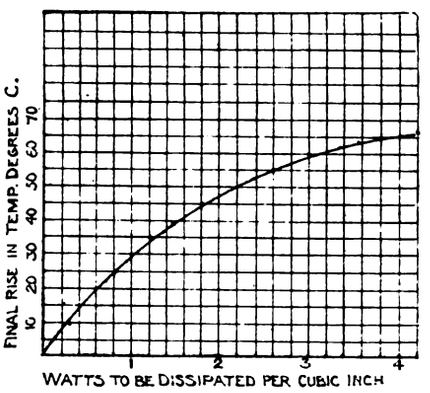
Solution of Sulphuric Acid and Water.

| Per cent. $H_2SO_4$. | Resistance in ohms per square foot 1ft. thick. |
|---|---|
| ·174 | 4·12 |
| ·43 | 1·75 |
| ·724 | 1·10 |
| ·985 | ·85 |

If a rise in temperature of T degrees F. are allowed, the water required to carry off the heat dissipated by one kilowatt-hour

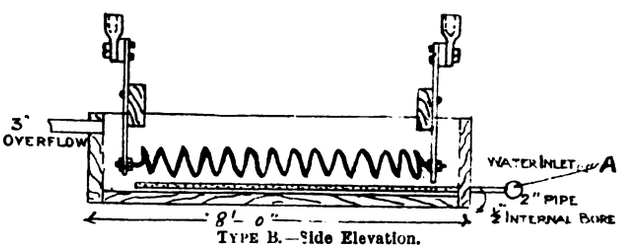
$$= \frac{34{\cdot}3}{T} \text{lb., or } \frac{34{\cdot}3}{T} \text{ gallons per hour.}$$

T = the allowable temperature of the liquid. When electrolytes other than water are used, continuous circulation of the solution is seldom possible, and curve No. 1 shows

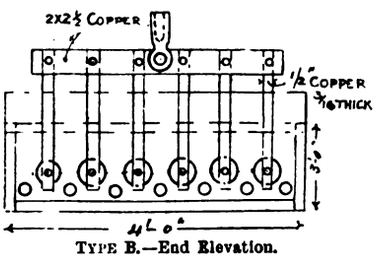



CURVE NO. 1.

the number of watts that may be dissipated per cubic inch of solution. A good margin should be allowed above the value shown for the curve, as several disturbing influences may slightly alter the results, such as (1) nature of tank, whether made of conducting or non-conducting material; (2) state of the atmosphere; (3) size of the tank, as a large tank will dissipate more watts per cubic inch than a small one; (4) back E.M.F. of cell, etc. A good average value is to take about 600 cubic inches of solution per horse-power dissipated. This will give good results for continuous running. For a stationary solution, of course, the tank will require to be larger than the above design.




TYPE B.—Side Elevation.




TYPE B.—End Elevation.

*Type B.*—This consists of coils of iron wire ·128in. diameter supported in a wooden box having a copious flow of cold water running through it. There are six spirals of wire, each spiral being about 65 yards long, the six being joined in parallel. The coils are joined to the terminal connection at each end of tank by means of copper strips ½in. × $\frac{3}{16}$in. The tank measures 8ft. × 4ft. × 3ft. To ensure an even distribution of the cooling water, the main delivery

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pipe, A, branches out into seven ½in. pipes, perforated on the upper side; this gives a more even effect than one large pipe. This tank will, with about 30 gallons of water passing through per minute, deal with a load of 1,500 amperes at 500 volts for long periods with practically no deterioration of the coils. The formula for quantity of water required is the same as that given for type A, but a good margin should be allowed, as the whole volume of the water does not come into contact with the heated surfaces.—A. V. A.

*Answer to No.* 781 (*awarded* 7*s.* 6*d.*).—I will first of all describe a liquid resistance used in a large central station for occasional tests of dynamos up to 800 kw. In Fig. 1 is shown a front view and side view of the apparatus. It

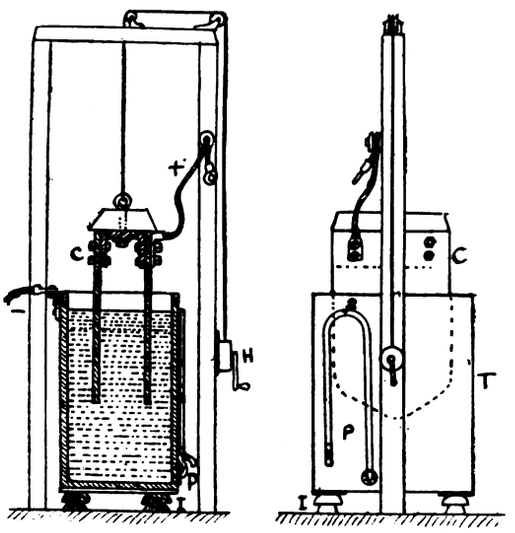



FIG. 1.

consists of an iron tank, T, supported on strong oil insulators, so as to insulate it from earth, as the tank is used as one pole. Two large cast-iron plates shaped as shown, C, form the other pole, and are suspended by means of a rope passing over pulleys at the top of the wooden supports. These iron plates are raised or lowered by means of a handle, H, fitted with ratchet, similar to the apparatus used for raising arc lamps. A flexible copper cable is fastened to the iron plates, as shown, and then fastened

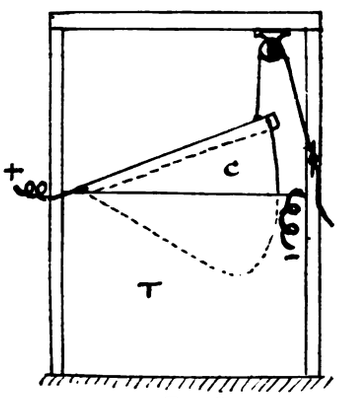
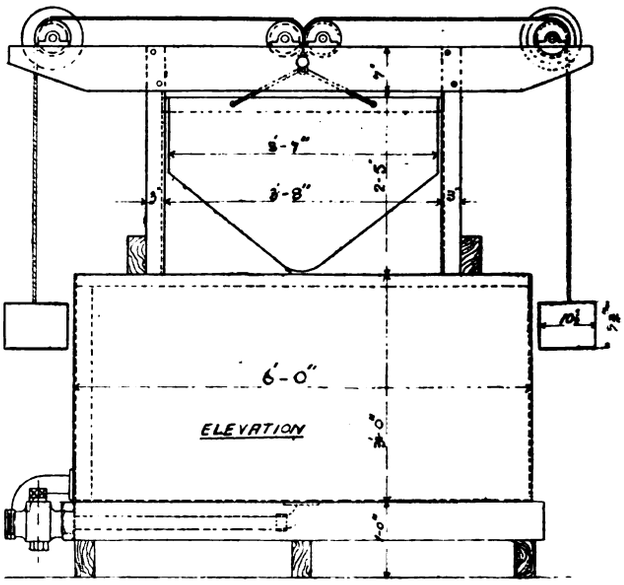
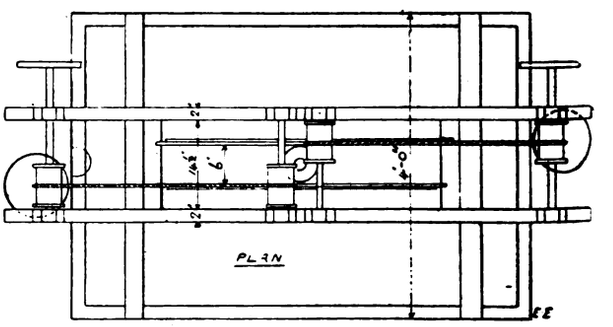



FIG. 2.

round an insulator. The end has a thimble sweated on to which the dynamo cable can be bolted. The other dynamo cable is connected direct to the tank. On a six-hour full-load test the liquid would gradually boil away. In order to keep liquid always at the same level and in constant circulation a pipe, P, is connected to the bottom of the tank, run up side of tank until proposed level of liquid is reached, then bent down again so as to form a siphon. If the tank contains more liquid than is required, the pipe, P, will siphon it off, and to prevent it acting after liquid has sunk to the proper level a small hole is drilled in the top of the pipe at S. This hole will stop the siphon action after a certain level is reached by allowing air into the pipe. As cold water is run in at the top and the water is siphoned off from the bottom of the tank, the contents can be kept cool. Canal water is used for filling the tank in question, it being found unnecessary to add any salt, as the water is impure enough without. If it is not desired to go to any great expense, the apparatus shown in Fig. 2 is very good for temporary use. The tank, T, is made of wood with a piece of sheet lead fastened to the two opposite sides and connected together to form the negative pole. Two pieces of lead or sheet iron, C, are fastened on either side of a piece of wood hinged at one end to one side of the wooden tank. These form the positive pole, and are raised or lowered by a rope passing over a pulley, as shown in sketch. The liquid soon gets very hot, and the current cannot be kept very steady during the test. I have, however, carried out a six-hour test of a 200-kw. machine successfully with it.—RESEARCH.

*Answer to No.* 781 (*awarded* 5*s.*).—A water resistance was constructed for use in testing a large number of 600-ampere 500-volt generators in the following manner. A galvanised sheet-iron tank, made of ¼in. plate, riveted together at the corners and well stayed, and mounted on a wooden stand, was used for the negative pole. The tank was provided with an overflow, a 2in. outlet pipe and cock at the bottom for emptying it, and ¾in. inlet pipe from the town's main. On the top of the tank was mounted a wooden structure, as shown in the sketch. Two sheet-




lead plates were used, each being ⅜in. thick, these being fitted with a wrought-iron bar at the top, each of which worked in a groove 1in. square cut in the uprights. The plates were counter-balanced by means of cast-iron weights, and wound up or down by the handwheels. The rope used was ⅝in. diameter hemp, well steeped in compound to preserve it from the steam. The positive main was taken to a stud on the wooden framework, and from there a number of smaller cables in parallel were used for joining it up to the plates. All the timber framework was well soaked in oil to preserve it from the wet. This arrangement was found perfectly satisfactory after exhaustive tests at a central power station in the Midlands.—C. G.

[Other replies to Question No. 781 will be given in our next issue.—ED. *E. E.*]

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JUNE 16, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

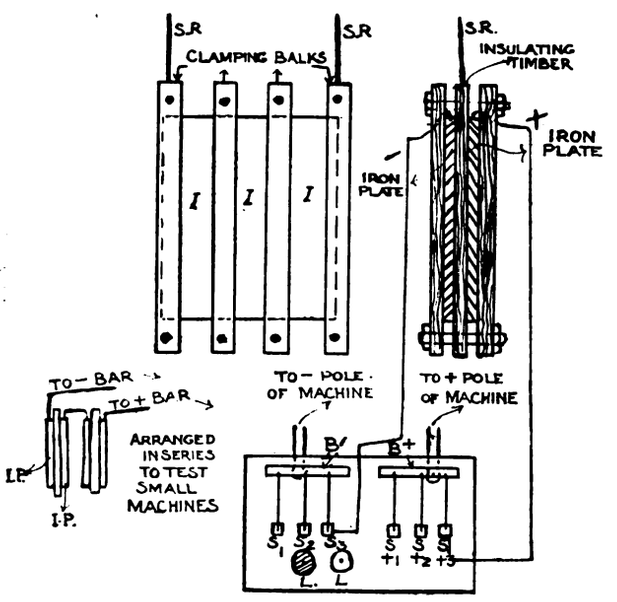
Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### ANSWERS.

*Question No.* 781.—Describe with sketch the best vat to use for loading a 600-kilovolt-ampere 400-volt generator.

*Answer to No.* 781 (*awarded* 5*s*).—The arrangement shown in the sketches is that in use at a fairly large power station for providing artificial loads for machines of from




250-1,500 kw. capacity. The sketch shows two wrought-iron plates (about 6ft. × 5ft.) insulated from one another by pieces of timber, and the whole held together by four baulks on each side, bolts running through the outside clamping baulk, through the insulating piece, and through the other clamping baulk. The whole arrangement is then suspended by the suspension ropes, S R, from the top of the settling tank for the circulating water supply to the condensers. It is usually worked with the plates completely immersed, as although the plates can be raised or lowered, it is found that, as the water from the river enters the settling tank at the bottom, when the plates are raised out of the water, the part exposed to the air becomes very hot, and consequently heats the surrounding water up, thus altering the load on the machine, the cold inflowing water, of course, staying at the bottom of the tank. Leads are taken from each plate, one to the bottom of, say, switch S+3, and the other to the bottom of switch S 3, these switches making contact with B+ and B−, to which bars the positive and negative leads of the machine under test are connected. Two, three, or as many of these plate arrangements can be suspended and immersed in the water as required, and in order to get sufficient load on they have only to be worked in parallel. The plates in use in this case are 6ft. × 5ft. × about $\frac{3}{32}$in., the insulating timbers being 2in. thick (the iron plates are, of course, shown out of proportion in the sketch for the sake of clearness), and this is found sufficient to deal with 1,300 amperes comfortably, thus easily finding load for a generator of 500-600 kw. at 550 volts, and for testing generators of 1,000 kw. and over two plates are worked in parallel on to the bars, B+ and B−, whilst for testing the 250-kw. generators two plates are worked in series as shown by the small side sketch. For the purpose of signalling from the switchboard to the attendant on the tanks, the two lamps, L L, are used, the hatched one being red; two similar lamps are also on the switchboard, and are connected into the same switches. When the load is getting too heavy the red lamp is lit up, and the attendant slightly raises the plates, the lamp being switched out when the load is right; similarly, the white lamp is used when more load is required. As mentioned before, these adjustments are comparatively slight, as, if the plates be raised too high (say above 3in.) out of the water, the load will not remain steady, due to the heating effect on the plates and the surrounding water. The chief object of the tank which is used for the purpose is, however, to provide water for the circulating pumps on the condensers, and, therefore, the entrance to the tank from the river is pretty low down. Were the tank designed solely for test purposes, arrangements would be made for the cold water to enter at the top; the circulation thus provided would neutralise most of the bad effect mentioned in this case.—W. T. W.

*Question No.* 782.—I want to connect a booster in circuit with one of the feeders in an alternating-current single-phase station, 2,000 volts earthed return. Should it be connected to the earthed or unearthed main, and why?

*Answer to No.* 782 (*awarded* 7*s.* 6*d.*).—It is usual practice to connect a feeder booster in series with the "inner" or unearthed conductor of a high-tension single-phase system, such as described by "G. E," and shown in Fig. 1. The

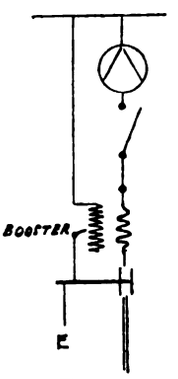



FIG. 1.

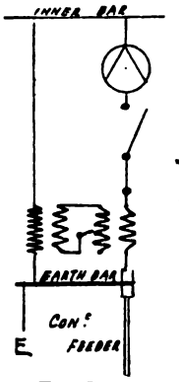



FIG. 2.

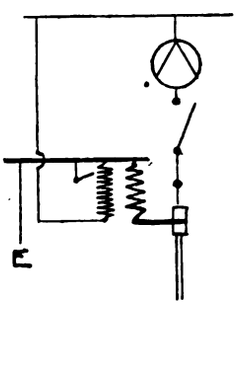



FIG. 3.

regulating switch is shown direct on the primary winding of booster, but sometimes, to avoid having regulating gear in direct connection with the high tension, the booster is arranged as shown in Fig. 2, so that regulation is effected on low-tension winding, thus rendering apparatus safer to handle.

There does not appear to be any theoretical reason why the booster should not be connected in circuit with the outer or "earthed" conductor, but it will be seen, on reference to Fig. 3, that if we connect it in this fashion there will be a difference of potential existing between the outer conductor and earth bar at the station, varying according to the amount of boost. Now it is correct to directly connect this conductor to earth at the station, and keep the difference of potential between this conductor and earth throughout the system at a safe figure to prevent any person receiving a dangerous shock from same.

Generally very little care is taken for the insulation of the outer fittings of dividing boxes, etc., even in some cases being left entirely bare, as they are only expected to be subjected to the difference of pressure existing between any part of outer system and station earth bar, and if one of these fittings should come in contact with earthed body, or outer of cable break down, the secondary of booster would be on dead short-circuit, its primary fuses would

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blow and a sudden drop in pressure result, according to amount of boost at time of breakdown.—H. T.

*Answer to No.* 782 (*awarded* 7*s.* 6*d.*).—The booster should be inserted in the unearthed main, for if placed in the earthed main (as shown in Fig. 1) there would be the probability of having a heavy local current set up between the two sides of the booster through the earth. Even if the earthed main is only earthed definitely at the station, there is always the likelihood of its getting connected to

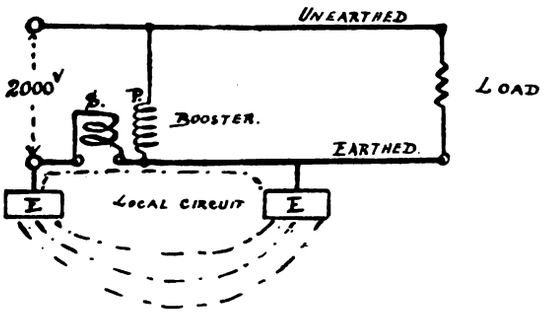


FIG. 1.

earth at some distant part of the line, and then the full booster volts (which in a 2,000-volt circuit may amount to several hundred volts) would be free to set up a current through the low-resistance circuit, consisting of the length of main between the two earthed points and the two earth connections. If the main is deliberately earthed all along its length, the connection across the booster secondary terminals, if inserted in the earthed main, would amount to a dead short-circuit.—Q.

*Answer to No.* 782 (*awarded* 7*s.* 6*d.*).—In nearly all the present-day systems of boosting on alternating-current supply systems, be they single-phase or polyphase systems, the general and principal idea, where ordinary static boosting transformers are installed and used, is to augment the pressure of supply by introducing the secondary of the transformer in series with the feeder, so that, to all intents and purposes, the secondary forms an integral portion of the feeder. This has the immediate effect of raising the potential of the feeder in question above the potential of the remaining feeder of the single-phase supply system, because there is induced in the secondary of the transformer a pressure which adds itself to that of the line.

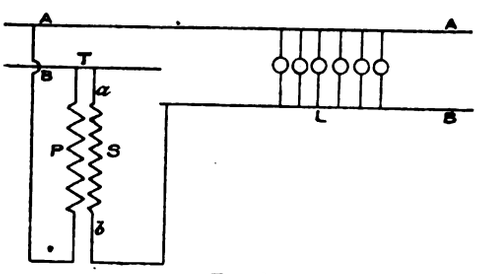


FIG 1.

In Fig. 1 will be seen a diagram representing the above system in a general manner, excluding details of the system. A and B are the two feeders referred to in the question; T is the static boosting transformer, with P as its primary and S as its secondary; L is a batch of lamps representative of the load. Suppose that the E.M.F. of supply before the transformer is reached is E volts—the virtual value is here referred to. Then there is impressed on the primary of the transformer a pressure of E volts. Let the ratio between the number of turns on the primary and those on the secondary be $\frac{1}{n}$; then the pressure induced in the secondary will be $\frac{1}{n}$ E volts, and this will augment the pressure of supply.

Firstly, let us suppose that the feeder A is earthed. It is clear this will have little or no effect upon the working of intermediary appliances in the system, such as the boosting transformer. The alteration in the conditions of working will not affect the primary of the transformer, because the earth will merely play the part of one terminal of such; and they will not affect the secondary, because this element has no immediate contact with the feeder A. Hence it—*i e.*, the booster—should be connected to the unearthed main, but this has not proved whether it is permissible or not to connect it to the earthed main.

Secondly, suppose that B (Fig. 1) is the earthed main. Then it is clear that the conditions of working are differentiated from those just considered. In the first place, however, it is evident that the working of the primary of the transformer will not be affected, but in connection with the secondary there is a different tale to tell. In this case, the terminals, *a* and *b*, of the secondary will practically be connected together through the medium of the earth, and the resistance of the intervening medium will be so slight as to produce a condition amounting almost to that of a transformer short-circuit. Now this would be objectionable for two prime reasons. First, there would be no augmentation of the pressure of the system, thus disposing of the use of the booster; and, second, the winding of the transformer might possibly be burnt out; or, if this did not occur, an abnormal amount of power would be absorbed by the transformer, producing waste, as well as a distorting and disturbing effect upon the working of the system as a whole. Hence we find that to connect the booster to the earthed main is to defeat the object in view.

The general conclusion, therefore, is that *the* policy is to connect the booster in circuit with the unearthed feeder—*i e.*, in circuit with B (Fig. 1) as the unearthed main.—G. W. BURLEY.

*Answer to No.* 782 (*awarded* 5*s*).—A brief consideration of the reasons for using the booster will help us to answer

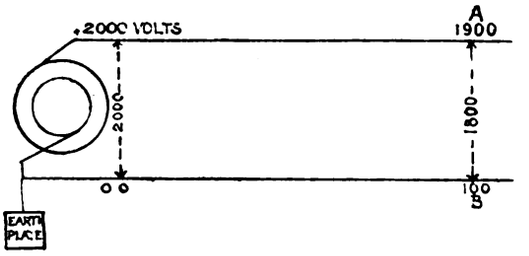


FIG. 1

this question. The feeder in which the booster is to be inserted is probably of considerable length and carrying a large current, with the result that there is a large voltage drop on the line and the pressure at the far end is considerably diminished. It has, therefore, been found necessary to raise the pressure at the far end of the feeder, as in all probability the feeder supplies a large number of arc lamps. This is accomplished by inserting a booster in the feeder.

I have assumed in Fig. 1 that there is a 100-volt drop in each cable for purposes of illustration. Therefore, we get a difference of pressure of 1,800 volts at the end of the feeder. Now let us suppose the booster is put on the unearthed main. It will, therefore, be seen that, as far as the actual working of the feeder itself is concerned, it is immaterial whether the booster is put on the earthed or unearthed main. There is, however, one consideration which decides the point. If the booster be put on the

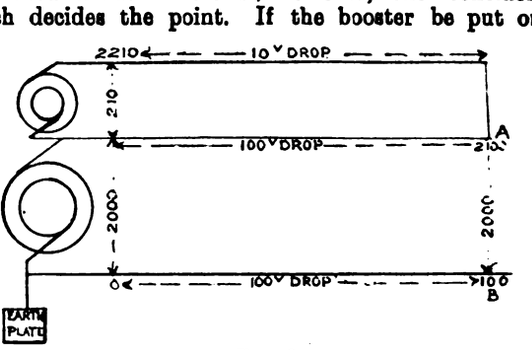


FIG. 2.

unearthed main, one terminal will be at a pressure of 2,210 volts and the other at 2,000 volts. The insulation unearthed side, and then the state of things will be as shown in Fig. 2. The booster gives an additional 200 volts pressure to the point A, making the pressure there 200 + 1,900 = 2,100 volts and the pressure between A and B

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$= 2{,}100 - 100 = 2{,}000$ volts. This is, of course, what we want. Now let us suppose the booster is put on the earthed main. I think, without drawing another diagram, that it is obvious that the booster pressure will subtract itself from the pressure at B, which, instead of being 100 volts above earth, will be $100 - 200 = -100$, or 100 volts below earth, giving a difference of pressure between A and B of $1{,}900 - (-100) = 2{,}000$ volts. This result is, of course, the same as if the boosters were on the will, therefore, have to withstand a stress of 2,210 volts. If, however, it is put on the earthed main, one terminal will be at 0 volts and the other at 200 volts, and the insulation will have to stand only 200 volts. Now, of course, a machine designed to stand 2,210 volts will cost considerably more than one to stand 200, and the risk of breakdown will be considerably greater. It is obvious, therefore, that the booster should be put on the earthed main, being so connected as to lower the pressure at the point on to which it feeds.—ERNEST P. HOLLIS.

*Answer to No.* 782 (*awarded* 5*s.*).—I should certainly recommend the booster being connected on the unearthed main; one very important reason for so doing is that in most, if not all, certainly all the high-tension stations the writer has been connected with the earthed main is never fused, so that one end of your booster would be at earth potential and the other end would be so much above it, according to what voltage your booster was giving. It, therefore, only remains for someone to earth your main on the side of the booster which is above earth potential and your transformer or booster will be on dead short-circuit.

Another important point to be observed is the safety of the jointers when working on the mains. If the whole of the system is to be connected to the booster, then there is not so much chance of a mistake being made, but if, as is most likely, a particular district only is to be connected to the booster, then it is essential that great care be taken to switch off the booster as well as drawing the high-pressure main fuse before allowing men to work on the mains, as one is liable to get accustomed to think the outer is dead earthed when on the particular section the outer may be considerably alive. The writer had an instance of this sort occur in which a man was told the main was dead when it was very much otherwise; the matter was discovered in time, however. As far as the working of the booster goes, the writer sees no reason why it should not work as well on the earth as the unearthed side, but for the above reasons I should certainly recommend the connecting of the booster on the unearthed mains, then the same precautions would be taken—*i.e.*, the removal of the high-tension switch or fuse. The booster being connected between the machine and fuse would ensure the safety of all concerned, and the same purpose would be served.—W. H.

*Question No.* 783.—Certain motors and generators are fitted with a continuous ring, connecting all pole-shoes together. What is the object of this ring, and what is its effect on the working of the machine?

*Best Answer to No.* 783 (*awarded* 10*s.*).—The object of these iron or steel rings is to introduce a length of highly-saturated material into the path of the commutating flux, and so reduce the variations of this flux between no load and full load. Since the ring forms a magnetic short-circuit between the poles, practically the whole of the ampere-turns on two poles are effective in saturating the few inches of iron between the poles. Thus a dynamo having 5,000 ampere-turns per pole and, say, 4in. between poles would have $\frac{10{,}000}{4\text{in.}} = 2{,}500$ ampere-turns available per 1in. of ring between poles, and this value would produce an excessively high saturation in the ring.

Besides the flux which passes direct across from pole to pole through the ring, a certain proportion of the flux which enters the ring at the poles passes into the armature at the region about the neutral line, and forms the commutating field of the machine just like the fringe of flux at the edge of ordinary pole-pieces does. By shifting the brushes forward (in the case of a dynamo) they can be set so that the commutated coil lies in a flux just sufficient to produce complete commutation. This commutating flux will pass along a path, as shown by the dotted line in Fig. 1, and will be looped with the whole field ampere-turns (10,000), and with the whole armature ampere-turns, say 8,000 in this case, opposing the field ampere-turns. These net ampere-turns, of $10{,}000 - 8{,}000 = 2{,}000$, have to pass the commutating flux through the magnet iron, through a certain small length of the saturated iron ring at $a\ a_1$, and through the air-gaps at $b\ b_1$. Supposing 500 ampere-turns are sufficient to pass the necessary commutating flux across the two air-gaps, and that no appreciable ampere-turns are required for the magnet iron (yoke and poles). Then $2{,}000 - 500 = 1{,}500$ ampere-turns are available for the iron ring, so that the lengths of ring between pole and brush positions at $a$ and at $a_1$ can together absorb 1,500 ampere-turns, and since the ring takes 2,500 ampere-turns per 1in., the length of ring at each side can be ·3in., for $\cdot 3 \times 2 \times 2{,}500 = 1{,}500$. Now, at no load, if the excitation is unaltered, there will be the full 10,000 ampere-turns available for producing the commutating flux through the ·6in. of ring and the two air-gaps. This will lead to an increase in saturation in the ·3in. of ring at $a$ and at $a_1$, and a fall in saturation in the remaining 3·7in. of ring, so as to maintain the total 10,000 ampere-turns on the 4in. of ring. Suppose the saturation of the ring is such that an increase of the commutating flux to double its full load value is sufficient to absorb the $10{,}000 - 1{,}000 = 9{,}000$ ampere-turns in place of 1,500 in the ring. In spite of the fact that the commutating flux forms only a small

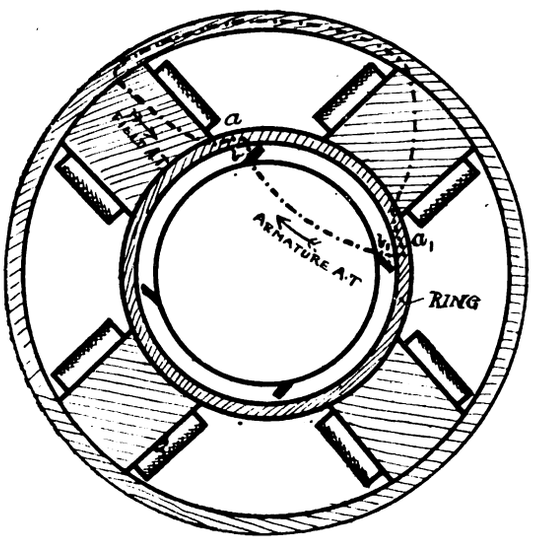


FIG. 1.

proportion of the total flux saturating the ring, it is quite possible for the doubling of this commutating flux to produce as large an increase in ampere-turns absorbed as this. In this case the commutating flux at no load would be to that at full load as 2 : 1. If no saturated iron were present, the commutating flux would be directly proportional to the ampere-turns available—*i e*, to 2,000 at full load and to 10,000 at no load—so that the ratio of commutating flux at no load to that at full load would in this case be as 5 : 1. The numerical values given are, of course, doubtful, but it is clear that the presence of saturated iron in the path of the commutating flux (especially if that saturation is to any considerable extent due to the commutating flux itself) tends materially to reduce the change of commutating flux between no load and full load due to armature reaction, and in this way helps towards a fixed brush position without sparking.

The same object is attained more or less satisfactorily in other designs by merely reducing the pole-tips to a very small cross-sectional area of iron, and so causing the ordinary working flux to saturate them. This avoids the additional magnetic leakage involved by the use of the rings, and at the same time makes the saturation of the pole-tip almost entirely dependent on the commutating flux, though this saturation does not reach so high a value as with the ring arrangement.—Q.

*Answer to No.* 783 (*awarded* 7*s.* 6*d.*).—The ring that connects the pole-shoes together is evidently what is known as pole bushing, and is to be found on machines made by the Allgemeine Elektrizitäts-Gesselschaft. It is of cast iron,

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of small section, its object being to produce a gradual falling off of the magnetic field toward the neutral point, also to keep a stiff field, where necessary, and prevent overcrowding at the pole corners (Fig. 1). The generation of eddy currents in pole-pieces is greatest at the corners, owing to the sudden change of field and the crowding of lines. It is obvious, to prevent this, we must so arrange arrange the poles that a gradual falling off of the field takes place toward the neutral spaces, allowing the current in the armature section to build up and die away gradually, when the latter is entering a field of different polarity. The pole bushing attains this object, but has the disadvantage that there is no interpolar air space, the pole embrace being practically 100 per cent., thus making the adjustment of the brushes for varying load rather difficult.

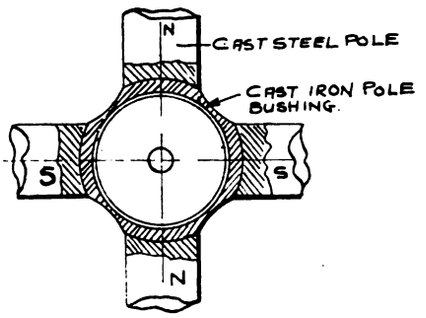


FIG. 1.

The crowding of the lines at the pole corners is produced by the reaction of the armature field upon the main field. When an armature is revolving in a magnetic field and carrying no current, the distribution of that field is uniform over the pole-face, as shown in Fig. 2, the dotted line representing the flux, but as soon as current is taken from the armature it resolves itself into a magnet, the flux of which (cross flux) acts across that produced by the main magnet, tending to displace it and twist it round in the direction of rotation (Fig. 3) in a dynamo. The flux distribution is no more uniform, but varies from a maximum value at the pole corners, A B, to a minimum at C D. It is obvious from this, that to bring the armature section in a proper reversing field for commutation, the neutral line, N N, will have to be shifted toward the direction of rotation in a dynamo and against it in a motor; thus the need for brush-shifting gear. In crane and tramway motors and all machines where fixed brushes are specified the amount of cross flux, due to armature ampere-turns, is kept very small, so as to interfere little with the original field.

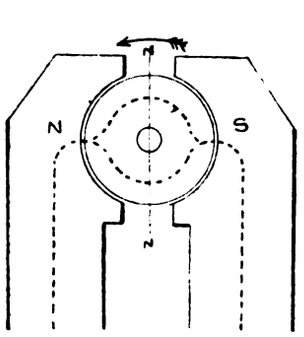


FIG. 2.

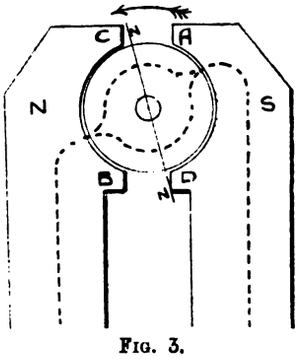


FIG. 3.

A good and much used method of keeping a stiff field and providing a good commutating fringe is to gradually increase the air-gap from the centre of the pole-face toward the tips, the armature then being eccentric with the bore. This has the advantage of confining the lines of force within the sphere of the pole-face, by proportionally increasing the reluctance toward the corners.—P. DEAN.

*Answer to No.* 783 (*awarded* 7*s.* 6*d.*).—The question does not state the material of which the ring is composed, but the object of fitting an iron ring to a dynamo or motor connecting all the pole-shoes together (as shown in Fig. 1) is to divert part of the magnetic flux from the armature. If it is required to saturate a field magnet by increasing the flux in it, without at the same time increasing the flux in the armature, it can be done by fitting one of these rings. For instance, we may suppose that we have a shunt-wound dynamo originally designed for 140 volts, and coupled direct to an engine. We now want the machine to supply a 100-volt circuit at the original speed and self-exciting. The voltage could be reduced to 100 by inserting resistance in circuit with the field winding, but probably

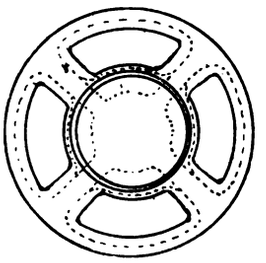

FIG. 1.

the machine would be unstable when working with such a weak field. If a small reduction in the speed or excitation took place, the voltage of the dynamo would drop away altogether. This can be explained by reference to Fig. 2, in which is shown Curve I, connecting volts and exciting ampere-turns at constant speed. When the machine was working at 140 volts its field magnet was fairly well saturated, but on reducing the excitation to get 100 volts the machine will be working on the straight part of the curve, where practically the only resistance

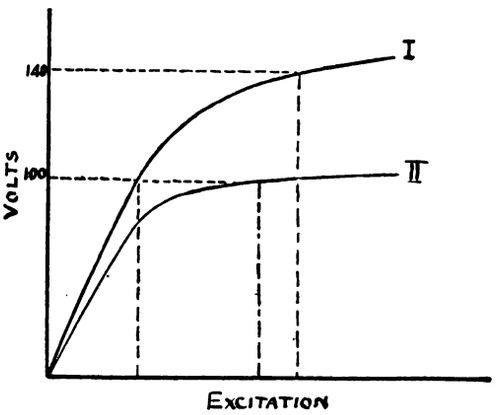


FIG. 2.

offered to the flux is the air-gap. Now, it is seen that when the machine is working on the steep part of the curve, a small alteration in the excitation produced by changing the speed or the regulating resistance in the shunt circuit will cause a rapid variation in the voltage. As a remedy, an iron ring can be fitted, and Curve II. will be the result. The exciting current for 100 volts will then be about the same as it was for 140 volts before fitting the

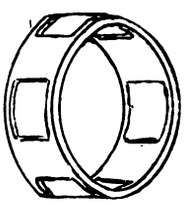

FIG. 3.

ring, and the machine will be perfectly stable. To get the full excitation with only 100 volts across the shunt, it may be necessary to connect the field coils in parallel. These rings have been tried as a preventive for sparking, but they have little or no effect in this direction. Some makers of motors and dynamos have adopted the arrangement for convenience of manufacture. All the pole-shoes are cast in one piece, with a thin bridge of metal holding them together, so that the whole can be readily machined and fitted in the magnet (see Fig. 3).—H. O. B.

[Other replies to Question No. 783 will be given in our next issue.—ED. *E. E.*]

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JUNE 23, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

### QUESTIONS.

791. Between the rails of a tramway system and the adjacent water-mains pressures up to ·25 of a volt are obtained when the generating plant is shut down. What do you consider is the cause of these potentials? There is an independent combined three-wire and alternating current supply in the town.—M. C.

792. In the Crompton automatic cut-out for automatically placing in circuit a substitutional resistance equivalent to the resistance of the arc, and which is used with 10-ampere, open-type, continuous-current street arc lamps, 10 in series on 460 volts, there are just two coils—one thick wire and one thin wire. The latter coil is in circuit the whole of the time, and apparently does all the work. Explain clearly the necessity for the use of the thick-wire coil, and also the functions which in this particular case it performs.—D. E. J.

### ANSWERS.

*Question No.* 783.—Certain motors and generators are fitted with a continuous ring, connecting all pole-shoes together. What is the object of this ring, and what is its effect on the working of the machine?

*Answer to No.* 783 (*awarded* 5*s*.).—This is one of the many devices which have been adopted to prevent sparking and at the same time keeping the cost of the machine low. The principal economy that can be effected in a dynamo is effected by having a large armature containing many ampere-turns and a weak field, but it is well known that such a machine will spark, for the armature interference will be great, causing the field to be distorted at high loads when a strong reversing field is required to overcome the large reactance voltage, and a very large lead of the brushes would be necessary in order to bring the short-circuited coil into a sufficiently strong reversing field. In order to make this more clear, let Fig. 1 represent a

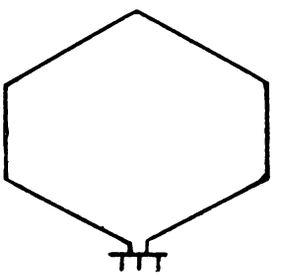

FIG. 1.

single armature turn connected to two adjacent commutator segments. Before coming in contact with the brush which short-circuits it, it has been carrying, say, 50 amperes in one direction and immediately after leaving the brush it is carrying the same current in the opposite direction. If this charge is to take place sparklessly, the coil must be traversing a magnetic flux of such strength and direction as to tend to reverse the current flowing in the coil, and the flux must be sufficiently strong to overcome the reactance voltage set up in the coil by the changing current, and the greater the load the greater the reactance voltage; therefore a stronger reversing field is required.

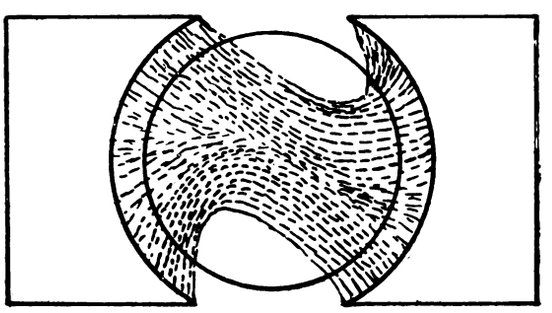

FIG. 2.

Now, it is well known that at high loads the field becomes distorted similar to Fig. 2, and it is necessary (in the case of a dynamo) to shift the brushes forward so as to bring the short-circuited coil into a sufficiently strong reversing field; but if this field distortion can be lessened in any way, the amount of lead required will obviously be reduced, and the machine will be less liable to spark with varying loads. This is not a difficult problem, although to do it well adds considerably to the cost of the machine, for the ampere-turns on the armature should be small as compared with those on the field, and the armature coils should have low reactance voltage; but in order to keep down the cost a number of inventions have been brought out for reducing sparking, and the ring of iron short-circuiting the poles described in the question is one of them. This ring forms a path of low reluctance for the magnetic lines, consequently they and the portion of the pole-pieces forming them are highly saturated. Hence the field is stiffened, and the armature cannot distort it to anything like the same extent, and from what has been said this will clearly help to minimise sparking.—E. AUSTIN.

*Answer to No.* 783 (*awarded* 5*s*).—The fitting of pole-rings is but one of the many devices that have been introduced for reducing the effect of armature reaction. The employment of these rings, or cast-iron bushes, is due to Dobrowolsky. Sometimes, instead of a complete ring, bridge pieces are fitted; these bridge pieces are fastened to the pole-horns in a somewhat similar manner to the well-known brass plates or grids that are to be seen on nearly every dynamo. The principal function of these rings is to prevent an abrupt change of magnetic line density at the trailing horns. They cause, so to say, a shading off in the density of the lines that are more or less crowded at the trailing horns. The more abrupt the change of density of the magnetic lines, the stronger the eddy currents in core and armature winding; therefore by gradually weakening, instead of suddenly changing the density of these lines, there is proportionately less danger to be feared from eddy currents. There have been many other methods suggested for obtaining this object, of which the following are the leading devices. Cast-iron shoes are fitted on the poles, the lower permeability of this metal in comparison with wrought iron preventing any abnormal crowding of magnetic lines at the polar horns; instead of the polar horns being parallel with the axis of the armature, they are sometimes cut off at an angle, or made V shaped. Another well-known method is to have the magnets bored to a larger diameter, by inserting packing pieces, so that when brought to their proper positions the air-gap gradually increases towards the horns. Some makers slot the pole, so that the trailing horn is but a comparatively thin slice, easily saturated. The use of these pole bushes is then a means whereby we may minimise the effect of eddy currents by preventing too great crowding of magnetic lines; the field falls off gradually instead of suddenly changing in strength. This advantage, however, is only obtained at the expense of limiting the amount of displacement that may be given to the brushes without sparking. In other words, the non-sparking angle through which the brushes may be moved is considerably reduced. When machines are fitted with these rings the brushes require careful adjustment. In practice, such machines are usually fitted with brushes of the "fixed position" variety.—M. M.

*Question No.* 784.—The system known as the free-wiring system has now been in vogue in certain towns for upwards of five years. How does it satisfy (1) the consumer; (2) the supply company; (3) the local contractor; and how are difficulties caused through tenants leaving and the new tenants refusing the use of the light adjusted?

*Best Answer to No.* 784 (*awarded* 10*s*.).—Before answering query No. 784 it is first necessary to consider by whom the so-called free wiring is carried out. So called, as it in reality amounts to an electric light system on the instalment plan. Free wiring may be generally divided into three classes, and the satisfactory result—apart from the demand for energy—to the supply company and the local contractors is entirely dependent on which class the system belongs to; the consumer is practically unaffected by those considerations: (Class 1) free wiring by a private firm, or more usually a local company having arrangements with the supply company; (Class 2) free wiring by the supply company solely as contractors; (Class 3) free wiring by the supply company, sublet to local contractors.

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*Case* 1.—The free-wiring firm having entered into an agreement with the supply company, carry out all free-wiring work, meet all expenses in connection with same, receiving in return a small sum per unit, say from a fraction of a penny to 1d. on current consumed by the party who occupies the premises so free wired. This, of course, extends only to a certain time proportionate to the size of the job, the probable current consumption, etc. The firm's money is thus simply invested in the premises, and in time is duly paid off plus a percentage varying, say, from 33⅓ to 40 per cent. This arrangement is usually satisfactory to both supply company and free-wiring firm, to the former because it speedily brings consumers, and to the latter as they, by waiting for payment, secure a larger percentage than in ordinary contracting work; they also have the further advantage of being the free-wiring firm, a fact which appeals to small shopkeepers, etc. The local contractors naturally oppose this system, as the free-wiring company, owing to their contract with the supply company, are able to secure the greater portion of the wiring work, the local men being, so to speak, cut out by the combine. The local men usually retaliate by making more or less exaggerated statements to prospective clients of theirs regarding the ultimate cost of free wiring, and argue the consumer pays for the cost within a year, but this is more a matter for the owner's consideration than the tenant. Placing the parties interested in the relative order of best results from the system: (1) the supply company; (2) the free-wiring company; (3) the consumer; (4) the local firms.

*Case* 2.—The foregoing remarks apply to this case also, but it is still more profitable to the supply company, any gain accruing going direct to them without a third party's intervention. The supply company are obliged to keep a staff of wiremen to carry out the wiring work. In the writer's opinion, this is very unfair to the local contractors, who are completely restricted to jobs they personally come in touch with. (Readers well understand this only refers to free-wiring work.) The supply company may allow a commission on work introduced to them, or allow the local man who so introduces a consumer to carry out the work for them, but when the station is a new one the tendency is for parties desiring an installation to apply direct to the station engineer, who is probably after circularising the town or city, and holding lectures and demonstrations to popularise electric light and power. It is not unusual in this case for the supply company to undertake lamp renewals. It is regrettable to say in some cases the lamps supplied are of a low efficiency, which fact need not be commented on. The writer has one case in mind where the direct consequence of the supply company carrying out all its own wiring work was the formation by local contractors of a rival free-wiring company!

*Case* 3.—This seems to be about the most satisfactory arrangement possible with free-wiring systems. Contractors in touch with intending consumers who desire free wiring price the job, and then send their estimate to the supply company. If the price is right, the supply company accept, and pay the contractor on completion. If the estimate submitted is too high, an effort at a compromise is made. In any case the contractor has his commission. The supply company sometimes go one better, and specify some particular wire and accessories which they keep in stock, and sell to the local contractors at a small percentage over list prices. In the event of a private party approaching the supply company for a free installation, tenders are invited from, or the work given to, some of the local firms. Naturally, owing to the middleman—as represented by the supply company—the contractor's profits are not as satisfactory as if dealing direct with the consumer, yet this arrangement is about the best that can be arrived at in such cases. Now the foregoing methods evidently affect the consumer but little. In every case he or his landlord pays a slight extra charge, either per unit or in some such manner. Instead of fixing this extra charge per unit, some supply companies have slot meters fixed on all free-wiring jobs, unless there are a large number of lamps. The slot meter gives about five hours' use of a 33-watt lamp for 1d., and so in time balances the original cost of the installation, which, of course, still remains the property of the company. The question of tenants leaving is a rather delicate matter to settle, still the company have some strong points in their favour: (1) the installation is their property, and can be removed by them; (2) probably, when installing same, they insisted on other illuminants, such as town gas, acetylene, etc., being altogether removed; (3) if the original tenant has been using the electric light for a reasonable time, the extra charge, meter rent, etc., has probably refunded a considerable amount, if not all, of the initial expenses; (4) they probably have the house-owner's signature to the agreement. Taking an extreme case. Tenant "A," for whom the wiring was carried out, leaves after, say, 12 months. Tenant "B" objects to the electric light. The house or shop is more than likely renovated and painted during the interval between A and B's occupancy. When the engineer, in the course of a tactful interview with "B," points out it will be necessary to lift floors, etc., to get the wiring out, also that the gas is disconnected as far as the street, etc., "B" generally comes round to looking at things the right way. If he still remains obstinate, and no agreement exists with the landlord, the fittings, etc., could be removed as far as possible, and the wiring left intact for future use. This is, however, a rare occurrence, new tenants generally accepting things as they find them. Further, it is the average that must be considered, not the individual. Concluding, the writer trusts other parties interested in this subject will put their views forward, and would like to mention that from a contractor's point of view he regards all free-wiring systems with disfavour.—J. E. H.

*Answer to No.* 784 (*awarded* 7*s.* 6*d.*).—"Free-wiring' schemes have now been in operation considerably longer than the period mentioned in your query, the first scheme being initiated some seven or eight years ago. The author is assuming, however, that your querist refers to a scheme carried out by some so-called "free-wiring" company, and not by the supply authorities themselves, as few municipalities, at any rate, have obtained the necessary powers.

Dealing with the first of the points under consideration—viz., the consumer—it can hardly be said that "free-wiring" schemes are satisfactory in the long run to this much oppressed individual. In return for the wiring of his premises, the consumer must enter into an agreement (about which he understands practically nothing, and which he probably never reads) whereby he undertakes to pay an extra charge, over and above the supply charges, of, say, 1d. or ½d. per unit, as a rental on the installation. This rental, of course, is dependent upon his consumption of electricity, but he must make a minimum payment per annum of from 9d. to 1s. per 8-c.p. lamp installed. The consumer has also the option of purchase of the installation at the expiration of four or five years, but until he does so he is never any nearer owning the installation, and should he at any time cease to use electricity he still remains liable for the minimum payment. Then, again, difficulties arise when any change of tenancy occurs. If the incoming tenant signs a new agreement, all well and good; if, however, he refuses, and decides to rewire the premises himself, the "free-wiring" company appear to have no option but to remove the wires and fittings from the installation at their own expense. It is claimed, however, by the company that a tenant is responsible for the minimum payment until the new consumer signs an agreement, or until the tenant purchases the installation. In this case, of course, the only course open is for the new tenant to remove the wires and fittings from his premises, and by so doing he immediately absolves the original tenant from any further claims. If, however, the consumer removes into new premises, and the premises that he has vacated remain empty for any length of time, or if the incoming tenant refuses to sign the "free-wiring" agreement, he is still held responsible for the minimum payment in connection with these premises. The "free wiring" company undertake to keep the installation in a proper state of repair for a period of six months from the date that it was put in; it follows that should a new tenant take over the installation at any time, he does not feel inclined to carry out any repairs to an installation that is not his own, and that he will afterwards have to pay a rental on.

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Regarding query No. 2—viz, the supply company—they are certainly benefited during the first year or two of the scheme, as by means of it they obtain a large number of customers who, in the ordinary course, could not afford the expense of wiring their premises outright, and would probably never become consumers of electricity. It is usual for the supply company to collect the rentals of these "free-wiring" installations with their quarterly accounts, and then to hand them over to the "free-wiring" company. By so doing, the supply company have to bear the burden of all the numerous disputes which from time to time arise, and which certainly do not tend to maintain a good feeling between the supply authority and the consumer. Should a consumer make extensions to his installation and decide to have these extensions carried out by a local contractor and paid for direct, complications are again liable to ensue. Two meters must now be put into the installation where one would suffice—one to register the consumption on the "free-wired" installation, and one for the consumption on the consumers' own wires and fittings. This naturally means extra expense for the supply company, and in a large undertaking entails considerably extra clerical work. If an extra price per unit is charged as a rental on the "free-wired" installation, the use of prepayment meters for these consumers is debarred, unless the supply company are prepared to go to the trouble of having certain of their meters calibrated for a higher rate per unit. Touching now upon the third point—viz., the local contractor—the adoption of a "free-wiring" scheme acts as a stimulus to him, and the competition that ensues, of course, benefits the supply company. The local contractor, as a rule, has a very poor opinion of those consumers who get their installations wired "without paying for them." The author is of opinion that some form of hire-purchase system should be adopted by the supply authority itself (either company or municipality), with carefully drawn and not too stringent regulations, as it is only by these means that small householders and shopkeepers can be induced to adopt electricity as an illuminant.—T. S.

*Answer to No.* 784 (*awarded 7s. 6d.*).—In towns where a gas supply exists, the gas-pipes are, as a rule, laid in a house during its erection, the expense being borne by the landlord, and forming part of the initial cost of the house. The interest on the extra outlay is, of course, included in the rent. The fact that, as a rule, a tenant desirous of having his house lighted by electricity must have it installed at his own expense, handicaps the electric supply companies in their competition with the gas interests. In order to overcome this difficulty and to increase the number of consumers, the supply companies in certain towns have adopted the free-wiring system in various forms, and with varying success, largely depending on the locality. An agreement must be signed by the landlord of the house giving his sanction to the wiring of his premises, and also by the tenant, who undertakes: (1) to keep the installation in repair, except in cases arising, within a reasonable period, from faulty material or workmanship; (2) to pay a minimum quarterly charge for energy. The installation remains the property of the company, unless, as sometimes happens, a consumer afterwards buys it over.

There are two alternative schemes adopted by certain companies for free-wiring. By the first, a consumer has his house wired throughout, free of cost, on agreeing to pay an extra charge—about 1d. per unit—on energy consumed, as interest on the outlay. By the second scheme, a certain number of lights are installed free in parts of the house to be selected by the company, the lights being placed, of course, where they will be most used. In the first case, the extra charge per unit covers the interest on capital spent and depreciation; in the second, the company gains nothing beyond an additional consumer and a maximum of demand to repay the cost of installation. Besides this, there is often difficulty in persuading a second tenant to take over his predecessor's agreement and to use the lights, and his refusal involves considerable trouble and loss to the company, who either have to let their installation lie idle or remove it at fresh expense. There are also people so constituted as to prefer not paying their lighting bills on leaving a district, and, having nothing to lose in the way of fittings, they have no hesitation in leaving behind them, with an unpaid bill, an installation which cost them nothing. From the consumer's point of view, the free wiring system cannot be otherwise than satisfactory. He has no initial outlay, no trouble nor responsibility in fixing his lights nor in removing his installation when he leaves the house. He is apt, however, to overlook the fact that the extra charge per unit, where it is added, is interest on the capital expended by the company on his installation, and includes it in his lighting charges, which then appear extravagant. It is often difficult to convince him that he is not being overcharged. In comparing his lighting account with his neighbour's gas bill, he is apt to forget that, while his neighbour pays indirectly for his gas-pipes, etc, *to his landlord*, who included the interest on that outlay *in the rent*, the cost of his own electric lighting installation is *not* included in the rent, but in his lighting account, in the shape of the extra charge per unit. In the case of a consumer who has a certain number of lights placed free of cost in approved positions, he often grumbles because he may not choose their positions, etc.

Of course, the adjustment of these difficulties, as of any others, depends largely upon the tact and management of the company's representatives. The success or failure of the system will be affected by local conditions. In a district with a "floating" population, where houses frequently change hands, it is not in the company's interest to advocate free wiring. The risk is too great, and the troubles with new tenants too numerous. In districts where most of the inhabitants own their dwellings, the case is different; for once the installation is made, the expense and trouble, so far as the company is concerned, are usually at an end, the interest on the outlay being included in the quarterly lighting account. The local contractor is often invited to quote special rates for the whole of the company's free-wiring work, and as the system attracts consumers who otherwise would not call in his services, he cannot but be satisfied. There can be no set rule for the adjustment of free-wiring difficulties, so much depending upon the local conditions, the tact and patience of the company's representatives, and the commonsense and fairness of the consumers. In towns where the system has been tried it is a mere matter of speculation, working out to the company's advantage in one case and proving, perhaps, a dead loss in another.—H. J. W.

*Answer to No.* 784 (*awarded 5s.*).—The system known as free wiring has, in most towns where it has been adopted, proved satisfactory on the whole. In order to obtain some idea of how free wiring affects the various parties concerned, it is necessary to consider the different methods by which it is applied. These may be summarised as under, the cost of the installation being recovered from the consumer in one of the following ways: (1) by a fixed rental being charged for his installation; (2) by a small additional price per unit for energy consumed; or (3) by the payment of instalments at fixed intervals, sufficient to wipe off the capital cost and interest after a certain number of years. In addition to the above methods, which have generally been adopted, there are one or two free-wiring companies in existence which undertake the wiring of premises on the repayment system, either direct with the consumer or through the supply authority. This method has, however, proved unsatisfactory to the local contractor owing to the unfair competition it creates, and is also troublesome to the supply authority, but has, so far as the author is aware, only been carried out to a small extent.

In any of the three chief methods enumerated, the installations may be carried out by the supply authority itself or through wiring contractors, but the latter is advisable so as not to create unfair competition and dissatisfaction amongst the wiring contractors, who really act as canvassers for the supply authority. The author knows of one city, though not in Great Britain, where the supply authority itself carries out the whole of the installation work for lighting, power, and any other supply, there being no outside wiring contractor. The introduction of free wiring (No. 3 method being adopted) has been very satisfactory, and has resulted in a large increase of custom, most consumers adopting the deferred payment system in preference to payment on completion.

In comparing the three methods quoted, No. 3 would

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appear to be the most satisfactory. Nos. 1 and 2 have the disadvantage that the installation always remains the property of the supply authority, whereas in No. 3 the installation belongs to the consumer after a certain number of years (usually not exceeding 10). All three methods are about equally satisfactory to the consumer and local contractor, as, providing the carrying out of the installations is left in the hands of the local contractors, all the methods benefit them, and it matters little to the consumer whether he pays rental, a little more per unit, or purchases by instalments.

There seems to be no doubt that wherever any of these systems have been adopted satisfaction has been attained all round. By their means electric light has been brought within the reach of many consumers who could not otherwise have afforded the necessary initial expenditure, and so-called free wiring has thus resulted in access of business to wiring contractors, and an increased load to the supply authority, making it possible to generate at a reduced cost per unit, and so cater for more custom. The consumers thus obtained are very often long-hour ones, although small, and are thus, perhaps, more profitable than many of the larger consumers.

As regards tenants leaving, little trouble is experienced, as the owner is generally a party to the agreement, and the new tenant, more than likely, will be only too pleased to avail himself of the electric light without a heavy initial expenditure. Should, however, any difficulty be experienced, the supply authority can take away all the fixtures, having previously charged the former tenant for any damage done during his tenancy. The cost of removing the fixtures is very small, and as probably a good proportion of the capital has been already repaid, the loss, if any, to the supply authority is practically nil.—H. A. N.

*Answer to No.* 784 (*awarded* 5*s.*).—Before answering the question in detail, I will give a short description of the system with which I am acquainted. The company undertake the wiring of premises, without initial cost to the consumer, under a rental system. In the two or more living-rooms plain three-light spider fittings are placed, and pendants in all the other rooms. A small Nernst lamp is, however, placed in one of the living-rooms, if required, fitted with a counterweight to work up and down, instead of the three-light fitting. Application forms must be filled in and signed by both the tenant and the landlord. The rental is 3d. to 4½d. per lamp per quarter, according to the easy or awkward position of the lights. Lights will be fixed in such rooms and passages as are in regular use and are likely, in the opinion of the engineer, to be of permanent utility. Consumers will be allowed the option of purchasing the installation either by a lump sum or by increased rental for a term of years. The installation must not be interfered with by anyone except the employés of the company. A rental is charged for all meters, unless of the prepayment type. Originally this system was worked on a different scale, the consumer paying no fixed rental, but was charged 1d. more per unit than the ordinary consumer. This was abandoned about a year ago, and the above system of rental established.

With regard to the consumer, it must be borne in mind that those who use this system of wiring are mainly of the working class or small tradespeople. They, therefore, are able to obtain a good, clean, safe, and convenient light without any initial outlay. The supply company, although not making an immediate profit, are, however, receiving interest on the outlay involved in installing the system, and are also getting an increased consumption of current, as these consumers would not make use of the supply if they had to pay for the wiring before they could use the light. The company are, therefore, or ought to be, satisfied. The local contractors, although at first a little nettled at seeing the company's wiremen doing so much work, have now seen that they have no cause to grumble. As I have stated before, the majority of the consumers on this system would not be able to spend a lump sum of money in installing the light, and so the local contractor is not losing customers through the company having power to wire houses on this system. In some places, however, I understand that the supply company put the work out to the local contractors at fixed prices. When a new tenant goes into a house wired on this system, and does not require the use of the light, all the fittings and pendants and the meter are taken down, and permission is generally granted to leave the ceiling roses, switches, and fuse boxes, as the landlord has signed the application form of the outgoing tenant, and so fully understands his position in case of that tenant giving notice. Although very rare, it has sometimes occurred that the whole of the wiring has to be taken out, owing to the new tenant desiring to use gas, and this, of course, means a severe loss unless the outgoing tenant has been in the house for several years.

On the whole, I may say that the consumers give very little trouble, and the system is working very satisfactorily. In conclusion, I must state that the present number of consumers on this system is about 1,500 out of a total number of about 4,000.—J. LLOYD.

*Question No.* 785.—It is noticed that dust collects much more on the positive than on the negative 'bus bars in a central station, also that it collects on the glass panes opposite the bars, and that more collects opposite the positive bar than the negative. How is this explained?

*Answer to No.* 785 (*awarded* 5*s.*).—In considering this question a few remarks may be made as regards so-called "positive" and "negative" electrification. Generally speaking, the rate of loss of charge from a charged conductor is proportional to the difference of potential between itself and its surroundings, but has been found to be much greater from "negatively" electrified surfaces than from "positively" electrified ones. This and many other phenomena appear to indicate that the so-called "negative" electrification is really the state of excess—*i e*, that in which there is *more* electricity than in the surrounding space—while the so-called "positive" electrification is a state of defect, or a state in which there is *less* electricity than in the surrounding space. For example, Crookes's experiments with vacuum tubes show that molecules are driven from the negative electrode towards the positive, the vanes of a little fan being repelled from the negative pole. Now, the negative main of a two-wire supply system, even if unearthed, tends to assume a potential near that of earth, which is evident to anyone from the fact that a shock is generally obtained from the positive to earth. Therefore, if "negative" is really the state of excess, there would tend to be a transfer of electricity from earth, and from the negative 'bus bar through the air to the positive bar. Further, it is a well-known scientific fact that in fine dry weather or in dry situations, when dust tends most to float in the air, the earth is "negatively" electrified relative to the air. Particles of dust, therefore, coming from the earth or objects in contact with it would be negatively electrified, and as the negative main and earth are at or near the same potential, these particles would, by virtue of their charge, be attracted to the positive 'bus bar. It is also possible that particles of dust, uncharged, floating near the negative bar, might be negatively electrified, repelled, and afterwards reach the positive. *This* action might also go on in the reverse direction, from positive to negative; but as the rate of loss—as already stated—is greater from the negative, the net result would be to transfer electricity—carried by dust particles—from negative to positive.

The question does not state whether the glass panes opposite the bars are those of windows, meter cases, or otherwise; but it is conceivable that the glass, which in itself is a good insulator, either is itself or has the dirt on its surface *locally* electrified by induction from the 'bus bars, and the free charge, repelled from the 'bus bars and of like sign to those of the 'bus bars, would have the same effect on dust particles as have the 'bus bars themselves, as explained above. As glass is "positively" electrified relative to cotton, silk, and most other substances on being rubbed by them, a more practical explanation is that the cleaning of the glass causes it to be "positively" electrified, and this, taken in conjunction with the charges induced locally by the 'bus bars, would cause an excess of "positive" charge opposite the "positive" 'bus bar over that opposite the "negative" 'bus bar; thus the glass locally will act on dust in the same way as the 'bus bars themselves.—R.

[Other replies to Question No. 785 will be given in our next issue.—ED. *E. E.*]

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JUNE 30, 1905.

## QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

### QUESTIONS

793. A battery working in conjunction with a reversible booster on a traction load has recently been overhauled and all sediment removed from bottoms of cells. Since then it has been noticed that large lead trees have been forming on a lot of the negative plates, causing a lot of trouble by short-circuiting cells. Would the fact of using acid out of an old battery, that has been idle for months, to top up the cells after overhaul cause the trouble, and could some reader give a remedy for same; also explain the cause of trees forming?—A. B. C.

### ANSWERS.

*Question No.* 785.—It is noticed that dust collects much more on the positive than on the negative 'bus bars in a central station, also that it collects on the glass panes opposite the bars, and that more collects opposite the positive bar than the negative. How is this explained?

*Answer to No.* 785 (*awarded* 7*s.* 6*d.*).—I have noticed for some considerable time that dust seems to collect on switchboards on or near to the 'bus bars and their connections. Some time ago, A. A. Campbell Swinton drew attention to the fact that some flexible wires in his office were clean while others always seemed to get covered with dust. On investigating the matter, he found that in the case of the dusty cords the switch controlling those lights was on the negative side, and thus the cords were always at the pressure of the positive main whether the lights were on or not. The clean cords had the switch fixed on the positive side, as shown in Fig. 1. One may argue that if the negative main is not earthed, why should it not attract dust. The phenomenon is due to the fact that the negative main

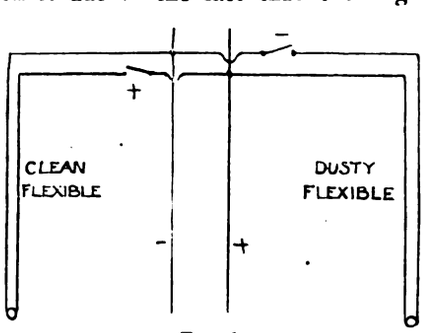



FIG. 1.

always tends to earth itself. A test on the Westminster Company's system showed the negative to be 30 volts below earth potential and the positive to be 170 volts above earth, so naturally a positively charged conductor would have a much greater attraction for dust than a negative one. To test the attractive effect of the positive 'bus bar in a station, take a glass plate thickly covered with dust, hold it immediately below the 'bus bar, and tap it smartly. The particles of dust will be seen to fly up and stick to the 'bus bar. The effect is very noticeable in a 500-volt traction station.

Now, to consider the fact of the dust collecting on glass or slate surfaces close to live conductors. On withdrawing a slate from the side of a positive switch in a Ferranti cell type traction switchboard, the dust will be noticed to have collected as shown in Fig. 2, the outline of the switch being shown dotted. At those points where the portions of the switch approach closest to the slate, the dust will be found the thickest. Considering Fig. 3, A being switch and B being piece of slate or glass. When the switch is not closed, both the switch and slate will be of neutral potential. On closing the switch it will be charged positively, and any dust floating about will be attracted to and adhere to the metal parts of the switch. Not only so, but there will be

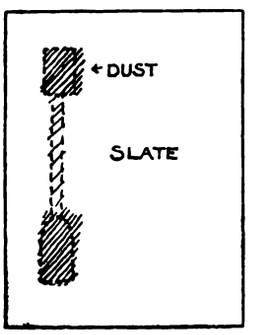



FIG. 2.

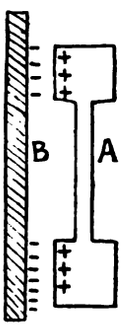
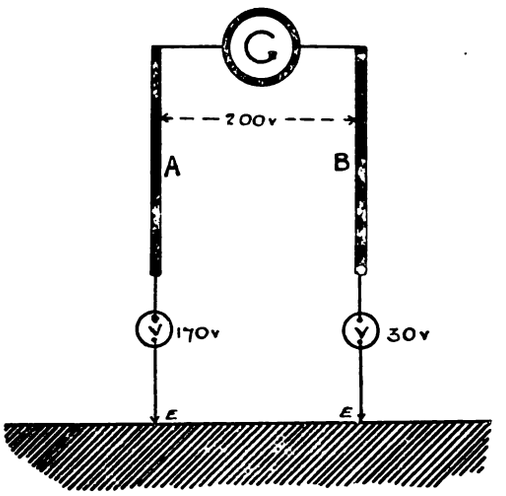



FIG. 3.

an induced charge of negative electricity on the surface of the slate closest to the switch. These portions of the slate that are charged will also attract the dust floating about, and a coating of dust will be formed as shown in Fig. 2. I have noticed a long string of dust particles attached to the switch stretching out horizontally to the slate. On removing the slate the particles fell down by the side of the switch, but on reinserting the slate panel they again assumed an horizontal position, showing that they were attracted by the negative charge on the slate.—W. A. T.

*Answer to No.* 785 (*awarded* 7*s.* 6*d.*).—The phenomenon which has been observed by "H. G. H." is by no means an uncommon one, yet it is a peculiar one, inasmuch that it has not been observed in connection with alternating-current supply systems, but only with those systems supplying continuous-current energy. The ultimate effects are really due to an electrostatic action, which, however, is brought into existence by peculiar conditions invariably present on




*all* continuous-current systems. The electrostatic action is one of attraction.

In the accompanying figure, suppose that A and B represent the positive and negative 'bus bars respectively of a central-station switchboard working on the ordinary two-wire system, also suppose that the voltage of supply is, for the purpose of providing a concrete example, 200 volts. Then the difference of potential between A and B will be 200 volts. If, however, an electrostatic voltmeter, say of the multicellular or similar type, is connected between the positive bar and the earth, as shown in the figure, it will be found that there is an indication of a difference of potential between that bar and the earth of approximately

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170 volts. Whilst, on the other hand, if the negative bar is served in precisely the same manner, then the voltmeter will indicate only 30 volts approximately. This shows that the potential of the negative bar is (170 – 30), or 140 volts nearer the potential of the earth than the potential of the positive bar is.

Now, the real action is this: The particles of dust, containing probably minute pieces of metal, mineral, etc., are at the potential of the earth because they are in contact therewith. The potential of the positive bar is 170 volts higher than this potential, and the consequence is that an electrostatic action in the form of attraction is set up between the bar and the particles of dust. The amount of attraction is proportional to the square of 170—namely, 28,900. Hence, an amount of dust proportional to this number collects on the positive bar. Attraction, of course, is set up between the negative bar and the particles of dust, but in this case the phenomenon is not so pronounced as in the previous case, because the amount of dust which collects on the negative bar is proportional to the square of 30, or 900. It is clear, from the foregoing, that there is practically 300 times as much dust attracted to the positive bar as there is to the negative, consequently, whilst a little may settle on the latter, it is almost imperceptible, and, certainly, it is incomparable with that which settles on the positive bar.

The phenomenon of dust collecting on the glass panes is really an extension of the above. The glass, being in the vicinity of the bars, is electrified by electrostatic induction, its potential, however, being opposite in sign to that of the bar electrifying it. The ultimate result is then precisely the same as with the bars, so far as external observation can detect. Because, since the pane opposite the positive bar will be more highly electrified than the pane opposite the negative bar, the former pane will attract the particles of dust more strongly than the latter.—G. W. BURLEY.

*Answer to No.* 785 (*awarded* 5*s.*).—The collection of dust on the positive 'bus bar is due to the electrostatic action of the 'bus bar on the particles of dust floating near. Each dust particle may be considered as an insulated conductor floating in the electric field set up by the positive 'bus bar. The dust then by cutting the lines of force acquires equal and opposite electrification at different parts of its surface, that part becoming positive which is presented to the negative boundary of the lines of force and *vice versâ*. Having been electrified by induction, the dust then obeys the well-known law of static electricity—namely, "that electrified bodies of like polarity repel each other, and those of unlike polarity attract each other. Thus, as each particle of dust comes within the active sphere of the positive bar it is electrified by induction, and its negative pole is attracted towards the positive 'bus bar, hence the abnormal collection of dust. The collection of dust on the window opposite the positive bar is due to the same inductive action. The particles of glass are electrified with their negative poles facing the positive bar, and so the positive poles of the dust are attracted towards the glass. The negative 'bus bar being at the same potential as the air around it has no inductive action on the dust or the glass opposite it, hence there is only a normal amount of dust on either.—B.

*Question No.* 786.—At a hydro-electric installation some surplus power is available. State the best method of obtaining a record of the same with a view to installing another turbine 12 months hence. Fall, 11ft., subject to frequent floods.

*Best Answer to No.* 786 (*awarded* 10*s.*).—In dealing with problems concerning water power, it is necessary to have full particulars of conditions before any definite opinion can be formed as to what might or should be done. Unfortunately, "A. R." does not give that, but only informs us that he has a head of 11ft., and has frequent floods. With a low fall it is quite common in England for flood rivers to reduce the available head considerably, owing to the tail water rising more than the head water. If there is a sharp bend or a narrow channel further down stream near the turbine-house, it is quite common for the tail water to rise several feet, while at the same time the water in the head race has only risen as many inches, so that "A. R." will need to ascertain to what extent this is likely to affect him, as the power available is not in proportion to the increased discharge of water. With only 11ft. head, each horse-power will need about 70 cubic feet of water per minute. We are not told to what extent his power is already developed, but it is clear, if he is using a fair amount of power, that the quantity of water to measure is beyond the capacity of the usual notched board method, and methods suitable for measuring much larger quantities must be used. If the head weir is in good repair, fairly wide, and level, it would be very useful for measuring the water, providing the whole of the water can be passed over it. To do this, drive a stake into the river near the bank, about 7ft. or 8ft. upstream from the weir, so that the top of the stake is level with the top of the weir. Now stop all water from going through the turbines by closing the hatches, and after the water has finished rising, measure the depth of water above the top of the stake, and, having previously measured the width of the weir, use the weir formula,

$$Q = 200\, l\, \sqrt{h^3},$$

Q being the quantity of water in cubic feet per minute, $l$ the length of the weir in feet, and $h$ the depth of water in feet or portion of a foot. If he measures the quantity of water in this way, say, once a week, or whenever he sees any appreciable change in the height of the river-level, he will get a record of quantities quite accurate enough, but when measuring the quantity he should the same day measure the difference in the levels of the head and tail waters, commonly called the head or fall. Having the quantity and head, he can calculate its power by

$$P = \cdot 001892\ Q\ H,$$

P being the theoretical horse-power, Q the cubic feet of water, and H the head in feet. The actual horse-power available for driving, after allowing for power lost on the bevel gears and belting, would range from 63 per cent. (for the cheaper types) to 70 per cent. (for the best English or Swiss makes) of the theoretical power.

If the head weir does not pass all the water, or is in bad repair, or through other causes not suitable for using for measurements, it is quite possible that somewhere in the neighbourhood of his installation "A. R." can find a length of the stream where the section is approximately constant for from 50ft. to 150ft. in length; then find the section by multiplying the width by the average depth; by taking several sections in the chosen length and determining the average section a nearer approach to accuracy is obtainable. Drive two stakes in this portion of the river a given distance from one another. Then almost fill an empty bottle that has a long neck with water so that only an inch or two of neck projects above water when put in the river. Throw this float in the river a little above the first stake and note the time (in seconds) which it takes to pass from one stake to the other; repeat several times, and take the average time. The quantity of water, Q, will then easily be found by multiplying the area of the stream by the measured length between stakes (both measurements in feet) and also by 60 and dividing the product by the time in seconds. From this result deduct 15 to 20 per cent. for side and bottom friction. This method gives a lot more trouble, as any difference in the discharge of the river alters the width and depth, and getting the average section for each difference in levels gives a lot of work.

Now, having obtained the data as to horse-power available and deducting horse-power in use he will arrive at horse-power now running to waste. This running to waste is possibly taking two courses. First, over the weir and down the by-pass. Second, if "A. R." was not careful in selecting his existing turbines, it is quite possible there is quite an appreciable loss of water there owing to their inefficiency. It then turns to the problem as to whether in the end (if his present turbine is wasteful), if it would be cheapest to instal another small turbine, or to take out his present machine and instal a more powerful one of a better type. If "A. R." has had but limited experience in this matter he has a difficult problem to solve, and I would advise him to get full data as to quantity and head of water and get in communication with one or two of the best turbine builders, who would be pleased to put their services at his command, and being experts would be less likely to slip up.—K.

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*Answer to No.* 786 (*awarded* 7*s.* 6*d.*).—The best way to find the amount of surplus power would be to find the total power of the stream, and compare the resultant figure with the horse-power already used; so we have first to measure the total flow or total quantity of water, and then convert this into mechanical and electrical horse-power to get what is required. There are two good ways to measure this total quantity.

*A.* In large streams it is done by finding the average cross-section of the stream for some distance along its length, say for 50 yards, and then measuring the velocity of water over that same distance by a water-meter. If an instrument is not available, it can be found by noting the velocity of a piece of wood in mid-stream with a marked distance and a reliable stop-watch. Take several readings to get good reliable average figures. Then if V = velocity of "wood" in feet per second, and $v$ mean velocity of the stream in feet per second, then

$$v = V \times \frac{7\cdot71 + V}{10\cdot28 + V} \text{ approximately.}$$

If A = sectional area in square feet;
Q = total quantity of water in cubic feet per second.

Then $$Q = A\,v \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

*B* If the stream be small, as the large majority of streams in England are, a temporary weir may be made

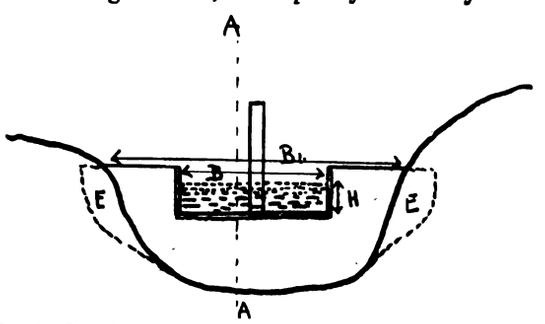


FIG. 1.—Cross Section. E = Edges of Weir Board Sticking into Bank.

and placed across the stream, so that the whole of the water passing down the stream will have to pass over a notch cut into this weir. Make up a large board big enough for the stream; the thickness must be large enough to stand the water pressure. This is, of course, a very variable quantity, and the details must be left to the engineer at this particular station. It is a good plan to slot the banks of the stream a little to take the extreme edges of this board. This will help to hold it firmly in place. On the top of the board, in the middle, a notch must be cut (see Fig. 1). This notch may be any width from one-fourth to total width of stream. Do not make it less than one-fourth. It must also be arranged so that there is not less than 6in. of water above the bottom of notch. That is the distance H (Fig. 1). The sides and bottom of the notch must be chamfered to a fine edge to get the best results, the chamfer being on the down-stream side. When the board is in its place in river, it becomes necessary to adopt

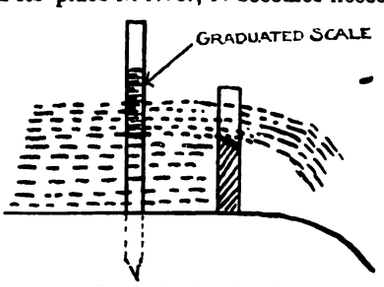


FIG. 2.—Section through A A.

some scheme to measure the distance H, as it may vary during the test, and also it is very important to measure it accurately. The best way is to drive a stake into the bed of river, some little way above the board where the water is comparatively still. This stake should be graduated over a large part of its length into feet and inches, and must be so fixed that the bottom of the graduated part, the zero of the scale, is on a level with the bottom of the notch (Fig. 2). This is done by driving the stake into water a little way, and then adjusting it as the water rises to the level of notch. When the water is just as high as the bottom of notch, the zero should be at water-level. Everything is now ready for taking observations.

Let H = height of water over notch in inches;
$H_1$ = " " " in feet;
B = breadth of notch in feet;
$B_1$ = " stream " ;
Q = total quantity of water in cubic feet per minute;
W = " " pounds "

We have the choice of several formulæ for calculation of Q or W. All are good, and agree well in practical working.

$$Q = 321\,H_1\,K\,B\,\sqrt{H_1} \quad . \quad . \quad . \quad . \quad (2)$$

Here we have a constant K which is $\cdot57 + \frac{B}{B_1}$ for all values of $\frac{B}{B_1}$ between one-fourth and unity.

$$Q = 321\,K\,B\,\sqrt{H_1^3} \quad . \quad . \quad . \quad . \quad (3)$$

$$Q = 7\cdot72\,K\,B\,\sqrt{H^3} \quad . \quad . \quad . \quad . \quad (4)$$

$$W = 482\,K\,B\,\sqrt{H^3} \quad . \quad . \quad . \quad . \quad (5)$$

Here constant K depends also on ratio of $\frac{B}{B_1}$. Exhaustive figures have settled the value of K as below:

| $\frac{B}{B^1}$ = | 1·0 | ·9 | ·8 | ·7 | ·6 | ·5 | ·4 | ·3 | ·25 |
|---|---|---|---|---|---|---|---|---|---|
| K = | ·667 | ·66 | ·65 | ·64 | ·63 | ·62 | ·61 | ·6 | ·595 |

If the notch is made half width of the stream—that is, $\frac{B}{B_1} = \cdot5$—then

$$Q = 4\cdot8\,B\sqrt{H^3} = 199\,B\sqrt{H_1^3} \quad . \quad . \quad (6)$$

Another formula used with this method is

$$Q = 40\,K\,(B - \cdot2\,H_1)\,H_1\sqrt{2\,g\,H_1} \quad . \quad . \quad (7)$$

The author specifies that the ratio $\frac{B}{B_1}$ should not be less than $\frac{1}{3}$, and also gives K as a constant = 62·2 for all values above this limit to unity.

Sometimes it is impossible to avoid having rather a high velocity of water as it approaches the board. If this velocity is too large to neglect, a slight modification is necessary. If V = this velocity in feet per second and $H_0$ the head due to it, then

$$H_0 = \frac{V^2}{2\,g};$$

and equation (3) becomes

$$Q = 321\,K\,B\,\{\sqrt{(H_1 + H_0)^3} - \sqrt{H_0^3}\} \quad . \quad (8)$$

Unless the velocity is really high this makes very little difference to result. If only an approximation is wanted, it can easily be neglected altogether. Only on one occasion have I known any appreciable difference in result of calculations to be caused by this water velocity before the board. That was on a small but rather rapid stream in a small village of Suffolk, where a turbine was being installed to run a dynamo for house lighting.

We have now obtained either our total quantity of water in cubic feet per minute, or total weight of water in pounds per minute for equation (5).

Let W.H.P. = total water horse-power;
Q = total quantity of water cubic feet per minute;
G = weight of cubic feet of water = 62·4lb.
H = head in feet;
W = total quantity of water pounds per minute.

Then $$\text{W.H.P.} = \frac{Q \times G \times H}{33{,}000} \quad . \quad . \quad . \quad . \quad (9)$$

$$\text{W.H.P.} = \frac{W \times H}{33{,}000} \quad . \quad . \quad . \quad . \quad . \quad (10)$$

From this the amount of power available can be calculated: first, by subtracting the W.H.P. already being used; secondly, by allowing for turbine efficiency, varying from 70 to 90 per cent. with different makes and sizes, we get the mechanical horse-power available from the surplus. Now, allowing for the efficiency of the elec-

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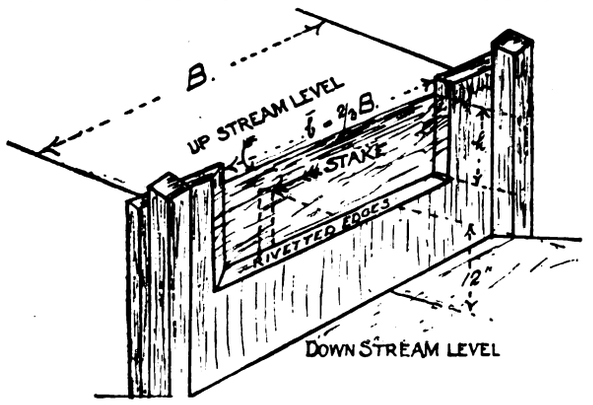
trical generator 85 to 95 per cent., according to kilowatt output, the exact figure for horse-power available still from the river for lighting or power supply will be obtained.

These tests should be taken with river in normal state, and the resultant figure used as a minimum basis, the frequent flooding will not then adversely affect the calculations.—F. R.

*Answer to No.* 786 (*awarded* 7*s.* 6*d.*).—Where the fall is only 11ft., and where the source of the water supply is liable to floods, a pressure turbine, arranged to work entirely immersed in the tail water if necessary, and provided with a suction pipe at its discharge, to take full advantage of the complete head during occasions of drought and a consequently diminished water-level at the tail race, would be the most efficient motor. In all probability the existing plant is of this description, hence it will be impossible to measure the water passing through these turbines at the tail race, resort having to be made to the watercourse. It is necessary that the quantity of water being used in the existing installation should be measured together with the water passing unused over the weir—if such exists—immediately below the intake; due note also being taken of the spill or overflow water at the turbine end of the watercourse, where a head tank is frequently employed joined up to the line of piping.




The means employed for measuring such quantities of water may be gleaned from the accompanying sketch and explanation. Place a board in a position where the water flows gently. Cut a notch in the board of sufficient depth to pass all the water to be measured, and not more than two-thirds of the width of the channel. The bottom edge of the notch should be level, and this edge, together with the sides, should be bevelled to almost a sharp edge towards the down-channel side, as shown, and the surface of the water, below the notch, should not be more than 12in. About 3ft. behind the notch drive a stake into the bottom of the channel, the top of the stake being level with the notch. When the water has reached its greatest depth measure the distance marked *h* in the sketch—from top of stake to surface—with a thin-edged rule; this will give the depth of water flowing. From the table given herewith, or from others found in most books of formulæ, the quantity of water in cubic feet per minute for varied depths of weirs can be readily worked out. The number in the table corresponding to the depth, *h*, when multiplied by the length of the notch in inches will give the quantity of water in cubic feet per minute.

| Depth of weir, *h*, in inches. | Multiplier. | Depth of weir, *h*, in inches. | Multiplier. |
|---|---|---|---|
| 1 | ·40 | 9 | 10·85 |
| 2 | 1·14 | 10 | 12·71 |
| 3 | 2·09 | 11 | 14·67 |
| 4 | 3·22 | 12 | 16·73 |
| 5 | 4·50 | 13 | 18·87 |
| 6 | 5·90 | 14 | 21·09 |
| 7 | 7·44 | 15 | 23·38 |
| 8 | 9·10 | 16 | 25·76 |

Taking an example of this method of calculation. If the depth, *h*, of water in the notch be 8in, and the length, *b* 60in., the multiplier given in the foregoing table corresponding to 8 is 9·10. Then we have 9·1 × 60 = 546·0 cubic feet per minute. Both in the watercourse and in the main stream below the intake, or at the weir, notch-boards as described might be placed, and also at the overflow or spill a similar method may be employed if the overflow edge is not level or is irregular. Should a concrete weir already exist in a stream of medium dimensions, by the application of substantial timbers, arranged in a manner akin to that of the notch-board in sketch, reliable results may be obtained. Readings of the measurements at the notch-boards, taken say twice each day and duly logged, when studied together at the year's end will provide the necessary data from which the surplus power in the stream not utilised is easily reckoned. The reason why separate records are taken of the volume of water passing along the watercourse to energise the existing turbines is to provide reliable figures, giving the water power used in producing the year's output in Board of Trade units, these latter, of course, having been carefully compiled.

In conjunction with these readings and measurements there should be tabulated simultaneously, during the year, the rainfall within the catchment area whence the stream draws its supply. A comparison of the total year's rainfall with previous annual results will determine whether the quantity of rain which has fallen throughout the year's test has been normal or otherwise. Some advantage would accrue from the use of more than one rain-gauge placed in different parts of the catchment area. This would obviate any error due to local showers being taken as general or common to the district.

It may be that a large river is involved in these calculations; if such be the case, then another method other than that of the notch-board may be more satisfactory, in which is eliminated all measurements of the water utilised in the existing plant, though this should still be done if convenient. By taking the total volume of water flowing in the river above the intake for the watercourse, the total power available is ascertained; deducting from this the capacity of existing plant, the surplus power is the resultant. This second method is as under: Choose a length of river about 50ft. to 100ft. in length, along which the water flows gently, and where the section of the river bed is reasonably uniform; find its area by multiplying the average width by the average depth, several sections on the chosen length being measured to find the mean dimensions. Two stakes should be fixed in the river some known distance apart; a float thrown in above the first stake should be timed from the moment it passes the first until it reaches the second stake. Repeat this several times to secure an average rate of flow, and from these figures the quantity of water passing in cubic feet per minute can be found by multiplying the average sectional area of the river by the measured length in feet, then again by 60, and dividing the product by the time in seconds taken by the float to pass over the chosen length from the first to the second stake. For instance, the sectional area of a river is 80 square feet, and the float passes over the measured length of 100ft. in 80 seconds, then $\frac{80 \times 100 \times 60}{80}$ = 6,000 cubic feet per minute. From this result nearly 20 per cent. must be deducted to allow for the friction on the banks and river bottom. Then 6,000 − 1,200 = 4,800 cubic feet per minute. A simple calculation at the end of the year's test from the accumulated figures will give the available water power now going to waste, and also whether any advantage would ensue from the construction of a storage dam. Assuming the average surplus water passing over the river to be 5,000 cubic feet per minute, this volume, with 11ft. as the available head, provides the following equation:

$$\frac{5{,}000 \times 62{\cdot}5 \times 11 \times {\cdot}75}{33{,}000} = \text{horse-power} = 78{\cdot}125 \text{ h p}$$

This equation will be correct for all turbines or other water motors of 75 per cent. efficiency.

In working out available water power it is not a reliable policy to allow for the full head of water in the suction pipe of a pressure turbine; about ·5 of the head due to this would be a safe estimate.—WALLSEND ON TYNE.

[Other replies to Question No. 786 will be given in our next issue.—ED. *E. E.*]

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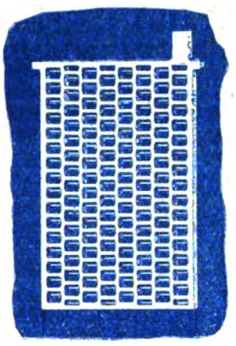

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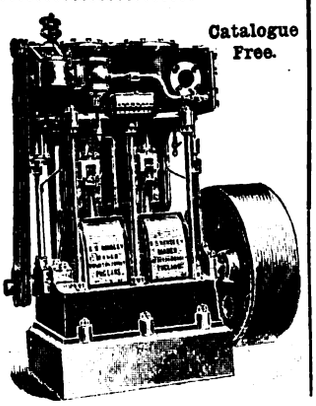

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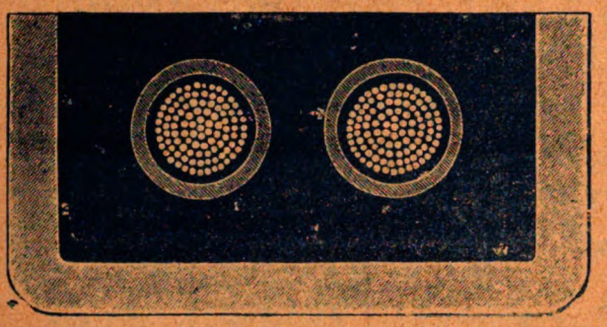

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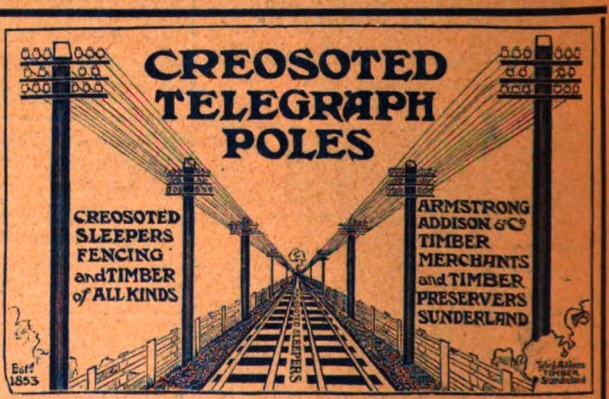


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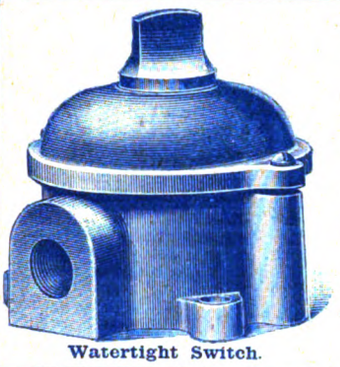

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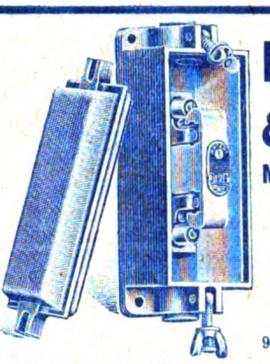

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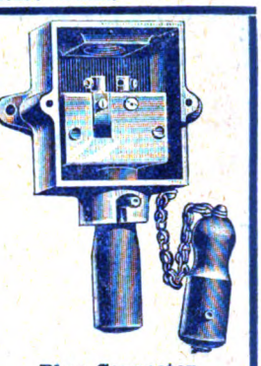

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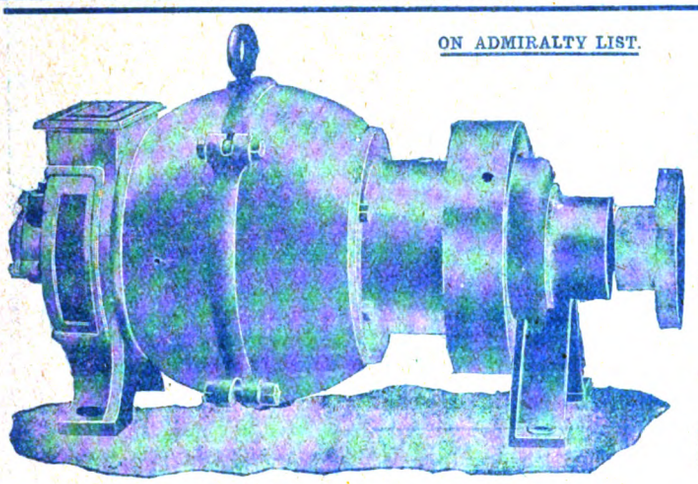

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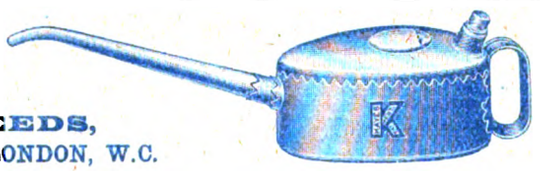

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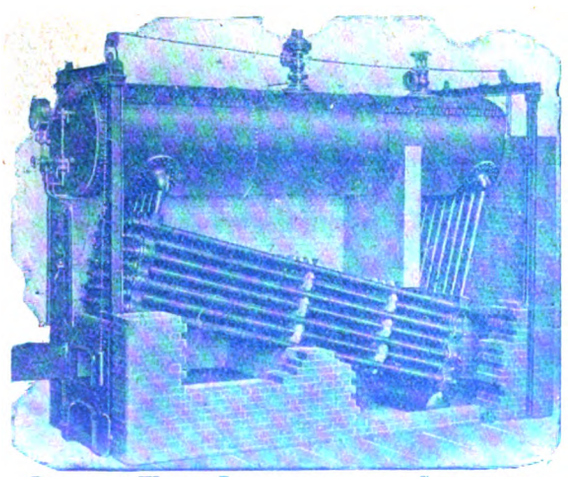

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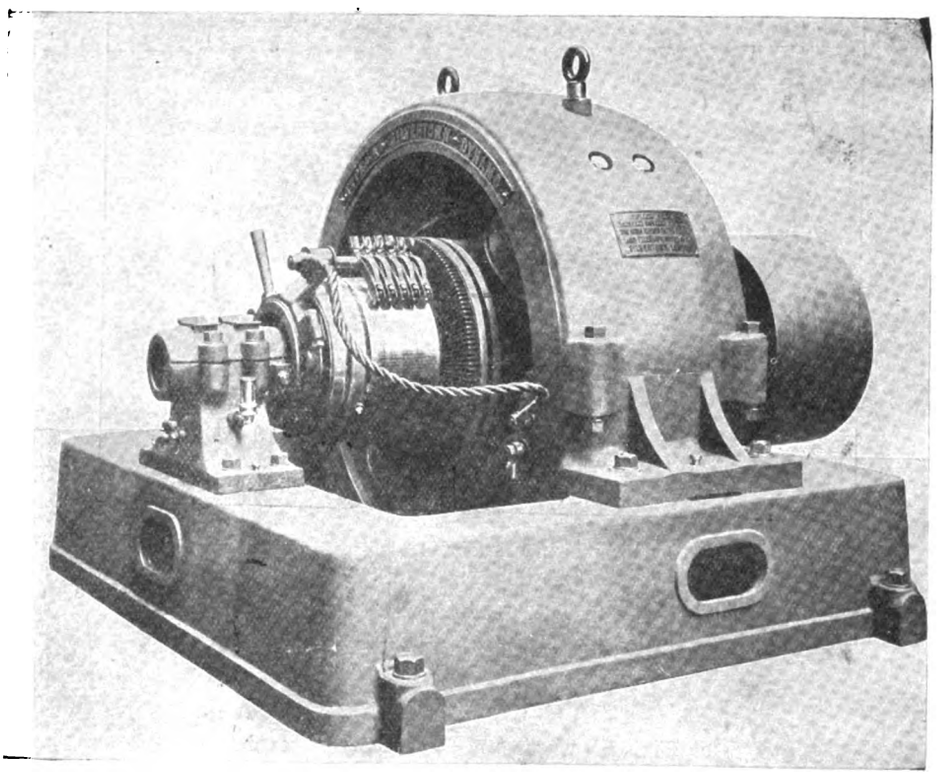

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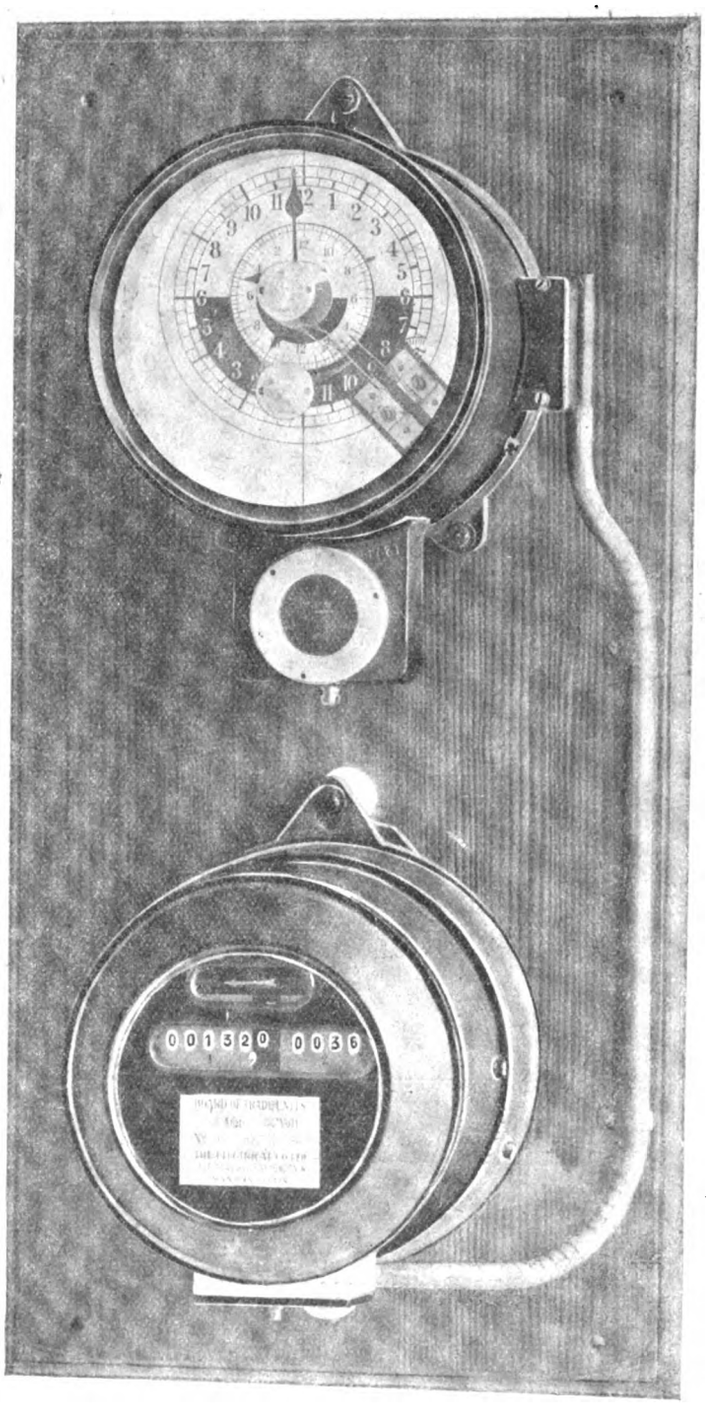


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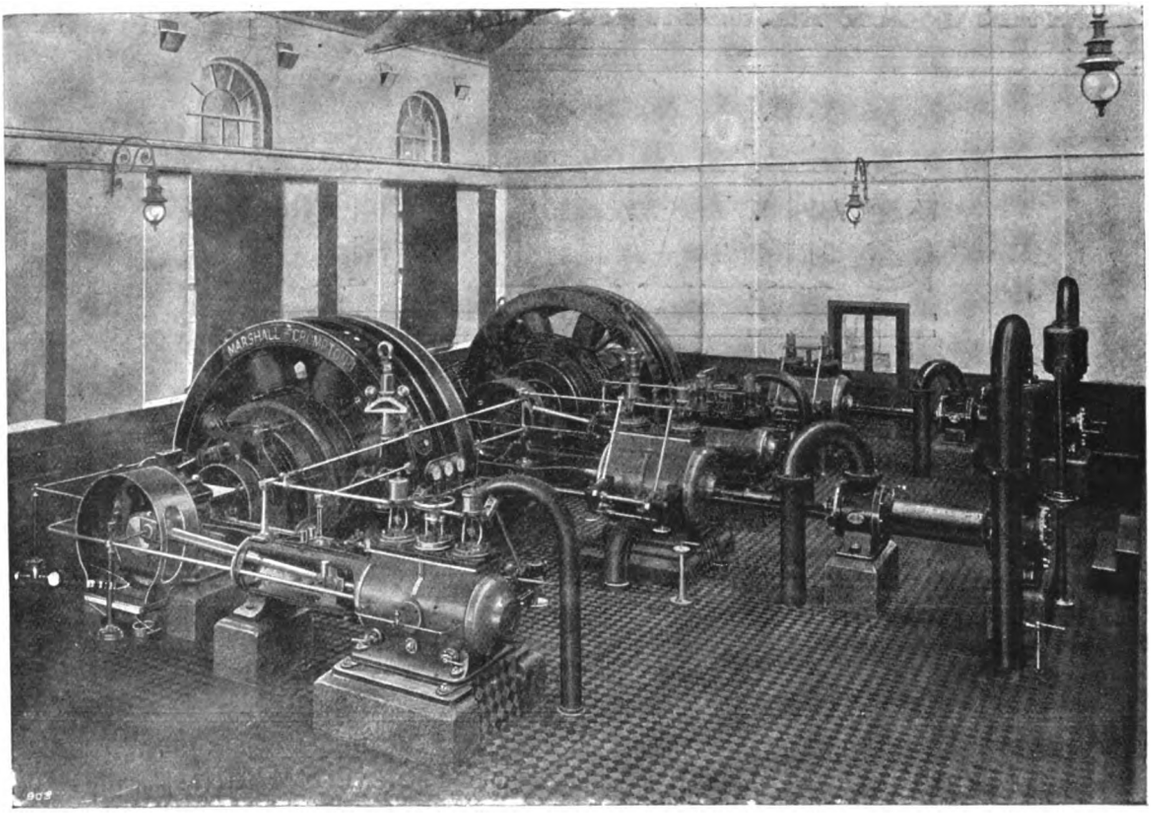


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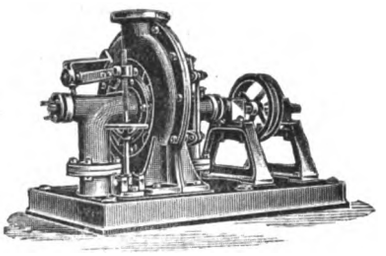

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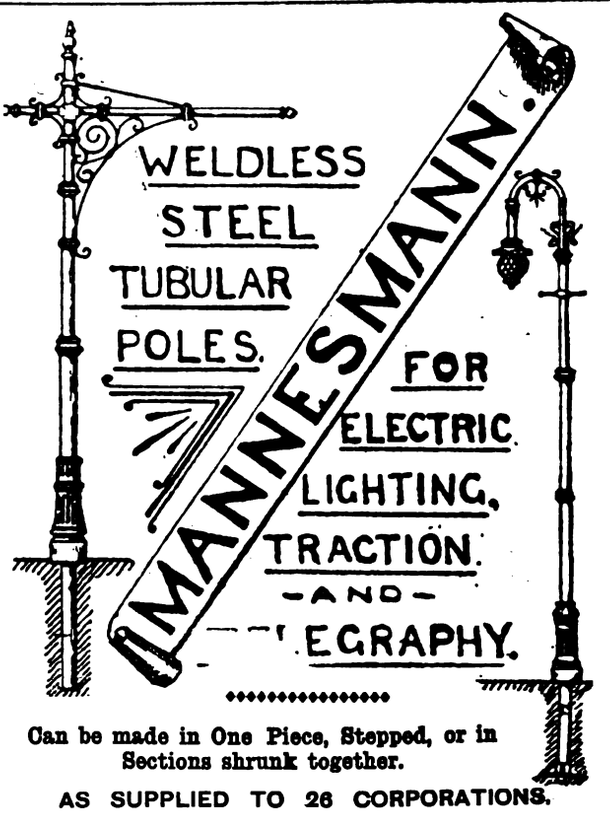


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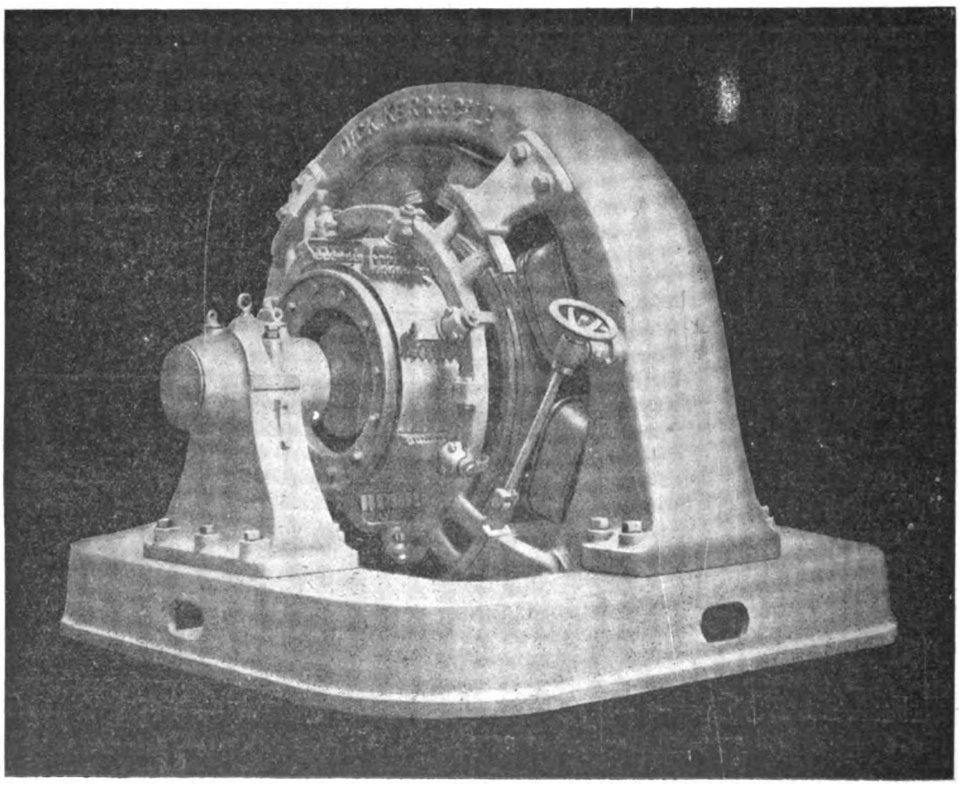

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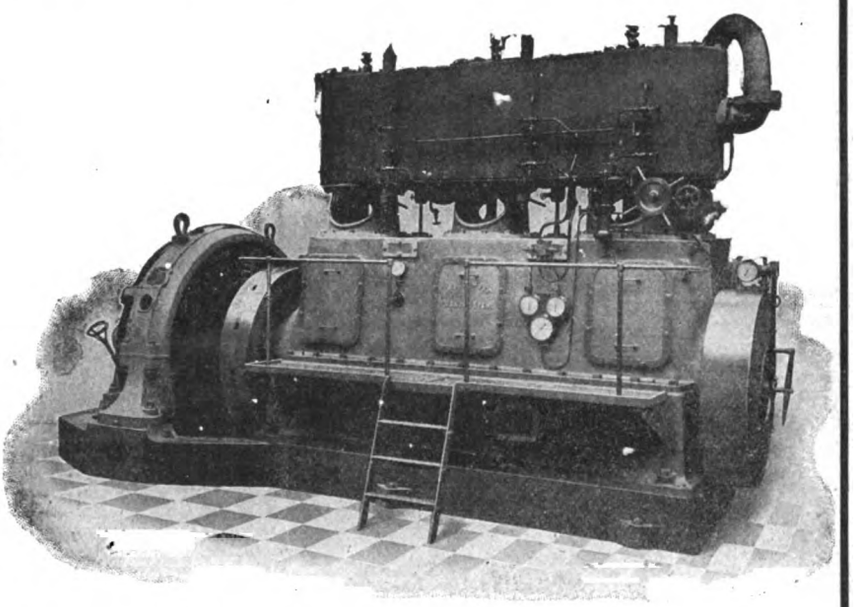

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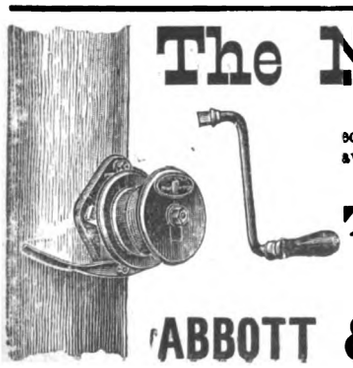

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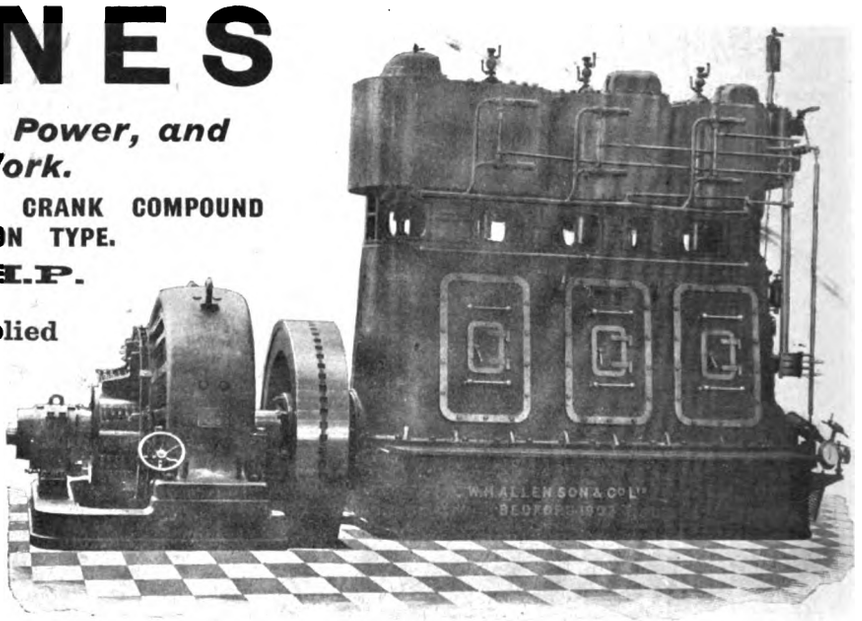

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### Accumulators.

British Accumulator Co., Ltd., 15, Victoria-street, London, S.W.
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Hart Accumulator Company, Marshgate-lane,
Johnson and Phillips, Old Charlton, Kent.
Tudor Accumulator Co., Limited, 16, Victoria-street, S.W.

### Accumulator Acid Manufacturers.

Berk, F. W., and Co., Limited, 1, Fenchurch-avenue, London, E.C.

### Address Label Makers.

Endolithic Manufacturing Co., 61½, Fore-st., E.C

### Arc Lamp Hoists.

Abbott and Co., Newark-on-Trent.

### Arc Lamps.

British Thomson-Houston Company, Rugby.
Brockie-Pell Arc Lamp, Limited, 60, Worship-street, London, E.C.
Crompton and Co., Chelmsford.
Defries, J., and Sons, 146 and 147, Houndsditch, London, E.C.
Electrical Company, Limited, 121-125, Charing Cross-road, S.W.
Foster and Co., Worple-road, Wimbledon.
General Electric Co., 71, Queen Victoria-street.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson and Phillips, Old Charlton, Kent.
Newton Electrical Works, Taunton.
Union Electric Co., 151, Queen Victoria-st., E.C

### Batteries (Primary) and Accessories.

General Electric Co., 71, Queen Victoria-street.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson and Phillips, Old Charlton.

### Belting.

Cort, A., and Co., Camberwell, London, S.E.
Hendry, J., 252, Main-st., Bridgeton, Glasgow.
Webb and Son, Combs Tannery, Stowmarket.
Willcox and Co., 36, Southwark-street, S.E.

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### Boilermakers.

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Davey, Paxman, and Co., Colchester.
Galloways Limited, Manchester.
Hindley, E. S., and Sons, 11, Queen Victoria-street, London, E.C.
Ransomes, Sims, and Jefferies, Ipswich.

### Cable and Wire-Covering Machinery.

Bridge, D., and Co., Castleton, Manchester.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson and Phillips, Old Charlton, Kent.

### Cable and Wire Makers.

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British Insulated and Helsby Cables, Limited, Prescot.
Callender's Company, Hamilton House, Victoria-embankment, E.C.
Electrical Co., 121-125, Charing Cross-road.
Garnett, W. T., and Co., Barkerend Mills, Bradford.
General Electric Co., 71, Queen Victoria-st., E.C
Henley's, W. T., Telegraph Works Company, Blomfield-street, London-wall, E.C.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson and Phillips, Old Charlton, Kent.
London Electric Wire Co., Playhouse-yd., E.C.
St. Helens Cable Co., Limited, Warrington.
Western Electric Company, Bridge-chambers, 171, Queen Victoria-street, E.C.

### Carbons (Arc Light).

Crompton and Co., Arc Works, Chelmsford.
Electrical Co., 122, Charing Cross-road, W.C.
General Electric Company, 69, 71, and 88, Queen Victoria-street, E.C.
India Rubber, etc., Co., Silvertown, Essex.
Johnson and Phillips, Old Charlton, Kent.

### Castings and Cleats.

General Electric Company, 71, Queen Victoria-street, E.C.
Haden, G. N., Trowbridge.
Kuettner, B., and Macdonell, 3, Adam-street, Adelphi, W.C.
Lowcock, A., Coleham Foundry, Shrewsbury.
Simplex Steel Conduit Co., Coventry-street Birmingham

### Dynamo Oil.

Willcox and Co., Southwark-street, S.E.

### Dynamos, Transformers, Motors, etc.

Allen, W. H., Son, and Co., Queen's Engineering Works, Bedford.
British Thomson-Houston Company, Rugby.
British Westinghouse Electric and Mfg. Co. Westinghouse Building, Norfolk-st., W.C.
Crompton and Co., Chelmsford.
Electric Construction Company, Dashwood House, New Broad-street, E.C.
Electrical Co., 121-125, Charing Cross-road.
Electromotors Limited, Openshaw, Manchester
Ferranti Limited, Hollinwood, Lancs.
General Electric Co., 71, Queen Victoria-street
India Rubber, etc., Company, Silvertown
Industrial Engineering Co., Hyde, Manchester
Johnson and Phillips, Old Charlton, Kent.
Lahmeyer Electrical Co., Limited, 109-111, New Oxford-street W.C.
Newton's Limited, Taunton.
Peebles, D. B., and Co., Edinburgh
Union Electric Co., 151, Queen Victoria-st., E.C

### Ebonite and Vulcanite.

Traun, Dr. Heinr., and Sons, 8, Redcross-street, London, E.C.

### Electric Cooking Apparatus.

Crompton and Co., Salisbury House, London wall, E.C.
General Electric Co., 71, Queen Victoria-street.

### Elevating, Conveying Plant, Cranes, etc

Crompton and Co., Chelmsford.
Electrical Co., 122, Charing Cross-road, W.C
General Electric Co., 71, Queen Victoria-st., E.C
Graham, Morton & Co., Ld., Hunslet, Leeds
Lahmeyer Electrical Co., Limited, 109-111 New Oxford-street, W.C.

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### Electrical Fittings.

British Mannesmann Tube Company Limited, Landore, R.S.O., South Wales.
Dorman and Smith, Ordsal Station Electrical Works, Salford.
Electrical Co., 121-125, Charing Cross-road.
General Electric Co., 71, Queen Victoria-street.
Lundberg, A. P., Pioneer Electrical Works, 477 to 487, Liverpool-road, N.
Munzing, H., 179, Upper Thames street, E.C.
New Brotherton Tube Co., Commercial-road, Wolverhampton.
Russell, J., and Sons, Crown Tube Works, Wednesbury.
Simplex Steel Conduit Co., Coventry-street, Birmingham.
Tucker, J. H., and Co., Sampson-road North, Birmingham.

### Electric Cooking Apparatus.

Crompton and Co., Salisbury House, London-wall, E.C.
General Electric Co., 71, Queen Victoria-street.

### Electric Light Contractors.

British Thomson-Houston Company, Rugby.
British Westinghouse Electric and Mfg. Co., Westinghouse Building, Norfolk-st., W.C.
Brockie-Pell Arc Lamp, Limited, 60, Worship-street, London, E.C.
Browett, Lindley, and Co., Patricroft, near Manchester.
Crompton and Co., Salisbury House, London-wall, E.C.
Electric Construction Company, Dashwood House, New Broad-street, E.C.
Electrical Power Storage Company, 4, Great Winchester-street, E.C.
Ferranti Limited, Hollinwood, Lancs.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson and Phillips, Old Charlton, Kent.
Lahmeyer Electrical Co., Limited, 109-111, New Oxford-street, W.C.
White, J. G. and Co., 22A, College-hill, E.C.

### Electric Locomotives.

British Thomson-Houston Company, Rugby.
British Westinghouse Electric and Mfg. Co., Westinghouse Building, Norfolk-st., W.C.
Electrical Co., 121-125, Charing Cross-road.
Lahmeyer Electrical Co., Limited, 109-111, New Oxford-street, W.C.

### Engine Accessories, Tanks, etc.

Babcock and Wilcox, 30, Farringdon-st., E.C.
Bailey, W. H., and Co., Manchester.
Bayliss, Jones, and Bayliss, Wolverhampton.
Davies and Metcalfe, Romiley, Manchester.
Graham, Morton & Co., Black Bull-st., Leeds.
Willcox and Co., 36, Southwark-street, S.E.

### Engineers' Stores.

Willcox and Co., 36, Southwark-street, S.E.

### Engines.

Allen, W. H., Son, and Co., Queen's Engineering Works, Bedford.
Browett, Lindley, and Co., Patricroft, near Manchester.
Crossley Bros., Limited, Openshaw.
Davey, Paxman, and Co., Colchester.
Galloways Limited, Manchester.
Hindley, E. S., and Sons, Bourton, Dorset, and 11, Queen Victoria-street, E.C.
Ransomes, Sims, and Jefferies, Ipswich.
Robey and Co., Lincoln.
Willans and Robinson Rugby.

### Glass Shades for Electric Light.

Walsh, J. W., Soho and Vesta Glass Works, Birmingham.

### Incandescent Lamps.

A.E.G. Manufacturing Company, 4, New Compton-street, Charing Cross-road, W.C.
British Thomson-Houston Company, Rugby.
Brockie-Pell Arc Lamp, Limited, 60, Worship-street, E.C.
Electrical Co., 121-125, Charing Cross-road.
General Electric Co., 71, Queen Victoria-street
Henley's, W. T., Telegraph Works Company, Blomfield-street, London-wall, E.C.
Linolite Company, 25, Victoria-street, S.W.
Zurich Incandesence Lamp Company, 47, Victoria-street, Westminster.

### Indiarubber Goods.

India Rubber, etc., Co., 106, Cannon-st., E.C.
Moseley, D., and Sons, Chapel Field Works Ardwick Manchester.
Willcox and Co., 36, Southwark-street, S.E.

### Insulators and Insulating Materials.

Blackwell, R. W., and Co., 59, City-road, E.C.
British Electric Equipment Company, Mansion House Chambers, 11, Queen Victoria-st., E.C.
Conduit and Insulation Company, 63, Queen Victoria-street, E.C.
Crystalate Manufacturing Company, 61½, Fore-street, London, E.C.
Electrical Co., 122, Charing Cross-road, W.C.
General Electric Co., 71, Queen Victoria-st., E.C.
Griffiths Bros, Mack's road, Bermondsey S.E.
Johnson and Phillips, Old Charlton, Kent.
Keys, W. H., Hall End Works, West Bromwich
Macintyre, J., and Co., Washington China Works, Burslem.
Price, Sons, and Co., Bristol.
Rowland Carr and Co., 6-8, Lime-street Square

### Ladders and Steps.

Heathman, J. H., and Co., Parson's Green, S.W

### Lamp Columns for Arc Lighting.

General Electric Co., 71 Queen Victoria-st., E.C.
Johnson and Phillips, Old Charlton, Kent.

### Lampholder Makers.

Dorman and Smith, Ordsal Station Electrical Works, Salford.
Electrical Co., 121-125, Charing Cross-road.
General Electric Co., 71, Queen Victoria-street.

### Lead-Covered Cables.

British Insulated and Helsby Cables, Limited, Prescot.
Callender Company, Hamilton House, Victoria Embankment, E.C.
Henley's, W. T., Telegraph Works Company, Blomfield-street, London-wall, E.C.
Johnson and Phillips, Old Charlton, Kent.
London Electric Wire Co., Anchor Works, Playhouse-yard, E.C.
St. Helens Cable Co., Limited, Warrington.
Telegraph Mfg. Company, Helsby, Warrington.
Western Electric Co., Bridge Chambers, 171, Queen Victoria-street, E.C.

### Mechanical Stokers and Conveyors.

Babcock and Wilcox, 30, Farringdon-st., E.C.
Graham, Morton & Co., Black Bull-st., Leeds.

### Mica.

Baxter, R. and S., 31, Murraygate, Dundee.
Taylor and Co., 19, Hatton Garden, E.C.

### Motors (Electric).

Allen, W. H., Son, and Co., Queen's Engineering Works, Bedford.
British Thomson-Houston Company, Rugby.
Churton, T. H., and Co., Atlas Works, Leeds.
Crompton and Co., Arc Works, Chelmsford.
Electric Construction Company, Dashwood House, New Broad-street, E.C.
Electrical Co., 121-125, Charing Cross-road.
Ferranti Limited, Hollinwood, Lancs.
General Electric Co., 71, Queen Victoria-st., E.C.
Industrial Engineering Co., Hyde, Manchester
Johnson and Phillips, Old Charlton, Kent.
Lahmeyer Electrical Co., Limited, 109-111, New Oxford-street, W.C.
Newton's Limited, Taunton.
Peebles, D. B., and Co., Edinburgh.
Rhodes Electrical Mfg. Company, 70 and 71, Bishopsgate-street Within, E.C.
Union Electric Co., 151, Queen Victoria-st., E.C

### Measuring Instruments (Electrical).

British Thomson-Houston Company, Rugby.
Electrical Co., 121-125, Charing Cross-road.
Everett, Edgcumbe and Co., 151 and 152, Great Saffron Hill, London, E.C.
Evershed and Vignoles, Acton-lane Works Chiswick, London, W.
General Electric Co., 71, Queen Victoria-st., E.C.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson and Phillips, Old Charlton, Kent.
Nalder Bros. and Thompson, 34, Queen-st., E.C.

### Nernst Lamps.

Electrical Co., 121-125, Charing Cross-road.

### Packings—Asbestos and Metallic.

United States Metallic Packing Company, Soho Works, Bradford.
Willcox and Co., 36, Southwark-street, S.E.

### Oil and Stores.

Kaye, J., and Sons, Leeds.
Reliance Lubricating Oil Co., 19 and 20, Water lane, Great Tower-street, E.C.

### Platinum Utensils.

Derby and Co., 44, Clerkenwell-road, E.C.
Smith and Co., 2, Ranelagh-road, East Ham.

### Projectors.

Johnson and Phillips, Old Charlton, Kent.

### Rheostats.

Defries, J., and Sons, 146-147, Houndsditch

### Screws.

Automatic Standard Screw Company, Halifax.

### Silk and Lace Shades.

Taylor and Co., 19, Hatton Garden, E.C.

### Slate.

Congdon and Powell, Bravington Works Bravington-road, Harrow-road, W.

### Switches, Cut-Outs, etc.

British Thomson-Houston Company, Rugby.
Dorman and Smith, Ordsal Station Electrical Works, Salford.
Electrical Co., 121-125, Charing Cross-road.
Ferranti Limited, Hollinwood, Lancs.
General Electric Co., 71, Queen Victoria-street.
Johnson and Phillips, Old Charlton, Kent.
Lundberg, A. P., Pioneer Electrical Works, 477 to 487, Liverpool-road, N.
Nalder Bros. and Thompson, 34, Queen-st., E.C.
Newton Electrical Works, Taunton.
Peebles, D. B., and Co., Edinburgh.

### Telegraph Poles.

Armstrong, Addison and Co., Sunderland.

### Telephones.

General Electric Co., 71, Queen Victoria-street.
Western Electric Co., Bridge Chambers, 171 Queen Victoria-street, E.C.

### Tower Wagons.

Heathman, J. H., and Co., Parson's Green, S.W

### Tramway Equipments.

British Electric Equipment Company, Mansion House Chambers 11, Queen Victoria-street.
British Mannesmann Tube Company, Limited Landore, R.S.O., South Wales.
British Thomson-Houston Company, Rugby.
Dick, Kerr, and Co., Abchurch-yard, Canno street, E.C.
Electric Railway and Tramway Carriage Works Limited, Preston, Lancs.
Ferranti Limited, Hollinwood, Lancs.
White, J. G., and Co., 22A, College-hill, E.C

### Turbines.

Electrical Co., 121-125, Charing Cross-road.
Gilbert Gilkes and Co., Kendal.

### Ventilating Fans.

Electric Railway & Tramway Carriage Works Preston, Lancs.
Gibbs, Jno., and Son, 72-76, Duke-st., Liverpool
Hardy and Padmore, Worcester.
Matthews and Yates, Cyclone Works, Swinton, Manchester.

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Baker's Patent Appliances Co., Scarborough.

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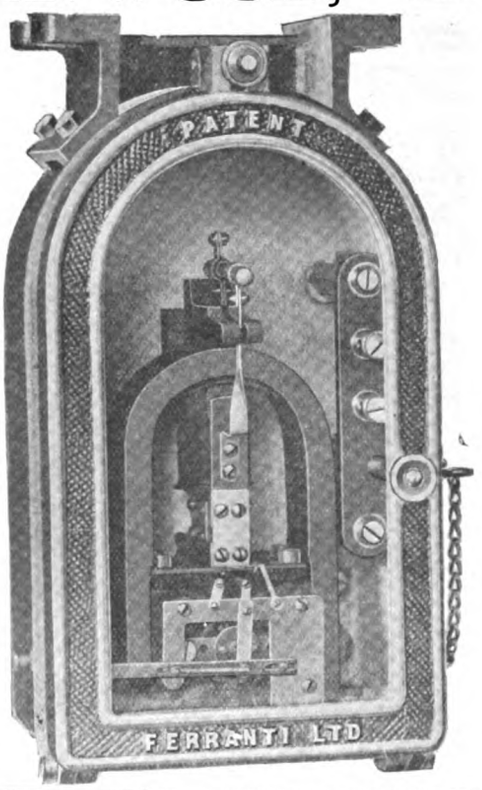


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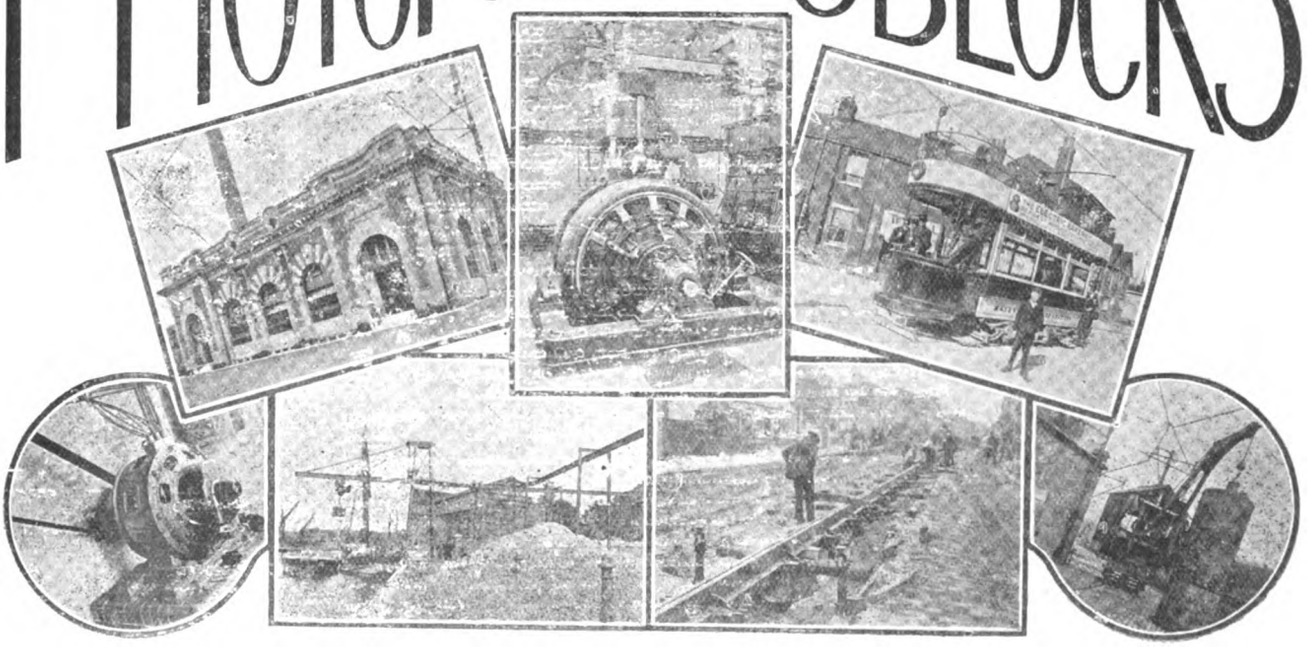

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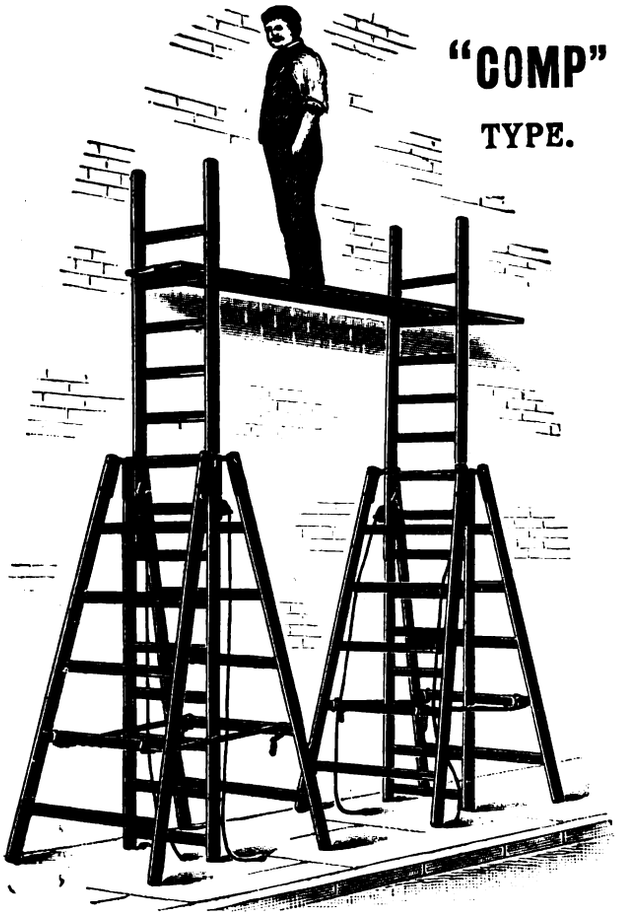

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**Heathman's Ladder Works,**
10, Parson's Green, LONDON, S.W.

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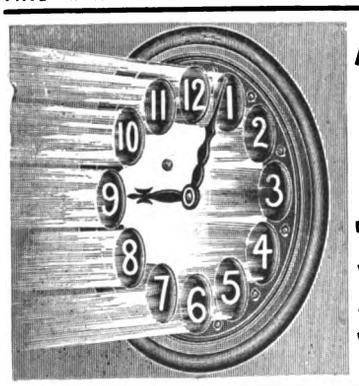

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Yorke, R. F., 3, Glebe-crescent, Stirling.
Young, G., Burleigh Lodge, Trinity Edinbro
Young, J., Metropolitan District Railway Company, St. James's Park Station, S.W.
Young, W., Aylesbury, Bucks.

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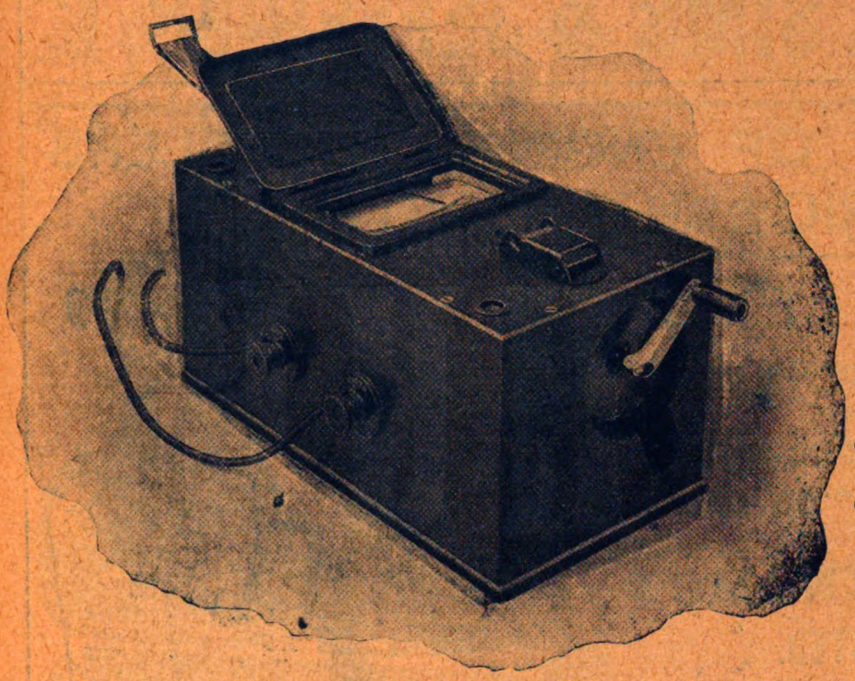
**This is Evershed's Megger in use for testing insulation.**



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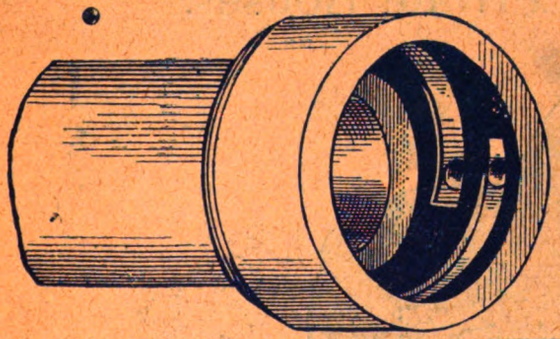
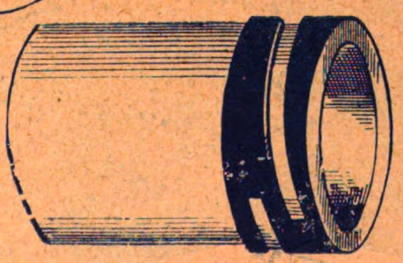


A Perfect Joint.

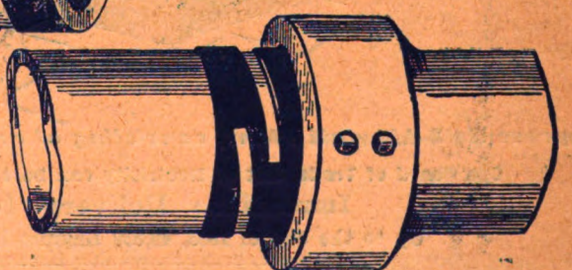
***A Screw Joint, but No Screw till Joint Formed.***

***EASY TO LAY.***



***Spirality Gives Perfection.***

**No Slip. Must Shear the Materials Before Breaking the Joint. Watertight & Strong.**



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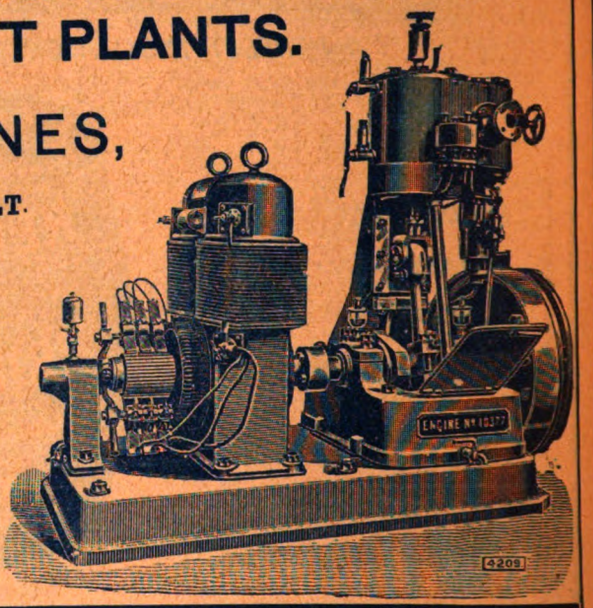

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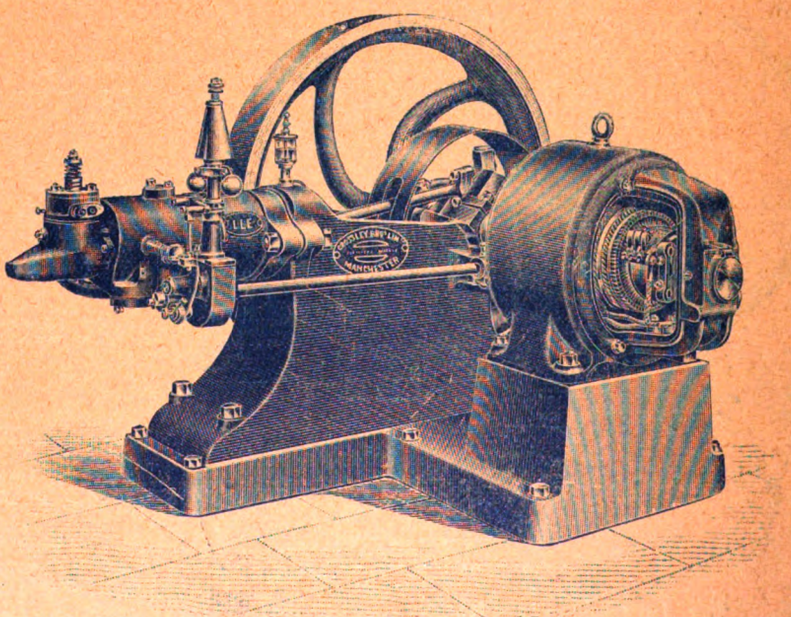

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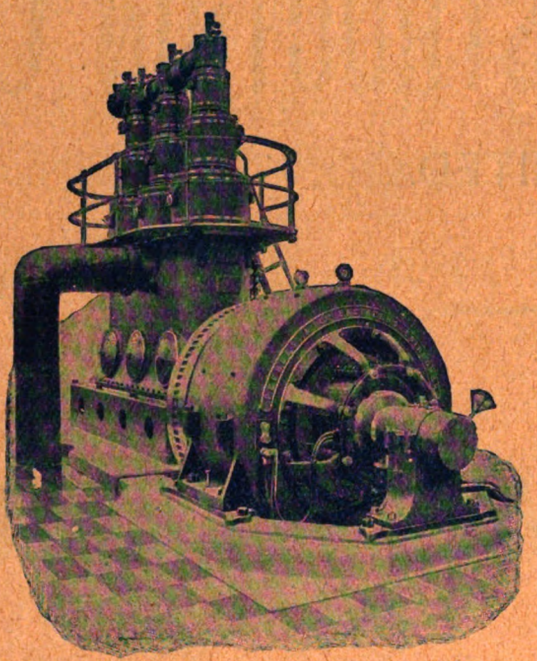

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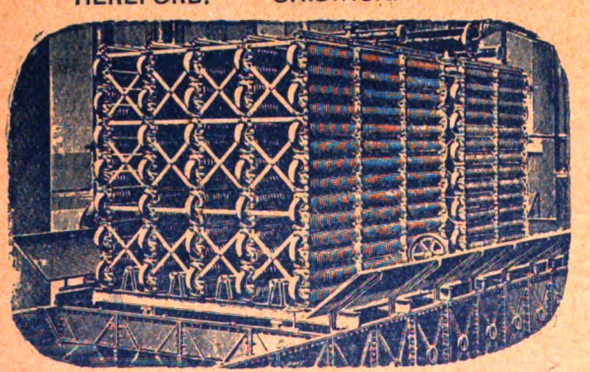

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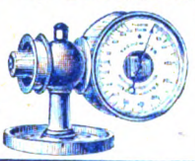

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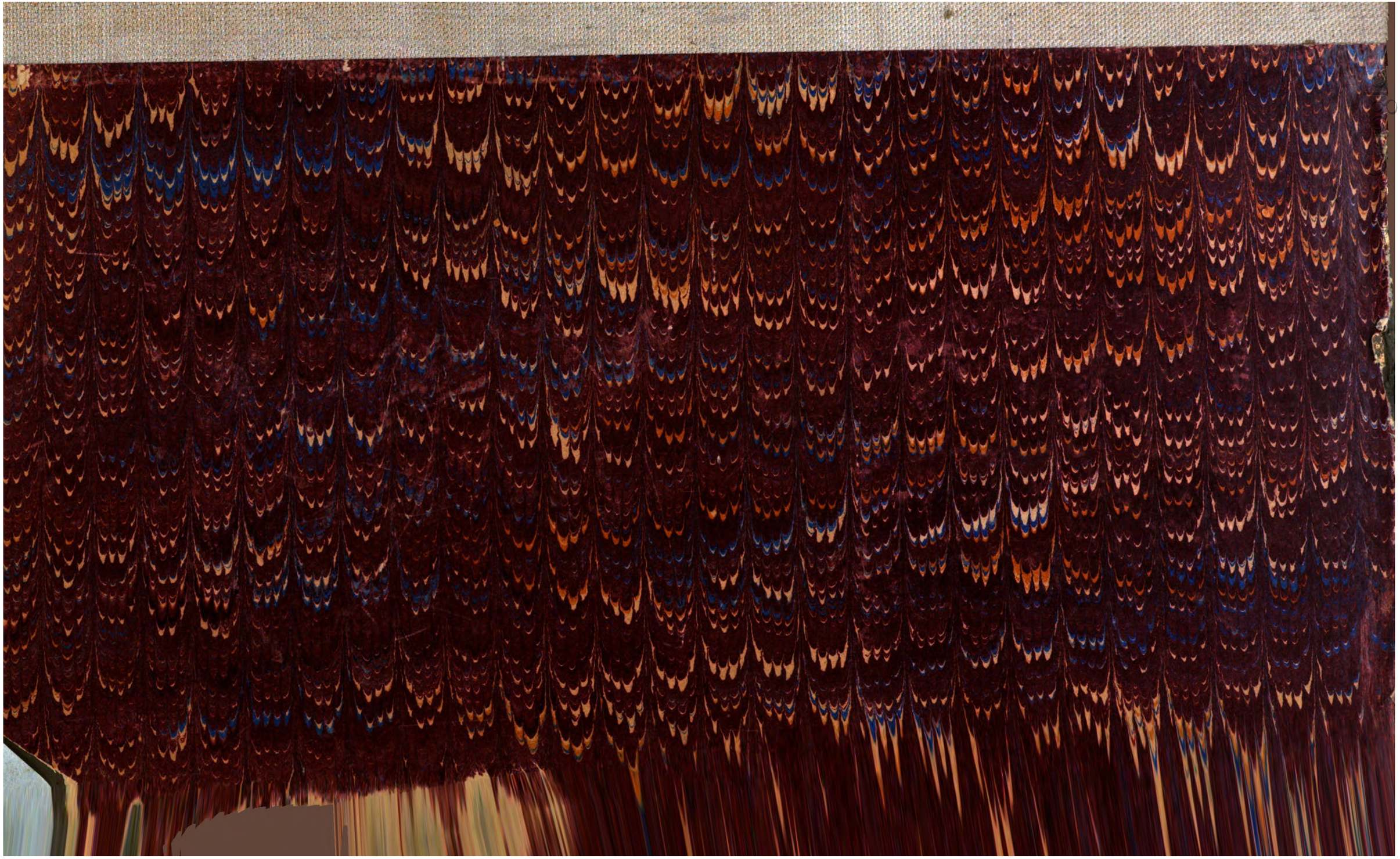
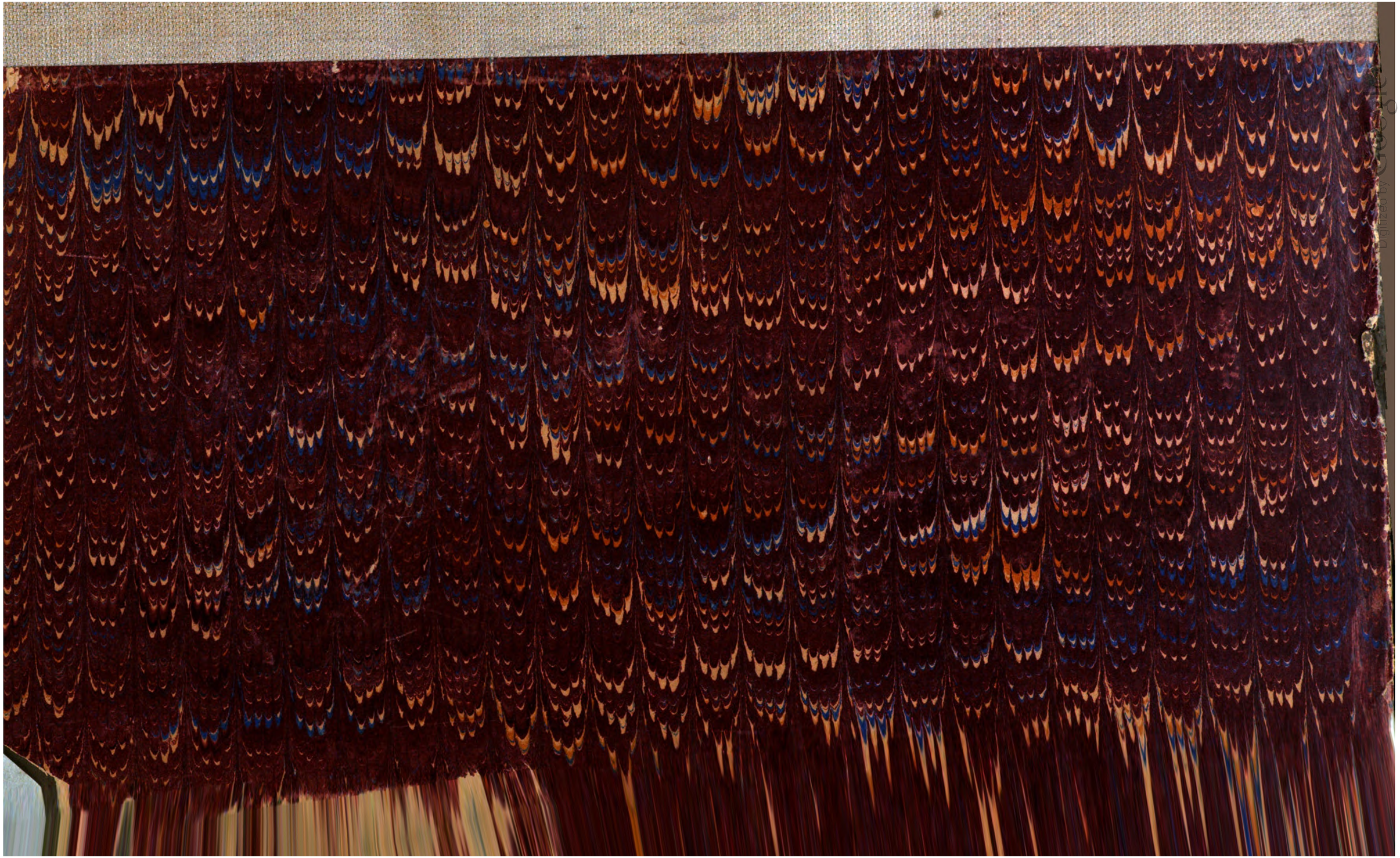
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